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Recent Changes in Cardiovascular Risk Factors among Women and Men

JUNG KI KIM, Ph.D.,[1] DAWN ALLEY, Ph.D.,[1] TERESA SEEMAN, Ph.D.,[2] ARUN KARLAMANGLA, M.D., Ph.D.,[2] and EILEEN CRIMMINS, Ph.D.[1]

ABSTRACT

Background: **The purpose of this study was to examine change over the 1990s in the proportion of men and women with measured high-risk values of cardiovascular risk factors.**

Methods: **Change in the prevalence of high-risk conditions based on clinical cutoffs for 10 cardiovascular risk factors was assessed in respondents aged ≥40 from the nationally representative, cross-sectional National Health and Nutrition Examination Surveys (NHANES) III (1988–1994) and IV (1999–2002).**

Results: **Both sexes experienced a reduction in the prevalence of high-risk levels of cholesterol (total, high-density lipoprotein [HDL], and low-density lipoprotein [LDL]) and high homocysteine and an increase in obesity and high C-reactive protein (CRP). Changes in the prevalence of high total cholesterol and high CRP were more pronounced among women. The percentage of women with high diastolic and systolic blood pressure increased, whereas this percentage decreased among men. During the same time, there was an increase in undiagnosed high blood pressure and in the use of antihypertensive medications without achieving adequate blood pressure control among women. Both sexes increased their use of cholesterol-lowering medication. These changes in diagnosis rates and medication usage did not explain the trends in the prevalence of high-risk blood pressure or high-risk cholesterol, although the larger increase in high CRP among women is related to increased use of postmenopausal hormone therapy over the 1990s.**

Conclusions: **We found mixed trends in cardiovascular risk factors for both women and men; some improved and some deteriorated. Changes in medication use and obesity did not explain these trends.**

INTRODUCTION

RECENT DECADES HAVE brought about a number of improvements in health outcomes, including continued declines in mortality[1] and disability,[2] as well as changes in treatment, including increased use of antihypertensive[3] and lipid-lowering medications,[4] which may have affected men and women differently.[5–7] Although women continue to experience lower mortality relative to men, trends in specific causes of death vary by sex,[5] and the mortality decline for wo-

[1]Andrus Gerontology Center, University of Southern California, Los Angeles, California.
[2]Division of Geriatrics, UCLA School of Medicine, Los Angeles, California.
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men at the oldest ages has slowed.[8] Disability rates are higher among women, and women appear to have gained less in healthy life expectancy in the last three decades.[6] Thus, men and women have not always experienced the same patterns of health change.

Clarification of potential changes in underlying risk factors for morbidity and mortality could help to interpret sex differences in trends in health outcomes. Even though reduction in cardiovascular deaths is the primary reason mortality rates have decreased over the last 30 years, cardiovascular disease (CVD) remains the number one cause of death.[1] In the United States, the recent rate of decline in CVD mortality has been slower for women than men.[9,10] Thus, examination of change in biological risk factors for CVD with a focus on sex differences may help clarify trends by sex in diseases as well as death and disability.

Recent studies have found mixed directions of change in indicators of cardiovascular risk in the population. Cholesterol levels appear to have decreased,[8,11–13] but weight and obesity have increased.[14,15] Changes in other risk patterns have been varied over recent decades. The prevalence of high blood pressure decreased from the 1960s through the early 1990s,[16,17] but a recent increase in the prevalence of hypertension has been noted.[11,18,19] Analysis of the older population has also indicated increases in levels of C-reactive protein (CRP) in the 1990s,[11,20] reflecting increased risk for CVD.

Little research has addressed whether these patterns of change are similar among men and women, although there are reasons that they might differ. A recent analysis suggests that gains in blood pressure control have occurred largely among men.[19] Men generally have higher levels of cardiovascular risk factors than women,[21–24] resulting in a higher risk for CVD among men at a younger age.[25,26] Recent studies on sex differences in biological cardiovascular risk factors among cohorts from the Wisconsin Longitudinal Survey and the MacArthur Studies of Successful Aging indicate that more men have high-risk levels of total and high-density lipoprotein (HDL) cholesterol, systolic and diastolic blood pressure, and higher waist/hip ratio.[27,28] Men are also more likely to be at risk based on levels of homocysteine[29–31] and triglycerides,[32] whereas women are more likely to have high levels of CRP.[33]

Men and women tend to have different patterns of cardiovascular risk factor accumulation with age. For instance, men tend to have higher systolic blood pressure than women through middle age,[34] but after menopause, systolic blood pressure increases in women to levels even higher than those for men.[35,36] This pattern of risk onset helps explain why coronary heart disease (CHD) mortality is significantly higher in men at younger ages but this difference diminishes with advancing age.[37]

In light of known differences in cardiovascular risk factors by sex and recent trends in the prevalence of various risk factors, it is important to address how recent changes in cardiovascular risk have differed for men and women. This study examines change over the 1990s in a set of indicators of cardiovascular risk, including systolic and diastolic blood pressure, three measures of cholesterol (total, LDL, and HDL), triglycerides, obesity, glycated hemoglobin, CRP, and serum homocysteine, using data on men and women ≥40 years of age from two nationally representative cross-sectional samples of the U.S. population, approximately 10 years apart. We include this age range because this is the age at which cardiovascular risk factors start to be clinically evident and cardiovascular events begin to occur. All these indicators have been related to mortality and to the incidence of CVD, stroke, and diabetes.[38–44]

MATERIALS AND METHODS

Data

Data are taken from the National Health and Nutrition Examination Surveys (NHANES) III and IV, cross-sectional studies of the civilian, noninstitutionalized population of the United States conducted by the National Center for Health Statistics, Centers for Disease Control and Prevention (NCHS/CDC). The studies include interviews, clinical examinations, and laboratory tests. NHANES III was collected from 1988 through 1994 (n = 11,448); the NHANES IV data used here were collected from 1999 through 2002 (n = 6,671). Change represented here is for an average of about 10 years (as NHANES III centered on 1990–1991 and NHANES IV on 2000–2001). The sample used in this analysis includes those age ≥40, and all statistics are weighted to reflect the noninstitutionalized U.S. population ≥40 years.

About 91% of those who completed the inter-

view in NHANES III and 89% of those in NHANES IV participated in the laboratory and physical examinations. Among these, about 90% have available data on most of the cardiovascular risk factors. Exceptions include metabolic factors that require fasting because only about half of the sample (the morning group) fasted in these studies. In addition, homocysteine was assayed only in the second half of NHANES III (1991–1994). Although the sample size is smaller for these markers, >90% of the potential respondents provided data. Persons with levels of CRP >10 mg/L were assumed to have acute infections rather than chronically high CRP and were eliminated from CRP analyses because we were interested in levels of CRP recognized as measuring risk for CVD.[45] On this basis, 1,045 people from NHANES III and 709 from NHANES IV were excluded. In general, missing subjects were older and more likely to be African American. The sample size for each indicator is shown in Table 1.

Measures

The cutoff levels defining clinically high risk and methods for measuring the risk factors are shown in Table 1. High risk is defined using measured values and does not initially consider the use of medication. Thus, those who take medication but do not have measured biomarkers in the high-risk zone are defined as not at high risk. In subsequent analyses, we examined self-reports of medication use that potentially affect measured levels of some of the risk factors. For comparability, we used the same cutoff levels for all the indices for men and women; but because it is a common practice to define cutoff levels of HDL cholesterol risk differently by sex, additional comparisons were done with a higher cutoff level of HDL cholesterol for women. Although performed by the same laboratory, assays used to measure CRP differed somewhat at the two dates. NHANES IV assay values were adjusted to be comparable using information derived from comparisons in another sample made by the laboratory doing both assays. The correlation between the two assays at levels >3.0 mg/L was 0.993. The algorithm reduced NHANES IV values in the original data by 9.9%.

Summary indicators of biological risk, such as the Framingham risk score and allostatic load, have included similar indicators of risk.[53,54] For this analysis, we created summary indicators by counting the number of high-risk indicators for each person. Similar approaches have been used in a number of analyses of summary biological risk or allostatic load.[53–55] We examined the av-

Table 1. High-Risk Cutoff Point for Cardiovascular Risk Factors and Sample Size in NHANES III and IV (≥40 Years of Age)

Indicator	*High-risk cutoff point*	*Sample* n *(NHANES III/IV)*
Systolic blood pressure[a]	≥140 mm Hg[46]	9269/5517
Diastolic blood pressure[a]	≥90 mm Hg[46]	9267/5517
Total cholesterol[b]	≥240 mg/dL[47]	9604/5636
HDL cholesterol[b]	<40 mg/dL[47]	9521/5637
Sex-specific HDL cholesterol[b]	<40 mg/dL for men[47] <50 mg/dL for women[47]	9521/5637
Fasting LDL cholesterol[b]	≥160 mg/dL[47]	3971/2456
Fasting triglycerides[c]	≥200 mg/dL[47]	4181/2543
Body mass index[d]	≥30 kg/m[48]	10124/5737
Glycated hemoglobin[e]	≥6.4%[49]	9523/5730
C-reactive protein[f]	>3.0 mg/L[50]	8483/4886
Serum homocysteine[g]	≥15 μMol/L[51,52]	4109/5718

[a]Average of three sets of blood pressure measurements.
[b]Hitachi 737 analyzer/Boehringer-Mannheim Diagnostics, Mannheim, Germany.
[c]H_2O_2 biproduct spectroscopy.
[d]Examination weight, standard anthropometry.
[e]Boronate affinity chromatography.
[f]ELISA: low-sensitivity in NHANES III, high-sensitivity in NHANES IV.
[g]Waters expertise chromatography software.

erage number of factors at high-risk levels by age and sex to summarize time change in total number of risk factors.

Analyses of the reasons for differential change in the prevalence of high-risk levels of specific biomarkers incorporated self-reported information on past diagnosis of hypertension and high cholesterol and use of prescription medication for these conditions among those who have been diagnosed in the past. As it has been suggested that hormone therapy is also associated with systolic blood pressure, total cholesterol, and CRP,[56–60] we also included self-reported current use of oral postmenopausal hormone therapy among women. Current smoking status and obesity (defined as body mass index [BMI] ≥ 30) were included in regressions examining reasons for change because of their potential associations with the prevalence of several high-risk biomarkers.[15,61]

Analyses

Changes in the percent of the population with high-risk levels of cardiovascular markers in NHANES III and IV were examined to evaluate trends within each sex and change in sex differences. To examine potential explanations for differential changes by sex in the prevalence of high blood pressure and high-risk cholesterol, we examined the population distribution of changes in measured risk and self-reports of diagnosis and use of medication. Next, we used logistic regression models, pooling data across NHANES III and IV, to look at the effect on the coefficient representing the change over time of changes in undiagnosed hypertension/cholesterol and medication use as well as changes in obesity and smoking behavior. The odds ratios (ORs) reflecting the relative likelihood of being in a high-risk group in NHANES IV compared with NHANES III and those of covariates are shown for men and women, separately. This approach allowed us to examine how the ORs indicating the effect of being in the later study changed with control for variables that offer possible explanations for the change over time. Age was controlled in the analysis, as the average age of men in the sample dropped from 56.6 to 56.0, whereas for women, the drop was from 58.5 to 57.5. In order to examine the reasons for changes in the prevalence of high CRP, we ran similar logistic regressions with controls for age, obesity, and smoking and included the use of hormone therapy for women.

RESULTS

Table 2 presents the prevalence of persons in the high-risk range for individual biomarkers for men and women in NHANES III and IV. Examination of change for each sex between the two surveys indicates that the prevalence of high systolic and diastolic blood pressure increased among women: the percent with measured high-risk systolic blood pressure increased from 24.0% to 30.2%, and the percent of women with high diastolic blood pressure increased from 4.7% in NHANES III to 6.6% in NHANES IV. In contrast, prevalence of high blood pressure declined among men, with a 2.3% and 3.0% decrease in high systolic and high diastolic blood pressure, respectively.

Prevalence of high-risk cholesterol levels declined among both men and women, although declines in high total cholesterol were greater among women than among men (8.7% vs. 3.8%). The prevalence of high-risk LDL cholesterol declined similarly for women and men (9.8% for women, 8.9% for men). Although the prevalence of high-risk HDL cholesterol decreased for both men and women, greater improvement was found for men (5.6% decline) than for women (1.8% decline). The proportion of women with high-risk HDL cholesterol decreased by about 2%–3%, regardless of whether high-risk is coded similarly for both sexes or on a sex-specific basis. Changes in high-risk triglycerides were not significant for either sex during this time period. The prevalence of obesity increased 6%–7% among both men and women, but no significant change was found in high-risk glycated hemoglobin for either sex. Both men and women also experienced increases in the proportion with high levels of CRP, although the increase in the prevalence of high CRP was greater for women than for men (15.5% vs. 10.0%). Both men and women experienced reductions in the prevalence of high homocysteine, 6.8% and 3.1%, respectively. Reductions in the prevalence of high homocysteine are probably explained by increased consumption of folate due to the supplementation with folate of cereals and flours begun in 1996.[11,62,63] Data from NHANES III and IV show that the mean level of

Table 2. Percent of Population at High-Risk Levels of Cardiovascular Risk Factors and Percent Current Smokers, Obese, and Using Hormone Therapy, by Sex, in NHANES III and IV

	Men				*Women*				p *for difference (men/women) in NHANES III*	p *for difference (men/women) in NHANES IV*
	NHANES III	*NHANES IV*	*% Change*	p *for change*	*NHANES III*	*NHANES IV*	*% Change*	p *for change*		
Cardiovascular risk factors										
Systolic blood pressure	23.6	21.3	−2.3	0.0244	24.0	30.2	6.2	<0.0001	0.6396	<0.0001
Diastolic blood pressure	11.8	8.8	−3.0	<0.0001	4.7	6.6	2.0	0.0002	<0.0001	0.0027
Total cholesterol	23.3	19.6	−3.8	0.0002	32.1	23.5	−8.7	<0.0001	<0.0001	0.0004
Fasting LDL cholesterol	25.5	16.7	−8.9	<0.0001	24.2	14.4	−9.8	<0.0001	0.3159	0.0720
HDL cholesterol	38.9	33.3	−5.6	<0.0001	12.7	10.9	−1.8	0.0211	<0.0001	<0.0001
Sex-specific HDL cholesterol	38.9	33.3	−5.6	<0.0001	38.0	34.8	−3.2	0.0050	0.3618	0.2381
Fasting triglycerides	23.2	23.8	0.6	0.8123	17.4	15.6	−1.8	0.3296	<0.0001	<0.0001
Body mass index	23.7	29.9	6.2	<0.0001	28.1	35.4	7.3	<0.0001	<0.0001	<0.0001
Glycated hemoglobin	9.6	10.7	1.1	0.1352	7.7	7.8	0.2	0.8006	0.0008	<0.0001
C-reactive protein	21.4	31.4	10.0	<0.0001	28.0	43.5	15.5	<0.0001	<0.0001	<0.0001
Serum homocysteine	12.0	5.2	−6.8	<0.0001	7.8	4.7	−3.1	<0.0001	<0.0001	0.4273
Health behaviors										
Current smoker	26.9	22.5	−4.4	<0.001	19.6	17.9	−1.7	0.0586	<0.0001	<0.0001
Obese	23.7	29.9	6.2	<0.0001	28.1	35.4	7.3	<0.0001	<0.0001	<0.0001
Hormone therapy user					13.0	23.3	10.2	<0.0001		

serum folate more than doubled between the two dates (from 17 ng/mL to 36 ng/mL), and the increase was similar for both men and women.

Given the potential for differential changes by age, we examined whether changes in the proportion of those with high-risk levels for cardiovascular markers differed among men and women in middle (40–64) and older (≥65) age. Generally, we found that changes in the prevalence of high-risk levels of these markers were similar for both younger and older groups (data not shown). The exceptions were that the improvements in cholesterol were greater among older groups. Specifically, the decline in high-risk sex-specific HDL cholesterol was not significant among middle-aged women (1.9%, $p = 0.1558$) or middle-aged men (2.1%, $p = 0.1141$), whereas it was significant among older women (5.1%, $p = 0.0012$) and older men (9.2%, $p < 0.0001$).

Comparisons of prevalence by sex at each time period (the last two columns of Table 2) show that in NHANES III, a higher percentage of men than women had high-risk values of diastolic blood pressure, HDL cholesterol, fasting triglycerides, glycated hemoglobin, and homocysteine. In contrast, women had a higher prevalence of high total cholesterol, obesity, and high CRP. Sex differences in NHANES IV were similar, except that women developed a higher prevalence of high systolic blood pressure, and the sex difference in homocysteine was reduced to nonsignificance. The only indicators for which there were no sex differences at either date were LDL and HDL cholesterol (with sex-specific cutoff points).

Differences between men and women in time changes were statistically significant for all the outcomes (data not shown), but the magnitude of the gender differences was substantial enough to be clinically significant only for trends in blood pressure, total cholesterol, and CRP.

We also examined the change in the average number of risk factors by age and sex in NHANES III and IV (Fig. 1). In both surveys, men had more risk factors at younger ages. In NHANES IV, the crossover to higher numbers of risk factors for women occurred at a younger age, and the difference at older ages was larger than in NHANES III. At ages below the crossover, the sex differences were smaller in NHANES IV than in NHANES III. At most ages, men experienced either no change or a small decline in the average number of indicators of high-risk from NHANES III to NHANES IV, whereas women tended to get worse. In both the 40–49 and 60–69 age groups, women exhibited a significantly greater number of total risk factors in NHANES IV compared with the earlier survey.

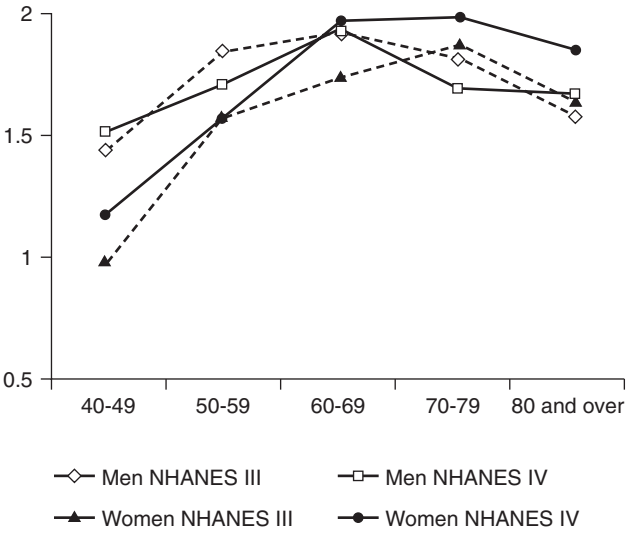

FIG. 1. Mean number of cardiovascular risk factors by sex and age: NHANES III and IV.

Possible reasons for change

We have observed large sex differences in the size and direction of changes in blood pressure, total cholesterol, and CRP. Potential explanations for differential changes for men and women in the prevalence of high-risk cholesterol and high blood pressure include changes in the prevalence of diagnosis and medication use in controlling high-risk conditions, as well as changes in obesity, smoking behavior, and use of hormone therapy. Previous research linking higher levels of CRP to obesity,[64,65] smoking,[66] and hormone therapy use among women[58–60] may provide some explanation for differential changes in CRP for men and women. Our data show that the percent of current smokers decreased over the period for men (27%–23%, $p < 0.0001$) but not significantly for women (20%–18%, $p = 0.0586$). Additionally, among women aged ≥40, use of oral, postmenopausal hormone therapy almost doubled during the 1990s (13%–23%, $p < 0.0001$) (Table 2).

Descriptive results

The prevalence of high blood pressure increased among women, whereas it decreased among men. Table 3 shows the percent of popu-

Table 3. Percent of Population by Measured Level of Risk and Self-Reports of Diagnosis and Medication Use, by Sex in NHANES III and IV

	Men				*Women*			
	NHANES III (%)	*NHANES IV (%)*	*Change (%)*	p *for change*	*NHANES (%)*	*NHANES IV (%)*	*Change (%)*	p *for change*
Systolic blood pressure								
Measured above risk level systolic blood pressure								
Undiagnosed	10.0	9.9	−0.1	0.9238	8.8	11.7	2.9	<0.0001
Diagnosed, no medication	5.0	3.1	−1.9	0.0001	4.3	3.9	−0.4	0.4767
Diagnosed, taking medication	8.6	8.3	−0.3	0.6083	10.9	14.6	3.7	<0.0001
Measured below risk level systolic blood pressure								
No history of high blood pressure	57.9	58.1	0.2	0.9034	56.1	49.5	−6.6	<0.0001
Diagnosed, no medication	8.7	5.7	−3.0	<0.0001	7.2	4.4	−2.8	<0.0001
Diagnosed, taking medication	9.8	15.0	5.2	<0.0001	12.8	15.9	3.1	0.0002
Total	100.0	100.0			100.0	100.0		
Total cholesterol								
Measured high-risk total cholesterol								
Undiagnosed	12.4	8.3	−4.1	<0.0001	15.5	10.2	−5.3	<0.0001
Diagnosed, no medication	9.4	8.9	−0.5	0.4709	13.9	10.4	−3.5	<0.0001
Diagnosed, taking medication	1.7	2.4	0.7	0.0465	2.6	2.8	0.2	0.7711
Measured not high-risk total cholesterol								
No history of high cholesterol	58.7	54.9	3.8	0.0019	53.8	55.2	1.4	0.2675
Diagnosed, no medication	14.5	11.9	−2.6	0.0021	10.9	11.1	0.2	0.7647
Diagnosed, taking medication	3.3	13.6	10.3	<0.0001	3.2	10.5	7.3	<0.0001
Total	100.0	100.0			100.0	100.0		

lation by measured level of risk and self-reports of diagnosis and medication use by sex in NHANES III and IV. Examining changes in the distributions of the sample between the two dates, there was a 6.6% decrease in women who have no history of high blood pressure and were measured as below the risk cutoff level. By NHANES IV, only half (49.5%) of women ≥40 years were in this category. For men, the percentage with no history of high blood pressure was about 58% (57.9% and 58.1%) in both studies. There was a significant increase of 2.9% in the prevalence of undiagnosed high blood pressure among women (from 8.8% in NHANES III to 11.7% in NHANES IV). The percentage of men who had high blood pressure and were undiagnosed remained at 10% in both studies (10.0% and 9.9%). The use of antihypertensive medication increased significantly for both sexes between the two studies. About 23% of men used antihypertensive medication by NHANES IV (the sum of men taking medication above [8.3%] and below risk [15.0%]) compared with only 18% in NHANES III (8.6% + 9.8%), an increase of about 5%. At the same time, the prevalence of antihypertensive use increased by 7% among women, from 24% (10.9% + 12.8%) to 31% (14.6% + 15.9%). However, in NHANES IV, less than half (47.9%) of women who reported taking medication had measured systolic blood pressure above the risk level (the 14.6 % on medication at low risk as a fraction of the total on medication, including the additional 15.9% also on medication but with values in the high-risk range), whereas almost two thirds of men (64.4%) taking medication had measured systolic blood pressure below the risk level (15.0% as a fraction of the total, including the 8.3% on medication with uncontrolled hypertension). The percent of women on medication with uncontrolled high blood pressure increased significantly, by 4% (from 10.9% to 14.6%), between the two studies, accounting for some of the increase in measured high blood pressure among women. In men, there was an increase in control of high blood pressure; the proportion of men taking antihypertensive medicine and having adequately controlled blood pressure went up by 5% (from 9.8% to 15.0%). Among men, there was also an increase in the efficacy of antihypertensive medications, as the percentage of those using medications and having measured systolic blood pressure below the cutoff point went from 56% (9.8% low risk as a fraction of total, including 8.6% on medication above risk) in NHANES III to 64% (15.0% low risk out of total, including 8.3% above risk) in NHANES IV. Thus, more women with high blood pressure went undiagnosed in NHANES IV, and women on medication were less likely to have controlled blood pressure relative to men.

The prevalence of high total cholesterol decreased more among women than among men, despite the fact that among women, the percent with measured below risk and no history of high cholesterol did not change (53.8% and 55.2%), whereas for men, it dropped about 4% (from 58.7% to 54.9%). In addition, the use of cholesterol-lowering medication increased somewhat more among men. The prevalence of medication use among men increased from 5% in NHANES III (the sum of men taking medication above [1.7%] and below [3.3%] risk) to 16% in NHANES IV (2.4% + 13.6%), an increase of 11%, compared with an increase of 7% among women, from 6% in NHANES III (2.6% + 3.2%) to 13% in NHANES IV (2.8% + 10.5%). For women, there was a decrease in both undiagnosed high total cholesterol (from 15.5% to 10.2%) and the percentage with measured high levels of cholesterol who had been diagnosed and were not using medication (from 13.9% to 10.4%); these percentages did not change as much among men. Thus, the greater decline in high-risk levels of cholesterol among women is linked to a reduction in the percentage of women with measured high risk cholesterol levels who are not prescribed medication (a reduction of 3.5%, from 13.9% to 10.4%). Cholesterol-lowering medications appeared more effective for both men and women at NHANES IV than at NHANES III. The percentage of those taking medications who had measured levels below risk was 85% (13.6% low risk of total including 2.4% above risk) for men and 79% (10.5% low risk of total including 2.8% above risk) for women at NHANES IV. This was an increase from 67% (3.3% out of sum of 3.3% and 1.7%) and 55% (3.2% out of sum of 3.2% and 2.6%) at NHANES III.

Regression results

Next, we examined the changes in the prevalence of high-risk markers by controlling for possible explanatory factors in logistic regression models predicting the likelihood of having measured high-risk systolic blood pressure, total cho-

TABLE 4. ODDS RATIO OF BEING IN HIGH-RISK SYSTOLIC BLOOD PRESSURE, TOTAL CHOLESTEROL, AND CRP IN NHANES IV RELATIVE TO NHANES III

	Men				*Women*					
	Model 1		*Model 2*		*Model 1*		*Model 2*		*Model 3*	
	OR[a]	*95% CI*	*OR*	*95% CI*	*OR*	*95% CI*	*OR*	*95% CI*	*OR*	*95% CI*
Systolic blood pressure										
NHANES IV	0.88	0.78–0.99	0.86	0.76–0.97	1.53	1.37–1.71	1.51	1.35–1.70	1.54	1.37–1.74
Age	1.06	1.06–1.07	1.06	1.06–1.07	1.08	1.08–1.09	1.08	1.08–1.09	1.08	1.08–1.09
Obese			1.17	1.02–1.33			1.29	1.15–1.46	1.31	1.16–1.48
Current smoker			1.17	1.01–1.34			0.89	0.76–1.03	0.91	0.78–1.07
Diagnosed and use medication[b]			3.23	2.82–3.69			3.01	2.67–3.41	2.99	2.63–3.39
Diagnosed and no medication[b]			3.57	3.03–4.27			3.63	3.07–4.30	3.38	2.84–4.03
Hormone therapy									1.00	0.86–1.16
Total cholesterol										
NHANES IV	0.80	0.71–0.89	0.81	0.72–0.91	0.65	0.59–0.72	0.64	0.57–0.71	0.63	0.56–0.70
Age	0.99	0.99–1.00	0.99	0.99–1.00	1.03	1.02–1.03	1.03	1.03–1.03	1.03	1.02–1.03
Obese			1.04	0.91–1.18			1.27	1.14–1.41	1.34	1.20–1.50
Current smoker			1.09	0.96–1.24			1.04	0.92–1.18	1.18	1.04–1.35
Diagnosed and use medication[b]			1.22	1.06–1.42			1.19	1.05–1.33	1.82	1.52–2.18
Diagnosed and no medication[b]			1.45	1.23–1.71			1.20	1.02–1.40	4.48	4.00–5.02
Hormone therapy									0.96	0.83–1.10
CRP										
NHANES IV	1.72	1.54–1.91	1.73	1.55–1.93	1.99	1.81–2.19	1.98	1.79–2.20	1.80	1.62–2.00
Age	1.02	1.02–1.03	1.03	1.03–1.04	1.01	1.01–1.01	1.01	1.01–1.02	1.01	1.01–1.02
Obese			2.78	2.47–3.13			3.51	3.16–3.91	3.60	3.22–4.03
Current smoker			2.27	1.99–2.58			1.13	1.00–1.29	1.11	0.97–1.27
Hormone therapy									2.07	1.81–2.37

[a]OR, odds ratio; CI, confidence interval.
[b]Never diagnosed is reference; question on use of medication not asked if not diagnosed.

lesterol, or CRP (Table 4). We presented sex-specific models for each dependent variable, and our focus was on the variable representing time change from NHANES III to NHANES IV. In the first model, only age was controlled; later models controlled for obesity, smoking, and diagnosis/medication and for hormone use in women.

Model 1 indicates the probability of being in the high-risk category in NHANES IV relative to NHANES III with only age controlled, that is, assuming the samples at the two time points had the same age distribution. The odds of high-risk blood pressure were 12% lower among men, but 53% greater for women (Table 4, model 1). After adding obesity, smoking, diagnosis and medication, and hormone use into the model (Table 4, models 2 and 3), the OR reflecting the time change remained almost the same. This result indicates that the time trends in the prevalence of high blood pressure in both men and women are not explained by changes over time in smoking, obesity, diagnosis or use of medication, and hormone use.

Regression results on total cholesterol showed that the relative likelihood of being in the high-risk cholesterol in NHANES IV compared with NHANES III with only age controlled was 20% and 35% lower for men and women, respectively (Table 4, model 1), and it remained unchanged with obesity, smoking, diagnosis and medication, and hormone use controlled (Table 4, models 2 and 3). Again, results showed that changes in these potential explanatory factors do not explain changes over time in the prevalence of high-risk total cholesterol and differences for men and women.

Results on CRP (Table 4, model 1) indicated that the relative likelihood of being in the high-risk CRP group in the later survey compared with the earlier survey with only age controlled was 72% greater among men and 99% greater among women. When obesity and smoking were controlled (Table 4, model 2), the OR indicating time change did not change for either men or women. When the use of oral, postmenopausal hormone therapy was controlled in model 3, the OR reflecting the time change among women decreased by 18%. This result suggests that the increase in the prevalence of high-risk CRP among women would have been smaller without the concurrent increase in the use of hormone therapy and that the relative increase over time in high-risk CRP would have been similar among men and women if women had not increased their use of hormone therapy.

DISCUSSION

This study examined the trend in cardiovascular risk factors for women and men aged ≥40 during the 1990s. The prevalence of measured high-risk cholesterol (total, HDL, and LDL) and high homocysteine decreased for both sexes, whereas the prevalence of obesity and high CRP increased for both men and women. The decrease in the prevalence of high total cholesterol and the increase in high CRP were more pronounced in women. Furthermore, trends in the prevalence of high blood pressure differed by sex: women experienced an increase, but men experienced a decrease in the prevalence of both high diastolic and high systolic blood pressure. At the same time, the age pattern of sex differences in cardiovascular risk has changed, so that the age at which women have more high-risk factors than men has fallen by about 10 years in the last decade. Reports indicating that men of this age are more likely to have high-risk levels of blood pressure and cholesterol are no longer true in the U.S. population ≥40 years of age.

Descriptive results reveal important sex differences in trends in diagnosis and treatment of cardiovascular risk factors. This study validates previous results suggesting that increases in blood pressure control have occurred primarily among men.[19] Across the 1990s, there appears to have been an increase in the proportion of women who are both undiagnosed and have measured high blood pressure. Furthermore, women on antihypertensive medication appear to be less effectively treated for high blood pressure relative to men. Differences in effectiveness may be related to other factors, including intensity of therapy and compliance, not explicitly addressed here.

In contrast, both men and women have benefited from higher rates of diagnosis and more effective treatments for cholesterol.[12] However, these changes did not explain population-level decreases in the prevalence of high cholesterol among both sexes. The positive effects of better treatment of high cholesterol may be mitigated by a continued high rate of smoking among both men and women, as well as large increases in the prevalence of obesity. These trends may also be related to changes in other health behaviors, in-

cluding diet and exercise, not examined here. Future research should address potential explanations for divergent trends in blood pressure and cholesterol risk among women.

Our analysis suggests that the increase in the use of postmenopausal hormone therapy appears to explain some of the larger increase in the prevalence of high CRP among women, but not the increase in the prevalence of high-risk systolic blood pressure or the decrease in the prevalence of high-risk total cholesterol. The recent increase in the use of hormone therapy appears to be associated with higher levels of CRP.

Changes in cardiovascular risk factors are important indictors of recent changes in cardiovascular health in the U.S. population. The picture is somewhat sobering. Some indicators show a population at less risk, and some show a population at greater risk than in the past. Women's health, especially older women's health, appears to have deteriorated relative to men's health. In addition, these results clarify the important role of antihypertensive and cholesterol-lowering medication in preventing further increases in cardiovascular risk in both men and women.

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Address reprint requests to:
Eileen M. Crimmins, Ph.D.
Andrus Gerontology Center, USC
3715 McClintock Avenue, MC 0191
Los Angeles, CA 90089-0191

E-mail: crimmin@usc.edu