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Socioeconomic Status and Clinical Stage of Patients Presenting for Treatment of Chronic Venous Disease

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Clinical Research

Socioeconomic Status and Clinical Stage of Patients Presenting for Treatment of Chronic Venous Disease

Abdul Kader Natour,[1] *Ali Rteil,*[1] *Paul Corcoran,*[1] *Mitchell Weaver,*[1] *Syed Ahsan,*[2] *and Loay Kabbani*[1]

Objectives: The association between socioeconomic status (SES) and chronic venous insufficiency has not been rigorously studied. This study aimed to determine the influence of SES on the clinical stage of patients presenting for chronic venous disease therapy.

Methods: We performed a retrospective study of a prospectively collected data from the Vascular Quality Initiative Varicose Vein Registry at our tertiary referral center. Medical records of patients who underwent therapy for chronic venous disease between January 2015 and June 2019 were queried. SES was quantified using the neighborhood deprivation index (NDI), which summarizes 8 domains of socioeconomic deprivation and is based on census tract data derived from the patients' addresses at the time of the treatment. High NDI scores correspond with lower SES. The association between SES and severity of vein disease at presentation was assessed with bivariate analysis of variance and linear regression analysis.

Results: A total of 449 patients with complete SES and clinical-etiology-anatomy-pathophysiology (CEAP) class data were included in the study. The mean age was 58 years, 67% were female, and 60% were White. CEAP classes were distributed as follows C2, 22%; C3, 50%; C4, 15%; C5, 5%; and C6, 8%. Patients with lower SES (higher NDI score) tended to have a higher CEAP class at presentation ($P < 0.05$). SES was not associated with history of deep venous thrombosis, use of compression therapy, or venous clinical severity score.

Conclusions: At our institution, patients with more advanced venous disease tended to belong to a lower SES group. This may reflect that patient with a lower SES have a longer time to presentation due to delay in seeking medical help for venous disease.

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Abbreviations: CEAP, clinical-etiology-anatomy-pathophysiology; CVD, chronic venous disease; NDI, neighborhood deprivation index; SES, socioeconomic status.

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INTRODUCTION

In the United States, approximately 25–40% of women and 10–20% of men have chronic venous disease (CVD).[1] Additionally, it has been reported that 23% of adults have varicose veins, affecting 11 million men and 22 million women between the ages of 40 and 80 years.[2,3] The high prevalence of CVD and cost associated with treatment especially in its advanced stages make this disease a significant burden on healthcare resources.[4] Treating CVD costs an estimated $3 billion per year in the United States.[5] This health care burden will continue to rise as the population of older adults grows and the prevalence of obesity increases.[6] Moreover, the incidence of varicose veins has been reported at 4–5%, the disease progression rate has been shown to be about 4%, and interventions for CVD are expected to increase by 60% between 2013 and 2021, all indicating a continuous increase in the CVD health care burden.[6] In 2018, more than 38 million Americans lived below the poverty line, and 8.5% of the population were uninsured.[7] This problem is amplified in the city of Detroit, where nearly 38% of inhabitants live in poverty.[8] Low socioeconomic status (SES) has been shown to be associated with increased morbidity and mortality in cardiovascular patients,[9] increased risk of deep venous thrombosis,[10] delayed access to health care, and decreased access to specialized treatments and procedures.[11,12] To our knowledge, no studies have looked at the association between SES and advanced stage presentation of CVD. This study aims to determine the influence of SES on the clinical stage of patients presenting for CVD therapy.

MATERIALS AND METHODS

The Vascular Quality Initiative Varicose Vein Registry at our tertiary referral center was queried to identify all patients who underwent therapy for CVD (stab phlebectomies, venous ablations) between January 2015 and June 2019. The patients come from local communities around our vein clinics situated in several locations in southeast Michigan. This study was approved by our institutional review board and conducted in accordance with the Health Insurance Portability and Accountability Act and the prevailing ethical principles governing research. Patient informed consent was waived.

Sociodemographic variables identified included gender, age, body mass index, and race/ethnicity (African American, White, Asian, and other). Exposure variables included preoperative use of compression stockings, history of deep venous thrombosis, venous clinical severity score, and the clinical-etiology-anatomy-pathophysiology (CEAP) classification. Deep vein thrombosis was confirmed by history and physical exam performed by the attending physician at the time of presentation.

Table I. Categorization of the cohort into Messer Index[a] Quintiles and CEAP classes

Quintile	NDI quintile	Cohort, *N* (%)
1	-1.59, -0.16	226 (50.4)
2	-0.16, 1.26	164 (36.4)
3	1.26, 2.69	54 (12.0)
4	2.69, 4.11	5 (1.2)
5	4.11, 5.54	0 (0.0)
CEAP Class	CEAP Explanation	Cohort, *N* (%)
C2	Varicose veins	98 (21.8)
C3	Edema	226 (50.3)
C4	Skin damage	67 (14.9)
C5	Healed venous leg ulcer	23 (5.1)
C6	Venous leg ulcer	35 (7.8)

[a]Messer Index: Otherwise known as the neighborhood deprivation index (NDI), the Messer Index reflects the socioeconomic status of patients, with higher score indicating lower socioeconomic status.

Messer Neighborhood Deprivation Index

The neighborhood deprivation index (NDI) was used to measure SES. The NDI is based on census tract data derived from patients' addresses at the time of operation. This is a standardized and reproducible index that summarizes 8 socioeconomic variables, including the percentage of households that had the following characteristics: head of household had less than a high school education; head of household was male with a professional occupation; head of household was unemployed; head of household was a woman with dependent children; household income was below the 1999 federal poverty level; household was considered crowded; household had an annual income of <$30,000; and household was on public assistance. The NDI represents 6 social domains: poverty housing, occupation, employment, education, residential stability, and racial composition. The NDI is calculated and a score is given to each individual ranging from -1.59 to 5.54. The index is traditionally categorized into quintiles, with the fifth quintile corresponding to the most socioeconomically challenged (Table I). In our data, there were too few patients in quintiles 4 and 5 to list separately. The NDI has been used in several studies to study the effect of SES.[13-15]

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CEAP Classification

CVD severity was quantified using the CEAP classification. This is a comprehensive classification system that was developed to allow uniform diagnosis and comparison of CVD patient populations.[16,17] The CEAP classification includes 7 clinical categories ranging from no visible signs of venous disease (C0) to active venous ulcer (C6). In our study, patients with CEAP classes of C2 to C6 were included (Table I).

Data Analysis

SES variables were combined and standardized to increase interpretability of the models prior to the analyses. Specifically, income-related SES variables were set to present increases of $10,000, and all other SES variables were set to present increases of 10%. Pearson chi-square test or Fisher exact test were performed for the categorical variables. Independent t-test was used for continuous variables. The association between SES and CEAP was studied using bivariate analysis of variance and linear regression analysis. Similarly, the association between SES, demographics, and exposure variables was assessed using multivariate linear regression. SPSS version 27.0 was used for statistical analysis (SPSS, Armonk, NY), and a P value <0.05 was considered statistically significant.

RESULTS

Characteristics of the Study Cohort

CVD was identified in 493 patient records, 449 of which contained complete SES and CEAP data. Baseline characteristics for the cohort are summarized in Table II. The average age of these patients was 58 years, 67% were female, and 60% were White. Compression stockings were used by 92% of patients. History of deep venous thrombosis and superficial thrombophlebitis was present in 8% and 7% of the patients, respectively. Prior varicose vein treatment was documented in 32% of the cohort, and 8% of the patients were maintained on chronic anticoagulants. The average venous clinical severity score was 8.3. The average median household income was $51,300; 11.6% were below poverty level; and 21% had at most a high school diploma. The average NDI was 0.03 and the distribution of patients among quintiles is shown in Table I. At presentation, CEAP classes were as follows: C2, 22%; C3, 50%; C4, 15%; C5, 5%; and C6, 8% (Table I). Almost all the patients had some sort of insurance (Table II). The average number of primary care office visits was 22/year (includes internal medicine, geriatric medicine, family medicine, and obstetrics and gynecology) with a range of 0–116/year. Patients with more severe CVD on presentation were more likely to live closer to the hospital ($P = 0.03$; Fig. 1).

SES and Disease Severity at Presentation

The mean NDI did not correlate with gender ($P = 0.875$). SES significantly differed among ethnic groups, with African Americans having the highest NDI (least affluent) ($P < 0.001$) (Table III). Use of compression stockings and history of deep venous thrombosis did not correlate with NDI ($P = 0.171$ and $P = 0.636$, respectively). Venous clinical severity score was not associated with NDI (95% CI, -0.007 to 0.031; $P = 0.218$). Univariate analysis showed that affluent patients (lower NDI) had significantly more prior varicose vein treatments ($P = 0.03$). This association did not persist in the multivariate linear regression model (Table IV).

An inverse linear correlation was seen between the CEAP class at presentation and median household income ($P < 0.05$; Fig. 2). Likewise, there was a linear correlation between the CEAP class at presentation and the NDI ($P < 0.05$; Fig. 3).

DISCUSSION

This study analyzed the association of SES with the severity of CVD at presentation in a general population-based sample in the United States. As with other diseases, we found that lower SES was significantly associated with more severe CVD presentation. In our study, all patients had some sort of insurance and nearly all of them had access to a primary care physician. Our results suggest that the delay in presentation may not be related to access to healthcare, but may be related to lack of education, lower health literacy, or increased health neglect. Conversely, patients with higher SES tended to present with a lower CEAP disease class and tended to have had a higher number of previous venous procedures. This may reflect those patients with a higher SES may have access to better health care and seek medical therapy earlier in the disease process.

The incidence and prevalence of CVD are increasing. The two main risk factors for CVD are obesity and age.[6] Thus, with the trend of increased longevity in the general population and the growing prevalence of obesity, the burden of CVD is expected to significantly increase over the upcoming years.[6] This increasing CVD health care expenditure

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Table II. Demographics summary of the cohort

Variable Demographics	All patients ($N = 449$)
Age, years, mean ± SD	58.4 ± 12.5
Female, *N* (%)	303 (67.5)
White, *N* (%)	270 (60.5)
African American, *N* (%)	124 (27.8)
Body mass index, mean ± SD	33.0 ± 7.7
Socioeconomic variables	
Median household income (in $1000), mean ± SD	51.3 ± 25.9
Percentage below poverty	11.6 ± 11.3
Messer index[a]	0.03 ± 0.89
High school graduate, %	21.0 ± 12.3
Insurance, *N* (%)	
Medicare	69 (15.6)
Medicaid	36 (8.1)
Private	338 (76.3)
Any insurance	443 (98.7)
Exposure	
Chronic anticoagulation, *N* (%)	34 (7.7)
Venous Clinical Severity Score, mean ± SD	8.3 ± 4.4
Use of compression, *N* (%)	402 (91.8)
History of deep venous thrombosis, *N* (%)	35 (7.9)
History of superficial thrombophlebitis, N (%)	29 (6.6)
Prior varicose vein treatment, *N* (%)	143 (32.4)

SD, standard deviation.
[a]Messer Index: Otherwise known as the neighborhood deprivation index, the Messer Index reflects the socioeconomic status of patients, with higher score indicating lower socioeconomic status.

Table III. Differences in mean NDI among demographic and exposure variables

Variable Demographics	Mean NDI ± SD	*P*-value
Gender (Male; Female)	0.04 ± 0.83; 0.03 ± 0.92	0.87
Race		<0.001
Asian	-0.83 ± 0.30	
African American	0.66 ± 0.82	
White	-0.28 ± 0.77	
Other	0.15 ± 0.83	
Exposure		
Chronic anticoagulation (No; Yes)	0.01 ± 0.88; 0.03 ± 0.84	0.90
Use of compression stockings (No; Yes)	0.22 ± 0.96; -0.002 ± 0.876	0.17
History of deep venous thrombosis (No; Yes)	0.02 ± 0.89; 0.09 ± 0.84	0.64
History of superficial thrombophlebitis (No; Yes)	0.01 ± 0.88; 0.13 ± 0.95	0.53
Prior varicose vein treatment (No; Yes)	0.09 ± 0.91; -0.12 ± 0.82	0.03

NDI, neighborhood deprivation index; *SD, standard deviation.*

makes early detection and treatment particularly important for reducing patient suffering, improving quality of life, and reducing health care costs.

Without treatment, most patients with CVD are prone to disease progression. In the Bonn Vein Study, 32% of C2 patients with saphenous varicose veins progressed to stages C3-C6 within 6 years.[18] In the Edinburgh Vein Study, 57.8% of 334 CVD patients had progressed to a higher CEAP class or developed new varicose veins after a mean follow-up period of 13.4 years, with an annual progression rate of 5%.[19] One study showed that 0.5% of all patients with CVD have active venous ulcers, costing around $10,500 annually in combined

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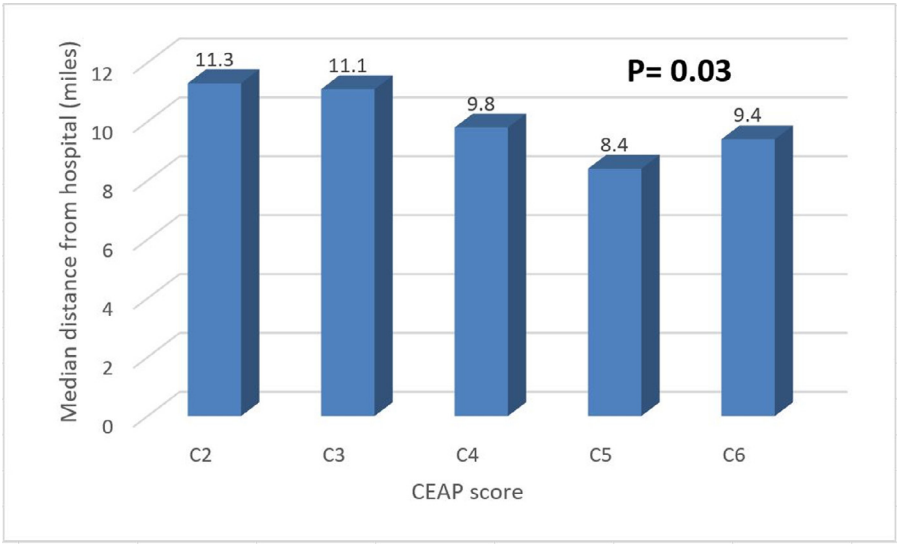

Fig. 1. Chart comparing median distance from the hospital according to CEAP Score. Abbreviations: CEAP, Clinical, Etiology, Anatomy, and Pathophysiology.

Table IV. Multivariate linear regression model for NDI in the study population

Variables	Unstandardized coefficients		Standardized coefficients	95% CI for B		*P* value
	B	SE	Beta	Lower bound	Upper bound	
Age (years)	-0.004	0.003	-0.063	-0.011	0.002	0.16
Prior VVT	-0.059	0.086	-0.031	-0.228	0.109	0.49
White	ref					
African American	0.892	0.091	0.456	0.714	1.070	<0.001
Asian	-0.548	0.397	-0.062	-1.330	0.233	0.17
Unknown/Other	0.368	0.134	0.126	0.104	0.632	0.006

NDI, neighborhood deprivation index; ref, reference variable; SE, standard error; VVT, varicose vein treatment.

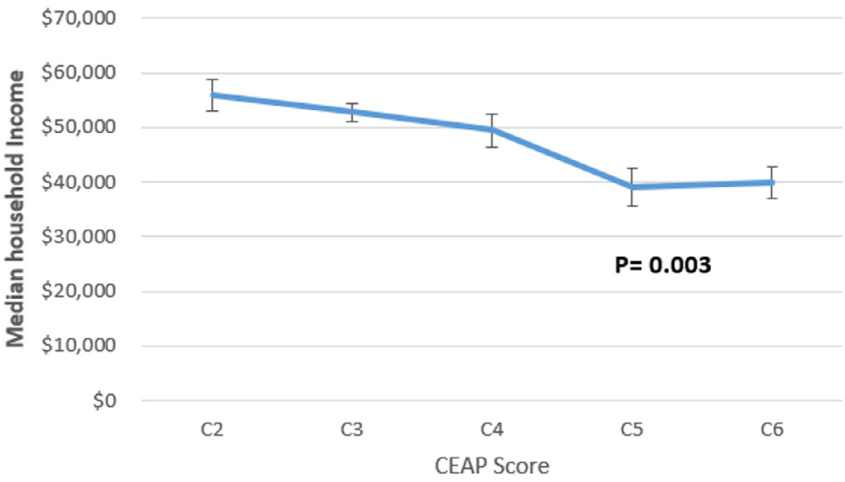

Fig. 2. Chart comparing median household income according to CEAP Score. Abbreviations: CEAP, Clinical, Etiology, Anatomy, and Pathophysiology.

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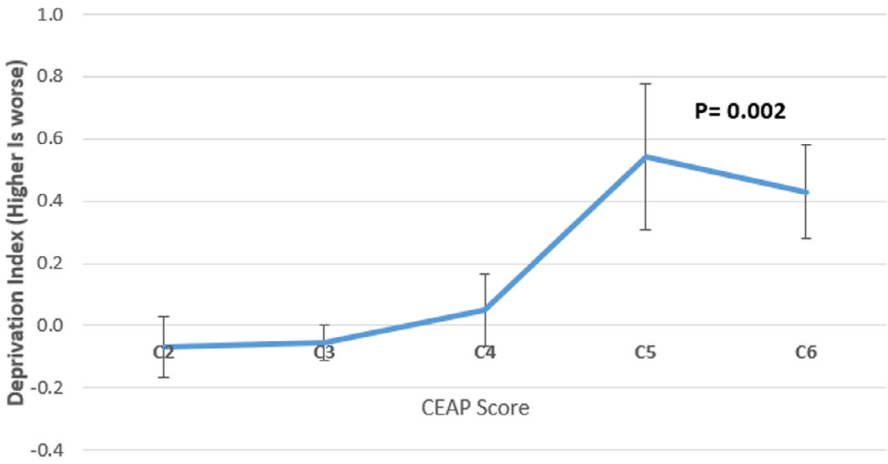

Fig. 3. Chart comparing NDI according to CEAP Score. Abbreviations: CEAP, Clinical, Etiology, Anatomy, and Pathophysiology; NDI, neighborhood deprivation index.

patient and health insurer cost.[20] Furthermore, for patients who experience increasing CVD severity, ulcer development can occur in up to 25% of these patients across the course of their illness.[21] In severe cases, CVD has led to limb loss.[22–25] Another study indicated that in the Western world, the management of leg ulcers may consume up to 1% of total health care costs.[26]

Treatment for CVD is multimodal and includes conservative (e.g., stockings and bandages) and interventional (e.g., venous drugs, sclerotherapy, and surgery) therapies.[4] The prevalence of treatment increases with disease severity, from 2.7% in C0 patients to 96% in C5/C6 patients.[4] The proportional increase in total cost for CVD care with increasing disease severity is due to the higher number of hospitalizations, surgical procedures, medications, and other multilevel treatment models used in more advanced disease.

Although some risk factors for the development and progression of CVD are unmodifiable (e.g., age, female gender, and family history), other factors can be mitigated through lifestyle changes (e.g., physical activity, smoking cessation, and weight loss).[27] There is ample evidence in the literature to show that appropriate early, conservative, and interventional treatment for CVD can significantly delay or prevent disease progression and provide a highly cost-effective use of health care resources.[27,28] Therefore, early management of patients presenting with CVD could help limit the number of patients who progress to severe CVD, which is the population that incurs the main proportion of the CVD health care burden.[6]

SES has been defined in multiple ways in the literature.[13,15,29,30] Owing to the numerous parameters that can be used to describe SES, no single variable can be all inclusive for quantifying this measurement. Rather, SES is a concept that encompasses multiple societal factors, including income, wealth, occupation, and educational status.[31] In our analysis, we used a composite score to quantify SES that encompassed several variables, including median household income, educational level, family income, percentage of people below the poverty level, and the NDI.[32] Our composite score minimized the limitations of using a single variable to predict SES. Initially, NDI had been used to explore the association of SES with low birth weight.[33] NDI has also been used to show that low SES is associated with up to 37% decreased probability of individuals participating in health checks.[34] Another study has shown that patients with low SES, as defined by a high NDI, were more likely to inappropriately use the Emergency Department as a primary destination for urgent health care instead of using a primary care physician's office.[35] Patients with high NDI also have been shown to have a lower likelihood of achieving long-term cessation of opiate and cocaine injection.[15] Finally, patients with high NDI have been shown to be more likely to have unhealthy weight and have a higher prevalence of adverse health behaviors such as smoking, physical inactivity, and unhealthy diet, which could explain

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the increased risk of colon cancer in this group.[14] In our study, we showed that patients with high NDI were significantly more likely to present with more severe CVD as defined by the CEAP classification. This may reflect those patients with a higher SES may have access to better health care, or that they seek medical therapy earlier in the disease process.

There may be a multitude of explanations for why patients with low SES have advanced CVD stage presentation. The relationship between lower SES and delayed access to health care has been shown in multiple studies.[36–41] Lower education has been shown to be strongly related to poor health literacy, which is in turn an important risk factor for delay in seeking medical care and worse health outcomes.[39] In our cohort, patients with higher NDI were less likely to be high school graduates ($P < 0.001$), which might reflect poorer health literacy and a decreased level of seeking medical care. In addition, other studies have shown that patients with lower SES tend to be diagnosed at more advanced gastrointestinal tumor stages because of unequal access to health care.[40] Moreover, patients with low SES tend to experience barriers to effective treatment, such as financial burden, inadequate insurance coverage, and lack of access to effective therapy.[41] This association may contribute to the poorer health outcomes experienced by less affluent patients and highlights the need for a multifaceted approach to addressing health equity for low SES patients that targets health care providers and the health care system as a whole.[37] In our study, most patients had access to a primary care physician, the entire patient population had some sort of insurance, and patients with more severe CVD were more likely to live closer to the hospital. This may suggest that the delay to CVD presentation might be better explained by lack of education, medical knowledge, or motivation to follow-up rather than lack of access to health care. Further research is needed to extract the reasons for possible delay in seeking medical care for CVD in patients with low SES.

Limitations

This study is retrospective in nature which allows determination of only association and not causation, and variables analyzed were limited to those recorded. In addition, an inherent selection bias existed since we are a referral center. Generalizability is limited since this study is not population based. We did not conduct personal interviews with patients, which may have better corroborated their home locations, SES, prior medical treatment, and reasons for possible delay in seeking medical care. Moreover, algorithms based on patients' census tract information were used to estimate SES variables and hence were not collected individually, which might have distorted some associations. Finally, the time frame for CVD presentation extended over several years. Therefore, the patients' neighborhoods and zip code designated areas might have changed over time with regard to their SES parameters.

CONCLUSION

Patients with lower SES tend to present with more advanced venous disease to our tertiary referral center. This reflects a delay in seeking proper treatment. This may be due to lack of medical education, or lack of access to proper health care. Further studies are needed to elucidate the cause of this delay in treatment. Understanding what drives health care disparities is needed for improving access to quality health care and making it more equitable.

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CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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