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American Indians/Alaska Natives and Cardiovascular Disease: Outcomes, Interventions, and Areas of Opportunity

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Abstract
Purpose of Review Cardiovascular disease (CVD) is a reported leading cause of death among American Indians and Alaska Natives (AI/ANs) and takes a disproportionate toll on these populations. Using the electronic database PubMed, the purpose of this review is to summarize findings from CVD morbidity/mortality outcome studies, as well as CVD and CVD risk factor intervention studies among AI/ANs, published in 2014 and 2015.
Recent Findings Eighteen empirical studies that focused on CVD outcomes and CVD/CVD risk factor interventions were reviewed. Four of five studies on CVD mortality found that CVD is a leading or second leading cause of death among AI/ANs and that CVD mortality is still disproportionately high compared to whites. Three studies examined smoking or high-fat diets and found an association between these risk factors and CVD. Two CVD prevalence studies did not find statistically significant differences between AI/ANs and whites; however, this may be due to specific sample characteristics of these particular studies. Seven of eight CVD/CVD risk factor intervention studies, ranging in type of interventions delivered and outcomes measured, found beneficial CVD/CVD risk factor outcomes. One study uniquely underscored historical trauma and social determinants of health as barriers to healthy living.
Summary CVD disproportionately burdens AI/AN communities. Large-scale studies that oversample for AI/ANs are needed to document the continuing effects of CVD among Indigenous communities and monitor their disparity status in CVD morbidity/mortality. More interventions with control or comparison groups are also needed to address CVD and CVD risk factors among AI/AN communities and document their effectiveness. In addition, collaborative community-based interventions that tackle root issues of CVD-related disparities and attend to social determinants of health are needed.

Keywords American Indians · Alaska Natives · Cardiovascular disease · Cardiovascular disease risk factors · Health disparities

This article is part of the Topical Collection on *Race and Ethnic Disparities*

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Introduction

Cardiovascular disease (CVD) is a formidable and global public health challenge [1•]. In the USA, CVD is the leading cause of death [2]. Although USA rates of death attributable to CVD have recently declined, CVD-related mortality and the burden of CVD and its associated risk factors remain high [3]. Furthermore, the current and projected rise in prevalence of several CVD risk factors coupled with increasing population growth and life expectancies may increase CVD incidence and morbidity and reverse the currently declining CVD mortality trend [1•, 4••]. This may be especially true for Indigenous peoples of the USA.

Indigenous peoples of the USA—hereby referred to as American Indians and Alaska Natives (AI/ANs)—suffer from significant social, economic, health, and health care disparities in comparison to other USA populations. CVD is a health problem that takes a disproportionate toll on AI/ANs, with incidence rates that double the general population [5]. In a systematic review of stroke, a form of CVD, Harris et al. found that stroke mortality rates for AI/ANs were among the highest of all USA racial/ethnic groups [6•]. The same is true for prevalence of several CVD risk factors. For example, AI/ANs are 2.3 times more likely to have diabetes (a major risk factor for CVD) in comparison to the general USA population [7] and have the highest proportion of cigarette smoking in the USA [8]. Adding to these problems, studies have found that rates of CVD and CVD risk factors are on the rise among the AI/AN population [9, 10].

As a result of the increasing morbidity/mortality of CVD among AI/ANs, it is essential to continually evaluate CVD morbidity/mortality among this population, as well as efforts to reduce this health disparity. A prior review of health disparities for CVD and associated factors among AI/ANs demonstrated that rates of CVD were clearly higher for AI/AN populations than non-AI/AN populations [4••]. The purpose of this review is to examine more recent trends of CVD outcomes among AI/ANs and include intervention studies that address CVD and CVD risk factors among this high-risk population. We will then outline several important considerations for CVD/CVD risk factor interventions as they pertain to the AI/AN population.

Identification of Relevant Studies

We conducted a recent systematic review of literature on CVD among AIANs that was published in 2014 and 2015. Using the electronic PubMed database, we ran a search for the elected time frame using the terms cardiovascular disease OR heart disease and combined that with terms associated with Indigenous peoples of the USA (i.e., American Indians OR Native Americans OR Alaska Natives OR Indigenous). We limited the 339 articles retrieved from this initial search to empirical studies that included CVD and CVD risk factors among AI/ANs. Case studies, review articles, studies on children and adolescents (under 18 years of age), and articles that focused solely on Indigenous peoples outside the USA (e.g., First Nations and Indigenous populations from Canada, Australia, and New Zealand) were excluded. We limited our search to studies that include AI/ANs from the USA due to the unique histories of Indigenous populations, diverse sociopolitical contexts, and differing systems of health care in various countries. Of the 85 empirical studies that remained, we retained those that captured AI/ANs as a distinct category and focused on outcomes of CVD (myocardial infarction, coronary heart disease, heart failure, angina pectoris, and stroke) and interventions on CVD or any CVD risk factor. We report on the 18 studies that remained.

CVD Outcome Studies

Of the 18 articles, 10 articles had CVD itself as an outcome variable (Table 1). Five explored CVD mortality rates [12••, 14, 15, 17, 19], 2 examined racial/ethnic disparities that include CVD [11, 13], and 3 examined how risk factors contribute to CVD/CVD mortality [8, 16, 18]. Results of the following studies are provided only for CVD outcomes as they pertain to AI/ANs.

CVD Mortality Among AI/ANs

Five articles reported on trends and disparities in CVD mortality rates among AI/ANs, independent of risk factor contributions. Howard et al. examined mortality data and calculated relative and absolute differences in mortality risk between non-Hispanic whites and several racial/ethnic groups (including AI/ANs) for the 25 leading causes of death [15]. Ischemic heart disease ranked second as cause of death among all racial/ethnic groups. The study found that AI/ANs had a lower risk than whites for the top 5 leading cause of death, including ischemic heart disease (ranked 2nd), other forms of heart disease (ranked 3rd), and cerebrovascular diseases (ranked 4th). However, limitations of this study (as noted by the authors) include potential misclassifications of race/ethnicity on death certificates (i.e., misclassifying AI/ANs as non-Hispanic whites) and causes of death [15].

Another study [12••] provided an overview of leading causes of death and all-cause mortality for AI/ANs through analyses of temporal trends and comparisons between non-Hispanic whites and AI/ANs by geographic region. Importantly, they linked USA National Death Index records with Indian Health Service (IHS) patient registration records to reduce misclassification issues and identify AI/AN deaths incorrectly labeled as non-AI/AN. Within IHS Contract Health Service Delivery Area counties, AI/AN death rates were almost 50% greater than rates in whites, with the highest death rates occurring in the Northern and Southern Plains. CVD was the leading cause of death for AI/AN men (as it was for white males) and the second leading cause of death for AI/AN females. In both genders, causes of death were elevated for AIs/ANs compared with whites. The authors also found that the significant decrease over the last two decades in all-cause death rates for the white population was not found among the AI/AN population [12••].

Howard et al. determined all-cause, CVD, and cancer mortality among four cohorts of Western AN people [14]. In AN men, CVD (characterized by heart failure, coronary heart

Table 1 Summary of research on CVD outcomes among AI/ANs

Study	Sample	Design	CVD outcome variable	Covariates	CVD findings
Creanga et al., 2014 [11]	3,476,392 delivery hospitalizations (women 15–49 years old) AI/AN women ($N = 20,535$ delivery hospitalizations)	Cross-sectional	*CVD-related severe morbidity indicators: -Heart failure during procedure or surgery -Operations on heart and pericardium -Puerperal cerebrovascular disorders -Cardiac arrest/ventricular fibrillation -Acute myocardial infarction	*Race/ethnicity *Maternal age *Insurance coverage *Household income *Chronic medical conditions *HIV/AIDS *Blood transfusion	*AI/ANs had higher rates of severe morbidity than non-Hispanic white women and morbidity rates that exceeded 10 per 10,000 delivery hospitalizations for heart failure *Cardiovascular measures—heart failure during procedure or surgery, operations on the heart and pericardium, puerperal cerebrovascular disorders, cardiac arrest/ventricular fibrillation, and acute myocardial infarction – were not statistically significant or were not reported due to low case numbers
Espey, et al., 2014 [12••]	4,979,709 death records in CHSDA counties (<1–≥85 years old) AI/AN death records ($N = 122,644$)	Cross-sectional	*Death resulting from heart disease and stroke	*Race *Gender *Age *Region	*Death rates for AI/AN were nearly 50% greater than rates for whites *The highest death rates occurred in the Northern and Southern Plains; the lowest rates in the East and the Southwest *Heart disease is the leading cause of death for AI/AN men and the 2nd leading cause of death for AI/AN women
Henke et al., 2015 [13]	1,341,727 employees at fortune 500 companies (18–64 years old) AI/AN (1.4%)	Cross-sectional	*CVD	*Race/ethnicity *Sex *Age *Health plan *Urbanicity *Division/region *Employee classification *Industry	*AI/ANs had a significantly higher prevalence of CVD than Asians, but no significant differences for rates were found among non-Asian race/ethnicity groups
Howard et al. 2014 [14]	4569 western Alaska Native adults (18–95 years old)	Cross-sectional	*Death resulting from: -Heart failure -Coronary heart disease -Stroke	*Gender *Age *BMI *Smoking history *Diabetes *Study *Region	*In men, CVD was the 2nd leading cause of death *Of the 29 male CVD deaths, 59% was attributable to CHD and 28% was attributable to stroke *In women, the leading cause of death was CVD *Of the 31 female CVD deaths, 45% were from CHD and 35% were from stroke *Compared with USA whites, CHD mortality rates for AI/ANs appear lower in men and women *By contrast, stroke rates for AI/AN men and women appear higher than those for the USA white population
Howard et al., 2014 [15]	USA death records for non-AI/ANs, 1999–2010 (<1–≥85 years old) Non-Hispanic AI/AN USA death records, 1999–2010 (<1–≥85 years old)	Cross-sectional	*Difference in years of life loss due to: -Ischemic heart diseases -Other forms of heart disease	*Race/ethnicity *Age	*Ischemic heart disease was the 2nd leading cause of death for AI/ANs

Table 1 (continued)

Study	Sample	Design	CVD outcome variable	Covariates	CVD findings
			-Cerebrovascular disorders		*AIANs had lower relative risk for CVD causes of death: ischemic heart disease, other forms of heart disease, and cerebrovascular disease
Mowery et al., 2015 [16]	1.63 million non-Hispanic AI/AN adults (35 ≥ 80 years old) Non-Hispanic white adults (35 ≥ 80 years old)	Cross-sectional	*Smoking attributable fractions (SAFs) and smoking attributable mortality (SAM) for: -Ischemic heart disease -Other heart disease -Stroke	*Age *Gender *Race/ethnicity	*AI/ANs had higher age-adjusted death rates for ischemic heart disease, other heart disease, and stroke than whites *AI/AN men and women aged 35–54 years, had the highest rate ratios for stroke and other heart disease *SAF for ischemic heart disease, other heart disease, and stroke were higher among AI/ANs than whites (especially among women) *SAM for AI/ANs for ischemic heart disease, other heart disease, and stroke were higher among AI/ANs than for whites
Schieb et al., 2014 [17]	Non-Hispanic AI/AN death records (35 ≥ 85 years old) Non-Hispanic white death records (35 ≥ 85 years old)	Cross-sectional	*Stroke death rates	*Age *Race/ethnicity *Region	*Stroke death rates for AI/ANs in all regions combined was similar for men and women *Alaska and the Southern Plains consistently had the highest stroke death rates among AI/ANs *AI/ANs in the Southwest had the lowest stroke death rates *In all regions combined, stroke death rates were higher for AI/ANs than for whites in all age groups except 85 years and older
Trude et al., 2015 [18]	424 American Indian adults or adults married to an American Indian (18–75 years old)	Cross-sectional	*Self-reported CVD	*Age *Sex *Level of education *Tobacco	*High-fat food consumption was highly associated with self-reported CVD *High consumption of unhealthy snacks was associated with an increase in self-reported CVD *Frequent consumption of healthy foods was associated with higher odds for self-reported CVD
Veazie et al., 2014 [19]	AI/AN adult death records (35 ≥ 85 years old) White adult death records (35 ≥ 85 years old)	Cross-sectional	*Heart disease as an underlying cause of death (UCOD) *Heart disease as 1 or more multiple cause of death (MCOD)	*Age *Gender *Region *Year of death *Race/ethnicity	*AI/AN had higher UCOD and MCOD heart disease rates than whites *AI/AN MCOD rates were 84.3% higher than UCOD *AI/ANs and whites had declining heart disease death rates
Zhang et al., 2015 [8]	4549 American Indian adults (45–74 years old)	Cross-sectional	*CVD mortality	*Age *Sex *Study site *Current *Educational level *Alcohol consumption, *Physical activity	*CVD death accounted for 32.8 and 30.7% of the total deaths in AI/AN men and women, respectively *Overall, current smoking significantly increases CVD mortality in women but not men *Subgroup analyses by age showed that current smoking was significantly associated with

Table 1 (continued)

Study	Sample	Design	CVD outcome variable	Covariates	CVD findings
				*BMI *Low-density lipoprotein cholesterol *High-density lipoprotein cholesterol *Renal function *Hypertension *Diabetes	excess CVD mortality in women younger than 55 years, but not in those older than 55 years *No significant association was observed between current smoking and CVD mortality in center-specific analysis

disease, and stroke) was the 2nd leading cause of death. In women, CVD was the leading cause of death. After adjudication, where CVD mortality derived using standardized criteria and medical record review were compared with those obtained from death certificates, only 56% of CVD classified deaths were determined to be caused by CVD. Concordance was higher for heart failure and stroke than for coronary heart disease. Compared with USA whites, coronary heart disease mortality rates were lower among AN cohorts, while stroke rates were higher [14].

Schieb et al. [17] and Veazie et al. [19] examined CVD mortality (stroke and heart disease mortality, respectively) among AI/ANs. Both of these studies utilized National Vital Statistics System data for 1990–2009 and, similar to Espey et al.'s study [12••], linked these with IHS patient registration data to adjust for misclassification of race for AI/AN persons. Results from the Schieb et al. study [17], which predominantly focused on IHS Contract Health Service Delivery Area counties, indicate that while stroke mortality rates decreased between 2001 and 2009, they were higher overall among AI/ANs than among whites, with regional variation. Age-adjusted heart disease death rates (as the underlying cause of death and with multiple causes of death) were also found to be higher for AI/ANs than for whites (again with regional variation), despite declining heart disease mortality rates for both populations during the 19-year time frame [19].

Racial/Ethnic Disparities in CVD Morbidity

Two CVD outcome studies examined racial/ethnic disparities in health and morbidity. Henke et al. [13] examined 15 chronic health conditions that existed among a national sample of employees of six racial/ethnic groups. Through analyses of health care claims data, the study found that AI/ANs had a statistically higher prevalence of CVD than Asians. However, there were no significant differences for rates among non-Asian racial/ethnic groups [13]. In a second study of racial/ethnic disparities in morbidity, Creanga et al. [11] examined differences in severe maternal morbidity during delivery hospitalizations across seven states in a 2-year period. AI/ANs had higher rates of severe morbidity than non-Hispanic white women and morbidity rates that exceeded 10 per 10,000 delivery hospitalizations for heart failure. However, rates of CVD measures—heart failure during procedure or surgery, operations on the heart and pericardium, puerperal cerebrovascular disorders, cardiac arrest/ventricular fibrillation, and acute myocardial infarction—were not statistically significant or not reported due to low case numbers [11]. This study analyzed delivery hospitalizations as the unit of analysis versus individuals, meaning that if a woman gave birth more than once in the 2-year study period, her morbidities were classified twice.

Risk Factors and CVD Morbidity/Mortality

The impact of risk factors on CVD morbidity/mortality was examined in three studies. One study [18] examined the relationship between dietary patterns and CVD/CVD risk factors of obesity, diabetes, and hypertension among five AI communities. Using the Adult Impact Questionnaire and the Food Frequency Questionnaire over a 30-day recall period, they found that high-fat food consumption was highly associated with self-reported CVD, with 6 times greater odds in those people with the greatest frequency of fat intake in comparison to those with the lowest frequency. High consumption of unhealthy snacks was also associated with CVD, with 3 times greater odds in those people who consumed unhealthy snacks the most in comparison to those who consumed them the least. More frequent consumption of healthy foods was also associated with higher odds for CVD, perhaps due to the obese classification of the majority of participants at baseline and the short time span of food recall. Importantly, participants in this study were not necessarily AI: they were either AI or married to an AI [18].

Two other studies focused on smoking-related mortality among AI/ANs. Using data from a large representative sample of the Strong Heart Study [20], Zhang et al. [8] evaluated the impact of cigarette smoking on CVD, cancer, and all-cause mortality among AI/ANs across different sites. CVD accounted for 32.8% of total deaths in AI men and 30.7% of total deaths in AI women. Although no significant association between current smoking and CVD was found in site-specific analyses, current smoking among the sample overall was significantly associated with an increased risk of CVD mortality among women less than 55 years, but not in women older than 55 years or in men [8]. Mowery et al. [16] examined smoking-attributable fractions (the proportion of mortality within a population caused by exposure to smoking) and smoking-attributable mortality for AI/ANs and whites using mortality data collected from 637 IHS Contract Health Delivery Service Area counties. They found that smoking-attributable fractions and smoking-attributable mortality rates were higher among AI/ANs than whites for ischemic heart disease, other heart disease, and stroke [16].

CVD and CVD Risk Factor Interventions

In addition to reviewing studies that capture CVD as an outcome measure, we examined studies designed to address CVD and/or CVD risk factors. We found 8 articles of this nature during the 2-year time span (Table 2). Interventions ranged from those medical in nature to those that were community-based. Although these interventions targeted CVD or CVD risk factors, studies often reported on outcomes different from biological or behavioral changes in CVD/CVD risk factors.

Medical Interventions

Gepner et al. [24] examined the effects of vitamin D supplementation (low vitamin D is associated with CVD) on arterial stiffness and central blood pressure among a sample of 98 postmenopausal AI women. The women, who generally had low vitamin D levels, were randomized to either receive low or high doses of vitamin D_3 on a daily basis for 6 months. Aortic systolic blood pressure, aortic pulse pressure, and aortic augmentation index were measured at baseline and at 6 months. Although the aortic augmentation index decreased after 6 months in the high dose group, none of the primary outcome measures were significantly affected by the vitamin supplementation [24].

Another study [25] was designed to evaluate the safety and efficacy of the Venous Window Needle Guide (VWING) device for cannulation of established and mature arteriovenous fistulas (AVFs) that were not able to be cannulated, but were otherwise well-functioning. Fifty-four patients at 11 trial sites had the VWING implanted. Successful AVF access was achieved in 96% of patients, and the 6-month AVF survival rate after implantation was 100%. Although the study found the VWING to be safe and effective in improving AVF cannulation, only 1 participant in the study was AI and specific data for this individual was not provided [25].

Interventions Initiated Through Community Health Workers/Community Advisory Boards

Three of the studies engaged community health workers or community advisory boards (CABs) in their efforts to reduce CVD or CVD risk factors. Using community-based participatory research (CBPR), Adams et al. [21••] worked with three tribal communities to develop CABs to identify and reduce environmental barriers to healthy diet and exercise. Although there was individual community variation, CABs noted several barriers (e.g., historical trauma, poverty, issues related to neighborhood safety) and then designed interventions to decrease/remove them. More than 1070 regular and new members participated in the three CABs over a 5-year period (averaging 19 participants per CAB meeting). Short- and long-term interventions were implemented (e.g., policies related to food served at meetings and schools to encourage healthy options, community gardens, development of a playground). Although this study did not examine whether or not there were biological or behavioral changes in CVD/CVD risk factors, structural changes implemented decreased environmental barriers at each site and improved options for healthy lifestyle choices [21••].

Table 2 Intervention studies on CVD/CVD risk factors

Study	Sample	Design	CVD/CVD-related outcome variable(s)	Covariates	CVD/CVD-related findings
Adams et al., 2014 [21••]	1 community advisory board (CAB) for each of the 3 tribal communities: Menominee, Lac du Flambeau, Bad River American Indian adults ($N = 1070$)	Mixed methods -Qualitative -Within group pretest/posttest	*Successful creation of CABs *Varying types of community interventions (e.g., community garden) *Inter-CAB networking and dissemination	n/a	*CAB meeting attendance totaled more than 1070 regular and new members over 5 years for the 3 CABs and an average meeting attendance of 19 *CAB interventions decreased environmental barriers to health at each site and improved options for healthy lifestyle choices *CABs shared intervention designs and funding opportunities with each other
Espeland et al., 2014 [22]	5121 overweight or obese adults with type 2 diabetes (45–76 years old) American Indian ($N = 256$)	Randomized controlled trial	*Use of health care services -Hospitalizations -Outpatient visits/procedures -Rehabilitation/long-term care/home care *Health care services cost *Medication use *Medication cost *Per-participant 10-year cumulative mean of discounted costs	*Age *Sex *Race/ethnicity *Discharge location *Primary diagnosis *Length of stay *Clinic *History of CVD *Baseline BMI *Hypertension	*ILI led to a reduction in annual hospitalizations and number of medications, resulting in a mean relative per-person cost savings of $5280 over a 10-year average. However, these cost savings were not evident among participants with a history of CVD at baseline *Among AIs, there was not a significant mean annual cost difference ILI and DSE
Hurtado et al., 2014 [23]	1004 adults (≥18 years old) American Indian ($N = 67$)	Single-group pretest/posttest	*Healthy heart knowledge *CVD food-related risk factor behaviors *Physical activity *Confidence in preparing heart healthy food *Readiness to change behavior	*Age *Gender *Diabetes *Family history of heart disease *Race/ethnicity	*Among all participants: -Heart health knowledge and healthy food behaviors increased -There was an increase in participants classified as physically active, a greater proportion of participants reporting confidence or high confidence in their ability to prepare heart healthy foods, and a greater proportion who were in the action or maintenance stage of change *AI-specific findings: -AIs improved in heart health knowledge and adoption of healthy food-related behaviors -There was no significant difference in confidence to prepare healthy foods or stage of change
Gepner et al., 2015 [24]	98 post-menopausal American Indian women	Randomized controlled trial	*Aortic systolic blood pressure (aSBP) *Aortic pulse pressure (aPP) *Aortic augmentation index (AIx)	*Age *Baseline 25(OH)D	*Aortic blood pressure, aortic pulse pressure, and AIx were not significantly affected by vitamin D supplementation *Despite a clear increase in serum D levels, no significant differences in aortic blood pressures or arterial stiffness were observed in NA postmenopausal women
Jennings et al., 2014 [25]	51 patients with arteriovenous fistulas (17–84 years old) American Indian ($N = 1$)	Single-arm prospective study	*Access fistula through VWING device within 3 months after implant, achieving prescribed blood flow	*Age *Race/ethnicity *Gender *Diabetes *BMI	*Technical implantation success of the VWINGs with proper attachment, alignment, and palpability was achieved for 100% of devices

Table 2 (continued)

Study	Sample	Design	CVD/CVD-related outcome variable(s)	Covariates	CVD/CVD-related findings
			*Implantation success *Initial cannulation w/n 43 days of implantation *Occurrence of device/procedure adverse events		*The primary end point, effective cannulation within 3 months, was achieved in 75 of 79 (95%) devices *There were no study-related deaths *AVF survival rate at 6 months was 100%
Kimes et al., 2014 [26]	American Indian women and girls (≥12 years old; *N* = not specified)	Mixed methods -Qualitative -Within group pretest/posttest	*Change in dietary intake *Physical activity *Tobacco use *BMI *Self-esteem *Self-efficacy	*Age *Sex *Ethnicity *Marital status *Household size *Education *Annual income (for adults) *Perceived health status *Depressive symptoms *Religiosity	*There were challenges to initiating and sustaining enthusiasm from participants (retention was low with an average of 27% attendance) *Families were resistant to adopting low-fat alternatives *Social and political climate changes affected the intervention (e.g., changes in tribal leadership) *Churches are resources for faith-based health program
Moore et al., 2014 [27•]	3373 American Indian and Alaska Native adults (≥18 years old)	Single-group pretest/posttest	*Blood glucose *Blood pressure *Lipid control *CVD multifactor risk *Smoking status *Aspirin use *LDL cholesterol *HDL cholesterol *Triglyceride level *Average Framingham CHD risk scores	*Age *Gender *Assessment period (time) *Medication use	*Decrease in A1c levels *Decrease in systolic and diastolic blood pressure *Average HDL cholesterol levels increased *LDL cholesterol decreased *Average triglyceride decreased *Smoking decreased *Framingham CHD multifactor risk decreased *Prescriptions for aspirin and other anti-platelet use increased
Onders et al., 2014 [28]	Kodiak Area Native Association (KANA) health care clinics All Indian Health Service (IHS) clinics	Quasi-experimental 2-group pre-test posttest design	Screening rates for: *Comprehensive Cardiovascular exam *Tobacco use *Alcohol use *Depression *Intimate partner violence	*Type of health system (KANA vs all of IHS)	*KANA started with significantly lower screening rates and ended with significantly higher screening rates than IHS sites nationwide

Hurtado et al. [23] used community health workers that were trained to deliver a 10-session National Heart, Lung, and Blood Institute curricula to small groups of participants at 15 sites across the USA. Overall, 1004 total participants from four racial/ethnic backgrounds attended the education sessions. Based on a pre-post design, the study found that heart health knowledge and healthy food-related behaviors significantly increased among participants overall. There was also an increase in participants classified as physically active, a greater proportion of participants reporting confidence or high confidence in their ability to prepare heart healthy foods, and a greater proportion who were in the action or maintenance stage of change. However, there were a small number of AI participants in the study in comparison to other groups. Among AIs, heart health knowledge and adoption of healthy food-related behaviors significantly improved, but results were not significant for confidence or stage of change [23].

Another study [26] utilized community lay health educators to implement a CVD intervention. This feasibility study used a mixed-methods approach to develop a faith-based, culturally sensitive educational intervention for women and girls from the Lumbee tribe and to evaluate the intervention through questionnaires completed at baseline and completion of the intervention. The curriculum included 11 topics relevant for heart disease and stroke prevention. Although the study included primary (changes in dietary intake, physical activity, and tobacco use) and secondary (changes in body mass index, self-efficacy, and self-esteem) outcomes, these outcomes were not reported. The goal of this study was to determine the feasibility of conducting a study of this nature. The authors note that while there were many limitations to their intervention (e.g., slow rise in attendance, resistance to change in cultural traditions), churches were receptive resources for implementing faith-based health programs tailored to targeted groups [26].

Intensive Case Management and Electronic Clinical Reminder Interventions

Intensive case management has also been used in CVD/CVD risk reduction efforts. Moore et al. [27•] evaluated outcomes of multiple CVD risk factors among AI/ANs who were part of the Special Diabetes Program of Indians Healthy Heart Demonstration Project, which was a multi-disciplinary case management intervention. A case manager developed an individualized CVD risk reduction plan, which included weight loss, regular physical activity, diabetes and CVD risk reduction education, and improved nutrition as appropriate for each participant. Data were collected at baseline and 1 year later for 3373 AI/ANs from geographically and tribally diverse settings. The investigators found significant improvements in blood sugar, blood pressure, and lipid control and also saw a decrease in participant's average Framingham CHD risk score (which estimates average risk of developing CHD in 10 years). Significant improvements were also found in smoking status, aspirin and other anti-platelet use, and prescribed pharmacotherapy for CVD risk factors. Participants averaged seven case management visits for the year, with each additional visit being associated with greater CVD risk factor benefit [27•].

Another study [22] examined the effects of an intensive lifestyle intervention (ILI) on the use and cost of medical services among people with and without CVD. In a randomized control trial, 5145 individuals across 16 sites who were overweight or obese and had type 2 diabetes were assigned to receive ILI or diabetes support and education (DSE). The ILI participants were assigned calorie, dietary fat, and physical activity goals and received group and individual support and instruction weekly for the first 6 months, and then 3 times per month for the next 6 months. The DSE participants were invited to three group sessions on diabetes self-care per year during the first 4 years, and then one per year thereafter. Use and costs of health care services across an average of 10 years showed that ILI led to a reduction in annual hospitalizations and number of medications, resulting in a mean relative per-person cost savings of $5280 over 10 years. However, these cost savings were not evident among participants with a history of CVD at baseline. Additionally, among AIs, there was not a significant mean annual cost difference between those receiving ILI and DSE. This may be due to the small sample size of AIs, who comprised 5% of the overall study sample [22].

Lastly, Onders et al. [28] report on the effectiveness of electronic clinical reminders (ECRs) on a number of preventive screenings (tobacco use, alcohol use, depression, intimate partner violence, and a comprehensive CVD exam). Through a 5-step process, the Kodiak Area Native Association (KANA) initiated the use for ECRs for the 5 preventive measures. Although KANA started with significantly lower screening rates for all 5 measures, after ECR implementation, an analysis of results showed that they had achieved significantly higher rates for screenings than IHS sites nationwide [28].

Discussion

This review examined CVD outcomes studies and CVD/CVD risk factor intervention studies published during 2014 and 2015. The mortality studies reviewed indicate that CVD is either the leading or the second leading cause of death among AI/ANs [12••, 14, 15], with first or second rank order differences for men and women [12••, 14]. Similar to a previous systematic review [4••], the studies demonstrate overall that CVD mortality is still disproportionately high among AI/ANs in comparison to whites [12••, 17, 19], with variations

depending on the aspect of CVD measured [14] and geographical region [12••, 17, 19]. However, one study [15] found that AI/ANs were at lower risk for CVD mortality. Limitations of this study were potential misclassifications of race/ethnicity and causes of death, which were corrected for in several other studies reviewed [12••, 14, 17, 19].

Although the two prevalence studies [11, 13] did not find statistically significant differences in CVD morbidity when comparing AI/ANs with whites, this may be due to the specific sample characteristics (i.e., participants employed at large firms and delivery hospitalizations in women of childbearing age, respectively) in each study. In studies that examined risk factor contribution to CVD, smoking-related CVD morbidity and mortality were found to be greater among AI/ANs than whites [8, 16]. A third study of risk factor contributions demonstrated that high-fat food and unhealthy snack consumption were associated with greater odds of CVD among AIs and individuals married to AIs [18]. Surprisingly, as increase in healthy food consumption was also associated with greater odds of CVD. The latter finding may have been due to the obese classification of the majority of participants at baseline and/or the short time span of food recall [18]. Other studies that have examined dietary patterns among a multiethnic population [29] have shown that consuming foods that achieve a high diet-quality index score is associated with lower risk of mortality from CVD. An overall limitation of the outcome studies that included multiple racial/ethnic comparison groups was the small sample sizes for AI/ANs.

The eight CVD/CVD risk factor intervention studies reviewed range in types of interventions delivered and outcomes measured. Beneficial outcomes in intervention studies related to CVD/CVD risk factors were noted in seven of the eight studies reviewed, with the exception of a study examining the effect of vitamin D supplementation on CVD [24]. Three studies [22, 27•, 28] used ILI, intensive case management, or electronic health reminders as means to address CVD-related outcomes. Although one of these studies conducted a cost analysis of the effects of ILI versus DSE [22], the other studies focused on outcomes of multiple CVD risk factors [27•] and preventive screening rates for several risk factors associated with CVD [28]. Three studies used community-based efforts involving community health workers or CABs [21••, 23, 26]. However, only one of these studies [23] reported measurements for behavioral CVD risk factor change among individuals. The other two studies reported on the effectiveness of CABs in initiating environmental changes for healthy living [21••] and the feasibility of implementing a faith-based educational intervention [26]. Similar to the CVD outcome studies reviewed, an overall limitation of the intervention studies was the small sample size of AI/ANs in studies that had multiple races/ethnicities. In addition, several studies that focused solely on AI/ANs did not include a control group for comparison.

Among the intervention studies reviewed, one was unique [21••] in that it underscored issues of historical trauma [30] and social determinants of health as barriers to healthy living. There is tremendous heterogeneity among AI/AN communities with respect to size, geographic location, cultural practices, and languages. However, members of these communities share a common, painful history of colonization. This history serves as the basis for deep-rooted health inequities that exist among AI/ANs today [31, 32]. It is imperative that CVD/CVD risk factor interventions for AI/AN communities extend beyond individual paradigms of health (e.g., genetics and lifestyle/behavior choice) and target social determinants, such as historical trauma/unresolved historical grief, cultural degradation, interpersonal and systemic discrimination, poverty, and limited access to quality health care, that plague AI/AN communities. Although addressing social factors may be more difficult than addressing individual behavioral factors, research has shown that they may have a greater and longer lasting impact on health [33].

The Adams et al. study [21••] also explicitly mentions CBPR in their work with tribal communities. CBPR is a new norm for Indigenous communities actively reclaiming their rights to research processes and products and for researchers invested in ethical, community-driven research that promotes social change [34, 35]. The goal of CBPR is to nurture respectful, equitable partnerships between researchers and community partners throughout all phases of research [36]. CBPR emphasizes local knowledge, community strengths and resources, shared decision-making, bidirectional capacity building, sustained commitment, and mutual ownership of research products in these partnerships [37]. It prioritizes communities as stewards of their own knowledge production and leaders of wellness efforts.

In addition, the National Institutes of Health convened a workshop to develop a research agenda to address the disproportionate burden of CVD/CVD risk factors among rural populations [38••]. Workshop participants developed guiding principles for CVD research, as well as a comprehensive CVD research agenda with 21 opportunities for framing research, practice, and programs in rural areas [38••]. These principles and opportunities can be used in the development, implementation, and evaluation of CVD intervention efforts among AI/AN communities.

Conclusion

This review demonstrates that CVD, overall, disproportionately burdens AI/AN communities in the USA. Large-scale studies that oversample for AI/ANs are needed to document

the continuing effects of CVD among Indigenous communities and monitor the disparity status in CVD morbidity and mortality. More interventions with control or comparison groups are also needed to address CVD and its associated risk factors among AI/AN communities and document their effectiveness. In addition to focusing on individual risk factors for CVD (e.g., poor dietary patterns, physical inactivity, smoking), which several studies in this review addressed, collaborative community-based interventions that tackle root issues of CVD-related disparities and attend to social determinants of health are needed.

Compliance with Ethical Standards

Conflict of Interest Drs. Mohammed and Udell declare no conflict of interests.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by the authors.

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