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Obesity and associated cardiovascular disease risk factors : the impact on American Indians residing in Southern California, 2002-2006

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Obesity and Associated Cardiovascular Disease Risk Factors: The Impact on American Indians Residing in Southern California, 2002-2006

A Dissertation submitted in partial satisfaction of the requirements for the degree

Doctor of Philosophy

in

Public Health (Epidemiology)

by

Jennifer Lea Reid

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2009

The Dissertation of Jennifer Lea Reid is approved, and it is acceptable in quality and form for publication on microfilm:

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Chair

University of California, San Diego

San Diego State University

2009

DEDICATION

To my husband, Tim Reid, who has been with me through every step of this journey and shared both the trials and the successes. Thank you for your support, patience and encouragement and for always being there for me.

To my family, who understood and supported the time it took away from visits to complete this lengthy journey.

To my friends Tyler and Besa Smith, who encouraged me to join this adventure, and who were there to watch me finally cross the finish line.

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LIST OF ABBREVIATIONS

AIAN, American Indian/Alaska Native

BMI, body mass index

BRFSS, Behavioral Risk Factor Surveillance System

CDC, Centers for Disease Control and Prevention

CHIS, California Health Information Survey

CI, confidence interval

CVD, cardiovascular disease

IHS, Indian Health Services

IRB, Institutional Review Board

NADXS, Native American Data Extraction and Surveillance

NHANES, National Health and Nutrition Examination Survey

OA, osteoarthritis

OR, odds ratio

RPMS, Resource Patient Management System

SCAIHC, Southern California American Indian Health Clinics

US, United States

WHI, Women’s Health Initiative

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Reid JL, Morton DJ, Garrett MD, Wingard DL, von Muhlen D, Slymen D, Field M. Obesity and Other Cardiovascular Disease Risk Factors and Their Association With Osteoarthritis in Southern California American Indians, 2002-2006. In review.

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ABSTRACT OF THE DISSERTATION

Obesity and Associated Cardiovascular Risk Factors: The Impact on American Indians Residing in Southern California, 2002-2006

by

Jennifer Lea Reid

Doctor of Philosophy in Public Health (Epidemiology)

University of California, San Diego, 2009

San Diego State University, 2009

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Cardiovascular disease (CVD) is the leading cause of death among American Indian/Alaska Native (AIAN) adults. Obesity, and other CVD risk factors such as smoking, diabetes, and hypertension, are more prevalent in many AIAN populations compared to the overall US. Osteoarthritis (OA) prevalence may be elevated as obesity is a risk factor for OA, and arthritis is present in half of adults with diabetes or hypertension.

The purpose of this dissertation was to examine age and gender-specific obesity prevalence in Southern California AIAN children and adults and assess the age and gender-specific association of obesity and smoking with diabetes and hypertension and the association of these risk factors with OA in adults. Visit data from 10,000+ AIAN children and adults attending a Southern California AIAN health clinic system during 2002-2006 were used.

More than one-third of AIAN children aged 6-17 years were obese with more obesity in boys than girls. In adults, obesity (54%), smoking (17%), diabetes (15%), and hypertension (34%) were very prevalent. For women, increasing obesity was associated with diabetes but for men only morbid obesity was associated with diabetes. Smoking was associated with diabetes for some age groups. Increasing overweight/obesity and smoking were associated with hypertension among men and women aged 18-65 years.

Age-adjusted OA prevalence was higher in women (16.5%) than men (11.5%), and prevalence increased with age. Extreme 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. Diabetes was associated with more OA for women aged 35-54 years.

Southern California AIAN had higher obesity, diabetes, and hypertension prevalence than the general Southern California population, and higher obesity prevalence compared to other AIAN communities. In contrast, OA prevalence may be less than overall US prevalence, with no reliable comparisons to other AIAN communities available.

AIAN communities are understudied and their diversity makes it difficult to generalize health information from one location or tribe to another. Comprehensive research and interventions tailored to cultural customs and the health problems most prevalent in each tribal community are needed.

CHAPTER 1

Background and Significance/Research Objectives

The obesity epidemic in the US is a significant public health concern that has been well-documented using nationally representative data from the National Health and Nutrition Examination Surveys (NHANES) [1,2,3,4]. Obesity prevalence rates for American Indians/Alaska Natives (AIANs) were not published separately for NHANES, but the 2001 Behavioral Risk Factor Surveillance System (BRFSS) reported elevated obesity prevalence among 2,299 AIAN compared to non-Hispanic whites and some minority populations [5]. Most of the obesity prevalence rates reported by Story and colleagues for specific AIAN tribes and regions were the highest of any ethnic group in the US, with age- and gender-specific overweight/obesity rates ranging widely from 9-87% in more than 20 studies conducted from 1981 to 1998 that included at least 100 AIAN [6].

These widely ranging prevalence rates are not surprising as AIANs are a diverse group with 562 federally recognized tribes that are further distinguished by language and cultural traditions [7]. This diversity makes it often inappropriate and inaccurate to generalize health information from one location or tribe to another. At this time, obesity results for AIAN residing in California are limited. In the 2003 California Health Interview Survey (CHIS), 882 AIANs aged 18+ years residing in rural and urban California areas had a self-reported overweight/obesity prevalence of 64.2% [8]. A 2002 California public school study of 10-15 year olds included 8,971 AIANs, with overweight/obesity prevalence of 33.3% and 29.2% in boys and girls, respectively [9]. The latter study included those with origins in any of the original peoples of North, South, and Central America as AIANs, thus confounding the data for North American AIANs.

Obesity, along with smoking, diabetes, and hypertension, are all major modifiable risk factors for cardiovascular disease (CVD) [10], the leading cause of death among older AIANs [11,12]. The elevated prevalence of obesity found in AIANs results in a disproportionately higher diabetes prevalence [13,14]. Obesity is also associated with increased hypertension rates [15], which are on the rise in AIAN communities [16,17]. The risk of hypertension increases in diabetic patients [18] and diabetes risk increases in hypertensive patients [19]. Moreover, the CDC reports the AIAN tobacco use rate as higher than in other US population groups [20].

CVD risk factor prevalence in cross-sectional studies of AIAN populations was similar to or considerably higher than the overall US prevalence, with rates varying by gender and between regions [21,22,23,24]. American Indians from five states compared to the general population from their respective state, had higher prevalence of diabetes, hypertension, obesity, and current smoking [22,23], with higher smoking and obesity prevalence but lower diabetes prevalence in men compared to women [22]. In the REACH 2010 survey from 2001-2002, AIANs had the highest diabetes, obesity, and current smoking prevalence compared to other minority groups [21]. Among men, AIANs had the highest hypertension prevalence whereas among women, hypertension prevalence was second only to Blacks [21].

CVD risk factor prevalence differed by age and gender in the Strong Heart cohort study of older American Indians from 1989 to 1999 [25]. Diabetes and hypertension prevalence increased with age whereas current smoking prevalence decreased, with diabetes consistently higher and current smoking prevalence lower for women [25]. Hypertension prevalence was higher for men than women at the initial visit (mean age

56.3 years) with the difference disappearing after four years of follow-up [25]. From 1999 to 2003, obesity, diabetes, and hypertension prevalence increased in American Indian men in Montana whereas only hypertension prevalence increased in American Indian women [24].

In addition to CVD, obesity is a known modifiable risk factor for osteoarthritis (OA) [26]. OA is the most common form of arthritis, the leading cause of disability in the US, with increased risk in women and older adults [27,28]. As stated previously, obesity is a known risk factor for type 2 diabetes and hypertension [15] but further, approximately half of adults with diabetes or hypertension also have arthritis [27]. According to NHANES III results, prevalence of both hypertension and diabetes was significantly higher in those with OA compared to the general population without OA [29]. In contrast, those with OA smoked cigarettes less than the general population, although not significantly [29].

These CVD risk factors of obesity, diabetes, hypertension, and current smoking had similar or considerably higher prevalence in AIAN populations compared to the overall US or their corresponding state prevalence [21,22,23,24]. Whether OA was similarly more prevalent in AIANs was difficult to establish as data on this population were limited and did not differentiate OA from the broader category of arthritis [30,31].

A study of AIAN aged 18+ years from Alaska and the Southwest US found age-sex adjusted self-reported arthritis prevalence was higher among AIAN from Alaska (26.1%) but lower among AIAN from the Southwest US (16.5%), compared to the 2003-2005 National Health Interview Survey (21.5%) [30]. In Alaska, arthritis prevalence increased with age and was higher in women than men [30]. In Southwest US, arthritis prevalence increased with age but was only higher in women compared to men aged 55+ years [30]. 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% [31]. Similarly, arthritis prevalence increased with age and rates were higher in women than men (50.2% versus 35.4%) [31].

The Women's Health Initiative (WHI) cohort included more than 140,000 postmenopausal women aged 50+ years and collected information specific to OA. 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 [32].

Studies of obesity, including the association with diabetes, hypertension, and OA in AIANs may inaccurately represent these issues in Southern California AIAN. The extreme diversity present in the AIAN population makes it often inappropriate and inaccurate to generalize health information from one location or tribe to another. Even information derived from AIANs within California is problematic due to tremendous diversity statewide. Historically, more than 100 languages were originally spoken in California with approximately 50 languages currently still in use [33]. Extremely mixed traditional linguistic diversity, along with California geographic isolation and urbanization, indicate wide variation in cultural traditions and behaviors affecting health, many of which have survived to present-day practices.

In the existing literature, CVD risk factor studies are largely comprised of Caucasians with most not accounting for ethnic differences even though some ethnic groups have disproportionate risk [34]. In addition, gender and age differences are not well described in AIANs. Other than WHI, no studies have addressed the prevalence of OA and associated risk factors in AIAN.

Using data from a recent five-year period (Appendix 1) for Southern California AIAN children and adults aged 6+ years from one Indian health clinic system that has not previously been studied, this dissertation had three overall objectives:

1) determine gender- and age-specific overweight and obesity prevalence rates for children aged 6 to less than 18 years and adults aged 18+ years (Appendix 2) and compare them to other AIAN and racial/ethnic groups within the US (Chapter 2);
2) assess the association of obesity and smoking with diabetes and hypertension by gender and age groups and determine the gender- and age-specific CVD risk factor prevalence in adults aged 18+ years (Chapter 3, Appendix 3);
3) assess the association of obesity and other CVD risk factors with OA by gender and age groups and determine the gender- and age-specific OA prevalence in adults aged 35+ years (Chapter 4, Appendix 3).

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CHAPTER 2

The Prevalence of Obesity in American Indian Children and Adults Residing in Southern California, 2002-2006

ABSTRACT

Objective: Age and gender-specific overweight and obesity prevalence rates for Southern California American Indian/Alaska Native (AIAN) children and adults from a recent five-year period were examined and compared to other AIANs and racial/ethnic groups within the US.

Methods: Cross-sectional visit data from one Southern California AIAN health clinic system during 2002-2006 were extracted resulting in a sample of 9,201 AIANs aged 6 years and older.

Results: Obesity prevalence ranged from 33-47% for children and from 42-65% for adults. Boys were more obese than girls and children aged 10-13 years were more obese than other age groups. Men and women had similar rates of overall obesity; however, women were more likely to be morbidly obese. Southern California AIANs had higher overweight and obesity rates than all other US populations during a similar time period.

Conclusions: Elevated rates in this Southern California AIAN population provide further evidence of the obesity epidemic in AIANs. Weight loss and health promotion intervention/education programs should be developed to address the epidemic within this population. Prospective studies characterizing obesity incidence and primary risk factors for AIAN populations are needed.

INTRODUCTION

The obesity epidemic in the United States is a significant public health concern that has been well-documented using nationally representative data from the National Health and Nutrition Examination Surveys (NHANES) [1-4]. Accurate obesity rates are available for non-Hispanic Whites, non-Hispanic blacks, and Mexican Americans. Obesity rates for other groups such as Asian Americans and American Indians/Alaskan Natives (AIANs) exist from national data such as the 2001 Behavioral Risk Factor Surveillance System (BRFSS) and the National Longitudinal Survey of Adolescent Health; however, sample sizes are small, do not differentiate reservation-based populations, and are based on self-report for BRFSS [5].

In addition to under representation in national surveys, a single characterization of AIANs is difficult because they are a diverse group with 562 federally recognized tribes that are further distinguished by language and cultural traditions [6]. This diversity makes it often inappropriate and inaccurate to generalize data from one location or tribe to another. As evidence of such diversity, age- and gender-specific overweight/obesity rates ranged from 9-87% in more than 20 studies with at least 100 AIANs of all ages conducted from 1981-1998. These studies compiled by Story and colleagues depict obesity rates for many specific AIAN tribes and regions and indicate that most, if not all, AIAN groups have the highest obesity rates of any ethnic group in the US [7].

Although obesity prevalence rates are available in national datasets, data are limited for AIANs residing in California. In the 2003 California Health Interview Survey (CHIS), 882 AIANs aged 18+ years residing in rural and urban California areas were over-sampled from Indian Health Services (IHS) designated locations and had self-reported overweight/obesity prevalence of 64.2% [8]. A 2002 California public school study of 10-15 year olds included 8,971 AIANs with overweight/obesity rates of 33.3% and 29.2% in boys and girls, respectively [9]. For the latter study, the AIAN category included those with origins in any of the original peoples of North, South, and Central America, thus confounding the data for North American AIANs.

Small samples, inappropriate sampling techniques, poor differentiation of AIANs, and imprecise self-reporting, suggest the above prevalence rates may inaccurately represent obesity in Southern California AIANs. Moreover, rates that combine Northern and Southern California AIANs are problematic due to a tremendous diversity statewide. Historically, more than 100 languages were originally spoken in California with approximately 50 languages currently still used [10]. Extremely mixed traditional linguistic diversity, along with California geographic isolation and urbanization, indicate wide variation in cultural traditions and behaviors affecting health, many of which have survived to present-day practices.

Thus, the current study examined age and gender-specific overweight and obesity prevalence rates for Southern California AIAN children and adults from one Indian health clinic system, hereafter referred to as the Southern California American Indian Health Clinics (SCAIHC), during a recent five-year period. Further, this study explored gender and age differences in prevalence rates within this population, and compared this population to other AIANs and racial/ethnic groups within the US.

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. The Native American Data Extraction and Surveillance (NADXS) software program was applied to the RPMS to extract over 250 clinical variables (Appendix 1) from visits between January 2002-January 2007. NADXS has been validated and found to have greater than 97% accuracy when compared with data reviewed from the actual paper chart [11].

NADXS extracted a total of 572,200 visits. The unique chart number for each patient was used to consolidate visit data, yielding a sample of 18,943 patients (Appendix 2). Non-Indian patients (n=3,190) 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. AIANs residing within these two counties were from tribes originating inside and outside of California, with the majority from California tribes. From the remaining 15,240 eligible patients, 13,885 were aged 6 years or older. Of these, 4,684 did not have body mass index (BMI) data, leaving 9,201 patients. Lack of BMI data was primarily due to a multitude of dental or vision clinic visits where height and weight were not measured.

To protect the confidentiality of specific tribal communities, tribes will not be 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, and a federally-registered tribal-community IRB as well as the tribal health board of the SCAIHC approved this study.

Measures

Age was derived as of June 30 for each of the five years, and as of 2004 for the overall five-year period. Adults are defined as 18 years or older, children as aged 6 to less than 18 years. BMI was derived as weight divided by height squared (kg/m^2). For each patient, multiple BMI values from each year where data were available were averaged together to derive a yearly mean BMI. For adults only, multiple BMI values collected during the five-year period were averaged together to derive an overall mean BMI. From this point forward, BMI results reflect the mean BMI over the relevant time period.

Age and gender specific overweight and obesity prevalence rates were calculated by year. For adults, overweight was defined as 25 $kg/m^2 \leq$ BMI <30 kg/m^2 and obesity as BMI≥ 30 kg/m^2 [12]. For children, obesity status was based on the 2000 Centers for Disease Control and Prevention age and gender specific growth charts for the US [13]. Overweight was defined as a mean BMI at or above the 85^{th} percentile and less than the 95^{th} percentile, and obesity as a mean BMI at or above the 95th percentile or BMI greater than 30 kg/m^2. Categories of overweight and obesity are mutually exclusive.

For adults, overall 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) [12]. Age and gender specific prevalence rates were derived for each of the mutually exclusive BMI categories.

Data Analysis

For adults, the association between gender and BMI categories was tested for each age group with chi-square tests. If the general association was statistically significant at alpha=0.05 within an age group, the individual BMI categories (overweight and above) were tested for gender differences. A Bonferroni adjustment was made for multiple comparisons.

Overweight and obesity prevalence rates from 2002 for children were descriptively compared to other AIAN populations and racial/ethnic groups from 2002-2003. Similarly, adult rates were compared to other AIAN populations from 2000-2003 and other racial/ethnic groups using national data from NHANES and BRFSS. Prevalence rates for the SCAIHC population were derived for age groups similar to the comparison population. Age-adjusted rates were derived separately for children and adults.

Logistic regression was used to estimate the effect of gender and age on the probability of obesity in separate models for children and adults using data from 2004 (midpoint) only. Odds ratios and 95% confidence intervals were calculated. The interaction of gender and age group was assessed. All computations were performed with SAS Software Version 9.1.

RESULTS

In each year from 2002-2006, there was a minimum of 5,018 and a maximum of 6,602 patients available for analysis. Over the five-year period, the overweight and obesity prevalence rates for both children and adults fluctuated randomly with no significant trends (Table 2.1).

Children

In children, the mean age was 11.7 years with 53% girls. After age-adjustment, girls had a mean BMI of 23.7 kg/m^2 with overweight and obesity prevalence of 22% and 34%, respectively; boys had a mean BMI of 24.2 kg/m^2 with overweight and obesity prevalence of 17% and 42%, respectively (data not shown).

Over the five-year period, 2,463 children (1,282 girls and 1,181 boys) were available; although the actual sample size varied by year from 1,105 to 1,422. Overweight prevalence ranged from 16-22% and obesity prevalence ranged from 33-47%. Overweight prevalence had inconsistent differences among the age groups. Obesity prevalence was highest in 10-13 year olds with a 1.6 times higher likelihood of obesity compared to ages 6-9 years and 1.4 times higher likelihood compared to ages 14-17 years (Table 2.2). Although gender differences were not statistically significant, there appeared to be a higher prevalence of obesity in boys with a greater than 10% absolute difference between genders for some age groups.

Compared to children from other US ethnic populations during 2000-2004, the SCAIHC children had the highest obesity prevalence (Table 2.3) [9,14,15]. For example, SCAIHC children ranged from 25% more obese among boys aged 6-9 years to 72% more obese among girls aged 14-17 years when compared to children from the Aberdeen IHS

Service Area, (18 tribes in the Dakotas, Nebraska, and Iowa) [14]. Larger differences were seen when compared to 10-15 years enrolled in California public schools; with SCAIHC children aged 10-13 years having twice the obesity prevalence of AIAN boys and girls and Hispanic girls, and 78% more than Hispanic boys [9]. When compared to white non-Hispanics in the California public schools, SCAIHC children had more than twice the obesity prevalence [9].

Adults

In adults, the mean age was 42.2 years with 58% women. After age-adjustment, women had a mean BMI of 32.6 kg/m^2 with overweight and obesity prevalence of 23% and 57%, respectively; men had a mean BMI of 32.4 kg/m^2 with overweight and obesity prevalence of 29% and 58%, respectively (data not shown).

Over the five-year period, 6,738 adults (3,924 women and 2,814 men) were available; although the actual sample size varied by year from 3,913 to 5,180. Overweight prevalence ranged from 22-35% and obesity prevalence ranged from 42-65%. The overweight prevalence was similar among age groups up to age 65 years. Obesity prevalence varied by age group and was lowest in those aged 18-34 years, then increased by greater than 10% for those aged 25-34 years, and continued to increase slightly up to the 55-64 year age group. For those aged 65 years and older, there was a notable decrease in obesity prevalence while overweight prevalence increased. Logistic regression results for 2004 data showed that those aged 25-34 years or 65+ years were twice as likely to be obese than those 18-24 years, whereas those in the middle age groups from 35-64 years were 3-4 times more likely to be obese (Table 2.2). Moreover, men were 1.6 times more likely than women to be obese. Further analyses of gender differences in BMI categories are presented below.

There were 6,915 adults (4,033 women and 2,882 men) available for the analysis of BMI categories using mean BMI over the five-year period. The prevalence of each mutually exclusive BMI category by age group and gender is presented in Figure 2.1. Within each age group, there was a statistically significant association ($p<0.001$) between gender and BMI category for all except those 65+ years. Further comparisons described below identify the specific BMI category contributing to these differences.

Men were more likely to be overweight than women, with statistical significance ($p<0.05$) reached in two age groups (18-24 and 35-44 years), while more women were in the normal BMI category compared to men in every age group. The largest disparity between the genders was found in the more extreme categories of obesity. Although the overall obesity prevalence (BMI $\geq$30 kg/m^2) was similar between genders for all age groups, women had a higher morbid obesity prevalence ($p<0.05$: 55-64 years). The absolute difference between the genders ranged from 3-8%.

The distribution of BMI categories differed among the age groups, predominantly with similar distributions seen in the middle age groups from 25-64 years that differed from the youngest and oldest age groups. The highest normal BMI prevalence was 32% and occurred in those aged 18-24 years. The remaining age groups had considerably lower normal BMI prevalence at 11-19%. Very and morbidly obese prevalence was lowest in the youngest and oldest age groups, 24% and 21%, respectively, whereas the middle age groups had prevalence greater than 31%. The lowest morbidly obese prevalence was 8% for ages 65 years or older, with those aged 18-24 years at 12%, and the middle age groups highest at 16-18%. In general, overweight and obesity prevalence increased or remained stable with age up to 65 years, then obesity declined while normal and overweight prevalence increased.

The SCAIHC adults had the highest obesity prevalence rates compared to other US ethnic populations during 2000-2004 (Table 2.3) [4,5,8,16,17]. For AIANs, differences ranged from 26% more obesity in SCAIHC adults aged 18-26 to 74% more obesity in those aged 30+ years [5,8,16,17]. Differences were also present when compared to Hispanic and white non-Hispanic populations, with at least 50% more obesity among SCAIHC adults [4,5].

DISCUSSION

AIANs living in two Southern California counties and attending Indian Health clinics from 2002-2006 had high overweight and obesity prevalence that was consistent over the five-year period. In children, boys had higher obesity prevalence than girls and those 10-13 years were more obese than those 6-9 or 14-17 years. After adjusting for age, men were more likely to be obese than women. However, the morbid obesity prevalence was higher for women than men in all age groups. At 65+ years, obesity prevalence declined with a concomitant increase in overweight and normal weight prevalence consistent with trends seen in other populations after age 65.

The SCAIHC population had higher overweight and obesity prevalence than the general US population, California populations, and other AIAN populations during a similar time period. The only published obesity prevalence rates higher than in SCAIHC were from a previous decade in 1995-1996 for adult US Pima Indians, 63.8% for men and 74.8% for women [18]. More recently, Pima Indian children were studied from 1990-2000 to ascertain the timing of excess weight gain as compared to the general US population. While obesity prevalence rates were not explicitly provided, results indicated that from ages 11-20, at least half of the Pima Indians were obese [19]. Based on published rates, only Pima Indians had higher obesity prevalence than SCAIHC. No other published obesity prevalence rates for AIANs from recent years were similar to or higher than those found for SCAIHC.

In contrast to the higher obesity prevalence seen in Pima Indian children, Aberdeen IHS Area Indian children had prevalence rates that were 6-18% lower than SCAIHC children with rates varying by gender and age group, whereas overweight prevalence was similar between the two groups [14]. This study of 11,538 Aberdeen Indian children aged 5-17 years during 2002-2003 from 55 schools on 12 reservations [14] determined obesity status from measured BMI using the 2000 Centers for Disease Control and Prevention growth charts [13]. Aberdeen obesity rates were derived from children living on reservations which could account for the difference in prevalence compared to SCAIHC. Other studies containing obesity prevalence rates for non-California AIANs were lower than rates found in SCAIHC and were based on small sample sizes [17] or self-reported height and weight [5,16].

The only obesity prevalence rates for California AIAN children are from a study of public schools. These rates were more than 28% lower than rates for SCAIHC children of the same age group, 10-15 years [9]. While this study had 8,971 AIAN children with measured height and weight, it was not representative of all AIANs or comparable to data in the present study as it included native North, South, and Central Americans who maintained tribal or community relations. AIAN classification may have had loose criteria in the public school study whereas specific proof of AIAN status was required for eligible patients in the present study.

The 2003 CHIS over-sampled for AIANs from IHS designated locations and obtained overweight and obesity prevalence rates based on self-reported height and weight from 882 AIAN adults [8]. Overweight or obesity prevalence was approximately 20% higher for SCAIHC adults than for AIANs surveyed in CHIS [8]. This difference in prevalence may be due to the use of self-reported height and weight that are known to be systematically less than measured values [20]. Moreover, the sample size was relatively small and not disaggregated by age groups.

In comparison to most other groups, AIANs consistently had higher obesity prevalence [7]. Results of NHANES from 2003-2004 in adults showed obesity prevalence rates for non-Hispanic Whites of 30.2% for women and 31.1% for men and for Mexican Americans of 42.3% for women and 31.6% for men [4]. These obesity prevalence rates were considerably lower than those found for SCAIHC adults during a similar timeframe, 58.0% for women and 56.5% for men (Table 2.3). Obesity prevalence rates from BRFSS data during 2001-2002 were 28.3% for Hispanic American adults and 34.3% for AIAN adults [5]. In California, 2003 CHIS data had similar combined overweight/obesity prevalence rates for Latinos and AIANs, 66.0% and 64.2%, respectively, both of which were higher than rates for Whites, 53.9% [8]. Again, SCAIHC adult overweight prevalence rates from a similar time period were higher, 80.0% for women and 87.4% for men (sum of overweight and obesity rates in Table 3).

These elevated rates provide further evidence of the obesity epidemic in the US, particularly in a minority AIAN population. Over the five-year period, obesity prevalence was consistent with no indication of decreased obesity. Obesity, as discussed, will determine morbidity patterns that result in chronic disease for the long term. Such lack of a trend indicates a critical need for large weight loss and health promotion intervention/education programs to address the epidemic within this population and combat this continuing public health issue. Moreover, AIANs are a young population. High obesity prevalence in a young population leads to increased type 2 diabetes and hypertension prevalence at earlier ages, thus elevating the likelihood and risk of complications from these diseases as well. According to the CDC, the incidence of type 2 diabetes in children and adolescents is increasing in the US, particularly for ethnic minority groups including AIANs, African Americans, and Hispanic/Latino Americans [21]. Cardiovascular disease is the leading cause of death for AIAN adults [22]. Public health programs need to be implemented to slow this epidemic in the US, with emphasis on AIAN populations that are currently heavily impacted.

There are limitations to this study. These results represent Indians living in two Southern California counties who attended SCAIHC and may be affected by Berkson's bias. Even within the same tribe, some members attended SCAIHC and other members attended off-reservation health care facilities depending on their insurance. Therefore, this sample may not contain AIANs from all areas of Southern California. The California Indian Health Service estimates their registered population of AIANs residing in Southern California from 10/1/2003 to 9/30/2006 at approximately 40,000 [23]. This study includes 9,201 AIANs 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. However, due to the diversity present in California, these data may not be generalizable to the rest of California.

A strength of these results is their relevance as they arise from a current time period with a large sample size from an ethnic minority population that is underrepresented in national surveys. Data from this resident Southern California AIAN population have not been previously reported.

Another strength of these data are that those with missing BMI had similar levels of obesity compared to those with a measured BMI. The mean weight for those patients missing height, and therefore, without BMI measurement, was similar to the mean weight of the patients who had BMI measured. The obesity rate of patients missing BMI in 2002 who subsequently had BMI measured in 2003-2006 was compared to the obesity rates by adult age group. Rates were similar with no indication that patients missing BMI in 2002 had a different level of obesity when that measurement was obtained.

Southern California AIANs have extremely high obesity prevalence, even compared to other AIAN populations. This supports existing literature indicating that overweight and obesity prevalence is higher among AIANs compared to the rest of the US, including most other ethnic minority groups. This increased prevalence is evident as early as age six. Results from a five-year period showed no noticeable decline in obesity prevalence, underscoring that the obesity epidemic is ongoing. Obesity research with AIAN populations both in and outside of California needs broadening to include prospective studies identifying obesity incidence, the onset age of overweight/obesity, and primary risk factors. Further research of this nature will aid the design of intervention trials that include strategies to combat weight gain and increase nutrition and exercise within this understudied minority population.

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Chapter 2, in full, and titled, "The Prevalence of Obesity in American Indian Children and Adults Residing in Southern California, 2002-2006", has been submitted for publication. The dissertation author, Jennifer Reid, was the primary investigator and author of this paper. Co-authors were Morton DJ, Garrett MD, Wingard DL, von Muhlen D, Slymen D, and Field M.

Table 2.1. Prevalence (%) of Overweight/Obesity Among American Indian/Alaska Natives from Southern California by Age Group, Gender, and Year: 2002-2006

	Overweight* ($85^{th} \leq$ BMI < 95^{th} percentile)					Obese* (BMI ≥ 95th percentile)				
	2002 n=1105	2003 n=1159	2004 n=1223	2005 n=1422	2006 n=1319	2002 n=1105	2003 n=1159	2004 n=1223	2005 n=1422	2006 n=1319
6-9 yrs (n)	19.5	19.0	17.2	21.2	16.1	32.9	39.8	36.6	34.6	34.1
Girls (546)	19.6	21.1	17.0	26.1	20.7	32.5	38.1	33.0	28.3	32.0
Boys (521)	19.3	17.1	17.3	16.4	11.3	33.3	41.5	40.1	40.9	36.3
10-13 yrs	19.0	19.8	18.8	16.8	18.3	44.8	47.5	45.2	41.0	43.4
Girls (349)	16.0	20.2	21.0	18.6	21.4	42.2	42.9	42.0	39.9	37.8
Boys (360)	21.6	19.5	16.2	14.7	14.4	47.1	52.4	49.2	42.2	50.5
14-17 yrs	22.3	21.8	16.1	20.9	20.7	39.1	35.3	39.7	37.8	41.0
Girls (387)	21.8	21.5	19.1	20.7	22.8	35.6	31.1	36.8	32.8	36.8
Boys (300)	23.1	22.0	12.8	21.0	18.6	44.1	40.5	42.9	43.3	45.0

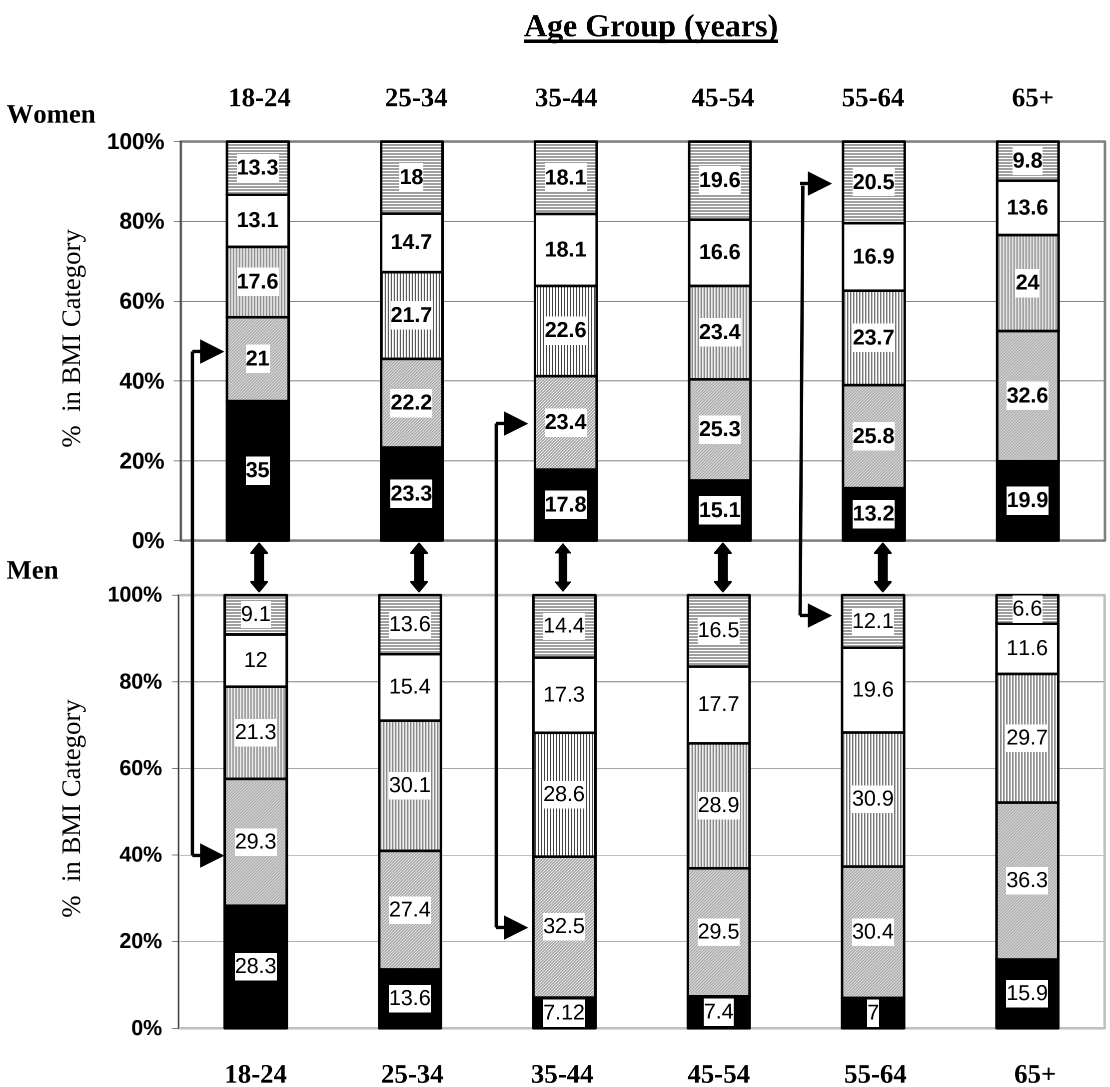
	Overweight ($25 \leq$ BMI < 30 kg/m^2)					Obese (BMI ≥30 kg/m^2)				
	2002 n=3913	2003 n=4297	2004 n=4793	2005 n=5180	2006 n=5109	2002 n=3913	2003 n=4297	2004 n=4793	2005 n=5180	2006 n=5109
18-24 yrs (n)	25.3	21.8	24.8	26.1	24.5	42.3	46.1	44.1	42.7	43.2
Women (712)	23.4	19.4	22.9	24.2	22.8	43.3	48.8	45.6	45.1	44.6
Men (446)	29.0	26.2	28.1	29.5	27.4	40.4	41.2	41.4	38.5	40.6
25-34 yrs (n)	24.3	23.0	22.4	22.5	23.5	57.7	57.0	57.4	58.0	56.2
Women (801)	20.1	19.7	21.4	20.6	21.1	57.4	56.3	55.0	56.2	54.7
Men (556)	31.7	28.9	24.1	25.5	27.3	58.2	58.2	61.4	60.8	58.5
35-44 yrs (n)	25.2	26.7	25.5	23.9	24.4	60.9	59.3	60.7	60.7	61.0
Women (848)	20.8	22.4	22.5	20.7	20.6	62.0	61.3	59.6	59.3	59.7
Men (636)	32.2	34.1	30.4	28.6	29.8	59.1	56.0	62.7	62.7	62.8
45-54 yrs (n)	25.1	26.3	26.1	26.0	26.2	62.2	61.4	63.0	62.5	62.7
Women (725)	21.5	23.8	24.1	23.5	22.4	62.9	60.9	62.3	61.8	63.1
Men (533)	30.5	29.8	28.9	29.4	31.8	61.0	62.2	63.8	63.6	62.2
55-64 yrs (n)	27.3	25.2	25.5	26.7	26.0	61.1	64.7	64.5	63.0	63.5
Women (493)	24.1	22.4	25.5	24.7	24.1	63.0	65.3	63.8	62.6	62.9
Men (365)	31.6	29.1	25.5	29.7	28.9	58.5	63.8	65.5	63.5	64.3
≥65 yrs (n)	34.5	33.6	32.6	31.5	32.1	49.1	47.8	50.7	50.3	50.5
Women (345)	32.8	30.9	30.8	29.6	30.9	49.2	48.5	49.8	49.9	49.3
Men (278)	36.6	36.8	34.9	34.1	33.6	49.0	46.9	51.7	51.0	52.1

* Overweight/obesity for age<18 from the 2000 US CDC growth charts based on BMI-for-age and gender percentiles.

Table 2.2. Logistic Regression of Obesity in American Indian/Alaska Native Children and Adults from Southern California: 2004

		Odds of Obesity* OR (95% CI)
Children		
Age:	6-9 years	1.00
	10-13 years	**1.61 (1.18, 2.19)**†
	14-17 years	1.14 (0.84, 1.54)
Gender:	Girls	1.00
	Boys	1.27 (0.99, 1.63)
Adults		
Age:	18-24 years	1.00
	25-34 years	**2.00 (1.57, 2.55)**
	35-44 years	**3.13 (2.43, 4.03)**
	45-54 years	**4.00 (3.05, 5.26)**
	55-64 years	**4.45 (3.27, 6.07)**
	≥65 years	**2.07 (1.55, 2.77)**
Gender:	Women	1.00
	Men	**1.58 (1.33, 1.88)**

Note: Bolded results are statistically significant at α=0.05.
* Results of separate logistic regression models for children and adults of the odds of obese versus not obese (under, normal, and overweight categories) for the specified variable (age category or sex) adjusting for the other variable (sex or age category) in the model.
† With 14-17 year olds as the reference group, the OR (95% CI) is 1.41 (1.04, 1.92).



Note: Normal Weight (includes underweight): <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. Based on mean BMI from 2002-2006.

↕ Within this age group, there is a significant association between gender and BMI category as assessed by chi-square test , $P < 0.01$.

Within this age group, there is a significant difference between men and women in the prevalence of the indicated BMI category as assessed by chi-square test, $P < 0.05$. Chi-square tests were performed separately for each age group and BMI category (except normal BMI category); p-values were adjusted with the Bonferroni method due to multiple testing.

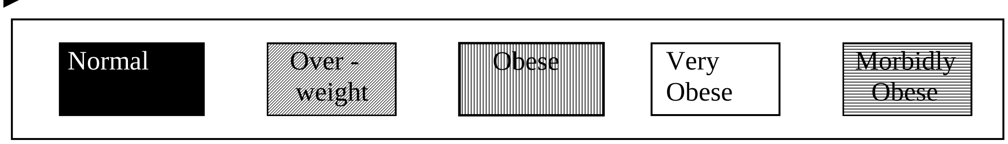


Figure 2.1. Distribution of BMI Categories Among American Indian/Alaska Natives From Southern California by Gender and Age: 2002-2006

Table 2.3. Selected Overweight and Obesity Prevalence Rates for US Populations Compared to American Indian/Alaska Natives from Southern California in 2002

	Age (y)	Year(s)	Sample Size	% Overweight (Not Obese)*		% Obese*	
				Women/ Girls	Men/ Boys	Women/ Girls	Men/ Boys
SCAIHC	**6-9**	**2002**	**365**	**19.6**	**19.3**	**32.5**	**33.3**
Aberdeen AI [14]	6-9	2002-3	4,002	19.1	19.5	24.8	26.7
Hopi AI [15]	6-12	2000	263	23.0	23.0	24.0	24.0
SCAIHC	**10-13**	**2002**	**395**	**16.0**	**21.6**	**42.2**	**47.1**
CA public schools [9]							
AIAN	10-15	2002	8,971	17.0	14.3	12.2	19.0
Hispanic	10-15	2002	330,758	21.9	17.3	18.7	26.5
White non-Hispanic	10-15	2002	275,722	15.2	14.1	8.8	13.2
Aberdeen AI [14]	10-13	2002-3	4,103	21.7	17.5	28.2	34.8
SCAIHC	**14-17**	**2002**	**345**	**21.8**	**23.1**	**35.6**	**44.1**
Aberdeen AI [14]	14-17	2002-3	2,103	20.4	16.1	25.2	25.6
SCAIHC	≥ 18	**2002**	**3,913**	**22.8**	**31.8**	**57.2**	**55.6**
CHIS 2003 CA [8]							
AIAN	≥ 18	2003	882	64.2 (overweight or obese)†			
Latino	≥ 18	2003	8,770	66.0 (overweight or obese)†			
White	≥ 18	2003	28,457	53.9 (overweight or obese)†			
REACH 2010 AIAN[16]	≥ 18	2001-2	1,791	----	----	37.7	40.1
SCAIHC	18-26	**2002**	**721**	**23.9**	**29.5**	**44.2**	**43.0**
Add Health AIAN [17]	18-26	2001-2	136	----	----	28.0	41.0
SCAIHC	≥ 20	**2002**	**3,741**	**23.0**	**32.2**	**58.0**	**56.5**
NHANES [4]							
Mexican American	≥ 20	2003-4	873	33.1	44.5	42.3	31.6
White non-Hispanic	≥ 20	2003-4	2,357	27.8	39.5	30.2	31.1
SCAIHC	≥ 30	**2002**	**2,982**	**26.7†**		**59.6†**	
BRFSS [5]							
AIAN	≥ 30	2001-2	2,299	35.1†		34.3†	
Hispanic	≥ 30	2001-2	12,153	42.2†		28.3†	

* For boys and girls, definitions of overweight and obesity are from the 2000 CDC growth charts for the US based on BMI-for-age and gender percentiles where overweight is defined as BMI from 85^{th}-<95^{th} percentile and obese is defined as BMI ≥ 95^{th} percentile. For adults, overweight is defined as BMI 25-<30 kg/m^2 and obese as BMI ≥ 30 kg/m^2.

†Rates are for women and men combined.

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CHAPTER 3

Gender and Age Differences in the Association of Obesity and Smoking With Hypertension and Type 2 Diabetes in Southern California American Indians, 2002-2006

ABSTRACT

Objective: Assess age and gender differences in the association of obesity and smoking with diabetes and hypertension and determine the prevalence of these CVD risk factors in American Indian/Alaska Native (AIAN) adults residing in Southern California.

Methods: Cross-sectional visit data from one Southern California AIAN health clinic system during 2002-2006 were extracted resulting in a sample of 10,351 AIAN adults aged 18+ years.

Results: Obesity (women: 53%, men: 55%), smoking (women: 16%, men: 18%), diabetes (women: 14%, men: 16%), and hypertension (women: 32%, men: 37%) were very prevalent in this population. For women aged 35+ years, increasing obesity was significantly associated with diabetes. For men aged 25+ years, morbid obesity was significantly associated with diabetes and smoking was significantly associated with diabetes for many age groups. Increasing overweight/obesity and smoking were associated with hypertension among men and women aged 18-65 years.

Conclusions: Southern California AIANs had higher obesity, diabetes, and hypertension prevalence than the general Southern California population, and higher obesity prevalence compared to other AIAN communities. These highly prevalent risk factors create a great burden, as CVD is the leading cause of death among AIAN adults. AIANs are diverse and need interventions tailored to cultural customs and health problems most prevalent in each tribal community.

INTRODUCTION

Obesity, smoking, diabetes, and hypertension are modifiable risk factors for cardiovascular disease (CVD) [1], the leading cause of death among older American Indian/Alaska Native (AIAN) adults [2,3]. In comparison to the general US population, many AIANs have an elevated prevalence of obesity [4,5] resulting in a disproportionately higher diabetes prevalence [6,7]. Obesity is also associated with hypertension [8], which is rising in AIAN communities [9,10]. Hypertension is more common in diabetes patients [11] and diabetes occurs more frequently in hypertensive patients [12]. Moreover, the CDC reports that AIAN tobacco use is higher than in other US population groups [13].

CVD risk factor prevalence in cross-sectional studies of AIAN populations is similar to or considerably higher than the overall US prevalence, with rates varying by gender and region [14-17]. American Indians from five states were compared to the general population from their respective state and had higher prevalence of diabetes, hypertension, obesity, and current smoking [15,16] with higher smoking and obesity prevalence but lower diabetes prevalence in men compared to women [15]. In the REACH 2010 survey from 2001-2002, AIANs had the highest diabetes, obesity, and current smoking prevalence compared to other minority groups [14]. Among men, AIANs had the highest hypertension prevalence whereas among women, hypertension prevalence was second only to Blacks [14].

CVD risk factor prevalence differed by age and gender in the Strong Heart cohort study of older American Indians from 1989 to 1999. Diabetes and hypertension prevalence increased with age whereas current smoking prevalence decreased [18]. In women, diabetes prevalence was consistently higher and current smoking lower compared to men [18]. Hypertension prevalence was higher for men than women at the initial visit (mean age 56.3 years) but the difference disappeared after four years of follow-up [18]. From 1999 to 2003, obesity, diabetes, and hypertension prevalence increased in American Indian men in Montana whereas the women only had an increase in hypertension prevalence [17].

Prospective studies, primarily among Caucasians, have found that gender- and age-related differences in coronary heart disease (CHD) risk may be mostly explained by differential prevalence of CVD risk factors in gender and age groups [19,20]. CVD risk factor studies rarely account for ethnic differences even though certain groups have a disproportionate risk [21]. Gender and age differences are not well described in AIANs.

The current study assessed the overall association of obesity and smoking with diabetes and hypertension by gender and age in Southern California AIAN adults aged 18+ years from one Indian health clinic system, hereafter referred to as the Southern California American Indian Health Clinics (SCAIHC), during a recent five-year period. Although CVD risk factor prevalence rates in some AIANs have been reported, there is much variation by tribe and by region. The present study determined CVD risk factor prevalence in a unique group of AIAN adults that 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 over 250 clinical variables (Appendix 1) 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 [22].

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 (Appendix 3). 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. AIANs residing within these two counties were from tribes originating inside and outside of California, with the majority from California tribes. From the remaining 15,145 eligible patients, 10,538 were aged 18+ years. Of these, 74 had Type 1 diabetes and 113 indicated diabetes with no ICD-9 codes to corroborate, leaving 10,351 patients.

There were 3,231 patients who were missing weight and/or height. 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 will not be named. No patient names, addresses, or social security numbers were extracted. The academic Institutional Review Boards (IRB) of the University of California, San Diego, 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 type 2 diabetes was determined from the patient's records by the presence of ICD-9 code 250 at any time during the five-year period. Results were confirmed by the presence of the date of diagnosis. 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 systolic blood pressure ≥140 or diastolic blood pressure ≥ 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.

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 (kg/m^2) was categorized as underweight (<18.5), normal weight (18.5-<25), overweight (25-<30), obese (30-<35), very obese (35-<40), morbidly obese (≥40) [23]. The under and normal weight categories were combined as patients had similar demographics, disease, and risk factor status.

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 [24]. Age was derived as of June 30, 2004.

Data Analysis

Prevalence of diabetes, hypertension, and both diseases were determined by BMI category and smoking status, stratified by age group and gender. Direct age adjustment to the overall population was used for prevalence rates not stratified by age group.

Gender-specific multivariable logistic regression models stratified by age group were used to assess the adjusted odds of diabetes, and separately, the adjusted odds of hypertension, associated with increasing BMI category (reference category: under/normal weight) and smoking status. In each model, the status of the other disease (hypertension and diabetes, respectively) was included as a covariate. Models were generated separately for men and women to examine the differential effect of CVD risk factors on diabetes and hypertension. Preliminary modeling indicated age by BMI interaction and gender by smoking interaction resulting in these stratifications by age and gender. BMI category was included as a categorical variable as linearity was not evident. A polychotomous logistic regression model with four outcome categories of both diabetes/hypertension, diabetes, hypertension, and neither diabetes/hypertension (reference) was used to assess whether increasing BMI had a synergistic effect on the likelihood of having both diabetes and hypertension.

All analyses were conducted subsequent to the implementation of an imputation method proposed by Rubin [25,26] where missing heights and/or weights were imputed for calculation of BMI. The Markov Chain Monte Carlo method was used to create a monotone missing pattern [27] then missing heights and/or weights were imputed from nonmissing height, weight, gender, 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 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. Results of imputed analyses are presented here, however analyses were performed without imputed data and resulted in similar trends in associations. The mean percent difference in BMI category odds ratios between the imputed and non-imputed analyses was –2% in the diabetes model and 16% in the hypertension model, with a mean difference in odds ratios of -0.28 and 0.01, respectively.

RESULTS

Of the 10,351 subjects, 55% were women and mean age was 41.4 years with no difference by gender (Table 3.1). Although men and women had similar mean BMI (~32 kg/m^2) they differed in distribution among BMI categories ($p<0.001$). More women were under/normal weight (women: 23%, men: 16%) and morbidly obese (women: 16%, men: 12%) than men, whereas more men were overweight (women: 24%, men: 29%) and obese (women: 22%, men: 27%) then women, with no gender difference in the very obese. Prevalence of other CVD risk factors was higher in men than women: diabetes (women: 14%, men: 16%, p=0.033), hypertension (women: 32%, men: 37%, $p<0.001$), both diabetes/hypertension (women: 11%, men: 13%, p=0.013) and current smoking (women: 16%; men: 18%, p=0.006). In total, 1522 patients had diabetes, and of these

1241 (82%) had hypertension as well. In contrast, 3549 patients had hypertension, and of these 35% had diabetes.

Diabetes and hypertension prevalence increased with age. The age-adjusted prevalence of each increased with increasing BMI for both men and women (Table 3.2). Diabetes prevalence doubled in those of under/normal weight (6%) to those who were obese (15%) and nearly doubled again in the morbidly obese (28%). Similarly, hypertension prevalence doubled in those of under/normal weight (15%) to those who were obese (37%) and rose more than a third in the morbidly obese (52%). The joint prevalence of diabetes plus hypertension also increased with increasing BMI.

In all BMI categories, men had a higher age-adjusted prevalence of diabetes and hypertension than women. Of note is the increased prevalence of hypertension in men compared to women in ages 18-44 that equalizes starting at age 45 with women having similar or even higher prevalence of hypertension for some BMI categories. In all BMI categories, current smokers had a higher age-adjusted prevalence of diabetes and hypertension compared to non-current smokers (data not shown).

Using sex-specific multivariable logistic regressions stratified by age group, the impact of BMI and smoking on the prevalence of diabetes and hypertension was assessed, with adjustment for hypertension or diabetes, respectively. Increased BMI and smoking were associated with increased adjusted odds of diabetes and hypertension that varied by age group and/or gender.

In women, increasing obesity was associated with increased odds of diabetes, a difference that was statistically significant after age 35 for the very and morbidly obese and after age 45 for the obese (Table 3.3). Being solely overweight was not associated with an increased likelihood of diabetes. In contrast, men aged 25+ years who were morbidly obese had significantly higher odds of diabetes, with some indication of a trend for increased odds of diabetes with increasing level of obesity.

For women, current smoking was generally associated with more diabetes, however, the association was significant only among those aged 55-64. Men who reported current smoking were nearly twice as likely to have diabetes; the association was significant in three age groups.

For both men and women, the adjusted odds of hypertension increased as BMI increased, except in AIANs aged 65+ years where the odds of hypertension at each level of overweight/obesity was generally twice that of under/normal weight, although not statistically significant for every category (Table 3.4). AIANs aged 55-64 years had increasing odds of hypertension from overweight up to the very obese category but odds did not continue to rise with morbid obesity. In those aged 18-34 years, women who were very and morbidly obese had considerably higher odds of hypertension compared to very and morbidly obese men.

In all age groups, men and women who currently smoked were more likely to have hypertension than non-smokers. Men tended to have greater odds of hypertension associated with current smoking than women, though differences were not statistically significant. In every age group, those with hypertension were more likely to also have diabetes, and vice versa.

In the polychotomous logistic regression, the adjusted odds of the joint presence of diabetes and hypertension with increasing BMI was equivalent to the product of the separate odds of diabetes and odds of hypertension. Thus, no synergistic effect of increasing BMI on the odds of both diabetes/hypertension as comorbid conditions was evident (results not shown).

DISCUSSION

AIAN adults living in two Southern California counties and attending Indian Health clinics from 2002-2006 had high prevalence of four CVD risk factors: diabetes (15%), hypertension (34%), obesity (53%), and current smoking (17%). Whereas gender and age differences were present in the association between obesity, smoking, and diabetes; the association between obesity, smoking, and hypertension was similar between genders and among those aged less than 65 years. The likelihood of diabetes increased for older, hypertensive women, with increasing levels of obesity, and for older, hypertensive men who were morbidly obese and currently smoked. The likelihood of hypertension increased for all diabetic, men and women who currently smoked, and with increasing levels of obesity for AIANs less than 65 years.

The likelihood of diabetes and hypertension associated with overweight/obesity found in this SCAIHC population was similar to other AIAN populations. Results from 1998 among 633 adults in the Catawba Indian Nation from North and South Carolina found obesity was associated with increased age-adjusted odds of diabetes (OR: 2.6, 95% CI: 1.3, 5.6) and hypertension (OR: 5.5, 95% CI: 3.0, 9.9) [28]. In a study of 2,006 Montana American Indian adults in 1999 and 2001 using an adapted BRFSS, overweight/obesity was associated with an increased gender and age-adjusted odds of diabetes (OR: 3.0, 95% CI: 2.0, 4.5) [29]. In both the Catawba and Montana population, diabetes, hypertension, and overweight prevalence were below SCAIHC rates [28,29].

Diabetes and Hypertension Prevalence

The SCAIHC diabetes and hypertension prevalence rates were higher than estimates for the US obtained from recent NHANES data [30]. SCAIHC hypertension prevalence was higher compared to national data for men (36.7% and 29.0%, respectively) but similar for women (32.3% and 32.5%, respectively) and within the range of published rates (26.3-37.5%) from the past 10 years for other similarly aged AIAN communities [14-17,30]. These national data showed women were more hypertensive than men [30], but one AIAN community had the same gender difference as SCAIHC with men more hypertensive than women, 38% versus 31% [17].

SCAIHC diabetes prevalence was also higher (women: 14.0%, men: 15.5%) compared to national data (women: 7.1%, men: 7.2%) for both genders but within the range of published rates (8.3-18.5%) from the last 10 years for other similarly aged AIAN communities [14-17,24,30]. Gender differences occurred in the REACH 2010 survey of two AIAN communities where women had more diabetes than men, 19.7% versus 16.8% [14]. According to the CDC, diabetes prevalence was 16.5% in AIANs aged 20+ years as calculated from the outpatient database of the IHS from 2005 and age-adjusted to non-Hispanic whites [31], with the largest age-adjusted rate in southern Arizona (29.3%). Age-adjusted diabetes prevalence of 10.3% was reported for AIANs from five states (not including California) using IHS data from 1998-2003 [24].

Obesity Prevalence

Southern Californian AIANs had a higher obesity prevalence (women: 52.9%, men: 54.8%) compared to both national data (women: 33.2%, men: 31.1%) and recently published rates (27.5-39.0%) from the last 10 years for other similarly aged AIAN communities [14,15,17,32]. Gender differences occurred in one AIAN community similarly to the SCAIHC community where men were more obese than women, 29.3% versus 25.8% [15] whereas in national data, men and women were similar [32].

Smoking Prevalence

SCAIHC adults had lower current smoking prevalence (women: 16.3%, men: 18.3%) than other AIAN rates from communities and national surveys that ranged from 19.7%-39.2% [13-17,24] and the overall 2006 US adult prevalence (women: 18.0%, men: 23.9%) [13]. Similar to SCAIHC, some studies had gender differences with higher current smoking prevalence among men [13,14]. However, SCAIHC women had a higher current smoking prevalence (16.3%) compared to all California women (11.4%), whereas SCAIHC men had similar prevalence (18.3%) to all California men (18.5%) as derived from the 2006 BRFSS [33].

CVD Risk Factor Prevalence Within California

For adult residents of the same two Southern California counties that comprise the SCAIHC population (n=2,668), diabetes, hypertension, obesity, and current smoking prevalence estimates from the 2005 California Health Information Survey (CHIS) were lower than reported for SCAIHC adults [34]. However, these prevalence estimates from the 2005 CHIS for AIAN adults residing in California (n=872) varied in their comparability with SCAIHC prevalence [34]. Following are comparisons between SCAIHC and the 2005 CHIS adults from the same two counties (referred to as CHIS County) and the 2005 CHIS AIAN adults statewide (referred to as CHIS AIAN). Comparisons were not made to the 2005 CHIS for AIAN adults residing in the same two

Southern California counties as SCAIHC due to unreliable estimates from insufficient AIAN sample sizes (n<100).

SCAIHC adults had higher diabetes prevalence (women: 14.0%, men: 15.5%) than both CHIS AIAN (women: 12.1%, men 12.9%) and CHIS County (women: 6.7%, men: 9.1%). In women, hypertension prevalence for SCAIHC (32.4%) was similar to CHIS AIAN (35.1%) but both were considerably higher than CHIS County (25.6%). In men, hypertension prevalence for SCAIHC (36.7%) was consistently higher than both CHIS AIAN (26.8%) and CHIS County (28.5%) [34].

SCAIHC obesity prevalence (women: 52.9%, men: 54.8%) was nearly twice the CHIS County prevalence (women: 24.4%, men: 28.4%) and still considerably higher than CHIS AIAN (women: 28.9%, men: 35.6%). SCAIHC current smoking prevalence (women: 16.3%, men: 18.3%) was considerably lower than CHIS AIAN (women: 28.1%, men: 39.1%) but slightly above the CHIS County prevalence (women: 12.7%, men: 18.6%) for women [34].

Other than regional and ethnic/racial differences, some of the disparity between prevalence rates obtained from SCAIHC and CHIS may be due to collection methods. SCAIHC prevalence was derived from clinic visits and disease diagnoses along with measured height and weight, whereas CHIS data relied on self-report, which often has under-reporting of unfavorable behaviors. CHIS determined diabetes and hypertension status from questions of whether or not a doctor ever told the subject he/she had diabetes or high blood pressure, respectively. Obesity status was determined from self-reported height and weight using the same BMI categories as in this study. Current smoking was determined for subjects who smoked at least 100 cigarettes during their lifetime and who currently smoked [34].

Limitations and Strengths

There are limitations to this study. These results represent Indians living in two Southern California counties who attended SCAIHC and may be affected by Berkson's bias. Even within the same tribe, some members attended SCAIHC and other members attended off-reservation health care facilities depending on their insurance. Therefore, this sample may 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 [35]. This study includes 10,351 AIANs 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. However, due to the diversity present in California and based on results from the 2005 CHIS [34], all results may not be generalizable to the entire population of California AIANs.

A strength of these results is their relevance 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 genders and age groups. Disease status was based on actual diagnosis and obesity from measured height and weight rather than self-report. Of particular importance is that CVD risk factor prevalence and associations of obesity and smoking with diabetes and hypertension from AIANs residing in California have not been previously reported.

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 change the resulting trends as indicated by comparison of imputed to non-imputed analyses.

Conclusion

Southern California AIANs had much higher obesity, diabetes, and hypertension prevalence than the US as a whole and, more specifically, than residents from the same California region. Compared to other AIAN communities, SCAIHC diabetes and hypertension prevalence rates were at the mid-range but obesity prevalence was considerably higher. Current smoking prevalence at SCAIHC was lower then seen in other AIAN populations and less than the national rate; however, prevalence was higher in SCAIHC women compared to California women.

The high prevalence of the modifiable CVD risk factors presented here are a great burden on AIAN communities where CVD is the leading cause of death among AIANs aged 45+ years [2,3]. AIANs are a diverse group with 562 federally recognized tribes further distinguished by language and cultural traditions, many of which affect current health behaviors [36]. This diversity is fundamentally evident in the substantial differences in CVD risk factor prevalence among AIAN communities. Such variation necessitates targeted interventions tailored to the cultural customs and health problems most prevalent in each tribal community.

ACKNOWLEDGEMENTS

Chapter 3, in full, and titled, “Gender and Age Differences in the Association of Obesity and Smoking with Hypertension and Type 2 Diabetes in Southern California American Indians, 2002-2006”, has been submitted for publication. The dissertation author, Jennifer Reid, was the primary investigator and author of this paper. Co-authors were Morton DJ, Garrett MD, Wingard DL, von Muhlen D, Slymen D, and Field M.

Table 3.1. Characteristics of SCAIHC Population Aged 18+ Years: 2002-2006

	Total (n=10,351)	Women (n=5,714)	Men (n=4,637)	p-value*
Variable	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	
Age (years)	41.4 (41.1, 41.8)	41.2 (40.8, 41.6)	41.7 (41.3, 42.2)	0.114
Mean BMI (kg/m^2)†	31.8 (31.6, 31.9)	31.8 (31.5, 32.0)	31.7 (31.5, 31.9)	0.752
	% (n)	% (n)	% (n)	
Age Group (yrs)				**0.057**
18-24	18 (1889)	19 (1095)	17 (794)	
25-34	21 (2163)	21 (1180)	21 (983)	
35-44	21 (2201)	21 (1208)	21 (993)	
45-54	18 (1829)	17 (990)	18 (839)	
55-64	12 (1233)	12 (696)	12 (537)	
≥65	10 (1036)	9 (545)	11 (491)	
BMI Category†				**<0.001**
Under/Normal	20 (2067)	23 (1312)	16 (755)	
Overweight	26 (2718)	24 (1379)	29 (1339)	
Obese	24 (2484)	22 (1239)	27 (1245)	
Very Obese	15 (1603)	15 (874)	16 (728)	
Morbidly Obese	14 (1479)	16 (910)	12 (570)	
Disease Status#				
Type 2 Diabetes	15 (1522)	14 (802)	16 (720)	**0.033**
Hypertension	34 (3549)	32 (1848)	37 (1701)	**<0.001**
DM/Hypertension	12 (1241)	11 (644)	13 (597)	**0.013**
Current Smoking	17 (1780)	16 (930)	18 (850)	**0.006**

* Tests for gender differences using analysis of variance F-test for continuous variables and chi-square test for categorical variables.
† Mean BMI (kg/m^2) from 2002-2006. Under/Normal Weight: <25; Overweight: 25-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.
# Categories are not mutually exclusive.

Table 3.2. Prevalence of Type 2 Diabetes, Hypertension, and Both by BMI Category*, Age Group, Gender, and Current Smoking

	Under/Normal			Overweight			Obese			Very Obese			Morbidly Obese		
	Diab	Hyp	Both	Diab	Hyp	Both	Diab	Hyp	Both	Diab	Hyp	Both	Diab	Hyp	Both
≥18 years†	n=2,067			n=2,718			n=2,484			n=1,603			n=1,479		
Total	6.0	15.4	3.4	9.6	28.4	7.6	14.7	37.2	11.8	20.2	44.0	17.2	28.3	51.8	24.7
Women	5.2	14.6	2.7	8.8	26.0	6.6	14.6	34.1	11.4	19.7	43.5	17.4	26.6	50.5	22.9
Men	7.2	16.7	4.6	10.5	30.9	8.7	14.9	40.4	12.2	20.9	44.5	17.0	30.9	53.8	27.5
Current Smoking	8.8	30.6	5.8	13.1	44.7	12.6	20.2	53.4	17.5	32.4	63.5	28.6	38.4	72.3	34.1
18-24 years	n=570			n=460			n=382			n=246			n=231		
Women	0.9	1.4	0.0	0.5	2.1	0.0	2.3	8.9	0.5	2.7	16.7	2.2	5.9	20.5	3.2
Men	0.0	5.5	0.0	0.0	9.9	0.0	2.8	18.5	0.7	3.7	19.3	0.8	7.0	30.8	6.2
25-34 years	n=428			n=538			n=522			n=334			n=341		
Women	2.3	3.3	0.4	2.3	7.5	1.6	4.5	15.3	2.2	6.0	23.5	4.6	13.4	35.7	10.5
Men	2.0	8.3	0.7	1.1	16.1	0.4	2.8	23.7	1.8	9.8	28.8	5.6	18.7	47.0	17.5
35-44 years	n=369			n=571			n=535			n=394			n=332		
Women	4.2	9.3	1.4	6.9	23.3	4.3	11.5	31.6	7.9	21.3	42.7	17.5	26.9	48.1	20.5
Men	3.9	9.1	1.7	8.3	27.8	6.0	10.2	41.0	7.9	17.3	46.0	13.5	28.9	53.0	23.9
45-54 years	n=280			n=481			n=467			n=298			n=303		
Women	5.1	18.0	3.2	11.1	35.8	8.7	20.8	49.8	16.7	28.8	60.0	24.9	40.9	73.5	38.1
Men	8.4	23.1	4.9	17.7	39.4	15.1	21.0	50.4	18.2	28.9	57.0	24.6	42.2	68.0	39.3
55-64 years	n=176			n=343			n=321			n=206			n=187		
Women	11.3	35.0	6.1	18.7	55.7	15.5	29.5	64.0	25.6	37.7	75.1	35.5	46.8	78.4	43.4
Men	16.3	26.1	9.5	20.2	52.5	17.4	35.5	64.1	29.8	40.2	75.0	37.1	55.7	65.8	49.1
≥65 years	n=244			n=325			n=257			n=125			n= 85		
Women	14.9	45.6	11.1	27.3	64.6	20.4	37.3	64.5	33.6	40.1	72.4	38.4	44.5	70.7	41.5
Men	24.4	45.6	20.2	27.4	62.3	24.8	35.6	65.4	30.9	43.1	59.4	38.5	52.1	69.1	45.4

Note: Individual sample sizes reflect the number of subjects in the indicated age group and BMI category. Diab=Diabetes, Hyp=Hypertension.
* Mean BMI (kg/m^2) from 2002-2006. Under/Normal Weight: <25; Overweight: 25-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.
† Prevalence rates in this section are age-adjusted.

Table 3.3. Adjusted Association of BMI and Current Smoking with Type 2 Diabetes Stratified by Age Group and Gender

	Odds of Type 2 Diabetes*: OR (95% CI)					
	18-24 years (n=1,889)	25-34 years (n=2,163)	35-44 years (n=2,201)	45-54 years (n=1,829)	55-64 years (n=1,233)	≥65 years (n=1,036)
			WOMEN			
BMI Category†						
Under/Normal	1.00	1.00	1.00	1.00	1.00	1.00
Overweight	0.53 (0.04, 6.62)	0.79 (0.23, 2.72)	1.21 (0.41, 3.58)	1.62 (0.69, 3.81)	1.33 (0.62, 2.86)	1.74 (0.90, 3.36)
Obese	2.04 (0.34, 12.28)	1.16 (0.37, 3.60)	1.78 (0.78, 4.05)	**2.84 (1.17, 6.92)**	**2.41 (1.15, 5.03)**	**2.88 (1.54, 5.39)**
Very Obese	1.88 (0.32, 11.02)	1.22 (0.40, 3.70)	**3.27 (1.33, 8.06)**	**3.85 (1.61, 9.23)**	**3.00 (1.37, 6.54)**	**2.93 (1.41, 6.07)**
Morbid Obese	3.90 (0.83, 18.17)	2.32 (0.84, 6.45)	**4.30 (1.80, 10.29)**	**5.62 (2.44, 12.95)**	**4.30 (2.02, 9.16)**	**3.64 (1.62, 8.18)**
Current Smoking						
Yes (vs No)	1.23 (0.43, 3.52)	1.02 (0.51, 2.03)	1.47 (0.97, 2.24)	1.21 (0.80, 1.81)	**2.00 (1.26, 3.18)**	1.12 (0.56, 2.24)
Hypertension						
Yes (vs No)	**5.47 (2.04, 14.69)**	**10.30 (5.61, 18.92)**	**6.12 (4.13, 9.08)**	**7.02 (4.54, 10.84)**	**4.74 (2.95, 7.62)**	**4.85 (2.97, 7.90)**
			MEN			
BMI Category†						
Under/Normal	Model not valid due to 0 cases of diabetes in the under/normal weight category	1.00	1.00	1.00	1.00	1.00
Overweight		0.46 (0.05, 4.72)	1.36 (0.45, 4.15)	1.70 (0.66, 4.39)	0.77 (0.29, 2.05)	0.86 (0.43, 1.71)
Obese		1.01 (0.19, 5.24)	1.37 (0.45, 4.16)	1.74 (0.71, 4.26)	1.53 (0.60, 3.88)	1.32 (0.67, 2.57)
Very Obese		3.65 (0.75, 17.91)	2.47 (0.84, 7.26)	**2.65 (1.02, 6.92)**	1.58 (0.59, 4.23)	2.17 (0.80, 5.90)
Morbid Obese		**5.93 (1.26, 28.01)**	**4.52 (1.51, 13.60)**	**4.14 (1.65, 10.36)**	**3.93 (1.47, 10.52)**	**2.80 (1.12, 7.01)**
Current Smoking						
Yes (vs No)	---	1.85 (0.96, 3.58)	**1.73 (1.10, 2.73)**	**1.59 (1.04, 2.41)**	1.00 (0.61, 1.63)	**1.97 (1.01, 3.84)**
Hypertension						
Yes (vs No)	---	**6.03 (3.07, 11.81)**	**6.04 (3.80, 9.61)**	**8.92 (5.63, 14.14)**	**6.60 (3.96, 11.00)**	**7.73 (4.53, 13.19)**

Note: Values are Odds Ratios (95% Confidence Interval). Odds ratios significant at $\alpha = 0.05$ are bolded.
* Results of a logistic regression model stratified by age category and gender for the adjusted odds of type 2 diabetes.
† Mean BMI (kg/m^2) from 2002-2006. Under/Normal Weight: <25; Overweight: 25-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.

Table 3.4. Adjusted Association of BMI and Current Smoking with Hypertension Stratified by Age Group and Gender

	Odds of Hypertension*: OR (95% CI)					
	18-24 years (n=1,889)	25-34 years (n=2,163)	35-44 years (n=2,201)	45-54 years (n=1,829)	55-64 years (n=1,233)	≥65 years (n=1,036)
WOMEN						
BMI Category†						
Under/Normal	1.00	1.00	1.00	1.00	1.00	1.00
Overweight	1.53 (0.44, 5.40)	**2.60 (1.12, 6.05)**	**3.10 (1.69, 5.68)**	**2.42 (1.47, 3.99)**	**2.18 (1.24, 3.84)**	**2.05 (1.17, 3.58)**
Obese	**6.72 (2.44, 18.50)**	**5.61 (2.58, 12.23)**	**4.21 (2.39, 7.41)**	**4.21 (2.48, 7.13)**	**2.85 (1.60, 5.07)**	1.70 (0.97, 2.98)
Very Obese	**13.69 (5.00, 39.63)**	**9.66 (4.35, 21.43)**	**6.04 (3.48, 10.49)**	**5.83 (3.34, 10.20)**	**4.70 (2.27, 9.71)**	**2.58 (1.17, 5.72)**
Morbid Obese	**14.78 (5.51, 39.63)**	**14.35 (6.70, 30.72)**	**7.30 (3.94, 13.52)**	**9.74 (5.31, 17.88)**	**4.94 (2.59, 9.44)**	2.01 (0.86, 4.70)
Current Smoking						
Yes (vs No)	**2.82 (1.66, 4.82)**	**2.18 (1.41, 3.37)**	**2.62 (1.88, 3.65)**	**2.92 (2.02, 4.22)**	**3.38 (1.90, 6.01)**	**2.11 (1.01, 4.40)**
Type 2 Diabetes						
Yes (vs No)	**5.29 (1.96, 14.26)**	**10.36 (5.66, 18.96)**	**6.17 (4.15, 9.17)**	**6.99 (4.53, 10.80)**	**4.85 (3.01, 7.80)**	**4.86 (2.98, 7.93)**
MEN						
BMI Category†						
Under/Normal	1.00	1.00	1.00	1.00	1.00	1.00
Overweight	1.70 (0.81, 3.59)	**2.51 (1.22, 5.16)**	**3.73 (1.73, 8.03)**	1.81 (0.99, 3.33)	**3.86 (1.75, 8.51)**	**2.03 (1.06, 3.90)**
Obese	**4.07 (1.95, 8.47)**	**4.01 (1.96, 8.21)**	**6.97 (3.41, 14.25)**	**3.04 (1.59, 5.79)**	**5.22 (2.34, 11.62)**	**2.20 (1.04, 4.65)**
Very Obese	**4.15 (1.80, 9.55)**	**4.78 (2.25, 10.15)**	**7.76 (3.47, 17.33)**	**3.83 (1.86, 7.92)**	**9.70 (3.90, 24.13)**	1.39 (0.56, 3.46)
Morbid Obese	**7.71 (3.44, 17.26)**	**9.39 (4.56, 19.34)**	**8.48 (3.71, 19.41)**	**5.15 (2.55, 10.41)**	**4.27 (1.69, 10.80)**	1.99 (0.68, 5.79)
Current Smoking						
Yes (vs No)	**3.92 (2.47, 6.20)**	**3.65 (2.50, 5.34)**	**2.55 (1.79, 3.64)**	**4.94 (3.16, 7.71)**	**5.03 (2.79, 9.08)**	**4.05 (1.59, 10.29)**
Type 2 Diabetes						
Yes (vs No)	**4.25 (1.43, 12.61)**	**5.99 (3.08, 11.64)**	**6.08 (3.81, 9.69)**	**8.95 (5.64, 14.20)**	**6.66 (3.98, 11.13)**	**7.65 (4.49, 13.03)**

Note: Values are Odds Ratios (95% Confidence Interval). Odds ratios significant at $\alpha = 0.05$ are bolded.
* Results of a logistic regression model stratified by age category and gender for the adjusted odds of hypertension.
† Mean BMI (kg/m^2) from 2002-2006. Under/Normal Weight: <25; Overweight: 25-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.

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CHAPTER 4

Obesity and Other Cardiovascular Disease Risk Factors and Their Association With Osteoarthritis in Southern California American Indians, 2002-2006

ABSTRACT

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

Methods: Cross-sectional visit data from one Southern California AIAN health clinic system during 2002-2006 were extracted resulting in a sample of 6,299 AIAN adults aged 35+ years.

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, there was 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 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.

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 or their corresponding state prevalence [8-11].

A study of AIANs aged 18+ years from Alaska and the Southwest US 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 Southwest US, 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% versus 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.

The current study examined gender and age-specific OA prevalence rates in Southern California AIAN adults aged 35+ years 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 that 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 over 250 clinical variables

(Appendix 1) 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 (Appendix 3). 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. AIANs residing within these two counties were from tribes originating inside and outside of California, with the majority from California tribes. 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. 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 will not be 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 patient's 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 1 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 gender. Direct age adjustment to the overall population was used for prevalence rates not stratified by age group. Gender-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] then missing heights and/or weights were imputed from nonmissing height, weight, gender, 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 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. Results of imputed analyses are presented, however analyses were 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 gender (Table 4.1). Although men and women had similar mean BMI (~32 kg/m^2), they differed in distribution among BMI categories ($p<0.001$). More women were under/normal weight (women: 20%, men: 14%) and morbidly obese (women: 16%, men: 12%) than men, whereas more men were overweight (women: 25%, men: 30%) and obese (women: 23%, men: 28%) than women, with no gender 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 genders and with increasing BMI in some age groups (Table 4.2). 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 genders.

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 4.3). Due to the stratification by gender 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 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 the 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 women 35-44 years old 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 increased odds of OA that was borderline significant.

Current smokers were more likely to have OA, although results were not significant in all gender 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).

In the current study, age-adjusted OA prevalence for AIAN aged 35+ years was 16.5% for women and 11.5% for men. OA 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 Southwest US (n=6,273) [6]. Arthritis prevalence for those aged 55+ years was 48.4% in Alaska and 32.8% in Southwest US. Arthritis prevalence increased with age in both regions; however, arthritis prevalence was increased for women compared to men in Alaska but not Southwest US until age 55+. 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 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 current study's OA prevalence in women was much lower compared to the one 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 age 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 gender. Additional analyses adjusted by gender 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 less than 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 living in two Southern California counties who attended SCAIHC and may be affected by Berson’s bias. Even within the same tribe, some members attended SCAIHC and other members attended off-reservation health care facilities depending on their insurance. Therefore, this sample may 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 available. 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 have 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 genders 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 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.

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Chapter 4, in full, and titled, “Obesity and Other Cardiovascular Disease Risk Factors and Their Association with Osteoarthritis in Southern California American Indians, 2002-2006”, has been submitted for publication. The dissertation author, Jennifer Reid, was the primary investigator and author of this paper. Co-authors were Morton DJ, Garrett MD, Wingard DL, von Muhlen D, Slymen D, and Field M.

Table 4.1. Characteristics of SCAIHC Population Aged 35+ Years: 2002-2006

	Total (N=6,299)	Women (N=3,439)	Men (N=2,860)	p-value*
Variable	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	
Age (years)	51.7 (51.4, 52.0)	51.7 (51.3, 52.1)	51.7 (51.3 52.2)	0.885
Mean BMI (kg/m^2)†	32.0 (31.6, 31.9)	32.1 (31.8, 32.4)	32.0 (31.7, 32.3)	0.783
	% (n)	% (n)	% (n)	
Age Group (yrs)				0.309
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†				<0.001
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)	<0.001
Type 2 Diabetes	22 (1369)	21 (718)	23 (651)	0.071
Hypertension	47 (2944)	46 (1581)	48 (1363)	0.182
Current Smoking	17 (1093)	17 (589)	18 (504)	0.605

* Tests for gender 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-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.

Table 4.2. Prevalence of Osteoarthritis by CVD Risk Factor, Age Group, and Gender for SCAIHC Population: 2002-2006

		Total (n=6,299)	35-44 years (n=2,201)	45-54 years (n=1,829)	55-64 years (n=1,233)	≥65 years (n=1,036)
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-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.

Table 4.3. Adjusted Association of BMI with Osteoarthritis Stratified by Age Group and Gender

	Odds of Osteoarthritis*: OR (95% CI)			
	35-44 years (n=2,201)	45-54 years (n=1,829)	55-64 years (n=1,233)	≥65 years (n=1,036)
		WOMEN		
BMI Category†				
Under/Normal	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:				
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:				
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	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 gender for the adjusted odds of osteoarthritis.
† Mean BMI (kg/m^2) from 2002-2006. Under/Normal Weight: <25; Overweight: 25-<30; Obese: 30-<35; Very Obese: 35-<40; Morbidly Obese ≥40.

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CHAPTER 5

Overall Conclusions and Discussion

RESEARCH CONTRIBUTIONS

American Indians/Alaska Natives (AIANs) are an understudied population overall with significant diversity between tribes thus making it often inappropriate to generalize health information between regions. For a group of Southern California AIANs not previously studied, this research provided current age- and gender-specific prevalence rates for obesity and other cardiovascular disease (CVD) risk factors, and addressed the association of elevated obesity and smoking with diabetes, hypertension, and osteoarthritis during a recent five year period. Research on California AIANs is very limited and this study contributed results for a specific Southern California AIAN group and extended the existing literature available for AIANs as a whole.

SUMMARY OF FINDINGS

Obesity (Chapter 2)

During a recent five-year period, AIAN children and adults from one Southern California Indian health clinic system, hereafter referred to as the Southern California American Indian Health Clinics (SCAIHC), had higher obesity prevalence than other US populations, California populations, and other AIAN populations during a similar time period. Gender and age differences within this AIAN group were also evident. Over the five-year period the obesity prevalence was consistent with no indication of decreased obesity.

Among children aged 6-17 years from SCAIHC, the age-adjusted obesity prevalence was 34% for girls and 42% for boys. Compared to other AIAN children during 2000-2004, SCAIHC children had the highest prevalence of obesity [1, 2, 3] with at least 25% more obesity than Indian children from 18 tribes in the Dakotas, Nebraska, and Iowa [2] and at least twice the obesity prevalence compared to AIANs enrolled in California public schools [1]. SCAIHC children had more than twice the obesity prevalence of white non-Hispanics in the California public schools [1].

Among adults from SCAIHC, the age-adjusted obesity prevalence was 57% for women and 58% for men. Women were more morbidly obese than men, whereas men were more overweight than women. At 65+ years, obesity prevalence declined with a concomitant increase in prevalence of overweight and normal weight consistent with trends seen in other populations after age 65. Compared to other AIANs during 2000-2004, SCAIHC adults had the highest obesity prevalence [4,5,6,7] with at least 25% more obesity based on results of two national surveys [6,7]. SCAIHC adults were considerably more obese compared to Hispanic and white non-Hispanic populations [7,8].

These results are consistent with existing literature indicating that AIANs as well as other minorities are disproportionately affected by the continuing US obesity epidemic [7] with obesity prevalence rates from many AIAN tribes the highest of any ethnic group in the US [9]. This continuing obesity epidemic will determine morbidity patterns resulting in chronic disease for the long term. Moreover, AIANs are a young population. High obesity prevalence in a young population leads to increased prevalence of type 2 diabetes and hypertension at earlier ages, thus elevating the likelihood and risk of complications from these diseases as well.

CVD Risk Factors (Chapter 3)

In addition to high obesity prevalence, our research found this SCAIHC population had high prevalence of other CVD risk factors that varied by gender: diabetes (women: 14%, men: 16%, p=0.033), hypertension (women: 32%, men: 37%, p<0.001), and current smoking (women: 16%; men: 18%, p=0.006). Prevalence also varied considerably by age. Whereas the association of obesity and smoking with diabetes varied by gender and age group, their association with hypertension was similar between genders and among age groups less than 65 years.

Increasing obesity was generally associated with increased odds of diabetes for women; however, for men the morbidly obese had significantly higher odds of diabetes, with only a slight trend for increased odds of diabetes with increasing level of obesity. Current smoking was generally associated with more diabetes for women; however, the association was significant only among those aged 55-64. In contrast, men who reported current smoking were nearly twice as likely to have diabetes; the association was significant in three age groups. Both women and men with hypertension were more likely to also have diabetes.

Obesity and current smoking were both strongly associated with increased odds of hypertension for both women and men. Whereas there were definitively increasing odds of hypertension for increasing obesity level in those aged less than 65 years, this trend was not evident in AIANs aged 65+ years. Men tended to have greater odds of hypertension associated with current smoking than women, though gender differences were not statistically significant. Both women and men with diabetes were more likely to also have hypertension.

The likelihood of diabetes and hypertension associated with overweight/obesity found in this SCAIHC population was similar to other AIAN populations [10, 11]. Their high prevalence of obesity, diabetes, and hypertension was greater than the US as a whole [8, 12] and, more specifically, than residents from the same California region [13]. SCAIHC diabetes and hypertension prevalence rates were within the range of other AIAN communities, but obesity prevalence was considerably higher [5, 14, 15, 16, 17, 18]. SCAIHC current smoking prevalence was lower then found in other AIAN populations and less than national prevalence; however, prevalence was higher in SCAIHC women compared to California women [5, 14, 15, 16, 17, 19, 20].

The high prevalence of obesity and other CVD risk factors in this SCAIHC population creates a great burden on this community as CVD is the leading cause of death among older AIAN adults [21, 22]. More specifically, results indicate higher prevalence compared to other AIAN groups. Examination of differences in diet and exercise patterns, genetic characteristics, and socioeconomic status may explain this discrepancy. Gender- and age-related differences in coronary heart disease (CHD) risk have been shown in prospective studies, primarily among Caucasians, to be mostly explained by differential prevalence of CVD risk factors in gender and age groups [23,24]. Prospective studies are warranted to address the health problems of this understudied minority.

Obesity and Osteoarthritis (Chapter 4)

The high obesity prevalence in the SCAIHC population may have further impact, as obesity is a known risk factor for osteoarthritis (OA) [25], the most common form of arthritis, which is the leading cause of disability in the US [26, 27]. Our research found that in this SCAIHC population aged 35+ years, OA prevalence increased with age and was higher for women than men (women: 16.5%, men: 11.5%, $p<0.001$). While obesity was generally associated with increased odds of OA in those aged 45-64 years, only the more extreme levels of obesity were significantly associated. Increasing BMI was not significantly associated with OA for the either the youngest (35-44 years) or the oldest (65+ years) group of women and men.

Hypertension was significantly associated with higher odds of OA in both women and men; an association that increased substantially with age. Diabetes showed some association with OA and current smokers had more OA, although results were not significant in all gender and age groups.

OA prevalence in the SCAIHC population was lower than found in the few existing studies on arthritis that included AIANs, which varied widely by study [28, 29, 30, 31]. 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. Although not always statistically significant, increasing obesity was associated with more OA prevalence [28, 29, 31] in these studies of AIANs.

This SCAIHC population may have lower OA prevalence than other AIAN populations but lack of other similar published results makes that difficult to determine.

Further studies are needed to determine the impact of OA within this understudied minority population.

LIMITATIONS AND STRENGTHS

The limitation of this research is that results represent AIAN children and adults living in only two Southern California counties who attended their local SCAIHC and may be affected by Berkson's bias. Even within the same tribe, some members attended SCAIHC and other members attended off-reservation health care facilities depending on their insurance. Therefore, this sample may not contain AIANs from all areas of Southern California. The California IHS estimates their registered population of AIAN users residing in Southern California from 10/1/2003 to 9/30/2006 at approximately 40,000 [32]. This study includes 10,351 AIANs who resided in Southern California and consists of some of the best current data. Although not fully representative of all Southern California AIAN, it is reasonable to generalize these results to the Southern California AIAN population. However, due to the diversity present in California, results may not be generalizable to the entire population of California AIANs.

One strength of these results is their relevance 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 informative comparisons between genders and age groups. Diabetes, hypertension, and OA disease status were based on actual diagnosis and obesity from measured height and weight rather than self-report. Of particular importance is that CVD risk factor prevalence and associations of obesity and smoking with diabetes and hypertension from AIANs residing in California have not been previously reported. Neither OA prevalence nor the association of obesity with OA has been previously reported for any large AIAN population.

The large proportion of missing BMI information is 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 of diabetes, hypertension, and OA, rather than excluding them due to missing BMI. Use of this method did not appreciably change the resulting trends as indicated by comparison of imputed to non-imputed analyses.

FUTURE DIRECTION

The high prevalence of obesity, diabetes, and hypertension are a great burden on this Southern California AIAN community and all AIAN communities as CVD is their leading cause of death in older adults [21, 22]. Further studies are needed to determine the impact of obesity on OA within this understudied minority population, particularly as obesity is on the rise and arthritis is the leading cause of disability in the US [26,27]. The AIAN population is a diverse group with 562 federally recognized tribes further distinguished by language and cultural traditions, many of which affect current health behaviors [33]. This diversity is fundamentally evident in the substantial differences in CVD risk factor prevalence among AIAN communities. Such variation necessitates targeted interventions tailored to the cultural customs and health problems most prevalent in each tribal community.

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APPENDICES

Appendix 1: Data Export Elements From RPMS

DATA ANALYSIS SERVICE				
SAS name	Excel	EXPORTED ELEMENTS FROM RPMS	Description of Data Item	Dictionary
id	A	Unique Id #	Unique ID for this visit. ASUFAC_IEN of the visit. IEN of visit is left zero filed to 10 digits.	SSN
chart	B	ASUFAC_HRN	Use ASUFAC and HRN at location of encounter, if one exists. Otherwise, ASUFAC_HRN at DUZ (2).	This code is 16 digit code; eg 2021010000889870
date	C	Visit/Admission Date	Date of Visit in CYYMMDD format.	
time	D	Time Of Day	Time of day in internal FileMan format; e.g., 1000, 1310, 0805	
day	E	Day Of Week	DOW in APC record definition format.	
location	F	Location Of Encounter	ASUFAC of location of encounter.	A four digit code eg 2021=Albuquerque, ASUFAC
type	G	Type	Type of Visit. C, I, O, 6, T, U, V, S, etc.	Indian Health Service - Visit Type Code Name
category	H	Service Category	Service Category: e.g., A, H, I, C, T, etc.	Indian Health Service - Service Category Codes Service code Service name
clinic	I	Clinic	Clinic of Visit, standard 2 digit code.	Clinci Codes01 General 02 Cardiac
primary	J	Primary Prov Affiliation/Discipline	Primary Provider's Affiliation and Discipline; e.g., 101	Provider Codes 01 - Hospital GM&S
first	K	Other Provider Affiliation/ Discipline	First Secondary Provider Affiliation/Discipline.	
second	L	Other Provider Affiliation/ Discipline	2nd Secondary Provider Affiliation/Discipline.	
third	M	Other Provider Affiliation/ Discipline	3rd Secondary Provider Affiliation/Discipline.	
fourth	N	Other Provider Affiliation/ Discipline	4th Secondary Provider Affiliation/Discipline.	
dob	O	DOB	DOB in format 2960908. CYYMMDD	
sex	P	Sex	Sex. M or F	
ssn	Q	SSN	SSN of patient or 9 blanks. No dashes.	
street	R	Mailing address-street		
city	S	Mailing address-city		
state	T	Mailing address-state		
zipcode	U	Mailing address-zipcode		
tribe	V	Primary Tribe	Tribe code from standard code book.	
resid	W	Community Of Residence	STCTYCOM code of patient's residence. Taken from the current community field.	Community Code comprises 2 digit state 2 digit county and 3 digit community
class	X	Classification/Beneficiary	Beneficiary Code from Standard Code book.	
eligible	Y	Eligibility	Eligibility Status from standard code book.	
Iquantum	Z	Indian Quantum	Total Indian blood quantum in decimal	
Tquantum	AA	Tribal Quantum	Blood quantum of primary Tribal membership in decimal	
visitda1	AB	Medicaid Elig On Visit Date	Y or N. If patient was Medicaid eligible on the visit date, this is set to Y, if not, N.	
visitda2	AC	Medicare Elig On Visit Date	Y or N. If patient was Medicaid eligible on the visit date, this is set to Y, if not, N.	
insurdat	AD	Private Insurance Eligibility On Visit Date	Y or N. If patient was Private Insurance eligible on the visit date, this is set to Y, if not, N.	
vital	AE	Vital Signs Done	Were vital signs taken?	
LMP	AF	LMP	Last LMP on file. Note: This may not be current. Check against date noted.	
dateLMP	AG	Date LMP Noted	Date LMP noted. Format: 2960809	
systolic	AH	Blood Pressure Systolic	Systolic Blood Pressure result	
diastol	AI	Blood Pressure Diastolic	Diastolic Blood Pressure result	
RW	AJ	%Recommended Weight	% RW as a number.	

Data Export Elements From RPMS – continued

headcir	AK	Head Circumference Done?	Y or N	
BMI	AL	Body Mass Index (BMI)	Calculated BMI from this visit's weight and most recent height	
height	AM	Last height recorded for patient	Search back for last height entered for that patient	
datehg	AN	Date last height measured	Date that last height was measured	
weight	AO	Weight		
ICDDx	AP	Primary ICD Dx	Primary ICD Dx. If this is a non-hospitalization visit, it is the 1st diagnosis entered.	
APCcode1	AQ	APC Code 1	APC Recode for diagnosis 1	
dateDx1	AR	Date of Onset Dx1		
causeDx1	AS	Cause Of Dx 1	1-Hospital acquired, 2-Alcohol- related, 3-battered child, 4-employment-related for Diagnosis 1	
causeinj	AT	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 1 is an injury 800-999.9.	
placein1	AU	Place Of Injury	PCC place of injury code for Diagnosis 1 if Diagnosis 1 is an injury.	
stagedx1	AV	Stage dx 1	Stage for Diagnosis 1	
diagno2	AW	Diagnosis 2	ICD Dx 2. If this is a non-hospitalization visit, it is the 2nd diagnosis entered.	
APCcode2	AX	APC Code 2	APC Recode for diagnosis 2	
dateDx2	AY	Date of Onset Dx2		
causeDx2	AZ	Cause Of Dx 2	1-Hospital acquired, 2-alcohol-related, 3-battered child, 4-employment-related for Diagnosis 2	
causein2	BA	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 2 is an injury 800-999.9.	
placein2	BB	Place Of Injury	PCC place of injury code for Diagnosis 2 if Diagnosis 2 is an injury.	
stagedx2	BC	Stage dx 2	Stage for diagnosis 2	
diagno3	BD	Diagnosis 3	ICD Dx 3. If this is a non-hospitalization visit, it is the 3rd diagnosis entered.	
APCcode3	BE	APC Code 3	APC Recode for diagnosis 3	
dateDx3	BF	Date of Onset Dx3		
causeDx3	BG	Cause Of Dx 3	1-Hospital acquired, 2-alcohol-related, 3-battered child, 4-employment-related for Diagnosis 3	
causein3	BH	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 3 is an injury 800-999.9.	
placein3	BI	Place Of Injury	PCC place of injury code for Diagnosis 3 if Diagnosis 3 is an injury.	
stagedx3	BJ	Stage for dx 3	Stage for diagnosis 3	
diagno4	BK	Diagnosis 4	ICD Dx 4. If this is a non-hospitalization visit, it is the 4th diagnosis entered.	
APCcode4	BL	APC Code 4	APC Recode for diagnosis 4.	
dateDx4	BM	Date of Onset Dx4		
causeDx4	BN	Cause Of Dx 4	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 4.	
causein4	BO	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 4 is an injury 800-999.9.	
placein4	BP	Place Of Injury	PCC place of injury code for Diagnosis 4 if Diagnosis 4 is an injury.	
stagedx4	BQ	Stage for dx 4	Stage for dx 4	
diagno5	BR	Diagnosis 5	ICD Dx 5. If this is a non-hospitalization visit, it is the 5th diagnosis entered.	

Data Export Elements From RPMS – continued

APCcode5	BS	APC Code 5	APC Recode for diagnosis 5	
dateDx5	BT	Date of Onset Dx5		
causeDx5	BU	Cause Of Dx 5	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 5.	
causein5	BV	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 5 is an injury 800-999.9.	
placein5	BW	Place Of Injury	PCC place of injury code for Diagnosis 5 if Diagnosis 5 is an injury.	
stagedx5	BX	Stage for Diagnosis 5	Stage for dx 5	
diagno6	BY	Diagnosis 6	ICD Dx 6. If this is a non-hospitalization visit, it is the 6th diagnosis entered.	
APCcode6	BZ	APC Code 6	APC Recode for diagnosis 6.	
dateDx6	CA	Date of Onset Dx6		
causeDx6	CB	Cause Of Dx 6	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 6.	
causein6	CC	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 6 is an injury 800-999.9.	
placein6	CD	Place Of Injury	PCC place of injury code for Diagnosis 6 if Diagnosis 6 is an injury.	
stagedx6	CE	Stage for dx 6	Stage for diagnosis 6	
diagno7	CF	Diagnosis 7	ICD Dx 7. If this is a non-hospitalization visit, it is the 7th diagnosis entered.	
APCcode7	CG	APC Code 7	APC Recode for diagnosis 7.	
dateDx7	CH	Date of Onset Dx7		
causeDx7	CI	Cause Of Dx 7	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 7.	
causein7	CJ	Cause Of Injury 7	Valid ICD9 E code for an injury. If Diagnosis 7 is an injury 800-999.9.	
placein7	CK	Place Of Injury 7	PCC Place of injury code for Diagnosis 7 if Diagnosis 7 is an injury.	
stagedx7	CL	Stage for dx 7	Stage for dx 7	
diagno8	CM	Diagnosis 8	ICD Dx 8. If this is a non-hospitalization visit, it is the 8th diagnosis entered.	
APCcode8	CN	APC Code 8	APC Recode for diagnosis 8	
dateDx8	CO	Date of Onset Dx8		
causeDx8	CP	Cause Of Dx 8	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 8.	
causein8	CQ	Cause Of Injury	Valid ICD9 E code for an injury. If Diagnosis 8 is an injury 800-999.9.	
placein8	CR	Place Of Injury	PCC place of injury code for Diagnosis 8 if Diagnosis 8 is an injury.	
stageDx8	CS	Stage for dx 8		
diagno9	CT	Diagnosis 9	ICD Dx 9. If this is a non-hospitalization visit, it is the 9th diagnosis entered.	
APCcode9	CU	APC Code 9	APC Recode for diagnosis 9.	
dateDx9	CV	Date of Onset Dx9		
causeDx9	CW	Cause Of Dx 9	1-Hospital acquired, 2- alcohol-related, 3-battered child, 4-employment-related for Diagnosis 9.	
causein9	CX	Cause of Injury 9	Vaild ICD9 E code for an inury. If Diagnosis 9 is an injury 800-999.9	
placein9	CY	Place Of Injury	PCC place of injury code for Diagnosis 9 if Diagnosis 9 is an injury.	
stageDx9	CZ	Stage for dx 9	Stage of dx 9	
hyperten	DA	Hypertension on Problem List	Y if Hypertension on problem list	
diabetes	DB	Diabetes on Problem List	Y if Diabetes on problem list	
LEamputa	DC	LE Amputation ever performed?	Y/N Look back on first export and collect any diagnosis or procedure codes, enter into "historical	
retinal	DD	Retinal laser therapy ever performed?	Y/N Look back on first export and collect any diagnosis or procedure codes, enter into "historical	

Data Export Elements From RPMS – continued

esrdever	DE	ESRD ever?	Y/N Only look at problem list for now.	
cvaever	DF	CVA ever	Y/N Only look at problem list for now.	
Myocardi	DG	Hx of Myocardial Infarction	Y/N Only look at problem list for now.	For ESRD evaluation
Peripher	DH	Hx of Peripheral Vascular Disease	Y/N Only look at problem list for now.	For ESRD evaluation
Lungcan	DI	Hx of Lung Cancer	Y/N Only look at problem list for now.	For Cancer Program
Breast	DJ	Hx of Breast Cancer	Y/N Only look at problem list for now.	For Cancer Program
Cervical	DK	Hx of Cervical Cancer	Y/N Only look at problem list for now.	For Cancer Program
Prostate	DL	Hx of Prostate Cancer	Y/N Only look at problem list for now.	For Cancer Program
Colon	DM	Hx of Colon Cancer	Y/N Only look at problem list for now.	For Cancer Program
Other	DN	Hx of Other Cancer	Y/N Only look at problem list for now.	For Cancer Program
TBstatus	DO	TB Status	Set of codes from TB Status Health Factors	
Hfactor1	DP	Health Factor (1)	First health factor for this visit	
Hfactor2	DQ	Health Factor (2)	Second health factor for this visit	
Hfactor3	DR	Health Factor (3)	Third health factor for this visit	
Hfactor4	DS	Health Factor (4)	Fourth health factor for this visit	
CPTcode	DT	Evaluation And Management CPT Code	CPT CODE from Evaluation and Management field of Visit file.	
levelser	DU	Level Of Service	Level of Service code from PCC form.	
ICDProc	DV	ICD Proc Code (1)	ICD Operation Code	
Procdate	DW	Proc Date (1)	Internal FileMan format of date of procedure	
Infect	DX	Infection (1)	Y - Yes	
ProcPro1	DY	Proc Prov Aff/Disc (1)	Operating Provider's Affiliation/Discipline Code	
CPTcod1	DZ	CPT Code (1)	CPT Code for this Procedure	
Dxdone1	EA	Dx Done For (1)	The number (1-9) of the diagnosis that this procedure was done for.	
ICDProc2	EB	ICD Proc Code (2)	ICD Operation Code	
Procdat2	EC	Proc Date (2)	Internal FileMan format of date of procedure.	
Infect2	ED	Infection (2)	Y - Yes	
ProcPro2	EE	Proc Prov Aff/Disc (2)	Operating Provider's Affiliation/ Discipline code	
CPTcode2	EF	CPT Code (2)	CPT Code for this Procedure	
Dxdone2	EG	Dx Done For (2)	The number (1-9) of the diagnosis that this procedure was done for.	
ICDproc3	EH	ICD Proc Code (3)	ICD Operation Code	
Procdat3	EI	Proc Date (3)	Internal FileMan format of date of procedure.	
Infect3	EJ	Infection (3)	Y - Yes	
ProcPro3	EK	Proc Prov Aff/Disc (3)	Operating Provider's Affiliation/ Discipline code	
CPTcode3	EL	CPT Code (3)	CPT Code for this procedure	
Dxdone3	EM	Dx Done For (3)	The number (1-9) of the diagnosis that this procedure was done for.	
Mamograp	EN	Was Mammography Performed	Y or N	look at exam code and ICD and CPT procedure codes
PAP	EO	Was a PAP Performed	Y or N	look at exam code and ICD and CPT procedure codes
Exacode1	EP	Exam code (1)	First exam code for this visit	

Data Export Elements From RPMS – continued

Exacode2	EQ	Exam code (2)	Second exam code for this visit	
Exacode3	ER	Exam code (3)	Third exam code for this visit	
Exacode4	ES	Exam code (4)	Fourth exam code for this visit	
PPD	ET	PPD Placed	Y or N. If ppd read value recorded on visit then value recorded in "PPD Read" field and "N" recorded in	
PPDresul	EU	PPD Result	Result in mm.	
EKG	EV	Was EKG performed this visit?	Y/N	
Immucode	EW	Immunization Code (1)	Immunization given, from standard codes	
Immuser	EX	Immunization Series (1)	Set of codes	
Immucod2	EY	Immunization Code (2)	Immunization given, from standard codes	
Immuse2	EZ	Immunization Series (2)	Set of codes	
Immucod3	FA	Immunization Code (3)	Immunization given, from standard codes	
Immuse3	FB	Immunization Series (3)	Set of codes	
Immucod4	FC	Immunization Code (4)	Immunization given, from standard codes.	
Immuse4	FD	Immunization Series (4)	Series for this immunization.	
NoRx	FE	# Of Rx's	# of prescriptions filled.	
Drugname	FF	ACE Inhibitor Drug name, if any	Was an ACE INHIBITOR filled at our pharmacy for this patient, this visit. Name of drug passed	
Insulin	FG	Insulin		
Sulfony	FH	Sulfonylurea		
Metfor	FI	Metformin		
Acarbose	FJ	Acarbose		
Troglita	FK	Troglitazone		
Aspirin	FL	Aspirin		
Labtest	FM	# Of Lab Tests Done	# of lab tests done.	
HGBA1C	FN	HGB A1C Value	If done, HGB A1C result	
Cholest	FO	Cholesterol Value	If done, serum cholesterol result	
LDL	FP	LDL Cholesterol Value	If done, LDL cholesterol result	
Creatini	FQ	Creatinine Value	If done, serum creatinine result	
Protein	FR	Was Proteinuria Present	Report value (e.g., neg., trace, 1+, etc.)	
Microalb	FS	Was Microalbuminuria Present	Report value	
Blood	FT	Blood glucose	If done, blood glucose result	
UAperf	FU	U/A Performed	Y or N	
Triglyce	FV	Triglycerides	If done, triglycerides value.	
HDL	FW	HDL	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation
Hemoglo	FX	Hemoglobin	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation
Albumin	FY	Albumin	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation
Bicarbin	FZ	Bicarbinate	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation
Calcium	GA	Calcium	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation
Phosphat	GB	Phosphates	Will need taxonomy of tests, problems with different meausrement units.	For ESRD evaluation

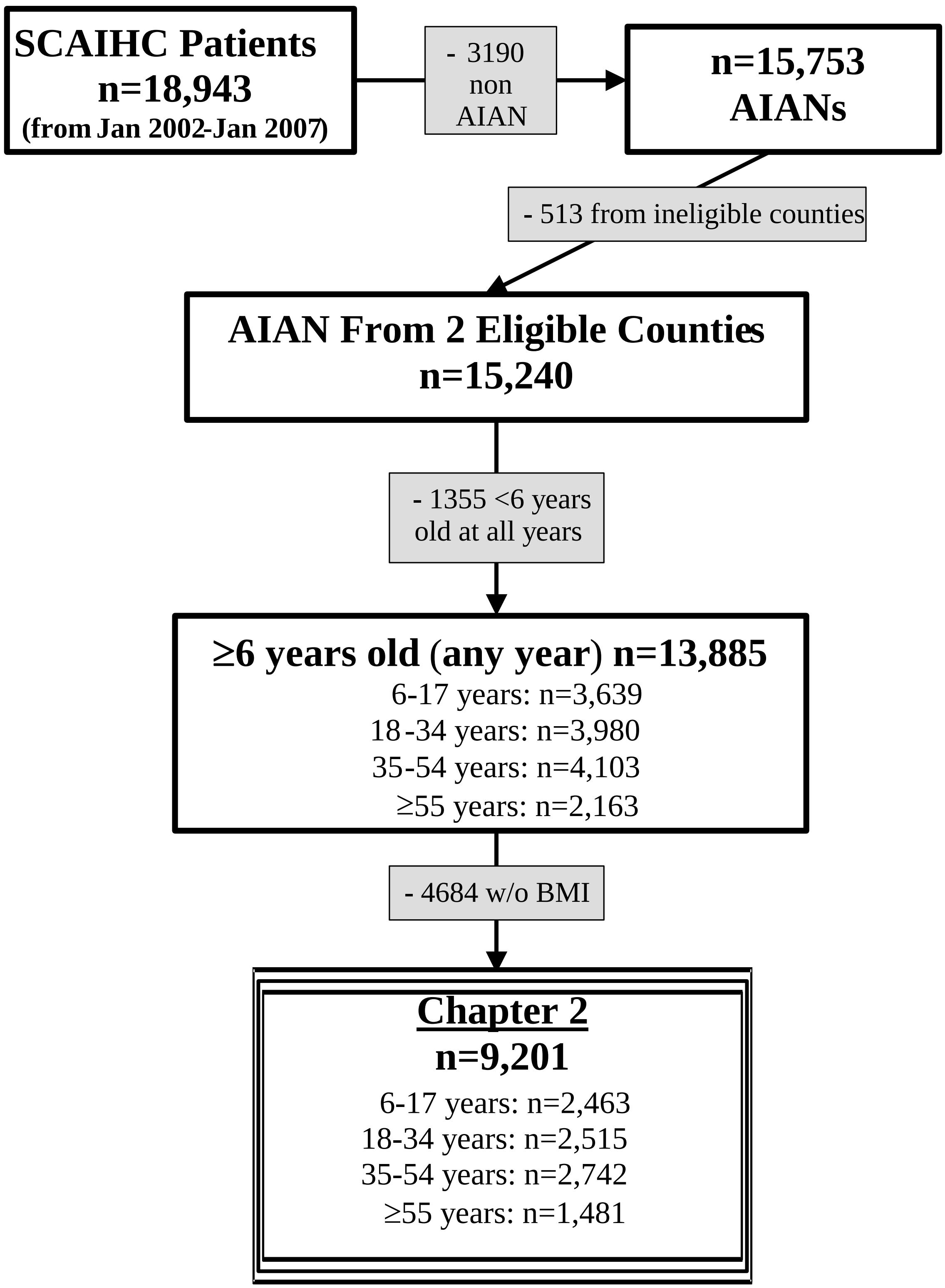
Data Export Elements From RPMS – continued

Uprotein	GC	Proteinuria upper normal range		
UMicroal	GD	Upper Microalbuminuria Normal Range	Report upper limits of normal for test used.	
Lowgluco	GE	Lower glucose normal range	To allow for eventual expansion to non-US sites	
Upgluco	GF	Upper glucose normal range	To allow for eventual expansion to non-US sites	
UpTrigy	GG	Upper Trigycerides normal range		
LowHDL	GH	Lower HDL normal range		
Lowalbu	GI	Lower albumin normal range		
Upalbum	GJ	Upper albumin normal range		
Lowbicar	GK	Lower bicarbinate normal range		
Upbicar	GL	Upper bicarbinate normal range		
Lowcalci	GM	Lower calcium normal range		
Upcalcu	GN	Upper calcium normal range		
Lowphos	GO	Lower phosphate normal range		
Upphos	GP	Upper phosphate normal range		
PtEdcod1	GQ	Pt. Ed Code (1)	First Pt. Ed. code for this visit	
PtEdcod2	GR	Pt. Ed Code (2)	Second Pt. Ed. code for this visit	
PtEdcod3	GS	Pt. Ed Code (3)	Third Pt. Ed. code for this visit	
PtEdcod4	GT	Pt. Ed Code (4)	Fourth Pt. Ed. code for this visit	
Admindat	GU	Admission Date	Admission date in internal FileMan format.	
Admisser	GV	Admission Service	Admitting Service (2-digit IHS code)	
Admintyp	GW	Admission Type	Admission Type	
AttenPhy	GX	Attending Physician	Affiliation/Discipline Code	
Causedea	GY	Cause Of Death	ICD CODE	
Consults	GZ	# Of Consults	Number of consults during an Inpatient stay	
Dischdat	HA	Discharge Date	Internal FileMan format of discharge date.	
Dischser	HB	Discharge Service	From Standard Treating Speciality Table.	
Dischtyp	HC	Discharge Type	IHS Standard Code for Discharge Type.	
Asufac	HD	Facility Transfer To (Asufac)	From Location table	
Length	HE	Length Of Stay	Length of Stay	
MIdwifer	HF	Midwifery	1 if midwife was a provider	
Activity	HG	Activity Time	Minutes	
Travel	HH	Travel Time	Minutes	
CHScost	HI	CHS Cost	For CHS visits, total cost info.	
ADAcode	HJ	ADA Code (1)	ADA Code	
ADAunit	HK	ADA Units (1)	# of Units	
ADAcode2	HL	ADA Code (2)	ADA Code	
ADAunit2	HM	ADA Units (2)	# of Units	
ADAcode3	HN	ADA Code (3)	ADA Code	

Data Export Elements From RPMS – continued

ADAunit3	HO	ADA Units (3)	# of Units	
ADAcode4	HP	ADA Code (4)	ADA Code	
ADAunit4	HQ	ADA Units (4)	# of Units	
ADAcode5	HR	ADA Code (5)	ADA Code	
ADAunit5	HS	ADA Units (5)	# of Units	
ADAcode6	HT	ADA Code (6)	ADA Code	
ADAunit6	HU	ADA Units (6)	# of Units	
ERvisit	HV	Disposition On ER Visits	If this is an ER visit, what was the disposition? Set of Codes	
dateDM	HW	Date of Diabetes DX	Date of DM DX	
SourceDM	HX	Source of DM Date of DX	Diabetes Register, Problem List, Earliest POV	
Dialysis	HY	Dialysis DX ever	Procedures and POVs are searched for any evidence of Dialysis	
EKGdate	HZ	Last EKG Date	Date of Last EKG	
TDdate	IA	Last TD Date	Date of Last Td	
Pneudate	IB	Last Pneumovax Date	Date of last pneumovax	
nextPnda	IC	Next to last pneumovax date	next to last pneuomox	
Tobaco	ID	I sTobacco Use on Problem List?	Is dx 305.1-305.13 on the problem list, Y/N	
PPDdate	IE	TB Dx or Pos PPD date	Date of last positive PPD, or date of last TB dx or TB entered on Problem list date.	
HRN_1	IF	HRN #1	HRN #1 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_2	IG	HRN #2	HRN #2 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_3	IH	HRN #3	HRN #3 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_4	IJ	HRN #4	HRN #4 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_5	IK	HRN #5	HRN #5 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_6	IL	HRN #6	HRN #6 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_7	IM	HRN #7	HRN #7 - ASUFAC_HRN where HRN is left zero filled to 6 digits	
HRN_8	IN	HRN #8	HRN #8 - ASUFAC_HRN where HRN is left zero filled to 6 digits	

Appendix 2: Patient Exclusions (Chapter 2)



Appendix 3: Patient Exclusions (Chapters 3 and 4)