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Health Insurance and Cardiovascular Disease Risk Factors

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Abstract

Background—Compared to those with health insurance, the uninsured receive less care for chronic conditions such as hypertension and diabetes and they experience higher mortality.

Methods—We investigated the relations of health insurance status to prevalence, treatment, and control of major cardiovascular disease risk factors, hypertension and elevated low-density lipoprotein (LDL) cholesterol, among Framingham Heart Study (FHS) participants in sex-specific age-adjusted analyses. Participants who attended either the seventh Offspring cohort examination cycle (1998–2001) or the first Third Generation cohort examination cycle (2002–2005) were studied.

Results—Among 6098 participants, 3.8% were uninsured at the time of the FHS clinic examination and participants' ages ranged from 19 to 64 years. The prevalence of hypertension and elevated LDL cholesterol was similar for the insured and uninsured, however the proportion of those who obtained treatment and achieved control of these risk factors was lower among the uninsured. Uninsured men and women were less likely to be treated for hypertension with odds ratios for treatment of 0.19 (95% CI 0.07–0.56) for men and 0.31 (95% CI 0.12–0.79) for women. Among men, the uninsured were less likely to receive treatment or achieve control of elevated LDL cholesterol than the insured, with odds ratios of 0.12 (95% CI 0.04–0.38) for treatment and 0.17 (95% CI 0.05–0.56) for control.

Conclusions—The treatment and control of hypertension and hypercholesterolemia are lower among uninsured adults. Increasing the proportion of insured individuals may be a means to

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improve the treatment and control of cardiovascular disease risk factors and reduce health disparities.

Keywords

health insurance; cardiovascular risk factors; hypertension; health disparities

BACKGROUND

The lack of health insurance is a large and growing problem in the United States. In 2008, 15.4% of the US population was uninsured and the number of uninsured persons has increased over the past two decades.¹

US adults without health insurance are less likely to receive screening for chronic medical conditions such as hypertension and hypercholesterolemia.² Conversely, approximately one in seven adults with diabetes or hypertension is without health insurance.³ Compared with the insured near-elderly, the uninsured near-elderly have a higher mortality rate, which is mostly confined to those with diabetes, hypertension, and coronary heart disease.⁴

Of studies that have looked at the treatment and control of cardiovascular disease risk factors by health insurance status, the majority have relied on self-reported diagnoses,⁵ only evaluated medication use without addressing the effectiveness of treatment,^{6,7} or have focused on hypertension alone.^{7,8} In the current investigation, we examined the prevalence, treatment, and control of hypertension and elevated low-density lipoprotein (LDL) cholesterol in Framingham Heart Study (FHS) participants according to health insurance status. The majority of the FHS participants reside in Massachusetts, which has a highly insured population compared to the US average and has legislated mandatory health insurance effective July 2007.⁹ The 3-year average for the percentage of the population that was uninsured from 2004–2006 was 10.3% for Massachusetts compared to 15.3 % nationally.¹⁰ Demonstrating differences in the treatment of cardiovascular disease risk factors in insured versus uninsured individuals in an area with high health insurance rates would underscore the public health implications of expanded insurance coverage.

METHODS

Study Population

The Framingham Heart Study is an observational study that began in 1948 when an original study cohort was enrolled. The children and spouses of children of the Original cohort were enrolled in the Offspring cohort, beginning in 1971.¹¹ The Third Generation cohort, comprised of children of Offspring cohort participants, was enrolled starting in 2002.¹² Data from the 3539 participants in the Offspring cohort's seventh examination cycle (1998–2001) and 4095 participants in the first examination cycle for the Third Generation cohort (2002–2005) form the basis of this investigation. Participants who were ≥ 65 years of age and therefore eligible for Medicare ($n=1238$) or had missing data on cardiovascular disease risk factors ($n=245$) were excluded. An additional 53 participants with missing data on insurance status were excluded, resulting in a final sample size of 6098 participants.

Exposure Variable

Insurance status was sought as part of the sociodemographic questionnaire participants completed during the clinic visit. Offspring cohort participants were asked, "Do you have health insurance?" Third Generation participants were asked about various types of insurance including Medicare, Medicaid, Veterans Administration or military insurance,

private or health maintenance organization insurance, or no insurance. Participants were classified as having no insurance if they did not respond affirmatively to any of the insurance categories but did answer at least one item of the insurance question.

Measurements and Definitions of Outcome Variables

The main outcome measures were blood pressure and LDL cholesterol. Blood pressure was determined by the average of two measurements performed by the examining physician during the clinic visit. Participants with systolic blood pressure ≥ 140 mm Hg or diastolic blood pressure ≥ 90 mm Hg, or those taking medication for a hypertension indication were defined as having hypertension. Medication usage was by self-report. All participants had fasting blood work performed at the clinic visit. LDL cholesterol was calculated using the Friedewald equation.¹³ A diagnosis of elevated LDL cholesterol was defined by National Cholesterol Education Program Adult Treatment Panel (ATP) III guidelines and was LDL cholesterol ≥ 160 mg/dL for those with no or one cardiovascular disease risk factor, ≥ 130 mg/dL for those with two or more risk factors, and ≥ 100 mg/dL for those with coronary heart disease, diabetes or a coronary heart disease risk equivalent¹⁴ or current usage of a lipid lowering agent.

Participants were diagnosed with coronary heart disease if they had prevalent myocardial infarction, coronary insufficiency, or angina as determined by physician investigator review of FHS clinic visit and hospital records. Similarly, participants were diagnosed as having cardiovascular disease if they had a diagnosis of coronary heart disease, stroke (ischemic stroke or intracerebral hemorrhage), heart failure or intermittent claudication as determined by physician review. For those without prevalent cardiovascular disease, a Framingham risk score was calculated predicting the 10-year risk of coronary heart disease.¹⁵ Presence of metabolic syndrome was defined as 3 or more of the following: waist circumference ≥ 102 cm for men or ≥ 88 cm for women, triglycerides of ≥ 150 mg/dL, high-density lipoprotein cholesterol < 40 mg/dL for men or < 50 mg/dL for women, fasting blood glucose ≥ 100 mg/dL or use of insulin or an oral hypoglycemic agent, and blood pressure $\geq 130/85$ mm Hg or anti-hypertensive medication use.¹⁶

Participants provided detailed information on medical check ups, hospitalizations, emergency department visits, smoking and alcohol use during the physician-administered examination. Heavy alcohol use was defined as ≥ 7 drinks per week for women and ≥ 14 drinks per week for men.¹⁷ The Center for Epidemiologic Studies Depression Scale (CES-D) score was utilized to determine depressive symptomatology with a score ≥ 16 indicating a high degree of symptoms.¹⁸ Participants also answered questionnaires providing detailed health and sociodemographic information such as self-reported education and income levels (both carried over from previous exams) and health status.

Treatment and Control of Outcome Variables

Hypertension treatment was defined as currently taking anti-hypertensive medication. Control of hypertension was defined as blood pressure $< 140/90$ mm Hg. Treatment for elevated LDL cholesterol was defined as currently taking prescription lipid lowering medication. Control of LDL cholesterol was defined by ATP III guidelines and depended on the number of cardiovascular disease risk factors each participant had at the time of the examination with levels being less than those described above.¹⁴ Treatment for all conditions was defined by the proportion of participants being treated for a condition among those with the condition. Similarly, control was defined as the proportion of participants with adequate control of a given risk factor among those defined as having that risk factor.

Statistical Analysis

All analyses were sex-specific due to the presence of spouse couples within the study sample that were unlikely to be independent with respect to insurance status. For all continuous variables, generalized linear models, adjusted for age and cohort (Offspring versus Third Generation), were used to compare differences in mean risk factor levels between the insured and uninsured. For dichotomous variables, a logistic regression model, adjusting for age and cohort (Offspring versus Third Generation) was constructed to compare the proportion of clinical and psychosocial factors among those with and without health insurance. Multinomial logistic regression was used for polytomous variables. To assess the relations between health insurance status and cardiovascular disease risk factor prevalence, treatment, and control, odds ratios and 95% confidence intervals were calculated using generalized estimating equations and logistic regression to adjust for age and relatedness between study participants, since the FHS has a family-based design. All statistical analyses were performed using SAS, v. 8.2 (SAS Institute Inc, Cary, NC). A two-sided p-value of <0.05 was considered statistically significant.

RESULTS

Baseline Clinical Characteristics

Women comprised 53.5% of the study sample. Five percent of men and 3% of women were uninsured; 59% of the uninsured were men. Mean systolic and diastolic blood pressures for the insured and uninsured were 122/78 and 121/77 mm Hg for men and 116/73 and 118/73 mm Hg for women, respectively (Table 1). For men, total cholesterol and LDL cholesterol values were significantly higher among the uninsured at 200 and 126 mg/dL compared to 194 and 121 mg/dL for the insured, respectively ($p=0.01$ and $p=0.03$). In women, no differences were seen in lipid concentrations according to health insurance status with mean LDL cholesterol values of 110 and 114 mg/dL for insured and uninsured women, respectively. The prevalence of preexisting coronary heart disease or cardiovascular disease, the average Framingham coronary heart disease risk score, and the prevalence of the metabolic syndrome did not vary by health insurance status for men or women. Uninsured women had significantly higher mean BMI (28.0 versus 26.5; $p=0.02$) and a higher prevalence of obesity (34% versus 23%; $p=0.01$). In men, 46% of the uninsured smoked compared to 16% of insured men ($p<0.001$); corresponding values for women were 33% and 16% ($p<0.001$). Uninsured men were more likely to have heavy alcohol use than insured men (21% versus 15%; $p=0.04$).

Baseline Psychosocial and Sociodemographic Characteristics

A comparison of categorical variables is presented in Table 2. There was a significant difference between the uninsured and insured in the percentage of persons defined as having a high level of depressive symptoms on the CES-D scale, which for men was 24% versus 8% ($p<0.001$) and for women was 20% versus 12% ($p=0.02$). The rates of hospitalization were similar between uninsured and insured men; however, uninsured men were more likely to have been seen in the emergency room. Among women the uninsured were less likely to have been hospitalized for any reason including childbirth, 43% versus 58% ($p=0.006$). The rates of routine physical examinations within the last 5 years were significantly lower among uninsured participants compared to insured participants in men (58% versus 88%; $p<0.001$) and in women (76% versus 94%; $p<0.001$). Only 53% of uninsured men obtained post high school education compared to 72% of insured men ($p<0.001$). There were no significant differences in the percentage of women with post-high school education by health insurance status. The uninsured were much more likely to have lower self-reported health status and had lower rates of family income $\geq \$75,000$ than the insured.

Prevalence, Treatment and Control of Cardiovascular Disease Risk Factors

Tables 3 (men) and 4 (women) report the sex-specific prevalence, treatment, and control of cardiovascular disease risk factors, adjusted for age and cohort. The mean systolic and diastolic blood pressures for men with a diagnosis of hypertension were $134/84 \pm 16/10$ and $141/89 \pm 14/8$ mm Hg for those with and without insurance, respectively. The corresponding values for women with hypertension were $136/81 \pm 18/10$ and $137/83 \pm 22/11$ mm Hg. Although the prevalence of hypertension was similar in uninsured versus insured men and women, the proportion of those treated for hypertension was lower for those without health insurance. The odds ratios for hypertension treatment were 0.19 in men (uninsured vs. insured; $p=0.003$) and 0.31 in women ($p=0.01$). The proportion of those with controlled hypertension also was significantly lower in uninsured men at 8% compared to 42% in insured men (odds ratio of control of 0.17; $p=0.01$).

Mean LDL cholesterol values among men with a diagnosis of elevated LDL cholesterol were 137 ± 37 and 154 ± 35 mg/dL for the insured and uninsured, respectively. Corresponding values in women were 142 ± 39 and 149 ± 38 mg/dL. The pattern for high LDL cholesterol among men was similar to that of hypertension. The proportion of those treated for high LDL cholesterol was 41% in insured men but only 7% in uninsured men (odds ratio of treatment 0.12; $p<0.001$). Control of LDL cholesterol was achieved in only 7% of uninsured men with elevated LDL cholesterol versus 31% in insured men (odds ratio of control 0.17; $p=0.004$). The percentage of women with elevated LDL cholesterol was marginally higher in the uninsured than the insured, but no differences in treatment or control were observed.

DISCUSSION

The proportions of those with treated and controlled major cardiovascular disease risk factors were considerably lower in uninsured compared with insured individuals. This was most notable for treatment and control of hypertension and elevated LDL cholesterol in men and for hypertension treatment in women. Whereas the lower rate of hypertension control in the uninsured has been demonstrated previously,⁵ the finding that the proportion of controlled hypercholesterolemia also is significantly lower in uninsured men than insured men is new.

Our investigation demonstrated lower proportions of treatment and control of blood pressure among uninsured hypertensive individuals. The only randomized insurance study in the US, The RAND Health Insurance Experiment, demonstrated that hypertensive individuals randomized to free health care had better blood pressure control than those who were randomized to insurance plans that required cost sharing.¹⁹ While the RAND study did not randomize people to uninsured versus insured health insurance status, and instead compared plans with a range in the amount of cost sharing for participants, their findings were consistent with the current results. In two quasi-experimental studies of insurance status investigating instances when Medi-Cal and Veterans Administration health insurance benefits were terminated, it was found that hypertensive patients whose benefits were cut experienced subsequent increases in blood pressure compared with those whose coverage was maintained.^{20,21} Taken as a whole, these prior studies and our findings suggest that the lack of health insurance does have direct adverse effects on blood pressure for those with hypertension.

The prevalence of elevated LDL cholesterol did not differ between uninsured and insured men and was marginally higher in uninsured versus insured women in this study. Uninsured men were significantly less likely to have their LDL cholesterol levels treated or controlled than insured men. To assess hypercholesterolemia, we focused our investigation on LDL

cholesterol because it is the focus of clear diagnostic and treatment guidelines.¹⁴ Of the previous studies that have examined prevalence of hypercholesterolemia by insurance status, all have used total serum cholesterol and not LDL cholesterol as in this evaluation.^{5,6,22} The difference in methodology may partially explain the new findings in this investigation. Our study also used contemporary data, from a time period when lipid lowering treatment recommendations have been more aggressive than in prior years.

Depressive Symptoms and Sociodemographic Factors

A notable finding was that the uninsured had significantly higher levels of depressive symptoms than the insured. It has been shown that the depressed uninsured are less likely to receive treatment than the insured who have depression²³ and that depression is more severe in the uninsured than the insured.²⁴ Differences in psychosocial factors such as depression may not reflect an association with lack of insurance, but rather may reflect other common factors such as differences in education and socioeconomic status. However, the significance of depression and other psychiatric illnesses as comorbidities in the uninsured deserves further investigation. Consistent with previous work, we again demonstrated that the uninsured have lower rates of routine medical check ups, lower income and self reported health status, and higher rates of smoking.^{2,4,5}

Potential Mechanisms for these Findings

There are many possible mechanisms for why those without health insurance would have lower proportions of treated and controlled hypertension and hyperlipidemia. Although the prevalence of hypertension was similar between those with and without insurance, this does not mean that the rates of diagnosis also were similar between groups. Given that those without health insurance are less likely to have routine medical examinations than the insured, hypertension and hyperlipidemia are likely under diagnosed among the uninsured. Indeed, the uninsured are less likely to be aware of personal diagnoses of hypertension or hyperlipidemia than the insured.⁵ Even if the uninsured were diagnosed with these conditions, treatment is dependent on access to continued medical care and control of risk factors is dependent on obtaining treatment. Thus, decreased rates of routine medical exams among the uninsured could have detrimental effects on rates of diagnosis, treatment, and control of cardiovascular disease risk factors. Additionally, hypertension and hypercholesterolemia are asymptomatic conditions, and the uninsured may be less inclined to seek screening or care for these conditions. The costs of physician visits, blood chemistry tests, and prescription medication likely explain much of the observed lower proportions of treated and controlled cardiovascular disease risk factors among the uninsured compared to the insured. However, many other measured and unmeasured factors such as lack of adherence to medical regimens due to depressive symptoms, poor understanding of health conditions due to lack of a regular health care provider, and cultural attitudes pertaining to the health care system, affect the interplay between health insurance and cardiovascular disease risk factor treatment and control. These complex interactions are beyond the scope of the present investigation but merit further elucidation.

Our study has a number of strengths. Data from the FHS are rigorously collected, 99% of participants had fasting blood chemistry tests, and physician investigators review all cardiovascular disease endpoints. Importantly this study used physician-measured blood pressure and obtained fasting laboratory values to define the main risk factors and their treatment and did not rely on self-reported diagnoses as in a preceding study.⁵

Due to the cross sectional nature of this investigation, we were unable to demonstrate that the lack of health insurance has a causal relation to uncontrolled risk factors or increased cardiovascular disease risk. Other limitations of this study include low numbers of uninsured

participants, which limited our power to demonstrate differences in some outcomes by health insurance status. The participants in the FHS are almost entirely white and reside mainly in Massachusetts. While the lack of geographic and racial diversity of the study participants does limit the ability to generalize the results of the current investigation, it also eliminates race as a confounder. Also, FHS participants undergo periodic examinations that can result in referrals back to their personal physician. Thus FHS participants may have more contact with the health care system, greater health literacy, and increased awareness of personal diagnoses of conditions such as hypertension and hyperlipidemia than among the general population. Unfortunately, we were not able to assess whether participants were underinsured. Including the underinsured, such as those with catastrophic insurance coverage only, among those with health insurance in this study might alter the observed association between health insurance status and rates of treatment and control of hypertension and hyperlipidemia.

Our investigation emphasizes the relations between insurance status and cardiovascular disease risk factor prevalence, treatment, and control. Although we studied a highly insured population - fewer than 5% of FHS participants were uninsured compared to more than 15% in the general population¹ - multiple noteworthy differences were identified. More research is needed to determine if the associations we observed are replicated in different samples with a greater proportion of uninsured participants. Improved management of these common and modifiable risk factors could be one way to reduce disparities in health care for the uninsured.

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Table 1
Baseline Clinical Characteristics by Health Insurance Status for Men and Women

	Men			Women		
	Insured (N=2697)	Uninsured (N=136)	P value ^a	Insured (N=3171)	Uninsured (N=94)	P value ^a
Age (years), mean ± SD	45 ± 11	42 ± 10	0.01	45 ± 11	46 ± 11	0.72
Systolic blood pressure (mmHg), mean ± SD	122 ± 14	121 ± 15	0.77	116 ± 16	118 ± 18	0.3
Diastolic blood pressure (mmHg), mean ± SD	78 ± 9	77 ± 10	0.22	73 ± 9	73 ± 10	0.97
Fasting blood glucose (mg/dL), mean ± SD	101 ± 20	101 ± 23	0.26	94 ± 20	97 ± 24	0.22
Total cholesterol (mg/dL), mean ± SD	194 ± 36	200 ± 40	0.01	193 ± 36	195 ± 40	0.67
LDL-C (mg/dL), mean ± SD	121 ± 31	126 ± 35	0.03	110 ± 32	114 ± 35	0.4
HDL-C (mg/dL), mean ± SD	46 ± 13	47 ± 12	0.35	61 ± 16	59 ± 18	0.15
Triglyceride level (mg/dL), mean ± SD	139 ± 103	141 ± 114	0.51	106 ± 67	117 ± 68	0.17
Framingham 10-y risk score ^b , mean ± SD	8.2 ± 7.0	7.0 ± 5.2	0.73	3.5 ± 4.1	4.3 ± 4.6	0.07
BMI (kg/m ²), mean ± SD	28.4 ± 4.7	28.1 ± 5.3	0.98	26.5 ± 6.1	28.0 ± 7.0	0.02
Obesity, n (%)	782 (29)	38 (28)	0.83	721 (23)	32 (34)	0.01
History of coronary heart disease, n (%)	88 (3)	4 (3)	0.52	31 (1)	1 (1)	0.98
History of cardiovascular disease, n (%)	115 (4)	5 (4)	0.54	59 (2)	1 (1)	0.49
Metabolic syndrome, n (%)	920 (34)	38 (28)	0.59	626 (20)	24 (26)	0.24
Current smoker, n (%)	443 (16)	62 (46)	<0.001	492 (16)	31 (33)	<0.001
Heavy alcohol use ^c , n (%)	404 (15)	28 (21)	0.04	418 (13)	17 (18)	0.23

Abbreviations: LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; BMI, body mass index

^aP-values are adjusted for age (years) and cohort (Offspring versus Third Generation)

^bExcludes those with known coronary heart disease

c, Heavy alcohol use defined as ≥ 14 drinks/week in men and ≥ 7 drinks/week in women

Table 2
Baseline Psychosocial and Socioeconomic Characteristics by Health Insurance Status for Men and Women

	Men			Women		
	Insured (N=2697)	Uninsured (N=136)	P value ^a	Insured (N=3171)	Uninsured (N=94)	P value ^a
CES-D score $\geq$ 16, n (%)	216 (8)	32 (24)	<0.001	383 (12)	19 (20)	0.02
Excellent or very good self-reported health status, n (%)	1725 (64)	74 (54)	0.004	2129 (67)	44 (47)	<0.001
Health care utilization, n (%)						
ER visits	1288 (48)	82 (60)	0.05	1332 (42)	44 (47)	0.19
$\geq$ 1 hospitalizations	1194 (44)	66 (49)	0.74	1829 (58)	40 (43)	0.006
Check up by doctor in the last 5 yrs	2369 (88)	79 (58)	<0.001	2976 (94)	71 (76)	<0.001
>12 years of education, n (%)	1952 (72)	72 (53)	<0.001	2336 (74)	58 (62)	0.32
Family income $\geq$ \$75,000, n (%)	921 (34)	16 (12)	<0.001	985 (31)	3 (3)	<0.001

Abbreviations: CES-D, Center for Epidemiologic Studies Depression Scale

^aP-values are adjusted for age (years) and cohort (Offspring versus Third Generation)

Table 3

CVD Risk Factor Prevalence, Treatment, and Control by Health Insurance Status for Men

	Insured, n (%)	Uninsured, n (%)	Odds Ratio ^a (95% CI)	P value ^a
Hypertension				
Prevalence	758 (28)	25 (18)	0.72 (0.45–1.17)	0.19
Treatment	449 (59)	4 (16)	0.19 (0.07–0.56)	0.003
Control	332 (42)	2 (8)	0.17 (0.04–0.68)	0.01
Elevated Low-Density Lipoprotein Cholesterol				
Prevalence	941 (35)	44 (32)	1.19 (0.79–1.80)	0.41
Treatment	383 (41)	3 (7)	0.12 (0.04–0.38)	<0.001
Control	287 (31)	3 (7)	0.17 (0.05–0.56)	0.004

^aOdds ratios and p-values are adjusted for age (years) and relatedness between family members

Table 4

CVD Risk Factor Prevalence, Treatment, and Control by Health Insurance Status for Women

	Insured, n (%)	Uninsured, n (%)	Odds Ratio ^a (95% CI)	P value ^a
Hypertension				
Prevalence	580 (18)	21 (22)	1.19 (0.66–2.15)	0.56
Treatment	397 (68)	8 (38)	0.31 (0.12–0.79)	0.01
Control	287 (49)	7 (33)	0.57 (0.22–1.44)	0.23
Elevated Low-Density Lipoprotein Cholesterol				
Prevalence	572 (18)	25 (27)	1.63 (0.99–2.67)	0.05
Treatment	207 (36)	6 (24)	0.55 (0.22–1.40)	0.21
Control	168 (29)	4 (16)	0.47 (0.16–1.36)	0.16

^aOdds ratios and p-values are adjusted for age (years) and relatedness between family members