Objective: This systematic review was undertaken to expand our understanding of the factors associated with racial/ethnic disparities in cardiovascular disease (CVD) risk factors (hypertension, diabetes, obesity, hypercholesterolemia, no leisure-time physical activity, and smoking), to assess the potential differences in the CVD risk factors by race/ethnicity, and to update and expand on existing reviews.

Methods: English-language, population-based CVD studies published between 1995 to present, which included one or more ethnic comparison in an adult population were reviewed.

Results: Sixteen studies were included in this review. Most of the studies found hypertension to be significantly higher in Blacks than Whites. Minority status was also significantly associated with diabetes. No one racial/ethnic minority population was consistently found to have a higher or lower prevalence of obesity or hypercholesterolemia. Mexican Americans had a significantly lower prevalence of smoking than Whites and Blacks; American Indian/Alaskan Natives (AIANs) had significantly higher prevalence of smoking compared to Whites. Mexican Americans had the highest prevalence of no leisure-time physical activity, followed by AIANs and Blacks.

Conclusion: Cardiovascular diseases are the leading cause of death in the United States, and disproportionate rates are seen in racial and ethnic minority populations. Systematically assessing and quantifying modifiable CVD risk factors is therefore crucial in these populations. Better understanding and awareness of the disparities of CVD risk factors by race and ethnicity may help clinicians and public health professionals develop culturally sensitive interventions, prevention programs, and services specifically targeted toward risk burdens in each of these populations. (*Ethn Dis.* 2007;17:143–152)

Key Words: Cardiovascular Disease, CVD risk factors, Heart Disease, Health Disparities

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BACKGROUND

Cardiovascular disease (CVD) is the leading cause of death in the United States and a growing public health concern.¹ While the death rates from CVD declined 22.1% from 1993 to 2003, the actual number of deaths declined 4.6%, in the same 10-year period.² Much of the burden of CVD morbidity and mortality is linked to the modifiable CVD risk factors³⁻⁹ and the differences in the incidence and prevalence of these risk factors by race/ ethnicity are substantial.^{10–14} Therefore, we must examine various CVD risk profiles and CVD burden by race/ ethnicity to understand and to explore opportunities to narrow health-related racial and ethnic disparities.

To our knowledge, the most recent literature review of CVD studies was published in 1997, wherein epidemiologic studies that examined impact of ethnic and socioeconomic status on cardiovascular diseases were reviewed.¹⁵ The purpose of this systematic review was to determine whether modifiable risk factors for CVD differed by race/ ethnicity. The risk factors selected for this review were hypertension, diabetes, obesity, hypercholesterolemia, smoking, and lack of leisure-time physical activity. These six risk factors were chosen because of their importance to CVD morbidity and mortality. With increasing systolic or diastolic blood pressure, hypertension-related risk for CVD increases.¹⁶ Among diabetics, the risk for CVD is two to three times higher compared to non-diabetics.¹⁷ Overweight and obesity have also been documented to be independent risk factors for CVD¹⁸ and are associated with high rates of CVD deaths.¹⁹ Regular physical activity is known to reduce the risk for CVD.²⁰ Further... we must examine various CVD risk profiles and CVD burden by race/ethnicity to understand and to explore opportunities to narrow health-related racial and ethnic disparities.

more, ample documentation exists of lowering of other modifiable CVD risk factors such as hypercholesterolemia, obesity, and hypertension with regular, moderate-intensity physical activity.²¹ Cigarette smoking as a risk factor for CVD has been documented extensively.²² Smokers have 70% higher risk for CVD compared to nonsmokers,²³ and the risk for CVD is directly associated with years of smoking.²⁴ In addition, some of these aforementioned risk factors act synergistically, thereby increasing the risk for CVD morbidity and mortality.^{25–27}

METHODS

A series of trial searches was performed initially by using a wide array of relevant search terms. Foremost, an Ovid search of MEDLINE and PubMed were undertaken to identify relevant studies. An effective combination of search terms was used to search the electronic databases. Table 1 summarizes the databases that were searched and the search terms that were used.²⁸

Electronic bibliographic databases, reference lists from relevant publications, conference proceedings (the Con-

Table 1.	Selected databases and search terms used
Databases	Searched:
Academic S	Search Premier Database

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Ovid MEDLINE®		
Ovid Pubmed		
Search Terms Used:		
CVD risk factors		
Smoking	Cigarette-smoking	Tobacco use
Diabetes	Diabetes mellitus	NIDDM
Obesity	BMI	Overweight
Hypertension	Blood pressure	-
No leisure-time	Physical activity	Exercise
Activity		
Hypercholesterolemia	High cholesterol	
Heart disease	Cardiovascular disease	Coronary artery disease
Health disparities		
Various ethnic minority & mi	nority groups	
Various medical and clinical	studies including systematic reviews	5
·		

Adapted from: Undertaking of systematic reviews of research on effectiveness CRD's guidance for those carrying out or commissioning reviews. CRD report No. 4 (2nd edition), March 2001.

ference Papers Index²⁹), and the internet (using general search engines such as Google) were also searched to ensure a thorough critical search of existing research studies.²⁸ Furthermore, key journals were also hand searched to identify very recent publications. An appendix summarizes the search strategy that was adopted and can be provided by author upon request.

Study Inclusion Criteria

The literature review included English-language, population-based CVD studies published from 1995 to the present, which included one or more racial/ethnic comparison, with two or more CVD risk factors studied, in adult population.

Out of 112 articles that were identified by the search, 13 articles were included in this review. Articles that failed to meet the inclusion criteria were excluded. Articles that were excluded had only one CVD risk factor that was explored or had only one race/ethnicity that was studied.

All epidemiologic studies used in this review are the original research studies, and the data points used are from the respective original research studies. Whites were considered as the referent group for race/ethnicity in all the research studies where the White population was included.

RESULTS

All studies reviewed are listed in Table 2, which summarizes the racial and ethnic comparison, methods, the CVD risk factors studied, and the author-acknowledged strengths and limitations of each study. The overall findings are summarized in Table 3. The format of this paper is organized according to the six selected modifiable CVD risk factors.

Hypertension

Twelve of the thirteen studies examined the differences in blood pressure by race and ethnicity. The studies included in this review tend to describe blood pressure in either mean blood pressure values,^{30,34,35,38–40} one measure of blood pressure values in sitting position,^{37,42} or prevalence of hypertension.^{31,33,41} The results are tabulated in Table 4.

Race/ethnicity was significantly associated with hypertension. Most of the studies included in this review found

significantly higher prevalence of hypertension in Blacks than in Whites. Greenlund et al combined the data from the Coronary Artery Risk Development in Young Adults (CARDIA) study and the Bogalusa Heart study to assess differences in CVD risk factors in Black and White young adults by geographic areas.³⁹ They found that for all sites, men had higher blood pressures compared with women, except in one site, where Black men and women tended to have higher mean systolic blood pressure than White men and women. In addition, family history of hypertension was also greater among Blacks than Whites within sites. Alvis et al reported significantly higher ageadjusted CVD mortality rates among Black men with hypertension (65.1 per 10,000 person-years) compared to Whites (55.8 per 10,000 personyears).40

However, in a study to assess the differential impact of CVD risk factor clustering on CVD and renal disease among Black and White patients with diabetes,³⁷ a clustering of three or more CVD risk factors was more predictive for CVD in Whites compared to Blacks.

A study of CVD risk factors among older Black, Mexican American, and White women³⁴ reported that Black men and women were significantly more likely to have approximately twofold higher prevalence of hypertension than White men and women (odds ratio [OR]=1.86, 95% confidence interval [CI] 1.18-2.94 in Black men; OR=1.83, 95% CI 1.28-2.62 in Black women). Although Mexican American men did not have a significantly higher prevalence of hypertension compared to Whites, Mexican American women had higher prevalence of hypertension after accounting for age and socioeconomic status (SES).³⁴ These findings were consistent with findings from other studies that have used the same national sample.30,43 The San Antonio Heart Study suggested that compared to Whites, Mexican Americans had some-

Study Design, Author and Year of publication	Data Source/Study Population	Sample Size	Age Groups	CVD risks factors studied	Racial/Ethnic Comparison	Strengths*	Limitations*
Crossectional Surve Winkleby, 1998 ³⁰	y, Random sample NHANES III, 1988–1994	5,266_2!	5 to 64 years	a,b,c,d,e,f	African-American, Mexican-American, White	Most comprehensive national survey data used that allowed for comparison of	Causality could not be established due to the study design,few questions in NHANES III to assess physical activity, measure of SES
Harwell, 2001 ³¹	Montana Statewide	1,905 ≥	±18 years	a,b,c,d,e	American Indians	Mexican-American and White women, availability of extensive and complete data	(education) did not take cultural practices/ beliefs in relation to specific CVD isk factors into account. Inherent limitations of a cross-sectional survey
Sharma, 2004 ³²	BKF35, 1999 NHANES III, 1988–1994	1,667 2	5 to 99 years	a,b,c,d,e	and Non-Indians Non-Hispanic Black, Mexican-American, Non-Hispanic White	NHANES data allows for validation of the self reported data using biochemical	data, telephone coverage blas, limited generalizabilityof findings [±] Failure to establish causality [±]
Appel, 2002 ³³	Mother from CHIS II study	1,110		a,b,c,d,e,f	African-American, White	measure [±] Use of subjects from a wide range of SES, large numbers	Self reporting bias, lack of external validity, temporal association could not be assessed
Sundquist, 2001 ³⁴	NHANES III, 1988–1994	3,520 6.	5 to 84 years	a,b,c,d,e,f	African-American, Mexican-American, White	or Aurican-Arriententans included A comprehensive national survey allowing for comparison of Black, White and Mexican-American population, availability of extensive data from both the home survey and medical examination, high response	Potential survival bias, failure to assess for temporal association
Finkelstein, 2004 ³⁵	WISEWOMAN participants	5,596		a,b,c,d,e	African-American, Hispanic, Alaskan	rates and minimal missing data Individual-level as well as community-level factors	Self-reporting bias [±]
Denny, 2005 ³⁶	BRFSS, 2001 and 2002	ΛΙ	≥55 years	b.c.e.f	Nauve, writte American Indian/ Alaskan Native, White	were controlled for Most Feasible means of evaluating behavioral risk factors [±]	Mainly reflect the issue of representativeness of the sample - telephone coverage bias, failure to calculate separately the response rates for racial groups
Crossectional Surv Summerson, 2002 ³⁷	y, Non-Random sample Type 2 Diabetic patients from a health clinic	323		a,b,c,d,e	African-American, White		Possible selection bias, confounding by variables not controlled for, limitation of statistical power, and generalizability of study results
Prospective Cohort Wei, 1996 ³⁸	The San Antonio Heart Study	3765 2!	5 to 64 years	a,b,c,d,e	Mexican-American, Non-Hispanic White	Random samping of the subjects at baseline, risk factor-mortality relations were analyzed separately in Mexican-Americans and non-Hispanic Whites	Misclassification of the Hispanic ethnicity on death certificates, undercertainment of Hispanic deaths in national death registries, misclassification of the cause of death on (as death certificate classification of CVD mortality was used)

Table 2. Cardiovascular disease risk studies with racial/ethnic comparison

RACIAL AND ETHNIC DIFFERENCES IN CARDIOVASCULAR RISK FACTORS - Kurian and Cardarelli

Table 2. Contin	ued						
Study Design, Author and Year of publication	Data Source/Study Population	Sample Size	Age Groups	CVD risks factors studied	Racial/Ethnic Comparison	Strengths*	Limitations*
Greenlund, 1998 ³⁹	CARDIA & Bogalusa Heart Studies	6,013	≥18 years	a,c,e	African-American, White	Geographic variation in CVD risk factors were assessed in addition to racial/ethnic variation [±]	Two epidemiological studies with similar protocols were used, hence there is a potential for massurement bias site/fresting interaction [±]
Thomas, 2005 ⁴⁰	MRFIT	3,20,870	35 to 57 years	a,d,e	African-American, White	Data used was from a large multi centeric research study - 22 clinical centers in 18 cities across the US, hence greater external validity of study findings w.r.t. men [±]	Missing data of deaths in Black men as Standard National Death Index matching algorithm was used to determne the cause of death, use of zip code based, race/ethnicity-specific median household income rather than individual SES, lack of generalizability of results
Henderson, 2001 ⁴¹	African-American and Hispanic population in LA county	71,796	45 to 75 years	a,b,e	African-American, Hispanic		to women Measurement bias - self-reported history of hypertension was used, BMI was calculated using the DMV files
Experimental Wilbur, 2001 ⁴²	Home-based moderate intensity walking intervention study participants	173	45 to 65 years	a,c,d	African-American, White	Varied and successful recruitment strategies used to attain the required sample size of African-American women	The strict inclusion criteria might have skewed the age range of the sample of midlife women included towards younger age group
CVD risk are a=Hyp Superscript number BRFSS=Behavioral R BRFSS=Behavioral R CHIS II=Cardiovasc. WISEWOMAN = wel MRFIT= Multiple Risk * Strengths and limit ± As reported by the	ertension, b=Diabetes, c=- represent entries in referenc isk Factor Surveillance Surv- llar Health in Children and I-integrated Screening and I factor Intervention Trial. ations as acknowledged by a authors of this review.	Obesity, d=(ces. ey; DMV=D Youth (CHIC Youth (CHIC Evaluation fo the authors (Cholesterol, e=Sn lepartment of Mol 2 II). r Women Across of the original arti	noking f=No Leis tor Vehicles. the Nation. cle.	sure-time physical activity		

RACIAL AND ETHNIC DIFFERENCES IN CARDIOVASCULAR RISK FACTORS - Kurian and Cardarelli

CVD Risk Factor	Racial/ethnic comparison	Elevated risk/higher prevalence for non-Whites	Lower risk/lower prevalence for non-Whites	No association/sim- ilar prevalence
Hypertension				
	Blacks, Mexican-Americans & White ^{30,34} Mexican-Americans& Whites ³⁸ Blacks & Whites ^{33,37,39,40,42}	30,33,38–40,42	35 ^a	35 ^b , 37
	Blacks, Hispanics, Alaskan natives & Whites ³⁵ American Indians & non-Indians ³¹ Blacks & Hispanics ⁴¹			
Diabetes	·			
	Blacks, Mexican-Americans & White ^{30,34} Mexican-Americans& Whites ³⁸ AIAN & Whites ³⁶	30,33,35,36,38		
	American Indians & non-Indians ³¹ Blacks & Whites ^{33,37}			
Ohacity	Blacks, Hispanics, Alaskan natives & Whites ³³			
Obesity	Blacks, Mexican-Americans & White ^{30,34} Mexican-Americans& Whites ³⁸	30,33–38	34 ^c	35 ^d , 39, 42
	Blacks & Whites ^{33,37,39,42} Blacks, Hispanics, Alaskan natives & Whites ³⁵ AIAN & Whites ³⁶			
	American Indians & non-Indians ³¹			
Hypercholesterole	mia			
	Blacks, Mexican-Americans & White ^{30,34} Blacks & Whites ^{33,37,40,42}	30,34,37,42	33,35,38,40	
	Mexican-Americans& Whites ³⁰			
Smoling	American Indians & non-Indians			
Silloking	Blacks Mexican-Americans & White ^{30,34}	30 31 36 39 ^f 40	30 ^g 33 35 38 39 ⁱ	34 37
	Mexican-Americans & Whites ³⁸ Blacks & Whites ^{33,37,39,40}	30,31,30,337,10	50,55,55,50,55	5 1,57
	Blacks, Hispanics, Alaskan natives & Whites ³⁵ AIAN & Whites ³⁶			
	American Indians & non-Indians ³¹			
No Leisure-time p	hysical activity			
	Blacks, Mexican-Americans & White ^{30,33} Blacks & Whites ³³	30,33,34 ¹ ,36		
	AIAN & Whites 38			
Superscript & italici	zed number represent entries in references.			
b No significant diff	erences in Blacks vs Whites.			
c Mexican-America	ns vs Whites.			
d Hispanic vs White	2. han white women			
f Blacks vs Whites in	n 3 sites of the 5 sites included in the study.			
g Mexian-American	s vs Whites.			
h Blacks vs Whites	in 2 sites of the 5 sites included in the study.			
i rural Blacks vs rura	al White women.			
J Blacks vs Whites. AIAN: American Ind	Jian/Alaskan Native.			

Table 3. Results of cardiovascular disease risk studies with racial/ethnic comparison

what higher relative risks associated with hypertension. Hypertension also significantly predicted all-cause mortality (relative risk =1.6) and cardiovascular mortality (relative risk =2.7) in Mexican Americans.³⁸

Risk factors for CVD and cerebrovascular death among Blacks and Hispanics in a large metropolitan city were described by Henderson et al. Ageadjusted mortality rates were two to five times higher in Blacks compared to Hispanics (373.15 in Blacks for hypertensive disease vs 50.37 in Hispanics).⁴¹

American Indian and Alaska Natives (AIANs) had significantly lower prevalence of hypertension compared to Whites and Blacks.³⁵ However in Montana, American Indians had higher prevalence of hypertension than non-Indians.³¹

Diabetes

Ten of the thirteen studies^{30-34,35-38,41} explored diabetes as a CVD risk factor by race/ethnicity. The results are tabulated in Table 5.

			Race/Ethnicity	/		
Author	White	African-American	Hispanic	Mexican-American	AIAN	Non-Indians
Winkleby, 1998 ³⁰ ; mean SBP(SD), mm Hg	114(15.8)	120.9(21.0)		114.7(17.1)		
Harwell, 2001 ³¹ ; %					15 ^{a,b}	10 ^a
Appel, 2002 ³³ ; %	10.6	27.3**				
Sundquist, 2001 ³⁴ ; %	52.6 ^c	67.1 ^c		51.2 ^c		
	62 ^d	74.1 ^d		71.1 ^d		
Finkelstein, 2004 ³⁵ ; mean SBP/mean DBP, mm Hg	123.5/76.4	127.4/79.9	120.2/74.2*		120.5	
Summerson, 2002 ³⁷ ; %	57.6	65.4				
Wei, 1996 ³⁸ ; mean SBP±SE/mean DBP±SE, mm Hg	113.8±14.2/71.1±9.4			117.4±15.8/72.6±9.4*		
Thomas, 2005 ⁴⁰ ; mean SBP(SD)/meanDBP(SD), mm Hg	129.8(15.7)/83.5(10.4)	133.6(18)/86.8(12.3)				
Wilbur, 2001 ⁴² ; mean SBP(SD)/meanDBP(SD), mm Hg	110.8(15.8)/70.1(11.7)	118.5(20.9)/71.9(14.8)				

Table 4. Hypertension prevalence by race/ethnicity

Note: AIAN - American Indian Alaskan Native; SBP - Systolic blood pressure; DBP- Diastolic blood pressure; SD - standard deviation; SE - Standard error Superscript number represent entries in references.

a = 18-44 years, b = American Indians in Montana, c = in men, d = in women.

* Significantly different from White (P<.05).

** Significantly different from White (P<.01).

Minority status was also significantly associated with diabetes. Blacks, Mexican Americans, and AIANs were significantly more likely to have diabetes than Whites. Sundquist et al found that both Black and Mexican American women had significantly higher prevalence of type 2 diabetes than White women after adjusting for demographic differences (Black women: OR=2.39, 95% CI 1.74–3.28; Mexican American women: OR=3.24, 95% CI 2.04–5.17).³⁴ In the San Antonio Heart Study, the relative risk of CVD mortality for diabetes in Mexican Americans was 3.8, with 95% CI of 1.8–7.9. The diabetes-CVD mortality association in non-Hispanic Whites did not achieve statistical significance.³⁸ Similarly, Denny et al reported that after adjusting for sociodemographic differences, AIAN elders (\geq 55 years of age as defined by the authors) were significantly more likely than Whites to report a higher prevalence of diabetes (OR=1.66, 95% CI 1.37–2.00).³⁶

Table 5.	Diabetes	Prevalence	(%) by	y Race/Ethnicity
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			Race/Ethnicity		
Author	White	African-American	Mexican-American	AIAN	Non-Indians
Winkleby, 1998 ³⁰ Harwell, 2001 ³¹	4.3	7.4	8.4	24 ^{a,b}	9 ^a
Appel, 2002 ³³	2.6	8.3**			
Sundquist, 2001 ³⁴	15.5 ^c 17 ^d	19.1 ^c 28.1 ^d	19.7 ^c 32.6 ^d		
Finkelstein, 2004 ³⁵	6	17*		10	
Denny, 2005 ³⁶ Wei, 1996 ³⁸	13 7		13.6*	21.9	

Note: AIAN - American Indian Alaskan Native.

Superscript number represent entries in references.

a = >=45 years, b = American Indians in Montana, c = in men, d = in women.

* Significantly different from White (P<.05).

** Significantly different from White (P < .01).

Obesity

Eleven of the thirteen studies explored obesity as a CVD risk factor by race and ethnicity. The studies included in this review tend to measure obesity in either mean body mass index (BMI) values,^{30,33,35,38,39,42} a measure of the waist circumference using a standardized procedure,³⁴ or as prevalence of obesi-ty.^{31,36,37} The results are tabulated in Table 6.

Results were conflicting with regards to obesity. Several studies found higher mean BMI in Blacks, and Mexican Americans than Whites^{30,33,37,38} while others failed to find any significant differences in the mean BMI among Blacks and Whites^{39,42} or among Hispanics and Whites.³⁵ Denny et al assessed disparities in chronic disease risk factors between AIAN and White elders and found that the significantly higher prevalence of obesity in AIANs compared to Whites persisted after adjusting for sociodemographic differences (OR=1.29, 95% CI 1.07-1.55).³⁶ Similarly, Sundquist et al reported that older Black women had the highest prevalence of abdominal obesity, followed by White and Mexi-

		Kace/etr	inicity		
White	African-American	Hispanic	Mexican-American	AIAN	Non-Indians
6.3(6.4)	29.2(7.3)		28.6(6.3)	38 ^{a, b}	16 ^a
5.5(5.6) 6.6 ^c 6 ^d	29.5(7)** 34.1 ^c 76.2 ^d		36.8 ^c 65.2 ^d		
9.2	32.5*	29.1		31.6*	
1.7	71.0			29.3	
6±5.3	71.9		28.6±5.7*		
	White 6.3(6.4) 5.5(5.6) 6.6 ^c 6 ^d 9.2 1.7 1.2 6±5.3 7.8(4.3)	White African-American $6.3(6.4)$ $29.2(7.3)$ $5.5(5.6)$ $29.5(7)^{**}$ 6.6^{c} 34.1^{c} 6^{d} 76.2^{d} 9.2 32.5^{*} 1.7 1.2 1.2 71.9 6 ± 5.3 $7.8(4.3)$ $28.03(4.72)$	White African-American Hispanic $6.3(6.4)$ $29.2(7.3)$ $5.5(5.6)$ $29.5(7)^{**}$ 6.6^{c} 34.1^{c} 6^{d} 76.2^{d} 9.2 32.5^{*} 29.1 1.7 1.2 71.9 6 ± 5.3 $7.8(4.3)$ $28.03(4.72)$	White African-American Hispanic Mexican-American $6.3(6.4)$ $29.2(7.3)$ $28.6(6.3)$ $5.5(5.6)$ $29.5(7)^{**}$ $28.6(6.3)$ $5.5(5.6)$ $29.5(7)^{**}$ 36.8° 6.6° 34.1° 36.8° 6^{d} 76.2^{d} 65.2^{d} 9.2 32.5^{*} 29.1 1.7 1.2 71.9 6 ± 5.3 $28.03(4.72)$ $28.6\pm 5.7^{*}$	WhiteAfrican-AmericanHispanicMexican-AmericanAIAN $6.3(6.4)$ $29.2(7.3)$ $28.6(6.3)$ $38^{a, b}$ $5.5(5.6)$ $29.5(7)^{**}$ 36.8^{c} 6.6^{c} 34.1^{c} 36.8^{c} 6^{d} 76.2^{d} 65.2^{d} 9.2 32.5^{*} 29.1 1.7 29.3 1.2 71.9 6 ± 5.3 $28.03(4.72)$

Table 6. Obesity prevalence by race/ethnicity

Note: AIAN - American Indian Alaskan Native BMI - Body mass index SE - Standard error SD - Standard deviation.

Superscript number represent entries in references.

a = >=45 years, b = American Indians in Montana, c = in men, d = in women, e= abdominal obesity, f= BMI≥28.

* Significantly different from White (P < .05).

** Significantly different from White (P<.001).

can American women. However, after adjusting for demographic differences, only Black women were significantly more likely to have abdominal obesity than White women (OR=1.77, 95% CI 1.17–2.69).³⁴

Hypercholesterolemia

Ten of the thirteen studies explored high cholesterol as a CVD risk factor by race and ethnicity. The studies included in this review defined hypercholesterolemia in either mean cholesterol levels,^{30,34} total cholesterol levels,^{35,37,38,40,42} or prevalence of high cholesterol.^{31,33} The results are tabulated in Table 7.

No one racial/ethnic minority population was consistently found to have a higher or lower prevalence of hypercholesterolemia. Few studies that were included reported Whites having higher prevalence of non-high-density lipoprotein cholesterol compared to Mexican Americans and Blacks.^{30,34} Still others reported that Whites had higher mean serum cholesterol values than Blacks,^{35,40} Hispanics,^{35,38} and Alaskan Natives.³⁵ Summerson et al reported a higher prevalence of high total cholesterol values (\geq 240 mg/dL) in Blacks compared to Whites.³⁷ However, Wilbur et al did not find any statistically significant racial/ethnic differences in the total cholesterol values among White and Black women.⁴²

Smoking

Ten of the thirteen studies explored smoking as a CVD risk factor by race and ethnicity. The results are tabulated in Table 8.

Table 7. High cholesterol prevalence by race/ethnicity

			Race/Ethni	city		
Author	White	African-American	Hispanic	Mexican-American	AIAN	Non-Indians
Winkleby, 1998 ^{30,e} ; mean(SD) Harwell, 2001 ^{31,f} ; (%)	148.8(43.8)	143.1(42.6)		148.2(42.1)	24 ^{a,b}	32 ^a
Appel, 2002 ^{33,f} ; (%)	10.3	5**				
Sundquist, 2001 ^{34,e} ; (%)	56.1 ^c 66.8 ^d	49.2 ^c 59 ^d		53.9 ^c 69 ^d		
Finkelstein, 2004 ³⁵ ; mean ^{f/g} (mg/dl)	217.2/56.9	208.6*/56.7	203.5*/52.6*		209.3*/60*	
Summerson, 2002 ^{37,f} ; (%)	24.1	29.4				
Wei, 1996 ^{38,f} ; mean (mg/dl) ±SE	210.1 ± 41.6			203.9±41.8*		
Thomas, 2005 ^{40,f} ; mean (SD), mg/dl	214.5(39.1)	210.1(42.4)				
Wilbur, 2001 ^{42,f} ; mean (SD), mg/dl	209(36.1)	210(32.4)				

Note: AIAN - American Indian Alaskan Native SE = Standard error SD = Standard deviation.

Superscript number represent entries in references.

a = >=45 years, b = American Indians in Montana, c = in men, d = in women, e = Non-High density lipoproterin cholesterol, f=Total cholesterol, g = High density lipoprotein cholesterol.

* Significantly different from White (P < .05).

** Significantly different from White (P<.01).

			Race/Et	hnicity		
Author	White	African-American	Hispanic	Mexican-American	AIAN	Non-Indians
Winkleby, 1998 ³⁰ ; (%)	30	33.1		15.7		
Harwell, 2001 ³¹ ; (%)					32 ^{a, b}	13 ^a
Appel, 2002 ³³ ; (%)	39.7	30.5**				
Sundquist, 2001 ³⁴ ; (%)	15.4 ^c	20.2 ^c		11.9 ^c		
•	10.7 ^d	$10.4^{\rm d}$		11.7 ^d		
Finkelstein, 2004 ³⁵ ; (%)	28	25*	12*			
Denny, 2005 ³⁶ ; (%)	13.9				26.7	
Summerson, 2002 ³⁷ ; (%)	18.2	22				
Wei, 1996 ³⁸ ; (%)	31.6			30.5		
Thomas, 2005 ⁴⁰ ; (%)	35.2	48.8				

Table 8.	Smoking	prevalence	(%)	by race/ethnicity
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Note: AIAN - American Indian Alaskan Native.

Superscript number represent entries in references.

a = >= 45 years, b = American Indians in Montana, c = in men, d = in women.

* Significantly different from White (P<.05).

** Significantly different from White (P<.001).

Mexican Americans had a significantly lower prevalence of smoking than Whites and Blacks^{30,38}; AIANs had significantly higher prevalence of smoking compared to Whites.31,36 Statistically significantly higher prevalence of smoking among AIAN elders compared to Whites persisted after adjusting for sociodemographic differences (OR= 1.78, 95% CI 1.46-2.19).36 Few studies reported higher prevalence of smoking in Blacks compared to Whites,⁴⁰ while others reported no significant differences^{34,37} or lower prevalence in Blacks compared to Whites.33 Of the five sites that were included in the longitudinal study of community differences in CVD risk factors, Greenlund et al found that White women had a greater smoking prevalence than Black women in two sites (37.6% vs 26.1%; 27.2% vs 19.7%; P value <.005), whereas Black women had significantly greater smoking prevalence in the remaining three sites.³⁹ In two of the five sites, little or no difference was seen between Black and White men in prevalence of current smoking, whereas Black men had significantly greater smoking prevalence in the remaining three sites (40.1% vs 19.3%; 53% vs 35.3%; 29.4% vs 14.9%; *P* value $\leq .005$).³⁹

No Leisure-Time Physical Activity

Four of the thirteen studies explored no leisure-time physical activity as a CVD risk factor by race and ethnicity. The results are tabulated in Table 9.

Mexican American women had the highest prevalence of no leisure-time physical activity compared to Black and White women.³⁰ American Indian and

Tabla Q	No loisuro timo	nhysical activity	provalanca (%)	by raco/othnicity
Table 9.		physical activity	μ ν	Dy race/eumicity

	Race/Ethnicity			
Author	White	African-American	Mexican-American	AIAN
Winkleby, 1998 ³⁰ ; (%)	20.5	39.7	43.5	
Sundquist, 2001 ^{34,c} ; (%)	17.1 ^a	27.7 ^a	26.3 ^a	
•	30.8^{b}	48.1 ^b	39.5 ^b	
Denny, 2005 ³⁶ ; (%)	29.3			37.2

Note: AIAN - American Indian Alaskan Native.

Superscript number represent entries in references.

a = in men, b = in women, c = Physical inactivity.

Alaska Natives (AIANs)³⁶ and Blacks^{33,34} also had higher prevalence of no leisure-time physical activity compared to Whites.

A large cross-sectional survey reported that compared to White women, more Black women were active or very active at work (69.3% vs 55.4%; $\chi^2 = 33.2$, *P* value < .0001).³³ However, the same study found more White women engaged in leisure time physical activity more than once a month (70.0% vs 53.8%; $\chi^2 = 46.1$, *P* value <.0001).³³ Similar findings were also reported by Sundquist et al. However, after adjusting for demographic differences, they reported that only Blacks were significantly more likely to report a higher level of physical inactivity compared to Whites (OR=2.62, 95% CI 1.82-3.76 in Black women; OR=1.88, 95% CI 1.19-2.97 in Black men).³⁴ Denny et al reported that the significantly higher prevalence of no leisure-time physical activity among AIAN elders persisted after adjusting for sociodemographic differences (OR=1.24, 95% CI 1.04–1.49).³⁶

DISCUSSION

This review provides an updated assessment of the relationship between

race/ethnicity and CVD risk factors. Considering the significant increase in the prevalence of many of these factors since the last published review in 1997, the studies we included reflected a marked change. Furthermore, racial and ethnic minorities continue to make up a greater percentage of the US population, which underscores the importance of monitoring the health status and health behaviors of these groups. Despite great strides in our understanding of CVD risk factors, they remain poorly defined in racial/ethnic minority populations. This is especially the case for AIAN populations in the United States, which were only included in three studies.

Future research should provide clear conceptual definitions of race, and while no consensus has been reached on how best to operationally measure it, future research would benefit from continued dialogue on this matter. Only one of the articles³⁷ we reviewed discussed measurement issues related to race and ethnicity. Greater conceptual precision is necessary to develop the best interventions and policy actions for CVD prevention. Although most of the articles included in this review^{30,32–38,40,41} adjusted for education and income levels, race is often considered a proxy for socioeconomic conditions and environmental factors. If race is conceptualized as a proxy for variables, such as socioeconomic position or cultural factors, better ways to measure these factors should be found, and future research should consider the impact of more fundamental determinants of CVD risk factors.44 Area-based measures, such as neighborhood conditions, should also be given consideration for influencing these risk factors. Identification of potential mediating and moderating factors in these pathways (for example, sense of personal control or social support) will further inform public health interventions.

This review is not without limitations. Foremost, comparison of existing literature was difficult because of the diverse study designs and lack of Future research should provide clear conceptual definitions of race, and while no consensus has been reached on how best to operationally measure it, future research would benefit from continued dialogue on this matter.

standardized operational definition of modifiable CVD risk factors. We also noted discrepancy in the measure of race and ethnicity; most investigators measured it as self-reported, while one group of researchers used an algorithm that took into consideration factors such as parental surnames, and birthplace to measure race and ethnicity. Secondly, this review could be incomplete, despite all the strategies that were adopted to ensure its completeness, because of factors such as publication bias.

In conclusion, heart disease is the leading cause of death in the United States, and disproportionate rates are seen in racial and ethnic minority populations.^{45–47} Systematically assessing and quantifying modifiable CVD risk factors is therefore critical in these populations. Better understanding and awareness of the disparities of CVD risk factors by race and ethnicity may help clinicians and public health professionals develop culturally sensitive interventions, prevention programs, and services specifically targeted toward risk burdens in each of these populations.

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Design concept of study: Kurian, Cardarelli Acquisition of data: Kurian Manuscript draft: Kurian, Cardarelli Statistical expertise: Kurian Administrative, technical, or material assistance: Kurian Supervision: Cardarelli