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Differences in Cholesterol Management Among States in Relation to Health Insurance and Race/Ethnicity Across the United States

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Abstract

Background—Across the United States (U.S.), hyperlipidemia remains inadequately controlled, and may vary across states according to differences in health insurance coverage and/or race/ethnicity.

Objective—To examine relationships between states' health insurance and race/ethnicity characteristics with measures of hyperlipidemia management across the 50 U.S. States and the District of Columbia.

Methods—Cross-validated, multiple linear regression modeling was used to analyze associations between states' health insurance patterns or proportions of racial minorities (from the 2010 U.S. Census data), and states' aggregate frequency of checking cholesterol within the previous 5 years or prescriptions written for lipid-lowering medications (from national survey and population-adjusted retail prescription data, respectively), adjusting for age, gender, body mass index, race/ethnicity, and poverty.

Results—In states with proportionately more uninsured, cholesterol levels are checked less often, but in states with proportionately more private, Medicare or Medicaid coverage, providers are not necessarily more likely to check cholesterol or to write more prescriptions. In states with proportionately more African-Americans and/or Hispanics, cholesterol is more likely to be checked, but in states with more African-Americans, more prescriptions were written, while in states with more Hispanics, fewer statin prescriptions were written.

Conclusion—Variations across states in insurance and racial/ethnicity mix are associated with variations in hyperlipidemia management; less-insured states may be less effective while states with more private, Medicare or Medicaid coverage may not be more effective. In states with proportionately more African-Americans vs. Hispanics, lipid medications may be prescribed differently. Our findings warrant further investigations.

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Keywords

Health insurance; Cholesterol screening; Lipid lowering medications; Race; Ethnicity; HMG-CoA reductase inhibitors

Introduction

Despite extensive knowledge of the role of hyperlipidemia in atherosclerosis, national consensus recommendations to guide clinical decision-making, and the availability of powerful lipid lowering medications, substantial improvements can still be made in optimally treating hyperlipidemia in the general population ^{1,2}. Numerous population-based surveys have demonstrated that large numbers of hyperlipidemic individuals are still not being adequately controlled to treatment targets ¹⁻⁵, and therefore remain at increased risk of atherosclerotic complications. More effective use of lipid lowering medications will likely produce substantial societal and economic benefits ⁶.

Across the United States, healthcare services are largely implemented under the jurisdiction of individual state governments, and as a result, the manner of implementation, effectiveness of insurance coverage, and as a consequence, the degree of health prevention enjoyed by patients may be highly variable across different states ⁷⁻¹⁴. Aggregate data from a nationwide survey of cholesterol medication prescriptions for each of the 50 U.S. States and the District of Columbia were recently gathered for a nationally disseminated but state-specific online medical education newsletter focusing on the management of lipid disorders ¹⁵. These data are now being used here to explore potential relationships between indicators of states' delivery of hyperlipidemia care and states' patterns of insurance coverage, taking into account the variations among states' demographic characteristics. The principal aims were to try to identify any such relationships that may inform potential healthcare system factors to optimize hyperlipidemia management, and to explore whether the different racial/ethnicity mixtures across states might also be independently related to their delivery of hyperlipidemia care.

Methods

A cross-sectional, secondary data analysis was conducted using population-based, statewide data obtained from publicly available survey sources that involved all 50 U.S. States and the District of Columbia. Analogous data from U.S. territories were not included because not all key variables were equally available for all territories. The study protocol was reviewed and exempted from informed consent requirements by the Institutional Review Board of Charles R. Drew University of Medicine and Science. All analyses were performed between August 2011 and August 2012.

The 2010 U.S. Census was the source of the following data: a) The proportion of each state's population that had no health insurance coverage, that was covered by any source of private insurance, by Medicare, or Medicaid ¹⁶; b) Each state's total population, and racial/ethnicity distribution categorized as the proportion self-reporting as White, African-American, Hispanic or Latino, and all other race groups combined (because of the relatively smaller numbers in each of these other race groups) ¹⁷; c) Each state's age and gender distributions, the former categorized as the proportion of the state's population age 18-44, age 45-64, and age 65 years, and the latter characterized as the proportion of females ¹⁸; and d) Each state's proportion of individuals falling below the 200% Federal Poverty Level (FPL) threshold (by 2010 reference income levels) ¹⁹. Also, the 2009 Behavioral Risk Factor Surveillance System (BRFSS) from the Centers for Disease Control and Prevention

was the source of the following data: e) Each state's distribution of body mass index (BMI), categorized as the proportion of the population who were lean ($< 24.9 \text{ kg/m}^2$), overweight (25.0 to 29.9 kg/m^2), and obese ($\geq 30.0 \text{ kg/m}^2$)²⁰; and f) Each state's adequacy of cholesterol screening, as indicated by the 2009 BRFSS survey of the percentage of individuals who reported having their cholesterol levels checked within the previous 5 years²¹ (i.e., the minimum frequency currently recommended by the screening guidelines of the Third Adult Treatment Panel of the National Cholesterol Education Program)²².

Data for each state's prescribing patterns of all major classes of lipid lowering medications over a period of 12 months ending in March 2010 were collected by the IMS Institute for Healthcare Informatics, in collaboration with the Physician Educational and Training Division of the American Medical Association for a continuing medical education project to highlight the management of hyperlipidemias and the utilization of lipid lowering medications, both nationally and specifically for each state to which the program was distributed¹⁵. National retail prescription data were sourced from the IMS XponentTM family of products, based on actual prescription activity within the U.S. retail, mail service, long-term care, specialty retail, and Puerto Rico markets²³. Based on complex algorithms and patented methodologies, Xponent projects prescriptions generated across all prescription channels and payment types (cash, Medicaid, third-party) for more than 800,000 individual prescribers every month. IMS collects over 75% of the retail prescription data for new and refilled prescriptions every day of the month. These source data were comprised of fully adjudicated medical and pharmaceutical claims for over 60 million unique anonymous patients from over 90 health plans across the U.S.

Four dependent variables were examined in the principal analysis: a) Adequacy of cholesterol screening, as reflected by the percentage of each state's population who reported having had their cholesterol levels checked within the past 5 years; the population-adjusted rates of prescriptions written over the 12-month period for: b) all lipid lowering medications; c) all HMG-CoA reductase inhibitors (statins); and d) all non-statin lipid medications (i.e., all other major classes pooled). Non-statin classes included fibrate agents (clofibrate, gemfibrozil and all formulations of fenofibrate and fenofibric acid available on the U.S. market), prescription niacin preparations (both immediate- and extended-release formulations), ezetimibe, bile acid sequestrants (BAS, including colestipol, cholestyramine and colesevelam), prescription formulations of omega-3 fatty acid esters, and combination agents that include at least one lipid lowering component (i.e., ezetimibe/simvastatin, extended-release niacin/lovastatin and extended-release niacin/simvastatin, amlodipine/atorvastatin, and pravastatin/ASA; but not including sitagliptin/simvastatin as these data were collected before this agent was approved for the U.S. market). Although non-statin prescriptions were written substantially less often than statins, it was decided *a priori* that if one or more independent variables predicted all non-statin prescriptions, a sub-analysis would be conducted on each non-statin class as a separate dependent variable (population-adjusted). However, for this sub-analysis, the omega-3 fatty acids category was excluded since the data only included prescription omega-3 formulations without the more commonly used over-the-counter formulations typically sold as dietary supplements, and thus would not have accurately reflected the actual use of this class of agents. Also, the heterogeneous category of combination agents was kept as its own distinct category in the sub-analysis because the aggregate manner in which the prescription data were gathered (e.g., the ezetimibe-statin combination pooled with niacin-statin combinations) did not permit a reliable partitioning of medications in this heterogeneous category into their component medication classes.

Six state characteristics served as independent predictor variables: The percentage of each state's population that was: a) uninsured; b) covered by any form of private health

insurance; c) covered by Medicare; d) covered by Medicaid; e) African-American race; and f) Hispanic ethnicity. The three forms of insurance coverage (i.e., b, c and d) are not mutually exclusive. All models included states' distributions of age, race/ethnicity, BMI, and poverty as potentially confounding independent variables. Although states' gender ratios varied only minimally across states, the potential for associations between gender and differential usage of healthcare services²⁴ could not be ignored, so each multiple regression model was analyzed with and without gender as a covariate, to specifically determine the influence of gender in each model. Gender was included in all models of the non-statin sub-analysis.

All statistical analyses were performed using SPSS version 20. In addition to descriptive statistics and unadjusted correlations, linear regression modeling was performed for each dependent variable using all of the above independent variables. Since stepwise regression is known to underestimate errors and overestimate the overall model fit²⁵, a cross-validation approach was applied for each model by conducting 15 iterations of a stepwise regression algorithm, each using a randomly sampled subset of approximately 85% of all of the data; independent variables that were significant contributors to each subset model were ranked according to the order in which they contributed to the model. Only the first 5 independent variables that significantly contributed in more than half of all subsets tested (i.e., 8 out of 15), and that also conferred an increment of 2% or greater to each model's total adjusted variance were accepted for each final, forced-entry regression model. Since all independent variables were included in the cross-validation, the final model still effectively accounted for the possible contribution of all independent variables as confounders. Also, this cross-validation approach and the selective entry of variables into each final model can help to account for the potential influences of multi-collinearity among closely related independent variables. Results were reported as the adjusted partial correlation coefficient for each significant independent variable in each final model, along with the total adjusted variance accounted for by all independent variables in each model. Statistical significance was defined as $p < 0.05$.

Results

Table 1 lists the descriptive statistics of each variable. Respectively, Alaska and Rhode Island had the lowest and highest population-adjusted rates of prescriptions written for statins as well as all lipid-lowering agents. Raw correlations between dependent and independent variables from the principal analysis are shown in Table 2. Not unexpectedly, cholesterol is more likely to be checked, and prescriptions are more likely to be written in states that have more older and Medicare-insured individuals, and less likely among states with more poor or uninsured individuals. Medications are also less likely to be prescribed in states with more Hispanic individuals.

Table 3 shows the results of our cross-validated regression models. In the principal analysis, without accounting for gender, in states with higher proportions of uninsured individuals, check cholesterol levels were less likely to be checked within the past 5 years; potential confounders such as poverty failed to appear in the model. Of particular note is that in states with greater proportions of individuals covered under private insurance, Medicare, or Medicaid, cholesterol was not any more likely to be checked, and lipid lowering medications were not more likely to be prescribed, independent of potential confounders such as age, race or poverty. However, once gender was added to the models, it became a significant predictor for each dependent variable. Gender eliminated the significance of uninsured status, African-American race and Hispanic ethnicity as predictors of checking cholesterol, as well as that of African-American race as a predictor of total prescriptions written. Interestingly, adding gender into the models unmasked significant associations of age 18-44

and overweight for predicting the checking of cholesterol, and Hispanic ethnicity for predicting total prescriptions written. In each model, adding gender increased the total adjusted variance explained by the overall model.

In regards to racial/ethnicity mix, in states with proportionally more African-Americans, cholesterol was more likely to be checked, and more lipid-lowering prescriptions were written, but only if gender was not accounted for (Table 3). Similarly, in states with higher proportions of Hispanic individuals, cholesterol levels were more likely to be checked, but statins were less likely to be prescribed; potential confounders such as BMI, type of insurance, and poverty failed to enter these models. However, once gender was adjusted for, Hispanic ethnicity was no longer a significant predictor of checking cholesterol, although it became a negative predictor of total prescriptions and remained a negative predictor of statin prescriptions.

In states with higher proportions of obese individuals, non-statins were more likely to be prescribed, but not necessarily statins, independent of insurance patterns or poverty (Table 3). In the sub-analysis of specific non-statins, in states with more obesity, each non-statin class of agents were prescribed more often, and in states with more elderly individuals, more fibrates, ezetimibe, and BAS tended to be prescribed. In states with more uninsured individuals, less niacin tended to be prescribed, while in states with more African-Americans, more combination agents tended to be prescribed. Not unexpectedly, models in this sub-analysis accounted for less of the total adjusted variance than those from the principal analysis.

Discussion

Our analyses of these aggregate, state-level data found that in states with more uninsured individuals, as expected, checking of cholesterol levels and writing prescriptions for lipid lowering medications occurred less frequently, but that differences in the gender ratios across states effectively accounted for these differences, consistent with the fact that women tend to be greater users of healthcare services than men ²⁴. However, there was also no positive relationship between the extent of coverage with private, Medicare or Medicaid insurance and either measure of cholesterol care, irrespective of gender, suggesting that none of these health insurance programs are contributing independently to improved care of hyperlipidemia.

It is well documented that the U.S. spends more money per capita for healthcare than any other developed nation in the world, but does not enjoy a proportionately better index of health ²⁶, likely attributable to the inherent inefficiencies of our uniquely fractured healthcare system ^{8-11,27} [ENREF 20](#). Private insurance plans differ widely across the nation ^{10,11}, as does the manner of implementation and access thresholds to Medicaid-funded services for each state's low-income residents ¹²⁻¹⁴. And even though Medicare is federally funded, Medicare spending per enrollee is far from uniform across different regions or states ⁸.

As expected, in states with higher proportions of elderly individuals, more prescriptions were written for statins as well as all lipid-lowering medications, independent of gender. The fact that this was also independent of states' insurance status (including Medicare coverage) likely reflects the greater tendency to prescribe lipid-lowering medications for elderly individuals in general, regardless of their healthcare coverage. In contrast, in states with higher proportions of middle-aged (but not elderly) individuals, cholesterol levels tended to be checked more often, independent of insurance status, which perhaps reflects a tendency

for individuals in this age group to visit their physicians more frequently as symptoms of chronic conditions are increasingly manifest (which may be particularly true for women ²⁴).

In states with greater proportions of African-American and Hispanic individuals, cholesterol levels were actually checked more than other states, which may seem counterintuitive given that such states are often poorer and might have less access to preventive care. However, since insurance coverage and poverty were adjusted for, it more likely reflects actual practice rather than hindrance from healthcare system barriers, and therefore may reflect well on the appropriately greater health surveillance that physicians in these states are providing, given the higher-risk profiles of disadvantaged minorities. However, upon adjusting for gender, these associations were lost, likely again reflecting the greater utilization of healthcare services by women that accounts for those associations. Adjusting for gender unmasked an inverse relationship between states with more Hispanic individuals and total lipid-lowering prescriptions. This could reflect a general lack of prescriptions being written in such states, with that association being weakened by the greater usage of healthcare services by women, but unmasked once gender is adjusted for in the model. If true, this would suggest a less extensive use of lipid-lowering agents in states with proportionately more Hispanic individuals. The same explanation could apply to the unmasking of age 18-44 and overweight BMI as predictors of checking cholesterol, as states with proportionately more of those individuals might have a greater tendency to be checked for cholesterol, but that it is women with these traits who are driving such a relationship.

In states with more obese individuals, more prescriptions tended to be written for non-statins but not statins, and since this was independent of states' insurance, race/ethnicity and poverty status, socio-economic factors (e.g., drug formulary restrictions, differential medication costs) likely do not account for this observation. Obese individuals (and the elderly) often have more severe lipid derangements that require greater use of combination therapies (e.g., statins plus a second agent), which would be consistent with the fact that all of the non-statin classes tended to be prescribed more often among the more obese states (and also consistent with the observation that most non-statins were also prescribed more in states with more elderly individuals). Niacin may be prescribed less often among uninsured states because of the greater use of non-generic, extended-release niacin in states with more insured individuals. However, this sub-analysis must be interpreted cautiously, since it is based on less robust data than compared to the principal analysis.

Our findings have several obvious limitations. We must acknowledge the coarse, aggregate nature of our data, and how at the state level, they may not be capturing more subtle benefits of each of the types of insurance coverage that may be occurring on a smaller scale. However, there is now evidence that even with aggregate data across whole nations, socioeconomic factors are indeed associated with cholesterol levels on a global scale ²⁸. Using aggregate, state-level data instead of individual level (e.g., patient, physician, or other point-of-care) data limits the certainty behind our conclusions. For our analysis methods, in addition to potential errors inherent to stepwise regression modeling that were partially addressed by cross-validation, stepwise regression is well known to be sensitive to the nature of the data used, its measurement and sampling accuracy, thus potentially limiting its generalizability to the greater population ²⁵. For those reasons, we chose not to rely solely on stepwise regression, but rather applied cross-validation followed by a regular, forced-entry regression for the final analysis. Additionally, these data were obtained from validated surveys instruments that applied rigid methodologies and were designed for the U.S. population to reflect upon the characteristics of the U.S. population, so there is no reason to generalize our findings beyond the population from which it was derived or for which it was intended. Stepwise regression is also prone to Type I errors, giving rise to models that may be overly optimistic ^{25,29}. This is an inevitable limitation of our modeling methods, and we

acknowledge that our findings should therefore be regarded as strictly hypothesis-generating rather than as any conclusive relationships between states' socio-demographic traits and their delivery of hyperlipidemia care. Also, the BRFSS measure of cholesterol checking within the past 5 years is based on patients' recall, and was not objectively validated with patients' clinical records, so we cannot be certain that it accurately reflects physicians' adherence to screening guidelines. The enumeration of prescriptions written, because of the nature of the available data, may not reflect actual medication usage, nor should it be any reflection of number of patients treated for hyperlipidemia, the adequacy of their physicians' decision-making in targeting lipid goals, or their effectiveness in reducing cardiovascular outcomes.

Conclusion

We conclude that, based on these aggregate, state-level data, in states with more uninsured individuals (women in particular), there may be less effective surveillance of cholesterol levels and less prescribing of lipid lowering medications. However, states with greater provision of private, Medicare or Medicaid coverage may not be any more effective with cholesterol surveillance or writing lipid-lowering prescriptions. In states with more disadvantaged minorities, cholesterol may be checked more aggressively (women in particular), but in states with more Hispanic individuals, providers tend to prescribe fewer statins and lipid-lowering medications overall. Our conclusions, although provocative, should be verified by further population analyses, ideally using data collected at the individual level and with cross-reference to actual lipid measurements, measures of actual medication usage, and verifiable evidence of how well treatment targets were met. Nevertheless, our findings raise important questions of how healthcare systems may be either facilitating or hindering the optimal delivery of hyperlipidemia management across different states, given their widely divergent demographic and socio-political profiles.

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Abbreviations

ASA	acetylsalicylic acid
BAS	bile acid sequestrant
BMI	body mass index
BRFSS	Behavioral Risk Factor Surveillance System
FPL	federal poverty limit
HMG-CoA	3-hydroxyl-3-methyl-glutaryl coenzyme A
SPSS	Statistical Package for Social Sciences
U.S.	United States

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Table 1
States' Distributions of Key Variables

	Lowest	Median	IQR	Highest
Female	48.0	50.8	50.3 – 51.3	52.8
Age 18-44	32.5	35.9	34.9 – 36.8	48.6
Age 45-64	19.8	26.9	26.0 – 27.7	30.9
Age 65	7.7	13.5	12.4 – 14.3	17.3
White	24.7	77.6	68.5 – 86.1	95.3
African-American	0.4	7.4	2.9 – 15.9	50.7
Hispanic	1.2	8.2	4.2 – 12.4	46.3
Others	2.7	10.1	6.0 – 14.5	73.7
BMI < 24.9 kg/m ²	30.1	35.5	33.8 – 38.5	42.8
BMI 25.0-29.9 kg/m ²	33.3	36.2	35.0 – 37.1	40.7
BMI 30.0 kg/m ²	21.4	27.5	24.8 – 30.4	34.5
Poverty (< 200% FPL)	19.3	32.8	28.2 – 37.4	44.1
Uninsured	5.6	14.0	12.5 – 18.1	24.6
Privately Insured	52.4	67.2	61.9 – 70.7	79.6
Medicare Insured	8.6	15.0	13.6 – 16.0	19.2
Medicaid Insured	6.5	14.5	12.8 – 18.3	23.4
Cholesterol Checked in Past 5 Years (% “Yes” Responses)	67.5	77.0	74.2 – 80.7	85.3
Total Prescriptions (rate per 1000 persons)	393.0 (AK)	747.0	615.1 – 848.7	1176.3 (RI)
Statin Prescriptions (rate per 1000 persons)	279.5 (AK)	546.4	443.5 – 681.4	939.7 (RI)
Non-Statin Prescriptions (rate per 1000 persons)	113.5 (AK)	199.0	144.8 – 243.2	358.2 (WV)
Fibrates (rate per 1000 persons)	30.7 (AK)	62.8	49.6 – 76.1	121.7 (WV)
Niacin Preparations (rate per 1000 persons)	9.0 (MT)	16.8	14.5 – 21.6	32.7 (WI)
Ezetimibe (rate per 1000 persons)	12.7 (AK)	22.4	16.1 – 26.0	40.8 (WV)
BAS (rate per 1000 persons)	3.4 (AK)	9.6	6.9 – 11.6	18.4 (WV)
Combination Agents (rate per 1000 persons)	20.9 (MA)	58.7	43.9 – 68.1	91.7 (AL)

Unless otherwise indicated, all results are expressed as the percentage of states' 2010 Census population

abbreviations that identify states are provided in parentheses for selected states (AK, Alaska; AL, Alabama; MA, Massachusetts; MT, Montana; RI, Rhode Island; WV, West Virginia). BAS, bile acid sequestrant; BMI, body mass index; FPL, federal poverty limit; IQR, interquartile range.

Table 2
Raw Correlations Between Dependent and Independent Variables

Independent Variable:	Dependent Variable:			
	Cholesterol Checked	Total Prescriptions	Statin Prescriptions	Non-Statin Prescriptions
Uninsured	−0.417 [†]	−0.284 [*]	−0.416 [†]	0.074
Privately Insured	0.158	0.053	0.136	−0.141
Medicare Insured	0.302 [*]	0.504 [†]	0.528 [†]	0.327 [*]
Medicaid Insured	0.176	0.217	0.260 [*]	0.069
Gender: % Female	0.704 [†]	0.592 [†]	0.615 [†]	0.397 [†]
Age 18-44	0.042	−0.073	−0.057	−0.089
Age 45-64	0.455 [†]	0.175	0.252 [*]	−0.036
Age 65	0.402 [†]	0.519 [†]	0.545 [†]	0.334 [*]
White	−0.171	0.018	0.049	−0.052
African-American	0.431 [†]	0.320 [*]	0.254 [*]	0.386 [†]
Hispanic	−0.217	−0.383 [†]	−0.402 [†]	−0.246
Others	−0.210	−0.332 [*]	−0.305 [*]	−0.309 [*]
BMI < 24.9 kg/m ²	0.006	−0.364 [†]	−0.226	−0.573 [†]
BMI 25.0-29.9 kg/m ²	0.051	−0.163	−0.157	−0.134
BMI ≥ 30.0 kg/m ²	−0.028	0.424 [†]	0.290 [*]	0.611 [†]
Poverty	−0.310 [*]	0.098	−0.009	0.306 [*]

Results are expressed as Pearson correlation coefficients.

BMI, body mass index.

*
p < 0.05

[†]
p < 0.01

Table 3
Cross-Validated Regression Models

Independent Variable:	Principal Analysis				Non-Statins Sub-Analysis				
	Cholesterol Checked	Total Prescriptions	Statins Prescriptions	Non-Statins Prescriptions	Ezetimibe	Fibrates	Niacin	BAS	Combination
Gender in Model:	- +	- +	- +	- +	+	+	+	+	+
Uninsured	-0.657						-0.315		
Privately Insured									
Medicare Insured									
Medicaid Insured									
% Female	-- 0.805	-- 0.532	-- 0.565	-- 0.309					
Age 18-44	0.500								
Age 45-64	0.688								
Age 65		0.606	0.497	0.390	0.444	0.402		0.392	
White									0.497
African-American	0.798	0.472							
Hispanic	0.499		-0.339	-0.320	-0.371				
Others									
BMI < 24.9 kg/m ²									
BMI 25.0-29.9 kg/m ²	0.420								
BMI 30.0 kg/m ²				0.611	0.572	0.421	0.593	0.554	0.539
Poverty									
Total Adjusted R ²	0.714	0.769	0.408	0.493	0.343	0.543	0.361	0.410	0.429
						0.451	0.289	0.429	0.513

Only those independent variables that were significant contributors ($p < 0.05$) after cross validation and conferring an incremental R^2 2% to the overall adjusted variance of each model are shown; blanks indicate non-significant contributions of the independent variable or an incremental $R^2 < 2\%$ to each respective model. Results for each independent variable are expressed as the adjusted partial correlation coefficient in the final cross-validated model. Results for the total adjusted variance (R^2) of each final cross-validated model are all statistically significant ($p < 0.001$ for each).
BAS, bile acid sequestrant; BMI, body mass index.