



Healthcare Disparities in Dysvascular Lower Extremity Amputations

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Abstract

Purpose of Review Our goal is to provide a current review of health disparities in patients with dysvascular lower extremity amputation, so that we can better identify how disparities persist after an amputation and how to reduce these disparities.

Recent Findings Health disparities in amputation risk, level, and outcomes exist in the USA based on race/ethnicity, gender, income, insurance, care provider, hospital, neighborhood, and US region.

Summary While health disparities exist for patients with dysvascular lower extremity amputation, little is known about differences in function, rehabilitation, and prosthesis prescriptions. Future research in this area is important, so that we can better identify how disparities persist after an amputation.

Keywords Dysvascular amputation · Healthcare disparities · Rehabilitation · Diabetes, peripheral vascular disease · Healthcare inequity

Introduction

Health disparities are the preventable differences in health outcomes among different groups based on their race or ethnicity, religion, socioeconomic status, gender, age, disability, mental health, gender identity, sexual orientation, or geographic location [1–3]. People with disabilities have historically been treated differently, whether through the past practices of institutionalization, forced sterilization, or housing, job, education, and healthcare discrimination [4, 5]. Nationally, people with disabilities have barriers to healthcare access due to cost and mobility, have higher rates of chronic disease, and are less likely to receive preventative care than the nondisabled population [6, 7]. In adults with acquired disabilities, health disparities have also been identified, with

an increased risk of stroke or traumatic brain and spinal cord injuries for minorities, a higher mortality rate following these events, and worse functional outcomes as well as a reduced likelihood of receiving inpatient rehabilitation or outpatient therapies [6, 8–11].

The intersection of multiple factors leads to health disparities, and models have been developed to provide a framework from which to study, better understand, and create solutions for improvement [12–14]. While no model can be complete, the *Beginning Disability Disparities Model's* presented by Allen Lewis in 2009 addresses the individual, historical, cultural, and societal impact on outcomes and participation, reflecting a more contemporary model of disability, and provides a common language for rehabilitation providers to approach this topic. The Lewis model defines disability disparity as one that:

“[E]xists when an underserved, ethnic or racial minority cultural group’s goal is to receive services within the formal, rehabilitation and disability system (public or private), but there is a differential experience based primarily on cultural orientation that results in higher incidence of disability, and/or lower participation levels in the formal helping system, and/or fewer successful individual outcomes when compared to majority culture groups.” [13]

This model uses five domains to organize the view of disability disparities based on the unique cultural and biologic factors of a group, the ethnocentric worldview of the care system and practitioner, and the systemic bias that affects

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participation and outcomes [13]. Domain one is how a group's intergenerational response to oppression, poverty, and social stress affects incidences of disease [13]. Domain two is how a group views their disability [13]. Domain three is the factors that may affect access to care, such as socioeconomic status (SES) or a group's culture of seeking help [13]. Domain four is the quality of services provided to a group, and domain five is the impact on individual outcomes within a group [13]. We use the Lewis model in this review to frame our discussion of health disparities in people following a dysvascular lower extremity amputation [13]. The goal of this article is to provide a current review of the health disparities that exist in patients with dysvascular lower extremity amputation, covering literature that was published between January 2010 and February 2020.

Methods

We completed a literature search of PubMed and CINAHL using search terms: disparities, race, regions, gender, amputation, dysvascular amputation, amputation level, amputation outcomes, and prosthesis prescriptions. The searches were limited to English language articles representing original research of adults with dysvascular amputation in the USA, published after January 1, 2010–January 2020. A total of 1051 articles were identified in the primary search. Nine hundred eighty-three were removed after review of title and abstract and an additional 23 duplicates were removed. Forty-five articles remained and were included in the review.

Background of the Health Disparities in Diabetes Mellitus (DM) and Peripheral Arterial Disease (PAD)

DM and PAD are common in the USA, with 34.1 million adults diagnosed with DM and at least 8.5 million people over the age of 40 diagnosed with PAD [15–17]. The majority of nontraumatic lower extremity amputations (LEA) are secondary to complications of these diseases [18]. Additionally, racial, ethnic, regional, and socioeconomic differences in the prevalence of DM and PAD have been recognized for many years. The prevalence of DM in non-Hispanic Whites (NHW) is 7.5%, Asians is 9.2%, Blacks is 11.7%, and Hispanics is 12.5%. American Indian/Alaskan Natives (AI/AN) have the highest prevalence at 14.7% [15, 19]. Additionally, DM is more common in the Southeast and in people with less education [15]. For PAD, Blacks have a higher prevalence than NHWs at 11.6% vs. 5.5% [17]. The US Hispanic prevalence of PAD ranges between studies from 1.8 to 13.7% [20]. The prevalence of PAD in AI/ANs in a single large study was 8.56% [21]. PAD is also more common in patients with lower educational level and household income [17].

Cardiovascular disease, retinopathy, nephropathy, peripheral polyneuropathy, and lower extremity amputation are unfortunate consequences of DM. While Blacks and Hispanics have been found to have lower rates of cardiovascular disease secondary to DM, the rates of retinopathy and nephropathy are higher in Blacks, Hispanics, and AIs [16, 19]. Differences in patient management practices and the degree of disease control result in these disparities. Compared with NHW patients, Hispanic patients are less likely to check daily glucose, complete adequate hemoglobin A1c, and cholesterol testing, or check their feet regularly [22, 23]. Similarly, Black patients have been found to receive HbA1c screening, cholesterol testing, and annual eye exams less than NHW patients [23–25]. One study, looking at racial differences at the individual physician level, found that Black patients were less likely to achieve good control of HbA1c or LDL despite similar rates of testing between Black and NHW patients [26]. This is supported by other studies that found Black men and women were less likely than NHWs to have good HbA1c and LDL control [24, 27]. AI with DM has been found to exercise less and to have HbA1c and LDL checked less than NHWs [22, 25]. While women have been found to receive more disease-appropriate screening than men, they are less likely to achieve good LDL and HbA1c control [24]. And when looking at the interactions of gender and race, Black women were less likely to get appropriate screenings and had poorer LDL and HbA1c control than NHW women [24, 25].

While multiple stages of treatment exist for PAD, including medications, smoking cessation, graded exercise programs, and surgery, the majority of the literature on health disparities in this population discusses differences in revascularization for critical limb ischemia (CLI) and intermittent claudication (IC). There is limited research on disparities in preventative practices, with one national study of Veterans which found Black patients are less likely than White patients to be on a statin or antiplatelet medication [28]. Another study found that patients from lower socioeconomic status communities are less likely to use a statin [29]. Revascularization, which includes surgery, angioplasty, stents, and atherectomy, is utilized in select patients with IC and for limb salvage with CLI. Multiple studies have found that Blacks and Hispanics are less likely to get revascularization than White patients [30–34]. Men are more likely than women to receive lower extremity revascularization (LER), when presenting to a hospital with IC or CLI [35–38]. This may be because women with PAD are more likely to present to the hospital emergently with CLI and found to have more advanced disease [35–38]. Women have been found to have a higher in-hospital mortality rate following LER procedures, although the types of procedures have not been consistent, with some groups identifying an increased risk for endovascular procedures alone, with others reporting an increased risk for both open and endovascular [35, 36, 38]. A more recent study using

Healthcare Cost and Utilization Project National Inpatient Sample (HCUP NIS) data found no differences in the in-hospital mortality rate between men and women following an endovascular procedure [37].

Finally, patient payer source has been implicated in the health disparities for patients with PAD [30, 39–41]. Patients with private insurance are more likely to be admitted for IC/CLI and to receive LER for IC [30, 39, 41]. One study investigated differences in treatments and outcomes after the insurance expansion of 2006 in Massachusetts compared with matched states that did not increase insurance access. They found that after the insurance expansion, the racial differences in disease severity at admission and the percentage receiving a LER were similar between White and non-White patients, but in states without the insurance expansion, disparities continued to exist between these two groups of patients [40].

Review of the Healthcare Disparities in Dysvascular Lower Extremity Amputations

Disparities in Amputation Risk

Lewis model domain one factors of racial and ethnic differences in the risk of LEA in patients with DM have been recognized for many years, and it is well established that Black, Hispanic, and AIs are at an increased risk of LEA compared with NHWs [23, 42–46]. Although major amputation (excluding toes and partial foot) rates in patients with DM have been decreasing, the rate of LEA in Blacks and Hispanics has not decreased as much as NHWs, with some reporting that these groups have amputations at more than double the rate of NHWs [23, 45–48]. There is less known about improvement in amputation rates for AIs, but one study using HCUP NIS data from 2002 to 2015 suggests that major amputation in AIs is increasing [44]. The current rate for LEA in AIs is a little more challenging to define, as they are often left out of analysis or grouped with White or other race [23, 45]. One 2010 study, looking at AIs in AZ using the Indian Health Service database, found they had more than a 10-fold higher risk of LEA compared with the US adult population with DM [19]. This is significantly higher than a more recent national study, placing the increased risk for AI at 1.5 times that of NHWs [44].

Similar disparities in the risk of LEA exist for Blacks, Hispanics, and AIs with PAD. Blacks and Hispanics are more likely to present to the hospital later in disease with gangrene, sepsis, and CLI than NHWs [28, 30, 49–53]. Arya et al. looked at incident amputation in a Veteran population and found that Blacks with PAD have an increased risk of amputation compared with Whites [28]. However, highlighting the role of preventative care, they also reported attenuation of the risk in patients that were taking antiplatelets and statin medications, although Black Veterans are less likely to be on these medications than NHWs [28]. Whites, Black, Hispanic, and

AIs with PAD are 1.5–2 times more likely to get a LEA than LER [33, 49, 50, 53–62]. One study reported a much higher risk for Blacks with PAD of 4 times the general population [63]. Asians with PAD have been found to have both increased and decreased risk compared with Whites, which may be due to how they are grouped (with or without Pacific Islanders) [54, 58]. Others have looked at the risk of amputation following LER procedures and found that when Black and Hispanic patients do receive LER, they continue to have an increased risk, compared with Whites, of requiring reintervention and LEA within the next 12 months [49, 61, 64–66]. There is some evidence that the disparities in amputation-free survival, after an LER, have been widening between Blacks and Whites with PAD [64].

Gender differences have also been recognized and represent aspects of domains two and three, related to a healthcare system's inability to provide services sensitive to diverse populations. LEA is more common in male patients with DM, PAD, and following LER [44, 48, 52, 54, 63, 67, 68]. There is evidence that women with PAD present later than men, with more advanced disease and with CLI [36, 37]. The odds of LEA rather than LER have been reported to be higher in women with PAD than men [30, 37]. One group looking at the differences in immediate post-op complications found that women were more likely than men to undergo LEA during hospitalization following a LER [36].

Socioeconomic factors, which are a component of domain three, appear to impact amputation risk for patients with DM and PAD, with increased disparities for people of color based on income and insurance. There is an increased risk of LEA in patients with DM on public health insurance (Medicare or Medicaid) compared with private/employer provided insurance [40, 46, 48]. Additionally, the income level in patients with DM is associated with LEA, with the risk of amputation increasing inversely relative to income [46]. Similarly, uninsured patients with PAD or patients with PAD that receive public health insurance are more likely to undergo amputation than patients that have private insurance [30, 39, 52, 54, 56]. Patients with lower income levels are more likely to be treated in hospitals performing fewer LER and more likely to get a LEA [54, 56]. Conversely, as household income and insurance access increases, patients with PAD have a decreased risk of amputation [54, 56]. One study using the HCUP National Emergency Department Sample database found that patients on Medicaid compared with Medicare have been found to incur a longer length of stay and higher hospitalization charges [46]. There is some evidence that insurance reform (i.e., increased coverage) can decrease amputation disparities for Black and lower income people with PAD and DM, closing the racial gap in amputation risk. Recent research, using HCUP NIS data, looking at amputation risk differences between Black and White patients being treated for diabetic foot ulcers and foot infections found that the prior

elevated risk of LEA for Black patients (OR 1.7 in 2003–4) had resolved in 2014, with Black and White patients with DM having similar risk [69]. This may be due to expanded health coverage through the Affordable Care Act which occurred during the study timeline. Another study looked at patients with PAD using the Massachusetts HCUP-State Inpatient Database compared with three other states, both before and after the insurance expansion in 2006, which increased the insurance coverage to 98% of Massachusetts residents. The study found that prior to the expansion, non-Whites presented with more severe disease were less likely to be offered LER and more likely to get a LEA in all four states [40]. After the expansion, there was no significant difference in disease severity at admission, risk of amputation, or revascularization between non-Whites and Whites in Massachusetts, while the disparities continued in the other three states [40]

There is hospital, provider, neighborhood, and regional variability in amputation rates for DM and PAD, which highlights issues corresponding to domains three and four of the Lewis model and differences in access to services and quality of the services provided [46, 61]. At the hospital level, patients treated in low-volume centers, those that perform fewer LER and LEA per year, are at an increased risk of LEA [30, 59, 70]. Blacks and AIs are more likely to be treated at low-volume nonteaching hospitals [61, 62]. One group found that as amputation volume increased in a hospital, racial disparity in amputation rates increased [52•]. They also found that the difference in amputation rates for Blacks compared with NHWs decreased when a vascular surgeon had more Black patients [52•]. At the neighborhood level, one study looked at patients with PAD being treated with infrainguinal bypass and found that patients in more distressed communities (using the Distressed Communities Index) [71] had higher short- and long-term risk of LEA [29]. Others have had similar results, with one group finding a 30% increased odds of LEA for residents of underserved counties (too few primary care physicians, high infant mortality rate, high poverty and elderly population) [68]. When looking just at neighborhood mean income level, there is an increased risk of LEA for those with PAD and DM in lower income neighborhoods [28, 43]. Racial disparity appears to worsen in wealthier zip codes. One study, using mean income levels by zip code, found that as income in neighborhood of residence increased, the odds of receiving LER also increased, but disproportionately more for White than Black patients, which resulted in a greater disparity in LEA risk for Blacks [30]. Regionally, there is a higher rate of LEA in the Southern USA and also in the Midwest and Oregon, compared with other areas in the USA. Additionally, Blacks in these regions undergo LEAs at disproportionately higher rates compared with Whites [34, 46, 58, 63, 64]. One group, looking specifically at the secondary risks in an area with a higher prevalence of DM along the Mexico-USA border, noted increased odds of LEA among Hispanics [48]. Patients with DM living in

rural areas have also been found to have an increased risk of ED visits or hospitalization for diabetic foot ulcers and LEA [46]. Further interactions between race and rurality in patients with PAD have been identified. NWs living in rural areas have increased odds of primary LEA compared with Whites in those same rural areas and to NWs living in urban areas [60].

Our search identified publications that examined disparities in dysvascular LEA risk and demonstrated an increased risk of amputation disproportionately affecting Blacks, Hispanics, AIs, women, people on public health insurance, and people with lower incomes. These studies were largely retrospective cohort analyses, with only a single prospective randomized controlled trial looking at amputation risk [65]. Both regional, national, and VA databases were used in these studies, allowing investigation of a broad patient population, with national, statewide, and hospital level variation in risk for amputation. Domain one, which relates to factors that affect the incidence of a condition, appears to play a role in healthcare disparities in the risk of amputation. Domain one hypothesizes that the increased incidence of amputations in minorities may be the result of current and historical oppression, poverty, and social stress [13]. While incomplete in explaining the racial disparity we observed in dysvascular LEA risk, the impact of domain one is critical, as perceptions of stress and a patient's response are developed over a lifetime. This suggests that the treatment of disease must first start in the community, addressing issues such as access to healthy foods, job security, quality of education, housing, and exposure to violence [72]. Domains two and three are also present and relate to access and group perspectives on disability within an ethnocentric care system. From this framework, Blacks, Hispanics, and women may be presenting later in disease progression and sicker due to a health system's challenges in engaging specific groups in preventative care.

Domain four, which relates to how physician or system level bias may affect the quality of care, also appears to be a factor in the increased incidents of dysvascular LEA. While there was a significant body of literature describing regional and hospital system differences, there was only a single study looking at disparities driven by provider level factors. That study's finding that increased diversity in a surgeon's practice may improve outcomes for Black patients is interesting, because it suggests provider level bias can affect outcomes [52•]. The finding by another study of increased racial disparity in wealthier neighborhoods is troublesome and may reflect provider bias in these areas, although the study was not designed to identify bias [30]. While there is limited data demonstrating differences in outcomes related to provider bias, this may have more to do with insufficient research on the topic, not the absence of inequity. In fact, a novel study by Hausmann et al. found that the implicit bias in SCI providers influenced the levels of disability in their patients [73].

Disparities in Amputation Level

Among Medicare patients with PAD, Black amputees were more likely to be female and to have a transfemoral level amputation than NHW amputees [32]. Multiple studies have found that while transtibial level LEAs are more common, transfemoral level LEAs were completed disproportionately more often in females and Blacks [74–76]. Yet, Hispanics are more likely than NHWs and Blacks to get a transtibial level amputation [34, 74, 75]. Other studies have found that patients with dysvascular amputation are more likely to receive a transfemoral amputation if they are low income or have public health insurance [34, 74, 75]. Regional variations in amputation level have been identified, with more transfemoral level LEA compared with transtibial in the South and Northeast [34].

While there are fewer studies looking at health disparities in the level of amputation compared with amputation risk, the disparity in level of amputation is important to recognize as a more proximal amputation results in worse quality of life, function, mobility, prosthesis use, and mortality outcomes [34, 77, 78]. Our search did identify evidence of disparities in amputation level due to race, gender, income, insurance provider, and regional difference, representing domains one and three of the Lewis model, access to care, and the increased incidence for certain groups. These disparities may be related to access to revascularization, hospital bias, or provider bias in triaging patients, or it could be that some patients are presenting to the hospital later and sicker and thus requiring a more proximal amputation [30, 50, 79–81].

Disparities in Outcomes and Prosthesis Prescriptions Following an Amputation

There is limited information related to domain five of the model, which looks at the impact of rehabilitation care on individual outcomes. A study published in 2016 reporting on the development of a model used to predict mobility after a LEA found that NHW race predicted improved mobility (more likely to meet basic and advanced mobility outcomes) but is unable to explain reasons why this result was identified [82]. Additionally, a single paper found prosthesis prescriptions following LEA were less likely in the South and for Black patients [83].

Even with this limited data, we see disparities emerging. It is likely that more disparities will be identified if future research targets long-term outcomes and healthcare provisions after an amputation. The implications to this blind spot are significant, as we have seen that certain groups and regions are disproportionately affected by LEA. The inability to return to a person's prior level of function can impact quality of life, management of other medical comorbidities, and reintegration to an individual's home and community and to their vocational prospects.

Conclusions

The goal of this article was to provide a current review of the health disparities that exist in patients with dysvascular LEA. We identified health disparities in amputation risk, level, and outcomes. These disparities represent differences in treatment based on race/ethnicity, gender, income, insurance, care provider, hospital, neighborhood, and US region. Moving forward, there is some evidence that community liaisons may lead to better management of DM and PAD, although it is not clear if this affects amputation [84, 85]. This fits within the conceptualization of domains two and three, in which healthcare systems should attempt to meet the unique needs of patients and communities based on diverse backgrounds and viewpoints. While it is reasonable that expanding insurance and improving access to preventative and medical treatment of DM and PAD for certain groups would improve outcomes and reduce amputations, this does not consider the unique cultural factors and social determinants that may prevent the uptake of recommendations and engagement in individual care. This is evidenced by continued health disparities within the VA population, despite seemingly equal access to care for all Veterans [28, 42, 51, 82, 83]. Additionally, research looking at the role of providers' historically held beliefs and biases, and the impact these have on the quality of care as described in domain four, will provide needed insight into how these important factors affect patient outcomes.

As rehabilitation providers, our primary role is in the pursuit of optimizing function and improving quality of life in our patients. It is in this area that we have so little information about the presence of health disparities for patients with dysvascular LEAs. This review identified limited research discussing disparities in function and prosthesis prescription following an amputation and reveals a need for more work looking into this topic. Future research looking at differences in mood, quality of life, mobility, functional outcomes, and prosthesis prescriptions will be important to better understand which health disparities persist beyond the amputation, with a goal of closing these gaps and ensuring that all people with an amputation are treated equitably and provided the best opportunity for success.

Compliance with Ethics Guidelines

Conflict of Interest Max Hurwitz and Molly Fuentes declare no conflicts of interest relevant to this manuscript.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

Abbreviations AI, American Indian; AN, Alaskan Native; CLI, critical limb ischemia; DM, diabetes mellitus; ED, emergency department; HCUP, Healthcare Cost and Utilization Project; IC, intermittent claudication; LEA, lower extremity amputation; LER, lower extremity revascularization; LDL, low density lipoprotein; NHW, non-Hispanic Whites; NW, non-White; NS, National Inpatient Sample; PAD, peripheral arterial disease

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