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Original article

Socioeconomic Factors Associated With Cholesterol Monitoring Among Patients with Hyperlipidemia; Application of The Andersen Behavioral Model

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ABSTRACT

Introduction: The National Cholesterol Education Program advices that adults with high blood cholesterol monitor their lipid profile at least once every two years. The study aimed to exam the association of socioeconomic factors and blood cholesterol monitoring. **Methods:** This study conducted cross-sectional secondary data analyses using 2011 Medical Expenditures panel Survey (MEPS). Study sample consisted of US. civilian, non-institutionalized adults who reported having high blood cholesterol. Cholesterol monitoring identified by patient's self-report. Series of descriptive statistics and weighted logistic regression analyses were used to evaluate the association between socioeconomic factors, identified by Andersen Behavioral Model, and cholesterol monitoring. SAS 9.3 statistical software was used for all analyses including sample weights and standard errors adjustments. **Results:** Approximately 71 million patients reported having high blood cholesterol in 2011. 3,611,273 patients did not monitor their blood cholesterol levels as recommended by the NCEP. Most of the respondents were between 65 to 85 years old. Race groups other than White and Black were significantly associated with less likelihood of following the NCEP's recommendation (OR: 0.582; 95% CI: 0.381–0.889). Compared to insured patients, uninsured patients were less likely to utilize cholesterol monitoring as recommended (OR: 0.358; 95% CI: 0.251–0.511). **Conclusions:** The study found a significant race difference in the report of blood cholesterol monitoring. Also insurance status was another factor in blood cholesterol monitoring. Increase awareness of cholesterol monitoring for minority groups and finding inexpensive alternatives for cholesterol monitoring for uninsured would help patients utilizing preventive care services for blood cholesterol.

KEYWORDS: Cholesterol monitoring, Andersen Behavioral Model, MEPS

INTRODUCTION

It is estimated that one-third of the adult population in the United States has high blood cholesterol [1]. Cholesterol is a soft lipid substance that the body produces and needs to function properly. High blood cholesterol can decrease or block blood flow in vessels [2]. Patients with high cholesterol have twice the risk of developing strokes and heart disease, the leading causes of death in the United States [1]. Intensive efforts to control high blood cholesterol include lifestyle modifications like weight control, increased physical activity, decreased fat intake, decreased carbohydrate intake, and smoking cessation and the use of lipid lowering agents [3]. Early identification and primary and secondary prevention interventions to reduce high blood cholesterol are effective in minimizing the risk of heart disease [4][5].

Early identification of hyperlipidemia is achieved through screening. The importance of screening for diagnosis and clinical interventions of hyperlipidemia is recognized by many health-care associations and public health organizations [6][7]. The National Cholesterol Education Program (NCEP) Adult Treatment Panel (ATP) III recommends that adults aged 20 and older have a lipid profile taken at least once every five years. Also, NCEP recommends that adults with high blood cholesterol (LDL level higher than 160 mg/dL) monitor their lipid profile at least once every two years [6]. In 2008 in the United States, two-thirds of adults aged 18 years and older had had a lipid panel within the previous five years [8]. Also the proportion of adults checked for hyperlipidemia within the previous five years improved from 2005 to 2008 [9]. The proportion of adults checked for hyperlipidemia improved in most states except for Missouri and South Carolina, both of which showed a decline. Sixteen states had no changes [9]. The Healthy People Objective 2020 aims to improve the percentage of hyperlipidemia screening within the next five years to 82.1% [8].

Beside health-care providers and policy-makers, researchers have recognized the importance of cholesterol screening. Several studies have examined the association between different socioeconomic factors and cholesterol screening [9][10][11][12][13][14]. Gender difference was a significant factor in utilizing cholesterol screening [9][12][14]. Women were more likely than men to have had a lipid panel[9][14]. However, among Medicare beneficiaries, females were significantly less likely to have preventive services compared with males[12]. Besides gender, different socioeconomic factors played a role in determining the use of cholesterol screening. The prevalence of blood cholesterol screening was significantly higher among persons aged ≥45 years than 18–44 years [9][10]. Moreover, the prevalence of blood cholesterol screening was significantly higher among non-Hispanics than Hispanics and among those with some college or higher degrees compared to those with less than a high school diploma [9]. Medicare beneficiaries with several chronic conditions were more likely to use preventive services[12]. However, no significant differences in cholesterol screening between young adults with and without coronary heart diseases risk factors were found after adjustment for health-care and socioeconomic factors [10].

Most of the literatures focused on cholesterol screening for adults, there is lack of research investigating cholesterol monitoring specifically in patients with hyperlipidemia. Our first goal of this study is to examine the prevalence of cholesterol mentoring for patients with hyperlipidemia. The second goal is to explore the association between socioeconomic factors and blood cholesterol monitoring among patients with hyperlipidemia.

MATERIALS AND METHODS

Data Sources

Data are from the 2011 Household Component of Medical Expenditure Panel Survey (MEPS). Administered since 1996, the MEPS is a nationally representative survey of the U.S. civilian non-institutionalized population. The MEPS survey has an overlapping panel design in which a new panel of households is selected each year from respondents to the previous National Health Interview Survey sample. Data are obtained in five rounds using computer-assisted personal interviews within two years. Generally, one member of the household represents all family members. The MEPS Household Component provides annual national estimates of use of health-care services, charges and payments, demographic characteristics, health conditions, health status, access to care, satisfaction with care, health insurance coverage, income, and employment [15].

Study Design

This cross-sectional study adapts the Andersen behavioral model. The study identifies socioeconomic factors associated with the use cholesterol monitoring among patients with hyperlipidemia during a one-year period. According to the Andersen behavioral model, which has been examined and continuously modified over the years, individuals' use of health-care services is due to predisposing characteristics, enabling resources and need factors [16].

Predispositions to use of health-care services (predisposing factors) include demographic characteristics like gender and age and social factors like education, race, ethnicity, living arrangement, and marital status. Factors that impede use of health-care services (enabling factors) include personal resources like health insurance and income and community resources like census region. Illness level (need factors) to use of health-care services include perceived physical health status, perceived mental health status, and medical conditions like diabetes, high blood pressure, angina, and stroke [17][18].

Previous studies have used the Andersen model to examine the use of preventive health-care services [19][20][21][22]. These studies have found significant associations between different constructs of the Andersen model (predisposing, enabling, and need factors) and the use of preventive health-care services. According to previous literature, the Andersen model explains up to 28% of variations in health-care use [23].

Data Extraction

Study eligibility criteria. Subjects were U.S. civilian non-institutionalized adults (age 20 and older) who self-reported diagnosis of high blood cholesterol in 2011. Adult patients who reported their last blood cholesterol check by a doctor or other health professional were included in the study.

Dependent variable. The dependent variable is a dichotomous category of whether each respondent had monitored his or her cholesterol level as recommended by the National Cholesterol Education Program (NCEP). NCEP recommends that adults with high blood cholesterol (LDL level higher than 160 mg/dL) monitor their lipid profiles at least once every two years[6]. MEPS questioners provide self-reported information on the last time respondents' cholesterol levels were checked by a health-care professional. Answers include "within past year," "within past 2 years," "within past 3 years," "within past 4 years," "within past 5 years," "more than 5 years," and "never checked." The answers were classified into two categories: 1) follow NCEP if last cholesterol level was checked by a health-care professional within two years and less and 2) did not follow NCEP if last cholesterol level was checked by a

health-care professional within three years or more or was never checked.

Independent variables. Following the Andersen behavioral model, several socioeconomic factors were selected as independent variables. Predisposing characteristics include age, gender, race, ethnicity, marital status, and education. Enabling factors include health insurance type (private, public, and uninsured), family income, living area (metropolitan/rural), and U.S. geographic region. Need factors include perceived physical health status, perceived mental health status, medical conditions (diabetes, high blood pressure, angina, and stroke), smoking, and body mass index.

Statistical Analysis

Descriptive statistics were used to identify national estimates in utilizing cholesterol preventive services. Moreover, comparisons of patients' socioeconomic factors were conducted. Logistic regression analysis was used to estimate the association between independent variables (socioeconomic factors) and the dependent variable (utilization of cholesterol monitoring). All analyses utilized SAS PROC SURVEY applications to adjust for the complex sampling design employed by MEPS database. All data management and analyses were performed using Statistical Analysis System (SAS) software, version 9.3.

RESULTS

Descriptive Characteristics

The U.S. had an estimated population of 311,125,758 non institutionalized civilians in 2011. There were 71,173,608 adults ages 20 years and older who had been previously diagnosed with hyperlipidemia by a health-care professional. Figure 1 illustrates the prevalence of cholesterol monitoring among hyperlipidemia patients. Of the patients diagnosed with hyperlipidemia, 3,611,273 patients (or 5.3%) did not monitor their blood cholesterol levels as recommended by the NCEP. Moreover, among patients who follow the recommendations of the NCEP, around 5 million patients had monitored their blood cholesterol levels within a two-year period.

Figure 1: Illustrates the prevalence of cholesterol monitoring among hyperlipidemia patients

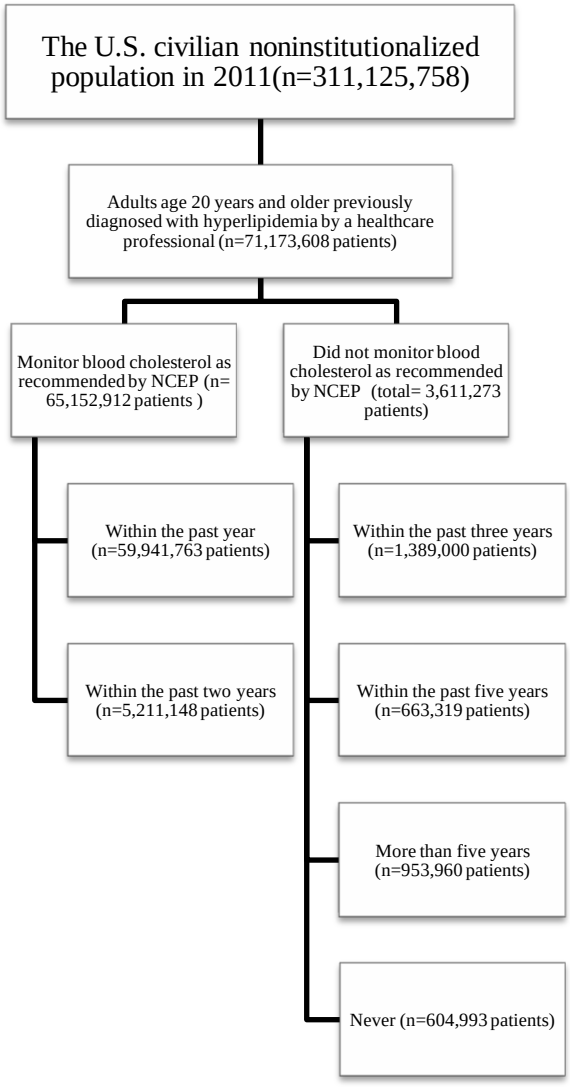

Table 1, 2, and 3 show the results from descriptive analysis comparing patients who followed and did not follow NCEP guidelines based on patients' predisposing, enabling, and need characteristics, respectively. Most of the patients were between 65 to 85 years old (24,825,968 patients), of which 98% (24,557,993patients) followed the recommendation of the NCEP. Over 90% of both females and males checked their cholesterol levels as recommended by the NCEP. In both groups, White patients had higher frequency, followed by Black and other races. In all, 85.7%, or 61,019,857, of patients were non-Hispanic, while 7,744,328 patients were Hispanic.

Table 1: Descriptive analyses comparing patients who followed and did not follow NCEP guidelines based on patients predisposing factors

	Total		**Followed NCEP guidelines** *		**Did not follow NCEP guidelines** †	
Factors	*Frequency*	*Weighted*	*Frequency*	*Weighted*	*Frequency*	*Weighted*
Predisposing Factors						
Age						
18 - 24	55	585,005	37	413,012	18	171,994
25 - 44	1,161	11,588,885	1,005	10,161,842	156	1,427,043
45 - 64	3,023	31,764,326	2,837	30,020,065	186	1,744,261
65 - 85	2,262	24,825,968	2,228	24,557,993	34	267,975
Sex						
Male	3,135	34,949,553	2,918	32,872,786	217	2,076,767
Female	3,366	33,814,632	3,189	32,280,126	177	1,534,506
Race						
White	4,678	57,458,485	4,389	54,523,204	289	2,935,280
Black	1,211	6,893,763	1,161	6,618,512	50	275,252
Others	612	4,411,937	557	4,011,196	55	400,741
Ethnicity						
Hispanic	1,244	7,744,328	1,136	7,108,445	108	635,883
Non-Hispanic	5,257	61,019,857	4,971	58,044,467	286	2,975,390
Marital status						
Married	3,733	42,202,450	3,533	40,371,036	200	1,831,414
widowed	787	8,028,179	770	7,885,711	17	142,468
Others	1,981	18,533,556	1,804	16,896,165	177	1,637,391
Education level						
Below High School	1,305	8,970,573	1,228	8,523,888	77	446,684
High School	3,135	33,007,726	2,933	31,123,623	202	1,884,104
Above High School	2,019	26,522,576	1,906	25,250,667	113	1,271,909

*Followed NCEP guidelines; last lipid profile was within 2 years and less

† Did not follow NCEP guidelines: last lipid profile was more than 2 years ago or never checked

Table 2: Descriptive analyses comparing patients who followed and did not follow NCEP guidelines based on enabling factors

	Total		**Followed NCEP guidelines** *		**Did not follow NCEP guidelines** †	
Factors	*Frequency*	*Weighted*	*Frequency*	*Weighted*	*Frequency*	*Weighted*
Enabling Factors						
Insurance coverage						
Any private	3,916	47,641,065	3709	45,371,122	207	2,269,943
Public only	1,900	16,256,245	1846	15,839,513	54	416,731
Uninsured	685	4,866,875	552	3,942,277	133	924,598
Income level						
Poor/Negative	1,137	7,755,303	1,055	7,132,982	82	622,321
Near poor	400	3,198,253	369	2,986,194	31	212,059
Low income	1,045	9,014,108	968	8,467,156	77	546,952
Middle income	1,882	19,829,671	1,759	18,674,977	123	1,154,694
High income	2,037	28,966,850	1,956	27,891,603	81	1,075,247
Metropolitan Area						
Non-metropolitan	976	11,132,279	920	10,524,374	56	607,906

Metropolitan	5,525	57,631,905	5,187	54,628,538	338	3,003,367
Region						
Northeast	1,059	12,625,026	1,027	12,230,858	32	394,168
Midwest	1,408	15,744,781	1,302	14,625,530	106	1,119,251
South	2,489	25,805,821	2,348	24,612,549	141	1,193,271
West	1,545	14,588,558	1,430	13,683,974	115	904,583

*Followed NCEP guidelines; last lipid profile was within 2 years and less
† Did not follow NCEP guidelines: last lipid profile was more than 2 years ago or never checked

Table 3: Descriptive analyses comparing patients who followed and did not follow NCEP guidelines based on patients need characteristics

	Total		**Followed NCEP guidelines** *		**Did not follow NCEP guidelines** †	
Factors	*Frequency*	*Weighted*	*Frequency*	*Weighted*	*Frequency*	*Weighted*
Need Factors						
Self-Perceived Physical Health Status						
Excellent	825	9,859,838	741	8,993,475	84	866,364
Very good	1,836	21,494,588	1,706	20,288,363	130	1,206,225
Good	2,245	23,248,006	2,128	22,177,199	117	1,070,807
Fair	1,191	10,637,072	1,143	10,303,051	48	334,020
Poor	402	3,508,573	387	3,374,716	15	133,857
Self-Perceived Mental Health Status						
Excellent	1,752	19,717,145	1,611	18,450,365	141	1,266,780
Very good	1,898	20,579,774	1,788	19,638,864	110	940,910
Good	2,082	21,250,469	1,974	20,181,454	108	1,069,014
Fair	601	5,680,485	570	5,382,749	31	297,736
Poor	166	1,522,011	162	1,485,179	4	36,832
Diabetes						
Yes	1,648	15,234,800	1,631	15,070,650	17	164,150
No	4,853	53,529,385	4,476	50,082,262	377	3,447,123
High Blood Pressure						
Yes	4,216	43,530,904	4,075	42,384,664	141	1,146,239
No	2,285	25,233,281	2,032	22,768,247	253	2,465,034
Angina						
Yes	405	4,293,102	397	4,238,795	8	54,307
No	6,096	64,471,082	5,710	60,914,117	386	3,556,965
Stroke						
Yes	531	5,035,463	521	4,959,214	10	76,249
No	5,970	63,728,722	5,586	60,193,698	384	3,535,023
Smoking						
Yes	996	10,130,443	909	9,253,015	87	877,428
No	5,113	54,650,395	4,836	52,190,308	277	2,460,087
Body Mass Index						
Underweight	49	485,759	44	442,885	5	42,875
Normal Weight	1,394	15,440,282	1,294	14,469,371	100	970,911
Overweight and Obesity	4,918	51,286,166	4,636	48,763,962	282	2,522,204

*Followed NCEP guidelines; last lipid profile was within 2 years and less
† Did not follow NCEP guidelines: last lipid profile was more than 2 years ago or never checked

The percentage of patients who had their cholesterol monitored within two years varied according to insurance status. Ninety-seven percent of patients with public insurance, 92% of patients with private insurance, and 81% of uninsured patients followed the recommendations of the NCEP. By region, 96.9% of patients in the Northeast, 95% in the South, 93.8% in the West, and 92.2% in the Midwest had checked their blood cholesterol levels within two years.
The majority of patients with high blood cholesterol level and other comorbid conditions follow the guidance of the NCEP; 98.9% of patients with hyperlipidemia and diabetes, 97.4% of patients with hyperlipidemia and hypertension, 98.7% of patients with hyperlipidemia and angina, and 98.5% of patients with hyperlipidemia and stroke had had their blood cholesterol checked within two years. In all, 10,130,443 of the patients were smokers, 8% of whom did not follow the recommendation of the NCEP.

Multivariate Analysis

Table 4 illustrates multivariate logistic regression in odds ratios (OR) and 95% Wald confidence intervals (CI). The adjusted odds ratios show the increased likelihood of monitoring cholesterol levels as recommended by the NCEP

compared to not monitoring cholesterol levels as recommended by the NCEP based on socioeconomic factors identified by the Andersen behavioral model, using a reference group in each category.

Table 4: Illustrates multivariate logistic regression in odds ratios (OR) and 95% Wald confidence intervals

Odds Ratio Estimates							
Effect	Point Estimate	95% Wald Confidence Limits		Effect	Point Estimate	95% Wald Confidence Limits	
Predisposing Factors				*Region*			
Age				Northeast		Reference group	
18 - 24‡	0.108	0.045	0.259	Midwest‡	0.383	0.220	0.667
25 - 44‡	0.158	0.090	0.278	South	0.632	0.364	1.097
45 - 64‡	0.264	0.152	0.459	West	0.555	0.300	1.027
65 - 85		Reference group		Need Factors			
Sex				*Self-perceived physical health status*			
Female	1.194	0.896	1.592	Excellent		Reference group	
Male		Reference group		Very good‡	1.696	1.070	2.689
Race				Good‡	2.107	1.346	3.298
White		Reference group		Fair‡	3.276	1.519	7.062
Black	1.035	0.662	1.905	Poor‡	1.905	0.735	4.934
Others‡	0.582	0.381	0.889	*Self-perceived mental health status*			
Ethnicity				Excellent		Reference group	
Hispanic	1.000	0.651	1.535	Very good	1.311	0.895	1.921
Non-Hispanic		Reference group		Good	0.983	0.619	1.560
Marital status				Fair	0.862	0.370	2.008
Married		Reference group		Poor	1.876	0.481	7.308
Others‡	0.590	0.438	0.796	*Diabetes*			
Widowed	0.792	0.364	1.724	Yes‡	4.158	2.149	8.043
Education level				No		Reference group	
Below high school	0.783	0.513	1.195	*High blood pressure*			
High school	0.838	0.613	1.144	Yes‡	2.315	1.680	3.191
Above high school		Reference group		No		Reference group	
Enabling Factors				*Angina*			
Insurance coverage				Yes	1.988	0.807	4.897
Any private		Reference group		No		Reference group	
Public only	1.295	0.792	2.119	*Stroke*			
Uninsured‡	0.358	0.251	0.511	Yes	1.335	0.533	3.343
Income level				No		Reference group	
Low income‡	0.554	0.350	0.878	*Smoking*			
Middle income‡	0.640	0.448	0.915	Yes	0.736	0.526	1.028
Near poor‡	0.387	0.216	0.694	No		Reference group	
Poor/negative‡	0.530	0.312	0.903	*Body mass index*			
High income		Reference group		Underweight	0.503	0.163	1.555
Metropolitan area				Normal weight	0.853	0.628	1.159
Non-metropolitan	0.745	0.487	1.141	Overweight and obesity		Reference group	
Metropolitan		Reference group					

‡Indicates adjusted odds ratio with 95% confidence interval is significant

There was no significantly increased likelihood of cholesterol monitoring in relationship to patients' gender, ethnicity, educational level, metropolitan area, self-perceived mental health status, angina, stroke, smoking, and body mass index. Three predisposing factors were significantly associated with likelihood of having had cholesterol checked within two years. All age groups, including patients' age 45 to 65 years, were less likely to monitor their cholesterol levels as recommended by the NCEP compared with patients older than 65 (OR: 0.264; 95% CI: 0.152–0.459). Race groups other than White and Black were significantly associated with less likelihood of following the NCEP's recommendation (OR: 0.582; 95% CI: 0.381–0.889). Divorced, separated, and single patients were less likely to have had their cholesterol checked by health-

care professionals within two years compared with married (OR: 0.59; 95% CI: 0.438–0.796).

Different enabling factors significantly determined cholesterol monitoring within a two-year period. In contrast to privately insured patients, uninsured patients were less likely to utilize cholesterol monitoring as recommended (OR: 0.358; 95% CI: 0.251–0.511). However, there was no significant difference between publicly and privately insured patients. Compared with high income, all other income categories (poor, near poor, middle income, and low income) showed decreased likelihood of utilizing cholesterol checks within two years.

Hyperlipidemia patients with other comorbid conditions like diabetes were more likely to monitor their cholesterol levels as recommended by the NCEP than patients without diabetes (OR: 4.158; 95% CI: 2.149–8.043). Moreover, patients with high cholesterol and high blood pressure were significantly associated with greater likelihood of following the NCEP guidelines than hyperlipidemia patients without hypertension (OR: 2.315; 95% CI: 1.680–3.191).

DISCUSSION

The study findings suggest that predisposing, enabling, and need factors play a significant role in monitoring blood cholesterol levels every two years for the 71 million American adults diagnosed with hyperlipidemia. A similar result has been reported by the Centers for Disease Control and Prevention in 2011 [1]. As shown in Figure 1, almost 90% of the patients monitored their blood cholesterol levels as recommended by the NCEP. Although this number is higher than the 76% screening of the general adult population reported by the CDC in 2009 [9], there is still an alarming number of patients (3,611,273) who have not monitored their blood cholesterol levels within two years and might be at risk for developing heart disease.

There was no significant increase of the likelihood of cholesterol monitoring for some predisposing factors like gender and ethnicity, as opposed to some previous studies [9][12][14]. This discrepancy could be due the fact that this study looks at patients with hyperlipidemia rather than the general population, which had been reported upon by the previous scholars. The studies that have investigated predisposing factors associated with cholesterol screening have shown significance in regard to age, race, and marital status [9][10]. This study finds similar patterns for cholesterol monitoring for patients with hyperlipidemia. Despite the type of health-care services, most of the literature agreed with this study that being married increases the likelihood of utilizing health-care services [18]. There are some possible explanations for the significance of marriage. Married patients might have better network referrals and access to information [24]. Another explanation is that health-care utilization might be affected by changes in patients' marital status [25].

Ronald Andersen included enabling factors as one of the indicators of inequitable access. Inequitable access to health care can be defined according to the determinants of medical care [16]. This study shows that more than one enabling factor determined the use of cholesterol monitoring. Several studies have showed different associations between income level and use of health-care services. On the one hand, lower income people in the U.S. had less contact with doctors and less access to mental health care [26][27]. On the other hand patients with financial constraints had more primary physician visits [28].This study indicates that hyperlipidemia patients with high incomes had higher likelihoods of mentoring blood cholesterol compared to patients in other, lower income categories in the United States. These results might change after the launching of the Affordable Health Care Act (ACA), which requires all plans to cover cholesterol monitoring at no cost to patients of certain ages or at higher risk [29]. This study shows that insurance status is a significant indicator in monitoring blood cholesterol level. Patients without insurance were less likely to have utilized cholesterol checking compared to privately insured patients. These results agree with previous studies that showed being insured significantly decreased the delay of health care and increased the use of health care among various groups [18]. Interestingly, and in contradiction of most previous studies [12][18], type of insurance, private or public, is non-significant in utilizing cholesterol monitoring.

The Andersen behavioral model has been used as a conceptual framework for this study. Previous studies have shown that need factors are strong predictors for utilizing physician, hospital, and dental services. However, this study used predisposing, enabling, and need factors to determine the use of cholesterol monitoring. Among the need factors, comorbid conditions like diabetes and hypertension are strong factors in utilizing cholesterol monitoring as recommended by the NCEP. That can be explained by the fact that patients with diabetes and hypertension have more physician visits than others [18].

This study has some limitations. Most importantly, the findings might have under-estimated the prevalence of hyperlipidemia because MEPS contains self-reported information. Also, MEPS does not provide data regarding the quality of cholesterol monitoring or the type of health-care provider who performed the monitoring and the protocol applied during the monitoring. However, the MEPS produces some of the best national representative data on health-care utilizations and costs in the United States. Another limitation is that this study applies the Andersen Behavioral model to define socioeconomic factors, but given the nature of secondary data analyses, an in-depth assessment on socioeconomic factors driven by qualitative or primary analysis would have provided insight into socioeconomic barriers that patients with hyperlipidemia might face. This study has a cross-sectional study design; the findings reflect patients diagnosed with hyperlipidemia in 2011 only, and no causal relationship can be detected. Future studies can seek in-depth assessment from longitudinal studies to evaluate socioeconomic barriers for patients with hyperlipidemia.

CONCLUSION

This study successfully adapted Andersen behavioral model to investigate the association between socioeconomic factors, and blood cholesterol monitoring. The study found a significant race difference in the report of blood cholesterol monitoring. Moreover insurance status was another factor in blood cholesterol monitoring. Increase awareness of cholesterol monitoring for minority groups and finding inexpensive alternatives for cholesterol monitoring for uninsured would help patients utilizing preventive care services for blood cholesterol. The results provide empirical evidence to policy-makers and health-care practitioners to emphasize the importance of cholesterol monitoring with consideration of patients' socioeconomic barriers.

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