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Race and socioeconomic differences associated with endovascular peripheral vascular interventions for newly diagnosed claudication

Caitlin W. Hicks, MD, MS^a, Peiqi Wang, MD, MPH^b, William E. Bruhn, BS^b, Christopher J. Abularrage, MD^a, Ying W. Lum, MD, MPH^a, Bruce A. Perler, MD, MBA^a, James H. Black III, MD^a, Martin A. Makary, MD, MPH^{b,c}

^aDivision of Vascular Surgery and Endovascular Therapy, Johns Hopkins University School of Medicine;

^bDepartment of Surgery, Johns Hopkins University School of Medicine;

^cDepartment of Health Policy & Management, Johns Hopkins Bloomberg School of Public Health.

Abstract

Background: Despite guidelines cautioning against the use of endovascular peripheral vascular interventions (PVI) for claudication, more than 1.3 million PVI procedures are performed annually in the United States. We aimed to describe national rates of PVI for claudication, and identify patient and county-level risk factors associated with a high rate of PVI.

Methods: We used the Medicare claims database to identify all Medicare beneficiaries with a new diagnosis of claudication between January 2015 and June 2017. A hierarchical logistic regression model accounting for patient age, sex, comorbidities; county region and setting; and a patient race-county median income interaction was used to assess the associations of race and income with a high PVI rate.

Results: We identified 1,201,234 patients with a new diagnosis of claudication for analysis. Of these, 15,227 (1.27%) underwent a PVI. Based on hierarchical logistic regression accounting for patient and county-level factors, black patients residing in low-income counties had a significantly higher odds of undergoing PVI than their white counterparts (odds ratio [OR], 1.30; 95%

Correspondence: Caitlin W. Hicks, MD, MS, Division of Vascular Surgery and Endovascular Therapy, Johns Hopkins University School of Medicine, 600 N Wolfe St, Halsted 668, Baltimore, MD 21287 (chicks11@jhmi.edu).

AUTHOR CONTRIBUTIONS

Conception and design: CH, PW, JB, MM

Analysis and interpretation: CH, PW, WB, CA, YA, BP, JB, MM

Data collection: CH, PW, WB, MM

Writing the article: CH, PW

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confidence interval [CI], 1.20–1.40), whereas the odds of PVI for black versus white patients was similar in high-income counties (OR, 1.06; 95% CI, 0.99–1.14). PVI rates were higher for low versus high-income counties in both the black (OR, 1.46; 95% CI, 1.31–1.64) and white (OR, 1.19; 95% CI, 1.12–1.27) groups. There were no significant associations of Hispanic, Asian, North American native, or other races with PVI in either low- or high-income counties after risk adjustment (all $P \geq .09$).

Conclusions: In the Medicare population, the mean rate of PVI of 12.7 per 1000 claudication patients varies significantly based on race and income. Our data suggest there are racial and socioeconomic differences in the treatment of claudication across the United States.

Keywords

Claudication; Peripheral artery disease; Race; Socioeconomic status; Disparities; Medicare

The overuse of medical procedures is an increasing problem in the United States.¹ In a recent survey of 2106 physicians, 11% of procedures and 21% of overall medical care was deemed to be unnecessary² and a 2012 report from the National Academy of Medicine estimated \$210 billion is wasted on unnecessary healthcare costs annually.³

In vascular medicine, the growing rate of endovascular peripheral vascular interventions (PVI) for claudication⁴ has come under scrutiny^{5,6} because of the lack of evidence to support its clinical effectiveness in many instances.⁷ It is well-demonstrated that maximum medical therapy in patients with claudication is effective and associated with an exceedingly low risk of limb loss.⁸ In contrast, perioperative complications following PVI are estimated to be as high as 10%,^{9,10} and may increase a patient's risk of future major amputation by up to 500%.¹¹ Despite these risks, the rate of PVI increased from 1.4 to 4.6 per 1000 persons between 1996 and 2006.⁴ Subsequently, guidelines from both the Society for Vascular Surgery (SVS)⁸ and the American Heart Association¹² were published recommending judicious use of PVI for claudication limited to patients with lifestyle-limiting symptoms who have failed a trial of medical management and exercise. In addition, the SVS, in collaboration with the Choosing Wisely initiative, has identified interventions in patients with claudication as one of the five procedures in vascular surgery whose necessity should be questioned.¹³

There are a number of explanations for why PVI may be overutilized among patients with claudication. Specifically, the procedures can be performed rapidly,⁵ are reimbursed at a high rate,^{14,15} and rely on what are often subjective indication criteria, including patient-reported compliance with an exercise program and worsening symptoms.⁸ One way physicians recruit patients for these procedures is to perform peripheral arterial disease (PAD) screenings on at-risk individuals, despite a U.S. Preventive Services Taskforce guideline that specifically recommends against this practice due to lack of supporting evidence and a risk of subsequent unnecessary procedures.¹⁶ Notably, PAD screenings have been observed in black churches,¹⁷ and may be more prevalent in lower-income and minority communities as well.^{18,19} The aim of our study was to explore patient and county characteristics associated with high PVI rates, and evaluate potential racial and socioeconomic differences in the use of these procedures.

METHODS

Study cohort.

We used the 2015 to 100% Medicare claims from 2017 (carrier, inpatient, and outpatient claims) for this cross-sectional cohort study. We included all Medicare beneficiaries who were diagnosed with claudication for the first time between January 1, 2015, and June 30, 2017. We excluded patients who had a previous PVI before their initial claudication diagnosis; patients who had a diagnosis of critical limb ischemia before their PVI, associated with their PVI, or within 6 months after their initial claudication diagnosis; patients who had less than 12 months of continuous enrollment in Medicare parts A and B before their initial claudication diagnosis; and patients from counties with 10 or fewer claudication patients^{20,21} or whose county characteristics were missing (Supplementary Fig 1, online only; Supplementary Table I, online only). The hospital institutional review board approved this study. Informed consent was waived because the data are publicly available.

Patient characteristics.

We obtained patient demographic information from the 2010 to 2017 Medicare Master Beneficiary Summary Files. Race was reported based on the race variable in the Medicare database, and was included because it is the primary exposure in the study. We linked ZIP code of residence to the Geo-code data provided by SAS software package (sashelp.zipcode; SAS Institute, Cary, NC) to obtain the corresponding state and county Federal Information Processing Standard Publication (FIPS) code. FIPS codes were further mapped to Core Based Statistical Area codes to determine if an area was metropolitan, micropolitan, or rural, based on the Core Based Statistical Area to FIPS County Crosswalk available from the National Bureau of Economic Research.²² We determined patients' comorbidities, including end-stage renal disease (ESRD), diabetes, hypertension, and ever smoking, based on diagnoses codes present on their claims within the 12 months before the claudication diagnosis (Supplementary Table I, online only). To define a comorbidity, we required at least one diagnosis from the inpatient claims or at least two diagnoses recorded more than 30 days apart from the outpatient and carrier claims.^{23,24}

County characteristics.

We obtained county-level median household income and poverty rate from United States Census Bureau Small Area Income and Poverty Estimates.²⁵ We obtained county-level We obtained county-level median household income and poverty rate from percentage of black race and prevalence of diabetes and smoking from 2017 County Health Rankings data.²⁶

Outcome.

We defined the primary outcome event as a patient undergoing a femoropopliteal PVI within 6 months (183 days) after an initial diagnosis of claudication (Supplementary Table I, online only). Femoropopliteal PVI was defined based on current procedural terminology codes 37224, 37225, 37226, and 37227 (Supplementary Table I, online only). We chose the 6-month cutoff for our analysis because the optimal exercise program for improving claudication pain in patients with PAD uses intermittent walking to near-maximal pain

during a program of at least 6 months.²⁷ We chose to limit our analysis to femoropopliteal PVI (rather than both aortoiliac and femoropopliteal PVI and open bypass surgery) in an attempt to decrease heterogeneity between groups.

The county-level crude PVI rate was calculated as the number of patients who had a PVI divided by the total number of patients diagnosed with claudication during the study time period. The county-level adjusted PVI rate was calculated as the observed-over-expected PVI rate ratio multiplied by the national crude PVI rate. For each county, the expected PVI rate was the sum of each patient's predicted probability of PVI, calculated based on their demographic characteristics and comorbidity status using a logistic regression model. We also plotted a national map to demonstrate the relationship between median household income and adjusted high PVI rates at the county level.

Statistical analysis.

We assessed patient- and county-level factors associated with undergoing a femoropopliteal PVI within 6 months of initial claudication diagnosis. Because medical management is the recommended initial treatment for claudication,^{8,12} higher PVI rates imply an overuse for the purposes of our analysis. We compared the crude PVI rates stratified by race and county-level median household income, and fitted a simple linear regression model for the county-level association between income and the race-specific crude PVI rate. We then used a hierarchical logistic regression model to examine the patient-level and county-level factors associated with a patient undergoing a PVI. The first-level variables consisted of patient characteristics (age, sex, race, ESRD, diabetes, hypertension status, smoking). The second-level variables were county-level characteristics (median household income, region, location), plus a random intercept to account for clustering by county. The county median household income was treated as a binary variable in this model, and divided as above or below the national median household income (\$48,000). We observed a potential interaction between race and county median household income in our stratified analyses, and thus an interaction term for race by income was incorporated into the regression model. The interaction term for race by income was incorporated into the statistical analysis by including a term for race, a term for income, and an interaction term for race $\times$ income in the logistic model, in addition to all other independent variables. The model estimated the coefficient for race, the coefficient for income, and the coefficient for race $\times$ income. The linear combinations of the three coefficients were used to estimate the effect of race at each level of income, as well as the effect of income at each level of race. As a sensitivity analysis, we repeated our analyses using PVI for claudication within 3 months and within 1 year of the initial claudication diagnosis as the outcome.

All statistical analyses were performed using SAS Enterprise Version 7.1 (SAS, Inc). A significance level of $P < .05$ was set for all analyses.

RESULTS

Study cohort

We included 1,201,234 claudication patients in our analysis, of whom 15,227 underwent a femoropopliteal PVI procedure within 6 months of receiving their initial claudication diagnosis. The overall crude PVI rate was 12.7 interventions per 1000 claudication patients.

Unadjusted analyses

Patient characteristics.—Patients undergoing PVI were younger (median age, 71 years vs 75 years), more frequently male (61.7% vs 50.2%), and more frequently black (12.7% vs 10.6%) than patients who did not undergo PVI (Table I). Patients who underwent PVI also more frequently lived in the South (47.6% vs 39.5%) and less frequently lived in a metropolitan setting (75.1% vs 80.8%) compared with non-PVI patients. ESRD (3.5% vs 1.7%), diabetes (41.0% vs 37.5%), and smoking (58.0% vs 35.9%) were more common in the PVI group.

County characteristics.—There were 3013 counties included in our analysis. The county-level median crude PVI rate was 12.4 per 1000 claudication patients (range, 0–182), and the median adjusted PVI rate was 11.8 per 1000 claudication patients (range, 0–189 per 1000). The 75th percentile for adjusted PVI rate was 20.8 procedures per 1000 claudication patients, so we defined a high PVI rate as 20 or more PVI per 1000 claudication patients. Counties that performed high rates of PVI performed a median of 29.7 procedures per 1000 claudication patients, compared with 8.2 procedures per 1000 claudication patients in counties with a low PVI rate. For the 1,201,234 claudication patients in our study, this difference corresponds with 35,670 PVIs performed in counties with high PVI rates compared with 9848 PVIs performed in counties with low PVI rates, with an absolute difference of 25,822 PVI.

Counties with high PVI rates had a lower median household income (\$45,473 vs \$48,326) and a higher prevalence of poverty (15.8% vs 14.7%) compared with counties with low PVI rates. A distribution of the nationwide variation in PVI rates stratified by median household income is shown in Fig. Counties with high PVI rates were also more frequently located in the South (51.1% vs 41.7%) or Midwest (35.7% vs 32.2%) regions than counties with low PVI rates, and were more frequently rural (49.% vs 37.9%) with a higher median prevalence of black (3% vs 2%), diabetic (12% vs 11%), and smoking (18% vs 17%) populations (Table II). Heat maps of county-level PVI rates, county-level median household income, and county-level proportion of black (vs white) claudication patients are provided in Supplementary Fig 2 (online only).

PVI rates stratified by race and income

PVI rates differed significantly based on both race and median household income (Table III). The crude PVI rate (per 1000 claudication patients) was highest for North American native patients (18.5), followed by black (15.2), white (12.5), Hispanic (10.7), and Asian patients (7.8). The overall crude PVI rate (per 1000 claudication patients) was 16.0 for counties with low (<\$48,000) median household incomes and 11.3 for counties with high (≥ \$48,000)

median household incomes, corresponding with a decrease of 0.17 in PVI rate per every \$1000 increase in income. Race-specific associations of PVI rate and income varied across difference races. Black patients had the biggest difference in PVI rate comparing low-versus high-income counties (19.9 vs 12.4 per 1000 claudication patients), with a decrease of 0.27 in PVI rate per every \$1000 increase in income. To a lesser extent, white patients also had higher PVI rate in low-income compared with high-income counties (15.5 vs 12.5 per 1000 claudication patients), with a decrease of 0.16 in PVI rate per every \$1000 increase in income.

Adjusted analysis

Patient characteristics.—We performed a hierarchical logistic regression analysis to identify independent variables associated with PVI within 6 months of an initial diagnosis of claudication (Table IV). After including patient- and county-level characteristics, as well as an interaction term for race and income, we found that patient-level factors associated with undergoing a femoropopliteal PVI for claudication included ESRD (OR, 1.78; 95% CI, 1.62–1.95), diabetes (OR, 1.09; 95% CI, 1.05–1.13), and smoking (OR, 2.11; 95% CI, 2.04–2.18). Patient ages other than 65 to 74 years ($P < .001$), female gender (OR, 0.76; 95% CI, 0.73–0.78), and patient hypertension status (OR, 0.86; 95% CI, 0.82–0.90) were protective.

County characteristics.—In our fully adjusted hierarchical regression model, the counties with the highest odds of PVI for claudication were located in the South (versus Northeast, odds ratio [OR], 1.72; 95% CI, 1.57–1.90), followed by the Midwest (OR, 1.62; 95% CI, 1.47–1.79), and West regions (OR, 1.40; 95% CI, 1.25–1.56). County location (ie, metropolitan, micropolitan, rural) was not significantly associated with PVI after risk adjustment (all $P \geq .06$; Table IV).

Race-income interaction.—County-level median household income modified the effect of race on the PVI outcome after risk adjustment (Table IV). In counties with median household income <\$48,000, black patients had a 30% increased odds of PVI than white patients (OR, 1.30; 95% CI, 1.20–1.40). However, in counties with median household income of \$48,000 or greater, we did not observe a difference in PVI rates between races (all $P \geq .10$; Table IV).

For black patients, residing in lower median income counties was associated with an almost 50% increased odds of PVI compared with residing in higher median income counties (OR, 1.46; 95% CI, 1.31–1.64). For white patients, residing in lower median income counties was associated with a 19% increased odds of PVI compared with residing in higher median income counties (OR, 1.19 (95% 1.12–1.27)).

Sensitivity analysis

We repeated the same hierarchical logistic regression model from above using PVI for claudication within 3 months and within 1 year of the initial claudication diagnosis as the outcomes. Although the specific OR values for each covariate changed slightly, there were no significant differences in the overall trends that we report (Supplementary Tables II and

III, online only). An additional analysis including both aortoiliac and PVI interventions also did not substantially alter our findings (data not shown).

DISCUSSION

Based on guidelines from the SVS and the American Heart Association, the use of PVI for claudication should only be used in select patients who have debilitating, persistent symptoms after a 6 months trial of walking therapy and maximum medical treatment.^{8,12} Despite efforts by Choosing Wisely to reduce unnecessary endovascular procedures for claudication,¹³ we found that the incidence of femoropopliteal PVI procedures ranged from 8.6 to 32.3 per 1000 Medicare beneficiaries with claudication depending on the county. Moreover, we observed a significant race-income interaction on PVI rate; black patients had a 30% variation in the PVI rate based on the median income of the county in which they resided, which was higher than any of the other races studied. These findings persisted even after accounting for PAD risk factors that may increase a patient's likelihood of having PAD and/or disease severity. Our data identify marked socioeconomic status (SES) and racial differences in PVI rates for claudication. These findings are concerning because they suggest that vulnerable patient groups may be exposed to a disproportionate number of unnecessary procedures.

Our finding that the crude prevalence of PVI procedures for claudication is 1.22-fold higher in black patients compared with white patients (15.2 vs 12.5 per 1000 claudicants) is concerning. Initially, we assumed this trend is merely a reflection of the different prevalence of risk factors in blacks compared with whites.³⁰ Eraso et al³¹ have previously demonstrated that diabetes, hypertension, chronic kidney disease, and smoking, all of which are significant risk factors for PAD, are higher in black patients compared with other races.³¹ Furthermore, the cumulative risk of PAD is higher for black patients with three or more risk factors compared with other races.³¹ Consistent with this notion, black patients have been shown to have a higher age-standardized prevalence of PAD compared with white patients (15.6% vs 11.4%) in a population-based study.³² However, we found that the odds of a black patient undergoing PVI for claudication is actually between 1.06-fold and 1.30-fold higher than that of a white patient even after accounting for PAD risk factors. These findings are consistent with data published by Loja et al.³³ Based on data from 41,507 patients who underwent PAD interventions in California between 2005 and 2009, the authors found that the odds of a patient undergoing a reintervention within 12 months was 1.17-fold higher in blacks compared with whites after risk adjustment. More concerning, black patients also had a 1.68 times higher risk of amputation within 1 year of intervention compared with their white counterparts. Loja et al³³ concluded that the higher intervention rates in black patients may be due to more severe disease, poor access to care, and/or poor access to optimum medical care.³³ Although the latter explanation may be true, our study focused on only those patients with claudication, and our results were similar. Patients with more severe disease, including rest pain and gangrene, were excluded from our analysis. As such, race-based differences in disease severity³⁴ cannot fully explain the high prevalence of interventions in black patients that we report.

Notably, we also found that the PVI procedure rate for claudication was 1.42-fold higher in low-income counties compared with high-income counties (16.0 vs 11.3 per 1000 claudication patients). Low income has been shown to be associated with a higher prevalence of PAD.³⁵ Some experts argue that race is simply a surrogate marker for SES, and that racial disparities in treatment patterns and outcomes are simply a reflection of poor SES.³⁶ Other authors have demonstrated that both race and SES can be independently associated with disparities in vascular interventions and outcomes.^{28,37,38} Based on data from 12,517 participants in the Atherosclerosis Risk in Communities (ARIC) Study, Vart et al³⁷ showed that risk of incident hospitalization for PAD is significantly higher for low individual and area-level SES. Although the strength of this association was somewhat attenuated after adjusting for traditional cardiovascular risk factors and access to healthcare, it remained significant for income. The association between low SES and incident hospitalized PAD also persisted after stratifying by race, suggesting that both race and SES are independently associated with PAD interventions. In addition, Arya et al³⁸ have shown that black race independently increases the risk of major amputation within the same SES stratum, regardless of PAD severity. Durazzo et al²⁸ also showed that black patients presenting with critical limb ischemia have a 1.77-fold higher risk of major amputation than white patients, and that this disparity paradoxically increases to 1.98-fold among black patients living in wealthier zip codes. These findings, along with the data that we report, support the notion that both race and SES appear to affect PAD-related disparities in different ways. Whether these differences are reflective of true discrimination, advanced presentation at the time of diagnosis, or another reason remains to be elucidated.

Aside from race and SES, other patient characteristics that we found to be associated with femoropopliteal PVI for claudication included younger age, male sex, ESRD, diabetes, and smoking. We expect that younger patients received more interventions because of their age and relative health compared with older patients. We were somewhat surprised to see a lower intervention rate in women compared with men given that women with claudication tend to have shorter maximal walking times and a greater compromise in daily function and quality of life.^{29,39} However, our findings are consistent with previously published data showing that women tend to undergo PVI at an older age and more often for chronic limb-threatening ischemia than men, despite have a similar prevalence of disease.^{40,41} The other associations we report were not surprising; ESRD, diabetes, and smoking have all been associated with a higher risk of claudication in prior studies.^{42–46} Notably, smokers have a shorter time to onset of claudication pain compared with nonsmokers,⁴⁷ which may lead to earlier intervention rates in this group. Similarly, ESRD patients with PAD have lower physical health scores than similar patients without PAD,⁴⁸ which may push some physicians toward PVI in an effort to improve quality of life.

The racial and socioeconomic disparities with PVI that we describe have important implications for patient care. Proper shared decision making is critical to ensure the appropriate application of PVI. Patients with lifestyle-limiting claudication that impact their employment options, for example, may be more appropriate for intervention than patients with mild claudication. Thorough patient education, both by the treating physician and through independent education, is an important prerequisite to addressing the overuse of these procedures. Importantly, as of 2017 Medicare began providing coverage for supervised

exercise therapy in beneficiaries with claudication,⁴⁹ which will hopefully result in increased use of exercise therapy in affected patients. Future studies assessing the use of this coverage will be informative.

The limitations of our study deserve consideration. First, we identified PVI procedures performed for claudication based on diagnosis and procedure codes in the Medicare claims database. We used strict exclusion criteria to ensure that our analysis was limited to patients with claudication only, but it is possible that some patients with critical limb ischemia were included inadvertently. It is also possible that some patients had a diagnosis of claudication before our capturing them. We required that patients have at least 12 months of continuous Medicare enrollment before their initial claudication diagnosis in an effort to limit this confounding. Second, we are unable to determine the symptom severity or medical treatment of patients undergoing PVI for claudication due to our use of an administrative dataset. Although we adjusted for factors associated with PAD, the Medicare database does not contain objective markers of disease severity such as Rutherford classification, ankle-brachial index, or walking index that could affect intervention rates. Third, we did not include aortoiliac PVI or open revascularization procedures in our analysis in an attempt to decrease patient and symptom heterogeneity. It is possible that more open interventions for claudication are performed in white and high SES patients, making the overall revascularization rates similar across groups. This notion is not supported by procedure-based data reporting open and PVI interventions for PAD in the Vascular Quality Initiative,⁵⁰ but has not expressly been evaluated in patients with claudication or on a population-based level. Fourth, we excluded patients who had a diagnosis of claudication before seeing a proceduralist, and thus the number of claudication patients we identified (1,201,234) may be an underestimation. Fifth, we do not have data on county-level physician density. It is possible that some county characteristics may be mediated by physician characteristics in the county, such as physician density, type of physician, and race of physician. Unfortunately, we do not have data on those physician characteristics, and therefore we were not able to study their potential mediating effects. Finally, we chose to define our study exposure as PVI within 6 months of diagnosis of claudication based on previously published data demonstrating that exercise rehabilitation programs for the treatment of claudication pain should be a minimum of 6 months.²⁷ We performed a sensitivity analysis at 3 months and 1 year after diagnosis, and our overall findings did not change. As a result, we are confident that our definition of overuse was appropriate and the socioeconomic and race trends that we observe are valid.

CONCLUSIONS

In the Medicare population, the mean rate of PVI of 12.7 per 1000 claudication patients varies significantly based on race and income. Our data suggest a racial and socioeconomic difference in the treatment of claudication across the United States, and highlight the need for patient education and shared decision making to ensure the appropriate application of PVI in affected patients.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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ARTICLE HIGHLIGHTS

- **Type of Research:** Retrospective review of 2015 to 2017 Medicare claims data
- **Key Findings:** In this analysis of 1,201,234 Medicare patients with new-onset claudication, the mean rate of peripheral vascular interventions was 12.7 per 1000 claudication patients, but varied significantly based on patient race and county-level household income.
- **Take Home Message:** Our data suggest there are significant racial and socioeconomic differences in the treatment of early claudication across the United States.

Fig. Nationwide (**A**) and examples of statewide (**B** and **C**) variation in adjusted peripheral vascular intervention (PVI) rate within 6 months of the initial claudication diagnosis.

Table I.

Baseline characteristics of patients with versus without a peripheral vascular intervention (*PVI*) within 6 months after initial claudication diagnosis

Patient characteristic	With PVI (n = 15,227)	Without PVI (n = 1,186,007)
Age, years	71 (33–110)	75 (4–112)
64	1958 (12.9)	125,516 (10.6)
65–74	8230 (54.1)	479,107 (40.4)
75–84	3897 (25.6)	350,280 (29.5)
85–94	1101 (7.2)	206,822 (17.4)
95	41 (0.3)	24,282 (2.1)
Sex		
Male	9398 (61.7)	595,216 (50.2)
Female	5829 (38.3)	590,791 (49.8)
Race		
White	12,349 (81.1)	973,842 (82.1)
Black	1935 (12.7)	125,211 (10.6)
Hispanic	296 (1.9)	27,485 (2.3)
Asian	187 (1.2)	23,821 (2.0)
North America Native	96 (0.6)	5097 (0.4)
Other/unknown	364 (2.4)	30,551 (2.6)
Region of residence		
Northeast	1906 (12.5)	248,802 (21.0)
Midwest	3516 (23.1)	257,385 (21.7)
West	2532 (16.6)	209,630 (17.7)
South	7251 (47.6)	468,464 (39.5)
Other	22 (0.1)	1726 (0.2)
Location of residence		
Metropolitan	11,436 (75.1)	957,752 (80.8)
Micropolitan	2065 (13.6)	126,045 (10.6)
Rural	1726 (11.3)	102,210 (8.6)
Comorbidities		
ESRD	526 (3.5)	19,872 (1.7)
Diabetes	6241 (41.0)	444,740 (37.5)
Hypertension	12,895 (84.7)	1,001,049 (84.4)
Smoking		
Never	6389 (42.0)	760,729 (64.1)
Ever	8838 (58.0)	425,278 (35.9)

ESRD, End-stage renal disease.

Values are median (range) or number (%).

Table II.

Characteristics of U.S. counties stratified by adjusted peripheral vascular intervention (PVI) rate (per 1000 claudication patients)

County characteristic	County-level adjusted PVI rate (per 1000 claudication patients)	
	<20 (n = 2221)	≥20 (n = 792)
Crude PVI rate	8.6 (0–25.4)	32.3 (16.4–181.8)
Median adjusted PVI rate (range)	8.2 (0–20.0)	29.7 (20.0–188.9)
Median income, \$	48,326 (23,115–134,609)	45,473 (22,045–118,035)
\$48,000	1087 (48.9)	482 (60.9)
48,000	1134 (51.1)	310 (39.1)
Poverty rate	14.7 (3.4–48.6)	15.8 (3.6–43.5)
<15%	1149 (51.7)	356 (45.0)
15%	1072 (48.3)	436 (55.1)
Region		
Northeast	208 (9.4)	9 (1.1)
Midwest	716 (32.2)	283 (35.7)
West	359 (16.2)	94 (11.9)
South	925 (41.7)	405 (51.1)
Other	13 (0.6)	1 (0.1)
Location		
Metropolitan	910 (41.0)	243 (30.7)
Micro-metropolitan	470 (21.2)	161 (20.3)
Rural	841 (37.9)	388 (49.0)
Black race prevalence		
<2%	2 (0–84)	3 (0–84)
2%	1053 (47.4)	361 (45.6)
Diabetes prevalence		
<11%	1168 (52.6)	431 (54.4)
11%	11 (3–24)	12 (5–22)
Smoking prevalence		
<17%	1069 (48.1)	328 (41.4)
17%	1152 (51.9)	464 (58.6)
	17 (7–41)	18 (8–37)
	1023 (46.1)	320 (40.4)
	1198 (53.9)	472 (59.6)

Only counties with more than 10 claudication patients are shown. Values are median (range) or number (%).

Table III.
Crude peripheral vascular intervention (PVI) rates (per 1000 claudication patients) stratified by race and household median income

Race	No. of claudicants	Crude PVI rate (per 1000 claudicants)			Change in crude PVI rate per \$1000 increase in income ^a	P value ^b
		Overall	Median income	\$48,000		
Overall	1,201,234	12.7	16.0	11.3	-0.17	<.001
North America Native	5193	18.5	19.6	17.3	-0.04	.85
Black	127,146	15.2	19.9		-0.27	<.001
White	986,191	12.5	15.5	11.4	-0.16	<.001
Other/unknown	30,915	11.8	15.5	11.	-0.16	.04
Hispanic	27,781	10.7	11.1	10.5	0.10	.29
Asian	24,008	7.8	7.3	7.8	0.07	.35

^aEqual to slope calculated from a simple linear regression with the covariate being county-level median household income and the outcome being race-specific county-level crude PVI rate.

^bP-value for the change in PVI rate with income.

Table IV.

Hierarchical logistic regression model for factors associated with peripheral vascular intervention (PVI) within 6 months after an initial claudication diagnosis^a

Variable	Adjusted odds ratio (95% CI)	P value
Patient characteristics (first-level)		
Patient age, years		
64	0.75 (0.72–0.79)	<.001
65–74	Ref	
75–84	0.69 (0.67–0.72)	<.001
85–94	0.39 (0.36–0.41)	<.001
95	0.14 (0.10–0.19)	<.001
Patient sex		
Female	0.76 (0.73–0.78)	<.001
Male	Ref	
Patient ESRD status		
Yes	1.78 (1.62–1.95)	<.001
No	Ref	
Patient diabetes status		
Yes	1.09 (1.05–1.13)	<.001
No	Ref	
Patient hypertension status		
Yes	0.86 (0.82–0.90)	<.001
No	Ref	
Patient smoking status		
Yes	2.11 (2.04–2.18)	<.001
No	Ref	
Country characteristics (second-level)		
County region		
Northeast	Ref	
Midwest	1.62 (1.47–1.79)	<.001
West	1.40 (1.25–1.56)	<.001
South	1.72 (1.57–1.90)	<.001
Other	1.24 (0.71–2.17)	.44
County location		
Metropolitan	Ref	
Micropolitan	1.07 (1.00–1.15)	.06
Rural	1.07 (0.99–1.15)	.09
Patient race by county median income		
Median income <\$48,000		
White	Ref	
Black	1.30 (1.20–1.40)	<.001
Hispanic	1.06 (0.84–1.32)	.63

Variable	Adjusted odds ratio (95% CI)	P value
Asian	0.60 (0.33–1.08)	.09
North American Native	1.04 (0.78–1.38)	.79
Other/unknown	1.00 (0.79–1.27)	.98
Median income \$48,000		
White	Ref	
Black	1.06 (0.99–1.14)	.10
Hispanic	1.08 (0.94–1.25)	.26
Asian	0.88 (0.75–1.03)	.11
North American Native	1.19 (0.88–1.61)	.26
Other/unknown	0.99 (0.88–1.11)	.82
County median income by patient race		
Among patients of white race		
Median income <\$48,000	1.19 (1.12–1.27)	<.001
Median income \$48,000	Ref	
Among patients of black race		
Median income <\$48,000	1.46 (1.31–1.64)	<.001
Median income \$48,000	Ref	
Among patients of Hispanic race		
Median income <\$48,000	1.17 (0.89–1.53)	.25
Median income \$48,000	Ref	
Among patients of Asian race		
Median income <\$48,000	0.81 (0.44–1.50)	.51
Median income \$48,000	Ref	
Among patients of North American native race		
Median income <\$48,000	1.01 (0.67–1.54)	.96
Median income \$48,000	Ref	
Among patients of other/unknown race		
Median income <\$48,000	1.22 (0.93–1.59)	.14
Median income \$48,000	Ref	

ESRD, End-stage renal disease.

^a All results from this table are calculated from one hierarchical regression model including all of the listed patient and county variables as covariates as well as an interaction term for (patient race) $\times$ (county median income). For the purpose of easier data interpretation, we presented the adjusted association between patient race and the outcome (PVI) by level of county median income; and the association between county median income and outcome by level of patient race separately.^{28,29}