

## Disparities in Amputations in Minorities

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### Abstract

**Background** As a result of the impact of health disparities on the healthcare system such as their influence on arenas significant to healthcare distribution, including cost, quality, and access, identification and resolution of health disparities is a primary national agenda item. Resolution of disparities in amputation is an area of opportunity that warrants further consideration.

**Questions/purposes** The purposes of our review are to highlight current data on disparities in amputation in minorities and to consider future goals related to an elimination of this disparity.

**Methods** Studies on disparities in amputation were accessed using the following databases: PubMed, Cinahl, OVID/Medline, Embase, and Cochrane databases. In each database, a search of title/abstract was performed for the search terms “disparities and amputation,” “race and amputation,” and “diabetes and amputation.” Each search was limited by human and English language.

**Where are we now?** A disparity exists in both frequency and level of amputation in minorities both in the presence and absence of a diagnosis of diabetes.

**Where do we need to go?** A need exists for future research involving a more deliberate examination of the use of preventive screening for patients at high risk for amputation across medical settings.

**How do we get there?** Research in this area would benefit from funding, large-scale data collection, and physician exposure to education on high-risk patients and preventive screening opportunities.

### Introduction

There is growing concern among health policymakers that racial health disparities are having a deleterious effect on patient healthcare quality and outcomes. The literature clearly supports differences in the use of surgical procedures between individuals of different races and ethnicities [41]. This review of the literature looks at the existence of such racial health disparities among lower extremity amputations, evaluating the ways in which race may be related to amputation resulting from peripheral limb ischemia and diabetes.

Amputation of the lower extremity can have a major impact on the health and quality of life of the recipient. Amputation is surgery that not only requires additional funds for rehabilitation, but also prosthetic creation, management, and maintenance [19, 40]. Amputation also plays a major role in an individual’s psychosocial, functional, and economic status, making it more difficult for a person to return to leisure, educational, and employment activities [25, 42, 50, 57].

Several studies have reported minority patients are much less likely to receive preventive vascular screenings and procedures [6, 43, 51]. In the case of peripheral arterial disease, minorities are less likely to have limb-sparing

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procedures such as angioplasty and lower extremity bypass and more likely to have amputation [5, 18, 22, 49]. Vascular disease, including lower extremity subclinical and symptomatic peripheral arterial disease and diabetes, occur at a substantially higher rate in minorities [7, 15, 21, 29]. According to Aboyans, higher rates of subclinical disease were quantified among blacks when using the ankle brachial index in normal asymptomatic patients [1]. The incidence of amputation related to vascular diseases is considerably greater among minority races and ethnicities than non-Hispanic whites in the United States [12, 53]. Although it is possible to prevent or delay amputation in the compliant patient with medications and treatment interventions, minorities experience amputation at a rate twice as high, if not higher, than nonminorities [11, 33]. Disparities in amputation appear both in regard to the overall rate of amputation in addition to the severity or level of amputation [9, 16].

This literature review provides a detailed overview of the extent of racial health disparities in amputation in the United States in both summary and graphic form.

For the purposes of this literature review, data provided primarily respond to the question “Where are we now?” This question is addressed through a summary of data on lower extremity amputations with regard to (1) overall prevalence, incidence, and odds; (2) level of amputation; and (3) the role of diabetes in disparities in lower extremity amputations. In addressing these points, this review of the literature answers the following questions: (1) Is there a difference in the rate or risk of lower extremity amputations in minorities? (2) Is there a difference in the risk of higher-level amputation in minorities? (3) What role does diabetes play in the risk of disparities in amputation in minorities?

### Search Strategy and Criteria

Studies on disparities in amputation were accessed using the following databases: PubMed, Cinahl, OVID/Medline, Embase, and Cochrane databases. In each database, a search of title/abstract was performed for the search terms “disparities and amputation,” “race and amputation,” and “diabetes and amputation.” Each search was limited by human and English language. We then selectively identified articles for this manuscript with no specific criteria.

### Differences in Rate or Risk of Lower Extremity Amputation

Racial health disparities in rate or risk of lower extremity amputation are well documented in the literature, particularly in studies that isolate patients who have undergone

a lower extremity amputation resulting from peripheral vascular disease or diabetes. Several studies look at all patients undergoing an amputation, whereas other studies consider only populations with a diagnosis of diabetes. Because disparities in the prevalence of diabetes could be a contributing factor to disparities in amputation, those studies are evaluated in the section on differences in precursors to lower extremity amputation. This section reviews studies that evaluate all patients receiving a lower extremity amputation regardless of diagnosis (Table 1).

Several studies support both higher rates of primary and repeat amputations, higher relative risks, or odds ratios when controlling for other confounding variables and lower rates of revascularization procedures among minorities. Data are presented in chronologic order of publication date. Tunis et al. studied the relationship between patient characteristics and the likelihood for lower extremity bypass, amputation, or angioplasty among 7080 cases in 1988–1989 from the Maryland Health Services Cost Review Commission data. These data provide information on all discharges from nonfederal acute care hospitals in the state of Maryland. As reported in the results from this study, the age-adjusted likelihood of having a procedure for peripheral was 1.6 times higher in blacks than in whites. Compared with patients who had angioplasty or bypass surgery, patients who had amputations were more likely to be black (OR, 2.5). Compared with patients who had bypass surgery, patients who had angioplasty were more likely to be white (OR, 1.7) [54].

McBean et al. evaluated the use of 17 different surgical procedures on Medicare beneficiaries using Medicare Provider Analysis and Review (MEDPAR) files data from the years 1986 and 1992. These authors were able to use the Medicare denominator file to create and evaluate differences in rates of use of certain procedures based on patient characteristics such as race. With regard to approximately 60,000 admissions related to amputation based on ICD-9-CMN procedure codes, black race was more likely to be correlated with admission for lower extremity amputation when compared with white race. The data provided in this study show a higher risk of amputation (1.71 versus 5.54 in 1986 and 1.75 versus 6.33 in 1992) among blacks when compared with whites [35].

Guadagnoli et al. studied the relationship between race and the use of surgical procedures for the management of lower extremity ischemia. Their data set consisted of all patients coded for lower extremity amputation by International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes 84.11 to 84.17 for various levels of lower extremity amputation, 39.59 for transluminal angioplasty, 39.25 or 39.39 for lower extremity arterial revascularization, older than 65 years of age, and at least one code ICD-9-CM diagnosis code for diabetes, gangrene, or

**Table 1.** Odds ratios of rate of amputation in minority race and ethnicity when compared with non-Hispanic whites found in the literature

Study	Author(s)	Population size	Odds ratio expressing increased rate of amputation among minority race and ethnicity
Variation in Utilization of Procedures for Treatment of Peripheral Arterial Disease	Tunis et al. (1993)	7080	The age-adjusted likelihood of having a procedure for peripheral was 1.6 times higher in blacks than in whites; compared with patients who had angioplasty or bypass surgery, patients who had amputations were more likely to be black (OR, 2.5); compared with patients who had bypass surgery, patients who had angioplasty were more likely to be white (OR, 1.7)
Differences by race in the rates of procedures performed in hospitals for Medicare beneficiaries	McBean et al. (1994)	Approx 60,000 lower extremity amputations	With regard to approximately 60,000 admissions related to amputation based on ICD-9-CM procedure codes, black race was more likely to be correlated with admission for lower extremity amputation when compared with white race; the data provided in this study show a significantly higher risk of amputation (1.71 versus 5.54 in 1986 and 1.75 versus 6.33 in 1992) among blacks when compared with whites
The influence of race on the use of surgical procedures for treatment of peripheral vascular disease of the lower extremities	Guadagnoli et al. (1995)	19,236	White patients almost twice as likely to undergo arterial revascularization (AOR, 1.96) and almost three times more likely to undergo angioplasty (AOR, 2.86) Black patients (AOR, 2.06) to undergo amputation when compared with white patients
Racial differences in operation for peripheral vascular disease: results of a population-based study	Brothers et al. (1997)	2,961	Black women 7.6× more likely to undergo amputation when compared with other women and 1.3× more likely when compared with other blacks
Impact of race on the treatment for peripheral arterial occlusive disease	Huber et al. (1999)	51,819	Black patients more likely to undergo lower extremity amputations than whites (OR, 3.79)
Lower extremity nontraumatic amputation among veterans with peripheral arterial disease: is race an independent factor?	Collins et al. (2002)	11,494	A greater risk of amputation noted among Hispanics (OR, 1.4) and blacks (OR, 1.5) versus lower extremity revascularization
Racial differences in the incidence of limb loss secondary to peripheral vascular disease: a population-based study	Dillingham et al. (2002)	27,149	Black race was associated with greater odds of loss a lower limb when compared with whites (OR, 2.4)
Explaining racial variation in lower extremity amputation: a 5-year retrospective claims data and medical record review at an urban teaching hospital	Rucker-Whitaker et al. (2005)	1,127	Black patients more likely to undergo lower extremity amputation (OR, 1.68) Blacks 2.5× more likely to be repeat amputees
Racial differences in primary and repeat lower extremity amputation: results from a multihospital study	Feinglass et al. (2005)	513	Black patients more likely than white or other race amputees to undergo first or repeat amputation (AOR, 1.7)
The adverse effects of race, insurance status, and low income on the rate of amputation in patients presenting with lower extremity ischemia	Eslami et al. (2007)	363,193	Patients of a nonwhite race significantly more likely to undergo lower extremity amputation than individuals of a white race (AOR, 1.91)
A census-based analysis of racial disparities in lower extremity amputation rates in Northern Illinois, 1987–2004	Feinglass et al. (2008)	33,775	Geographic regions with greater than 50% black population were 5× more likely to receive amputation when compared with primarily white geographic area

AOR = adjusted odds ratio.

peripheral artery disease using Medicare claims data from the Medical Provider Analysis and Review data set for the years 1989 and 1990. During this study, logistic regression was performed on a random sample of 19,236 Medicare

enrollees who underwent any limb-sparing or amputation of the lower extremity. Black, nondiabetic patients were more likely to have amputation (odds ratio [OR], 2.06; confidence interval [CI], 1.82–2.32) than whites at all levels of

amputation. White patients were almost twice as likely (OR, 1.96;  $p < 0.001$ ) to have lower extremity revascularization and almost three times as likely (OR, 2.86;  $p < 0.001$ ) to have lower extremity angioplasty [22].

Brothers et al. performed retrospective data analysis on 2961 patients receiving an operation for peripheral arterial disease between 1992 and 1993 in South Carolina using the data collected by South Carolina's Budget and Control Board. ICD-9-CM codes 84.10 to 84.19 and 84.91 were used to identify all patients who had undergone amputation during the year of the study. In addition, intermittent codes between 38.08 and 39.58 were used to identify patients who had repair procedures. Black women in this study had a greater relative risk for lower extremity amputation, 7.6 times more likely than other women and 1.3 times more likely than other blacks. The rate of limb-sparing procedures, however, was more common (OR, 1.43; 95% CI, 1.23–1.66) among whites [6].

In another retrospective analysis of hospital discharge data between the years 1992 and 1995, Huber et al. analyzed 51,819 procedures performed for peripheral arterial disease from the Florida Agency for Health Care Administration from 1992 to 1995 for all patients older than 44 years of age. Amputations were identified using ICD-9-CM codes 84.13 to 84.17, arterial revascularizations using code 39.59, and transluminal angioplasty using code 39.25. The incidence of amputation was much higher (5.0 versus 2.5 per 10,000) among blacks when compared with the white reference group, whereas the incidence of revascularization was much lower (4.0 versus 7.1 per 10,000) among blacks. While controlling for confounding variables, multivariate analysis of this data set revealed blacks were more likely (OR, 3.79; CI, 3.34–4.40) than whites to undergo amputation of the extremity [25].

Collins et al. analyzed data from the National VA Surgical Quality Improvement Program and from the Veterans Affairs Patient Treatment File to determine if race was independently associated with an increased odd for amputation versus revascularization in the case of lower extremity ischemia. In these data, 3085 vascular amputations and 8409 lower extremity bypass surgeries were identified using ICD-9-CM coding. A multiple logistic regression model was used to determine the relationship between race and lower extremity amputation versus lower extremity revascularization. Both black race (OR, 1.5; CI, 1.4–1.7) and Hispanic ethnicity (OR, 1.4; CI, 1.1–1.9) were identified as having greater risk for amputation versus revascularization [10].

During a retrospective analysis, Dillingham et al. identified all hospital discharges in the Maryland Hospital Discharge Data from 1986 to 1997 in which the ICD-9-CM code of 84.11 to 84.19 (lower extremity amputation) could be identified at least once during the admission. In this data

set, 27,149 discharges had a code of dysvascular amputation. Those with codes for amputation related to malignancy, trauma, or congenital abnormality were eliminated from the study. Although 25% of the population was black, they accounted for over 39.6% of all amputations. Their relative risk of amputation was greater than nonblacks at all age levels, except for the 0- to 14-year range (Table 2). When controlled models of logistic regression were used, black race was associated with an OR of 2.4 (CI, 2.24–2.56), a greater odds of loss of a lower limb when compared with whites [12].

In another analysis of data on the interaction of race and amputation, Rucker-Whitaker et al. performed a 5-year retrospective analysis on 1127 patients admitted to a specific hospital system for lower extremity bypass, angioplasty, or amputation between January 1, 1995, and February 1, 2000. The purpose of this study was to determine if race was a variable that predicted lower extremity bypass or angioplasty versus amputation of the extremity. From the hospital's administrative claims data, participants were identified by using the ICD-9-CM codes for lower extremity bypass or angioplasty (39.25, 39.29, or 39.50) or for lower extremity amputation (84.15 or 84.17). A logistic regression analysis suggested black race was associated with a 1.68 greater odds ( $p < 0.005$ ) of lower extremity amputation when compared with white race. In addition, the researchers selected 60 cases from blacks and 60 randomly selected cases from whites and compared in a case-control method the difference in amputations between the groups. Although the risk of primary amputations was similar, black race was associated with a 2.5 greater odds for repeat amputation when compared with white race [49].

Feinglass et al. analyzed racially stratified and randomly selected medical charts for 248 black, 235 white or other race, and 30 Hispanic patients older than 35 years of age

**Table 2.** Average annual discharge rates per 100,000 of dysvascular amputation by age and race

Age (years)	Black	Nonblack	Relative risk
0–14	0.3	0.3	1.0
15–24	3	1.4	2.1
25–34	11.4	5.1	2.2
35–44	32.2	13.9	2.3
45–54	117.5	41.6	2.8
55–64	268.8	104.6	2.6
65–74	499.5	209.6	2.4
75–84	938.2	312.7	3.0
85+	1355.2	276.8	4.9

Adapted from Dillingham TR, Pezzin LE, MacKenzie EJ. Racial differences in the incidence of limb loss secondary to peripheral vascular disease: a population-based study. *Arch Phys Med Rehabil.* 2002;83:1255, with permission from Elsevier.

undergoing above- or transtibial (TTA) amputation at three inner-city Chicago teaching hospitals between 1995 and 2003. In multivariate analysis of amputees identified by ICD-9-CM codes 84.15 and 84.17, this group of researchers found that blacks patients were more likely (OR, 1.7;  $p < 0.01$ ,  $p < 0.03$ ) to undergo both primary and repeat amputations [18].

Eslami et al. evaluated the interaction among race, socioeconomic status, and insurance status on the rate of amputation. By accessing the Health Care Utilization Project's National Inpatient Sample, researchers were able to identify 363,193 discharges during which the patient either underwent revascularization or amputation of the lower extremity. Univariate analysis of the data resulted in an association (OR, 1.91; CI, 1.65–2.20) between nonwhite race and amputation. Blacks were also more likely ( $p < 0.001$ ) to undergo amputation than revascularization with 38.8% of the sample receiving amputation versus 20% receiving revascularization [16].

Finally, Feinglass et al. analyzed disparities in amputation in 33,775 discharges in data obtained from the Illinois Department of Public Health between 1987 and 2004. These data represented all discharges in which the patient had an amputation from nine Northern Illinois counties. Discharges in which the patient underwent amputation were selected by using ICD-9-CM codes 84.12 (through foot), 84.15 (below knee), and 84.17 (above knee). Patients younger than age 35 years or with traumatic or cancer-related amputations were excluded from the study. Results from this study indicate that in geographic areas where the population was greater than 50% black, patients were five times more likely to have a lower extremity amputation compared with geographic areas with a primarily white population. In addition, amputation rates for the primarily white geographic locations were substantially different. The incidence of amputation was greater among African

American populations (65 per 100,000) than white populations (12 per 100,000) [17].

In summary, the literature provides many examples of a higher risk and rate of amputation among minority populations, particularly the black population. In the various studies mentioned the increased odds or risk for lower extremity amputation among blacks ranged from 1.7 to 7.6 (Table 1). The incidence of amputation ranged from 5.0 to 6.5 per 10,000 persons compared with 1.2 to 2.5 per 10,000 persons among whites.

### Differences in Level of Lower Extremity Amputation

The level of amputation has a direct impact on an individual's ability to remain a productive member of society [37, 38]. Several studies have shown higher-level amputation results in increased energy costs with mobility, increased rehabilitation needs, decreased use of and satisfaction with a prosthesis, biomechanical disadvantage, and greater financial burden [24, 27, 44]. Prevention of higher-level amputation would assist in preserving an individual's ability to work, attend school, or participate in social activities. Among studies that have evaluated level of amputation, a clear disadvantage exists among minority patients with blacks often more likely to have above-knee amputation when compared with whites (Table 3).

Lavery et al. retrospectively analyzed data on 8169 amputations from the 1991 data from the California Office of Statewide Planning and Development. By using ICD-9-CM codes, these researchers were able to categorize amputation by toe (84.11), foot (84.12), leg (84.13–84.15), and thigh (84.17–84.18). Among the population analyzed, blacks were more likely to have more proximal lower extremity amputations compared with non-Hispanic whites ( $p < 0.001$ ) and Hispanics ( $p < 0.001$ ) [32].

**Table 3.** Differences in level of amputation by race

Lavery et al. 1996 Diabetes Care	8169 Dysvascular amputations	Blacks significantly more likely to receive more proximal amputations when compared with nonwhites ( $p < 0.001$ , $\times 2$ 8.99) and Hispanics ( $p < 0.001$ , $\times 2$ 18.9)
Ashry et al. 1998 Journal of Foot and Ankle Surgery	5062 diabetes-related lower extremity amputations	Blacks with significantly greater costs and length of stay when compared with white reference group; higher costs and longer length of stay associated with higher-level amputations and multiple amputations
Van Houtum et al. 1998 Southern Medical Journal	1043 diabetic-related lower extremity amputations	Black ethnicity to be significantly associated with more proximal lower extremity amputation (OR, 1.76; CI, 1.01–3.90)
Dillingham et al. 2002 Archives of Physical Medicine and Rehabilitation	27,149 discharges with a code of dysvascular amputation	Black race made up 34.4% of the higher level (AKA) amputations when compared with white race with 27.4% of amputations ( $p < 0.001$ )
Lefebvre et al. 2009 Journal of the National Medical Association	80,845 weighted discharges with a code of dysvascular amputation	Black race 50% more likely (OR, 1.51) to receive an above-the-knee amputation when compared with white race

OR = odds ratio; CI = confidence interval; AKA = above-the-knee amputation.



In a separate study of patients hospitalized in six metropolitan statistical areas in southwest Texas, Van Houtum et al. performed a retrospective analysis on 1043 diabetic amputees admitted from January 1 to December 31, 1993. By using ICD-9-CM codes, the authors were able to categorize amputations into below the knee (84.11–84.16) and above the knee (84.17–84.18) and foot (84.11 and 84.12). Following an age-adjusted univariate approach, researchers found black ethnicity was associated (OR, 1.76; CI, 1.01–3.90) with more proximal lower extremity amputation but this relationship did not remain significant on stepwise logistic regression of the data [55]; thus, there is a question as to whether black ethnicity independently predicts a more proximal amputation.

Dillingham et al. analyzed the relationship between race and level of amputation using the ICD-9-CM codes 84.15 and 84.17 to separate above-the-knee (AKA) and below-the-knee (BKA) amputations. Their results reflect a much higher burden of AKA among blacks. In their sample population of 27,149 discharges from Maryland Hospital Discharge Data between 1986 and 1997, individuals of black race were more likely ( $p < 0.001$ ) to have higher-level amputations than whites [11].

Lefebvre et al. performed a retrospective analysis of the Health Care Utilization Project's National Inpatient Dataset for Fiscal Year 2003. By isolating discharges for vascular amputations using ICD-9-CM codes 84.11 to 84.19 and eliminating individuals younger than 35 years of age, a sample of 80,845 (weighted) discharges with a diagnosis of vascular disease and black or white race was analyzed to determine the possible relationship between race and level of amputation. Level of amputation was categorized using ICD-9-CM procedure codes into AKA (84.16–84.19) and BKA amputation (84.11–84.15). Bivariate and logistic regression results from this study

showed a 50% greater odds of AKA amputation associated with black race (OR, 1.51; CI, 1.4–1.7) [33].

Finally, a study by Ashry et al. documented the relationship among cost, length of stay, and level of amputation through a retrospective analysis of 1991 data from the California Statewide Planning and Development office. Although the authors did not directly examine the relationship between race and amputation, they did find increased length of stay and cost of stay were associated with higher-level amputation. In addition, the authors found blacks were more likely to experience greater cost ( $p < 0.05$ ) and greater length of stay ( $p < 0.05$ ) when compared with the reference group. Therefore, it could be inferred that blacks are either experiencing higher-level amputation or more often experiencing multiple amputations [4].

In summary, the literature provides many examples of a level of lower extremity amputation among minority populations, particularly the black population. In the various studies that used logistic regression and reported odds ratio, the increased odds for higher-level amputation among blacks ranged from OR 1.51 to 1.76 (Table 3).

#### Disparities in Amputation in Diabetes

Although there is a clear association between diabetes and amputation and a higher rate of diabetes among minority populations, health disparities associated with amputations among minorities with diabetes are mixed. Individuals with diabetes are more likely to have peripheral sensory neuropathy that can lead to neuropathic nonhealing ulcers and multisegmental infrapopliteal peripheral vascular disease that is less amenable to revascularization (Table 4). Eggers et al. analyzed data on 35,898 amputations on 24,886 patients with end-stage renal disease (ESRD) from the

**Table 4.** Diabetes and disparities in lower extremity amputation

Variation in the incidence and proportion of diabetes-related amputations in minorities	Lavery et al. 1996 Diabetes Care	Diabetes responsible for amputation among 87% of Hispanics, 62% of blacks, and 57% whites; blacks compared with whites $\times 2 = 6.7$ $p < 0.01$
Diabetes mellitus and nontraumatic lower extremity amputation in black and white Americans: the National Health and Nutrition Examination Survey Epidemiologic Follow-up Study, 1971–1992	Resnick et al. 1999 Archives of Internal Medicine	Blacks were significantly more likely than whites to receive lower extremity amputation; the difference, however, is significant only for incident diabetes mellitus (3.4% versus 1.4% [ $p = 0.02$ ])
Effects of ethnicity and nephropathy on lower-extremity amputation risk among diabetic veterans	Young et al. 2003 Diabetes Care	Statistically increased odd (OR, 1.4; CI, 1.31–1.48) of lower extremity amputation among black diabetics when compared with white diabetics
Racial differences in primary and repeat amputation: a multihospital study	Feinglass et al. 2005 Journal of Vascular Surgery	Blacks represented 60.3% of patients receiving primary lower extremity amputations compared with 53.1% of whites; among discharges in which the patient received a repeat amputation, the rate was 23.4% for black patients with diabetes compared with 20.0% of whites with diabetes

OR = odds ratio; CI = confidence interval.

Health Care Financing Administration's program management and information system for the years 1991 to 1994. Among patients with ERSB whose amputation was attributed to diabetic nephropathy, the rates of amputation were extremely high, 118 per 1000 persons in 1991 and 138 per 1000 persons in 1994. However, there was no difference in the rate of amputation between blacks and whites (OR, 2.7 and 2.8, respectively). Not everyone in this sample had diabetes, but the sample had a large population of diabetics, which may have influenced this lack of disparity [14].

Karter et al. is an isolated example of a study in which there were no differences in the rate or risk of amputation in a sample large cohort of patients with diabetes. In this retrospective study of the Northern California Kaiser Permanente Diabetes Registry from 1995 to 1998, 62,432 diabetics were analyzed using proportional hazard regression models to calculate adjusted hazard ratios for risk amputations in addition to other diagnoses such as ESRD, congestive heart failure, myocardial infarction, and stroke. Although black ethnicity was associated with the highest incidence of amputation (4.7 per 1000 versus 4.2 per 1000 in whites), there was no difference between these groups. In addition, during logistic regression analysis, Asian, black, white, and Native American race were not predictive of lower extremity amputation [28].

Although the last two studies demonstrated no differences between rates of amputation among minorities and non-Hispanic whites with diabetics, several studies report a continued disparity in amputation within the diabetic population. Lavery et al. retrospectively analyzed data on 8169 amputations from the 1991 data from the California Office of Statewide Planning and Development. By using ICD-9-CM codes, these researchers were able to categorize amputation by toe (84.11), foot (84.12), leg (84.13–84.15), and thigh (84.17–84.18). One study [32] found blacks were at the greatest risk of amputation among both the diabetic and nondiabetic populations compared with whites. In his sample population, diabetes was associated with amputation in 87% of Hispanics, 62% of blacks, and 57% of non-Hispanic whites. Overall, rates of amputation were 95.25 per 10,000 persons among blacks compared with 55.98 per 10,000 among non-Hispanic whites and 44.43 per 10,000 among Hispanics, a greater ( $p < 0.01$ ) difference than in the diabetic sample. In univariate analysis, there were more amputations resulting from diabetes among blacks and Hispanics compared with non-Hispanic whites.

Resnick retrospectively analyzed 14,407 subjects in the National Health and Nutrition Examination Survey 1971–1992 to determine the relationship among diabetes, race, and amputation. Although diabetes substantially increased the risk of lower extremity amputation in the sample population (OR, 7.19; CI, 4.61–11.22), in subjects with

diabetes mellitus, blacks were more likely than whites (3.4% versus 1.4%, respectively;  $p = 0.02$ ) to have lower extremity amputation for incident diabetes mellitus [47].

Young et al. found an increased odds (OR, 1.4; CI, 1.31–1.48) of lower extremity amputation among blacks with diabetes compared with whites when evaluating 3289 amputations in Veterans Administration hospitals in 1998. The Veterans Administration Patient Treatment file was used for analysis in this study [58].

In addition, Feinglass et al. identified disparities in amputation that remained after analysis of the diabetic population among approximately 500 amputees in three Chicago teaching hospitals in 1995 to 2003. Among the population with diabetes, blacks represented 60.3% of patients receiving primary lower extremity amputations compared with 53.1% of whites. In addition, 23.4% of black patients with diabetes and 20.0% of whites with diabetes required repeat amputation [18].

In summary, the research on racial health disparities in amputation among diabetic patients is mixed with a couple of studies showing a reduction or elimination in health disparities among minorities with diabetics. In studies that report a difference in amputation among patients with diabetes, the differences between white and black amputees were diminished when compared with studies that look at all patients with peripheral vascular disease or diabetes.

The two studies that reported no disparities based on race may offer insights into the disease process, because they studied unique patient populations. The study population from Kaiser Permanente, by definition, was an insured patient population. The elimination of amputation disparities could reflect better standardized medical care, better access to care, or elimination of lower socioeconomic, disadvantaged patients. Likewise, the study by Eggers et al. was in a large cohort of dialysis patients. Dialysis patients may reflect a subpopulation with multiple comorbidities. They may simply be so ill that race or access to medical care is no longer an issue. In this study population, the incidence of amputation was 10 times higher than other studies.

## Discussion

The purpose of this review of the literature was to present data that answers the question “Where are we now?” by examining (1) overall prevalence, incidence, and odds; (2) level of amputation; and (3) the role of diabetes in disparities in lower extremity amputations. This review of the literature has addressed the status of disparities in amputation by showing an increased rate or risk of lower extremity amputations in minorities, a greater risk of higher-level amputation in minorities, and that diabetes

decreases risk of disparities in amputation in minorities in a majority of the studies summarized.

We acknowledge limitations to our review and the literature. First, this review of the literature is based on a general literature search but was not performed at the level of a systematic review. Therefore it should be considered a selective review. Second, the quality of the manuscripts was not assessed in any quantitative fashion. Third, there are methodological issues associated with data collection and analysis of disparities such as racial identification, missing data, and biased data. In-depth discussion of these methodological issues is beyond the scope of this literature review.

#### Where Are We Now?

Blacks and Hispanics with peripheral arterial disease and diabetes experience a greater incidence and odds of amputation when compared with non-Hispanic whites. In addition, the literature also supports a greater severity of amputation as expressed by higher amputation levels among minorities compared with non-Hispanic whites. Finally, patients with diabetes are at less risk for a disparity in amputation when compared with those minorities with a diagnosis of diabetes.

#### Where Do We Need to Go?

Although it is well documented that African American ethnicity predisposes an individual to greater risk of developing peripheral arterial disease, coronary artery disease, myocardial infarction, diabetes, cerebrovascular disease, stroke, and hypertension [3, 8, 20, 26, 44, 52], studies that use multivariate control for the presence of these illnesses continue to support that race has an association with lower extremity amputation [10, 33]. Other predisposing factors that could be lending to this health disparity must be considered.

Therefore, the question remains as to why the differences in rate, risk, and level of amputation exist. Future research is required to address this question and to determine effective solutions. Regardless of increased virulence of disease, to thoroughly consider and examine the disparities that exist, we must consider limitations access to appropriate care, screening, and limb-sparing interventions that could ultimately prevent amputation. Is this an issue of patient compliance, access to preventive screening or preventive interventions, or overall quality of care received? In addressing the question, "Where do we need to go?," future research on disparities in amputation in minorities could focus on determining the patient, provider, and quality-level variables that could lend to these disparities.

Patient variables that could influence health disparities in amputations are individual health choices. Minorities have been noted to participate to a greater extent in adverse health risk behaviors, demonstrate decreased compliance with prescribed medical treatment, and have concerns about their ability to trust medical providers [13, 23, 30]. For example, Oster et al. evaluated the degree to which insured patients' use of diabetes preventive services varied based on race and ethnicity. Based on the results of the approximately 6000, blacks and Hispanics were less likely to use a majority of preventive services when compared with non-Hispanic whites [45]. Although the use of these services was low, diabetes prevention programs are very effective in low-income, minority populations, reducing lengths of hospital stays, rates of amputation, emergency room visits, and antibiotic prescriptions [46, 48]. For preventive care to be effective in reducing the number of amputations, the patient must be compliant with medications, exercise, and routine interactions with their primary care practitioner. A closer evaluation of patient decision-making may determine opportunities to decrease the complications associated with lower extremity peripheral arterial disease.

Provider variables have also been linked to disparate outcomes in the literature. Poor provider decision-making, lack of preventive screening, or interventions, whether based on ignorance, unconscious bias, prejudice, or stereotyping, can result in more complications and mortality from chronic disease. There is ample evidence of provider bias or stereotyping and the impact of physician-patient communication on health throughout the literature [56]. Future research can focus on which physician-level variables or attributes may be associated with the consequence of amputation.

Finally, with regard to quality of care, most studies in the literature support the fact that practitioners are often misdiagnosing or underdiagnosing peripheral arterial disease, especially among minorities [39]. Most studies involving quality assessment recommend investigating patient and physician knowledge of use of the tools to screen for peripheral arterial disease [2]. It is important not only to address whether the tools are being used, but also how and when so an evaluation on outcomes can be assessed. Initiations of screening programs should be monitored for quality control and the subsequent impact of these screening programs on preventing amputations should be considered.

#### How Do We Get There?

A complete elimination of a racial disparity in level of amputation may not be achievable as a result of the



multifaceted nature of health disparities and race [31, 34]. However, by acknowledging the presence of this specific disparity and the variables that lead to the presence of this disparity, it is possible to use the tools at our disposal to maximize the prevention of higher-level amputation. Future research studies can provide us with more information on the patient behaviors that might be contributing to higher rates and risk of amputation in minorities. Quality control measures can be implemented through assessment of a physician's and primary care practitioner's hands-on ability with use of the ankle brachial index and Edinburgh Claudication Questionnaire [36]. Finally, an examination of the impact of increased access to and quality of screening on subsequent amputations could be considered.

We have reviewed the evidence supporting a substantial adverse relationship between race and rate, risk, and level of amputation both with and without the presence of diabetes. There are many avenues to explore this subject matter further with interesting opportunities to research ways in which to prevent or eliminate this disparity.

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