Gender and Racial Disparities: The Impact on Diagnosis and Treatment of Peripheral Arterial Disease

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Abstract

Background. Research over disparities in peripheral arterial disease (PAD) has largely been focused on racial and gender differences between White and Black Americans. However, it is unclear whether or not disparities are present among other minorities, especially within the Hispanic population. Our study aims to determine whether racial and gender differences exist between Hispanic and non-Hispanic Americans regarding access and treatment for PAD care. **Methods**. Our study included patients previously diagnosed with PAD. Detailed patient charts were surveyed including demographics, health, and social histories. Participants were presented with a self-reported survey relating to perceptions to determinants of their care. Analysis of data was performed utilizing various statistical tests to compare the results of each question based on patient racial and ethnic factors. **Results.** A total of 100 patients were analyzed. Hypertension was the number 1 comorbidity for all patients. On average, comorbidities among males were more prevalent than in females. Non-Hispanic males had higher rates of tobacco and alcohol consumption and coronary artery disease (CAD) compared with Hispanic males. Regarding barriers to care, Hispanic males and females reported that language represented a major barrier to care. Furthermore, Hispanic females reported transportation barriers as an obstacle to care to a greater degree than non-Hispanic females. **Conclusion.** The "Hispanic paradox" seems to incorrectly suggest that Hispanics have a lower rate of CAD and PAD despite a high burden of cardiovascular risk factors compared with non-Hispanics. The reasons for such a paradox are somewhat unclear. One possibility is that Hispanics may have a higher rate of undiagnosed PAD due to reported barriers to healthcare access including transportation and language. Public health and policy strategies are needed to mitigate these barriers that affect Hispanics from receiving treatment and diagnosis for PAD.

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Peripheral arterial disease (PAD) is a clinical manifestation of atherosclerosis, affecting primarily the peripheral vasculature in the lower extremities. In its advanced form, PAD can result in critical limb ischemia (CLI) or critical limb threatening ischemia (CLTI). As such, early detection and proactive management are critical to patient outcomes. Diagnosis and treatment can be delayed, however, due to the wide spectrum of its clinical presentations. While there are classical PAD symptoms, such as claudication, lower-extremity hair loss, and non-healing ulcers or sores of the legs and feet, PAD is complex and its frequent atypical presentation complicates its management. Furthermore, changes in its definition (previously based on intermittent claudication, now based on ankle-brachial index ≤0.90) have contributed to varying estimates of its burden in communities.[1,2] Nonetheless, recent studies estimate that PAD and its associated conditions affect more than 200 million patients worldwide, and with continued trends in the aging demographic and lifestyle practices in the Western world, the incidence of PAD is predicted to continue growing.[3]

As the incidence and prevalence of PAD continues to rise in the United States, disparities in its diagnosis, treatment, and

outcomes have become a major focus point in cardiovascular research. However, the limited research efforts that are available have been primarily focused on PAD gender differences between men and women and racial differences between White and Black Americans. For example, female patients are more likely to be diagnosed with PAD at later ages, are more likely to present with advanced disease, and are less likely to undergo revascularization procedures.[4-9] Similarly, research demonstrates that Black Americans have disproportionately higher PAD prevalence along with worse prognosis and treatment outcomes.[10-12] Despite the large amount of literature evaluating such disparities, few studies have focused on the burden of PAD among other groups, especially the growing Hispanic population.[13-15] In regard to this limitation, this paper seeks to outline some of the disparities affecting the diagnosis, treatment, and outcomes of PAD among Hispanic and non-Hispanic populations including differences between males and females.

Methods

We examined 100 patients who were followed for PAD-related care at Texas Tech University Health Sciences Center-University Medical Center in Lubbock, Texas as a summer initiative to investigate the leading determinants of care affecting individuals' access. Patients were previously diagnosed with PAD by history and physical examination, ankle-brachial index, arterial Doppler, and angiogram. Diagnosis criteria included symptoms, history and physical presentation, and ankle-brachial index of ≤0.90 for symptomatic patients with normal coexisting comorbidities. We excluded patients <18 years of age and >90 years of age as well as pregnant women. Patients gave informed consent over the study, with authors conforming to institutional guidelines and ethics. Other information was recorded from patient records including demographics (gender, ethnicity, body mass index), social history (tobacco usage, alcohol usage), and coexisting comorbidities (hypertension, diabetes, heart disease, heart failure, hypercoagulable states, coronary artery disease, hyperlipidemia, kidney disease, history of any other cardiovascular disease).

Participants were presented with a self-reported survey consisting of 2 sections. No information on non-respondents was collected. The first section asked study participants 2 questions related to gender and ethnicity. Options for gender were male (M) and female (F). Options for ethnicity were Hispanic (HIS) and non-Hispanic (NH). The second section consisted of 10 interval-based questionnaires with answers on a scale from 1 to 10. These questions related to perceptions on various determinants of care (**Table 1**).

To evaluate patient characteristics, frequencies were reported for categorical variables and means ± standard deviations were expressed for continuous variables. Non-parametric χ^2 tests and Fisher's Exact tests were performed to assess the association of PAD risk factors/comorbidities to gender (male and female) and ethnicity (NH and HIS). To assess for patient access to various determinants of care, part 2 of the survey, consisting of 10 questions, was analyzed. Each question consisted of a scale from 1 to 10, with 1 being least impactful and 10 being most impactful. Two-sample independent *t* tests comparing mean results from each question on the survey were used to investigate statistical differences in responses between gender and ethnic groups (male vs female, NH vs HIS, NH males vs HIS males, NH females vs HIS females). All statistical analyses were performed using SPSS Statistics, version 28 (IBM Corp) and Microsoft 365 Excel, version 2206 (Microsoft Corp). $P<.05$ was considered statistically significant. An independent body was selected by 2 faculty members to independently review, calculate, analyze, and recheck all data and study-related analyses to confirm the findings.

Table 1. Ten key determinants of health used as metrics within this study to assess healthcare disparities. Designations of Q1-Q10 are referenced throughout the paper and in other figures for ease of analysis and interpretation.

Q1: Medication adherence	Q6: Social support
Q2: Language as a barrier	Q7: Accessibility
Q3: Transportation as a barrier	Q8: Symptom relief
Q4: Employment	Q9: PAD knowledge
Q5: Education	Q10: Family/work obligations

Results

All responses to the survey were collected and analyzed. Of the 100 participants, 45 (45.0%) were female, 55 (55.0%) were male, 61 (61.0%) were NH, and 39 (39.0%) were HIS. The mean age and body mass index for all participants were 65.8 ± 12.7 years and 30.5 ± 7.2 kg/m^2, respectively.

Demographics and risk factors/comorbidities of PAD from study participants are shown in **Table 2**. Hypertension (90.0%) stood out as the number 1 comorbidity across all boards, followed by hyperlipidemia (71.0%), tobacco history (70.0%), alcohol usage (59.0%), diabetes (58.0%), and coronary artery disease (56.0%). When broken down into gender-specific and ethnicity-specific groups, distribution of risk factors/comorbidities by gender differed more than when separated by ethnicity. Males were at risk of having more comorbidities (including history of alcohol and tobacco consumption, coronary artery disease, and heart disease) than females with the median age of men at 67.2 ± 12.2 years and women at 64.1 ± 13.1 years. More specifically, NH males are seen to be more likely to have smoked, engaged in alcohol consumption, and have higher incidences of heart disease compared to their gender and ethnic counterparts (**Figure 1**). Conversely, among HIS and NH patients with PAD,

TABLE 2. Patient demographics and characteristics.

	Overall	Males	Females	*P*-Value	Hispanics	Non-Hispanics	*P*-Value	His M	His F	NHis M	NHis F	*P*-Value
Demographics												
Age (years)	65.8 ± 12.7	67.2 ± 12.2	64.1 ± 13.1		65.5 ± 10.5	66.0 ± 14.0		63.6 ± 11.3	67.7 ± 9.4	69.3 ± 12.4	61.7 ± 14.8	
Body mass index (kg/m^2)	30.5 ± 7.2	29.8 ± 6.4	31.3 ± 8.1		30.1 ± 7.4	30.7 ± 7.1		28.9 ± 7.2	31.4 ± 7.5	30.4 ± 5.9	31.1 ± 8.6	
Comorbidities												
Tobacco history	70.0%	76.4%	62.2%	.12	56.4%	78.7%	.02	61.9%	50.0%	85.3%	70.4%	.048
Alcohol usage	59.0%	70.9%	44.4%	<.01	51.3%	63.9%	.21	66.7%	33.3%	73.5%	51.9%	.03
Hypertension	90.0%	92.7%	86.7%	.32	92.3%	88.5%	.54	90.5%	94.4%	94.1%	81.5%	.36
Diabetes	58.0%	58.2%	57.8%	.97	69.2%	50.8%	.07	76.2%	61.1%	47.1%	55.6%	.20
Heart disease	47.0%	58.2%	33.3%	.01	41.0%	50.8%	.34	47.6%	33.3%	64.7%	33.3%	.05
Chronic heart failure	16.0%	18.2%	13.3%	.51	17.9%	14.8%	.67	19.0%	16.7%	17.6%	11.1%	.87
Hypercoagulable	3.0%	3.6%	2.2%	.68	0.0%	4.9%	.16	0.0%	0.0%	5.9%	3.7%	.53
Coronary artery disease	56.0%	65.5%	44.4%	.04	56.4%	55.7%	.95	61.9%	50.0%	67.6%	40.7%	.17
Hyperlipidemia	71.0%	76.4%	64.4%	.19	61.5%	77.0%	.10	71.4%	50.0%	79.4%	74.1%	.16
Kidney disease	19.0%	20.0%	17.8%	.78	23.1%	16.4%	.41	19.0%	27.8%	20.6%	11.1%	.56

Data presented as mean ± standard deviation or percentage.
His M = Hispanic males; His F = Hispanic females; NHis M = non-Hispanic males; NHis F = non-Hispanic females.

HIS patients had higher rates of incidence in diabetes and hypertension (69.2% and 92.3%, respectively), while NH patients had higher rates of hyperlipidemia (77.0%).

When asked to assess their determinants of care, all participants on average stated that barriers involving language (3.26 ± 3.37), transportation (3.21 ± 3.12), familial/work obligations (2.04 ± 2.17), and healthcare coverage (3.36 ± 3.66) have minimal impact on their understanding of PAD (7.63 ± 2.80) and receiving care/treatment. Findings were similar among gender but differed by other characteristics, including ethnicity. In the context of determining factors affecting their care in **Figure 2**, HIS patients found that language barriers were most impactful to them when seeking healthcare/treatment for PAD (5.08 ± 3.98 in HIS patients vs 2.10 ± 2.29 in NH patients; *P*<.001). This stays true in **Figure 3** when Hispanic participants are separated and compared by gender against their counterparts (4.24 ± 3.73 in HIS males vs 2.15 ± 2.48 in NH males [*P*=.03]; 6.06 ± 4.15 in HIS females vs 2.04 ± 2.08 in NH females; *P*<.001). Additionally, in a subset population, HIS females reported transportation to have a significant impact in seeking healthcare/treatment for PAD compared with NH females (5.11 ± 3.68 vs 2.15 ± 2.03, respectively; *P*<.01). This is further corroborated by the findings in **Figure 4**, which show incredible burden on HIS females over the issue of transportation.

Discussion

Previous studies analyzing PAD disparities between African-American patients and NH patients have determined that there is a clear difference in access to healthcare and treatment outcomes between groups.[11] However, there are far fewer studies analyzing whether PAD disparities exist between HIS vs NH patients, as well as any gender differences between the 2 groups. In this cohort of 100 patients undergoing treatment and care for PAD, we identified several important factors contributing to racial and gender disparities among the HIS population when compared with the NH population. Our study identified 3 main disparities among PAD patients. First, there were notable differences in comorbidities between males and females. Males that presented to the clinic with PAD had a notably higher frequency of hypertension, history of alcohol and tobacco consumption, coronary artery disease, and heart disease compared with females across both HIS and NH patients. While this notable difference in comorbidities between genders has been well documented in the general population,[16] our study represents an important contribution toward understanding how these comorbidities specifically impact the diagnosis and treatment of patients with PAD.

Second, among our HIS patients, linguistic challenges present a major hurdle to seeking healthcare and treatment for PAD compared with NH patients. Current literature does not clearly express the risks associated with language barriers and treatment outcomes. However, we have seen that patients who face language barriers report a lower level of patient satisfaction and are less likely to visit a doctor for their symptoms.[17] Our data clearly show that HIS patients with PAD are far more likely to have adverse outcomes than NH patients with PAD.

Third, HIS females have a significant burden in the realm of healthcare access for PAD treatment and diagnosis due to the lack of transportation availability, which they have denoted to be the most impactful upon their care. Patients with issues finding reliable transportation are more likely to reschedule or miss appointments, delay their care, and have decreased compliance with their medication.[18] As such, HIS females are likely at a much higher risk of developing complex PAD-related complications, terminal CLI, and more adverse outcomes than NH females.

The "Hispanic paradox" is a concept that describes how HIS patients have a lower rate of coronary artery disease yet a high burden of cardiovascular risk factors.[19] Recent studies now suggest that this paradox may apply to PAD as well,[15] although the reasons behind it still remain unclear. One possible reason that has been suggested is that HIS patients may have a much higher rate of undiagnosed PAD compared with NH patients. Given that our study indicates that transportation and language are major barriers for the HIS population when it comes to seeking care, it is possible that HIS patients do indeed

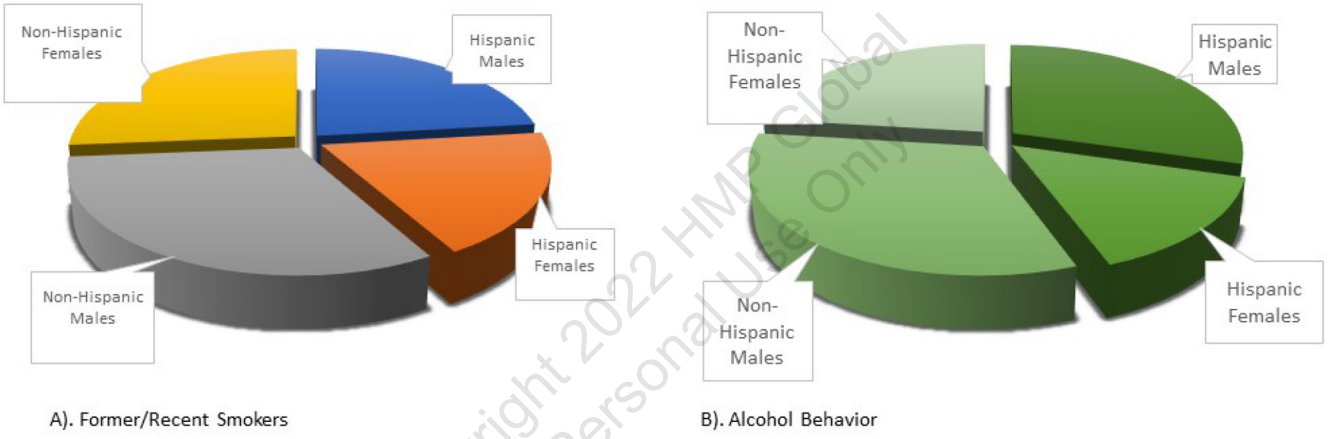

FIGURE 1. Behavior patterns of (A) smoking and (B) alcohol between genders and ethnicities. Figures 1A and 1B indicate that non-Hispanic males had significantly higher rates of smoking status and alcohol use. Figure 1B indicates that Hispanic females had the lowest incidence of alcohol usage.

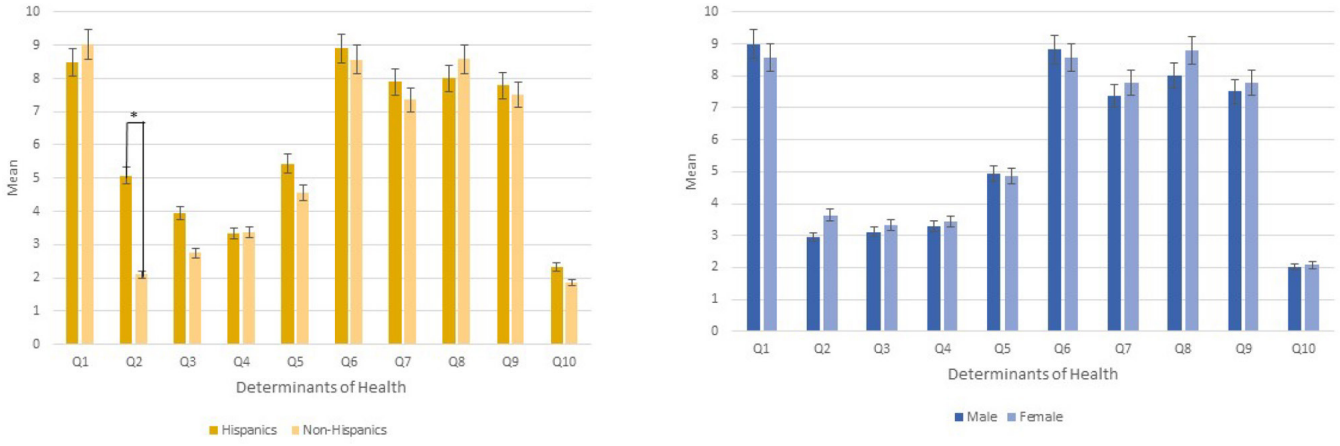

FIGURE 2. (A) Determinants of health based on ethnicity. Language barrier (Q2) was found to be the determinant of health with the greatest difference between Hispanic and non-Hispanic patients. Additionally, access to transportation (Q3) and education (Q5) were found to be considerable health determinants between these populations. (B) Determinants of health based on gender. Of the 10 questions proposed regarding determinants of health, there were no statistically significant differences between males and females found.

have a higher rate of undiagnosed PAD. However, more studies will need to be conducted in order to analyze this correlation more thoroughly. In our study, it appears that in the state of Texas in the United States in 2022, with all the advancements and progress of society, something as basic as language and transportation still remain as major barriers affecting access to care for a dominant minority population.

Study limitations. The study limitations are as follows. First, the study only contained patients who presented to our outpatient cardiology clinic over a short time span as a summer initiative. It did not include any PAD patients who presented to the emergency department or were admitted to inpatient medical care. As a result, this study can only be generalized to patients seen in a clinic setting. Second, it is possible that other comorbidities not accounted for in this study could play a role in the patient's ability to seek treatment for their PAD. However, in this study we accounted for all of the major cardiovascular-related comorbidities, and we anticipate that any non-cardiovascular comorbidities that a patient may have should not have any significant impact on our data and analysis. Registration collection for detailed data is ongoing. Finally, this study was a pilot project to randomly interview 100 new patients presenting with a new diagnosis of PAD over a period of 3 months. The study limitation included the sample size issue for HIS patients, from which it might be difficult to postulate details. However, we are comparing a similar

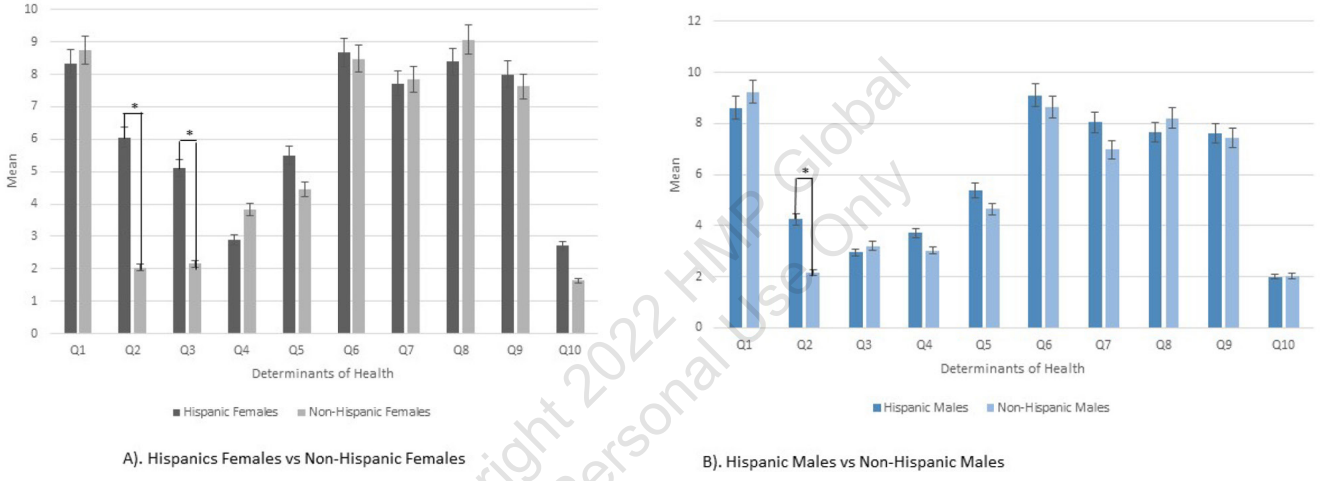

FIGURE 3. (A) Determinants of health between Hispanic and non-Hispanic females. Language barriers (Q2) and barriers to transportation (Q3) were found to significantly differ between Hispanic and non-Hispanic females, presenting far greater challenges for the former. (B) Determinants of health between Hispanic and non-Hispanic males. Language barrier (Q2) was found to be the determinant of health with the greatest difference between Hispanic and non-Hispanic males.

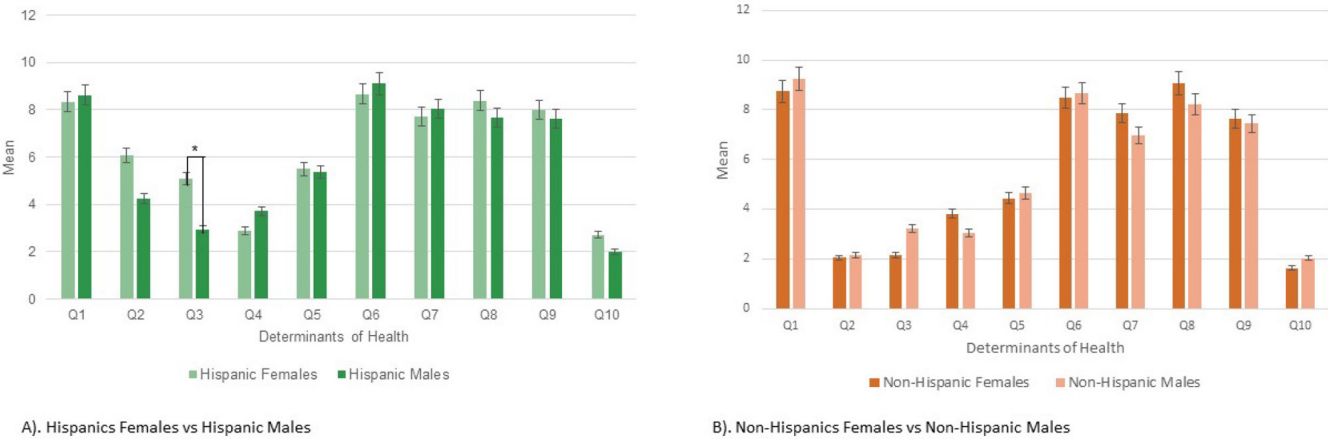

FIGURE 4. (A) Determinants of health between Hispanic genders. Hispanic females reported transportation (Q3) to have a greater impact in their ability to seek care for peripheral arterial disease compared with their male counterparts. (B) Determinants of health between non-Hispanic genders. Between non-Hispanic genders, there were no statistically significant differences.

trend across the spectrum of population that we interviewed, and this trend confirms our conclusion. We plan to study a larger sample size, which will follow up for further details, from our PAD Lonestar Registry data. Additionally, we plan to expand ongoing studies in the future to include more patients from our other healthsystem-linked cardiovascular clinics.

Conclusions

Our study indicates that numerous barriers and treatment disparities for PAD exist between HIS and NH populations and between males and females. These racial and gender disparities emphasize the urgent need for an increased focus on mitigating the barriers that affect HIS patients as well as an increased focus on treating PAD in females who present with comorbidities. These findings speak to the issues that underlie PAD treatment that warrant further study in patients with PAD.

In our study, we found reasons for the occurrence of the "Hispanic paradox" relating to lack of access to PAD care. HIS patients experience underreported rates of PAD as a result of barriers to care. Barriers negatively affecting diagnosis and treatment access were predominantly shown to be in language, education, and transportation.

In addition, while men demonstrate higher rates of comorbidities, women present with similar rates of PAD.[16] Our study appears to be the first to indicate that language, transportation barriers, and medication adherence may account for the higher prevalence of PAD in women. The most important aspect confirming the gender disparity is the finding that the disparity occurs between females and males as well as HIS females and males. Disparities in PAD care for women affect both minority and non-minority populations, highlighting how ubiquitous this disparity is and the urgent need to address these imbalances.

The disparities found in PAD treatment also emphasize the need for mass scale education and outreach to both female populations as well as HIS populations regarding prevention and care of PAD. It also includes the necessity for education programs for primary care physicians to understand this disparity to help resolve it. Just as there are nationwide campaigns to educate the public on heart disease, similar campaigns and outreach efforts must be put forth to target the epidemic of PAD as well as the disparities that lie within it. One of the major concerns regarding PAD is the risk of complications that stem from the disease—particularly amputations,[20] which are especially troublesome for the massive socioeconomic burden they impose on both individuals and their families.[21] Many patients with PAD tend to be the breadwinners of their house. When PAD leads to amputations, the ability for that individual to work and support their family is gravely diminished. This burden is especially pronounced in populations that generally present with lower socioeconomic status, such as HIS patients. We hope to use the findings from our study to promote PAD awareness within HIS communities in our area. Likewise, through these mass outreach efforts, the ultimate goal is that we will see a significant reduction in patients presenting to the clinic with PAD-related complications as well as a reduction in PAD-related mortality. One important aspect of the study was also confirming the fact that disparities affecting women were a major issue, as the same trends seen between White males and White females were similar to the disparity seen between HIS males and HIS females.

Future directions. Our plan is to continue data collection regarding PAD disparities and to form a database registry to further analyze the disparities noted above, and to include socioeconomic status as well. This will include detailed population statistics and a further analysis of demographics of the mentioned disparities. This work will be amalgamated into our existing Lonestar PAD registry. Furthermore, we plan to reach out to other communities throughout the state of Texas to see how these disparities affect different populations of patients with PAD.

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