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# Racial and ethnic disparities in lower extremity amputation: Assessing the role of frailty in older adults

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## Abstract

**Background:** Frailty is a state of decreased physiologic reserve contributing to functional decline and is associated with adverse surgical outcomes, particularly in the elderly. Racial disparities have been reported previously both in frail individuals and in limb-salvage patients. Our goal was to assess whether race and ethnicity are disproportionately linked to frailty status in geriatric patients undergoing lower-limb amputation, leading to an increased risk of complications.

**Methods:** A 3-year analysis was conducted of the National Surgical Quality Improvement Program database and included all geriatric (age ≥65 years) patients who underwent amputation of the lower limb. The frailty index was calculated using the 11-factor modified frailty index with a cutoff limit of 0.27 defined for frail status. Outcomes were 30-day complications, mortality, and readmissions. Multivariate regression analysis was performed.

**Results:** A total of 4,218 geriatric patients underwent surgical amputation of a lower extremity (above knee: 41%; below knee: 59%). Of these patients, 29% were frail, 26% were African American, and 9% were Hispanic. Being African American (odds ratio: 1.6 [1.3–1.9]) and Hispanic (odds ratio: 1.1 [1.05–2.5]) was independently associated with frail status. Frail African Americans had a higher likelihood of 30-day complications (odds ratio: 3.2 [1.9–4.4]) and 30-day readmissions (odds ratio: 2.9 [1.8–3.6]) when compared with nonfrail individuals. Similarly, frail Hispanics had higher 30-day complications (odds ratio: 2.6 [1.9–3.1]) and 30-day readmissions (odds ratio: 1.4 [1.1–2.7]) compared with nonfrail Hispanics/Latinos.

**Conclusion:** African American and Hispanic geriatric patients undergoing lower-limb amputation are at increased risk for frailty status and, as a result, increased associated operative complications. These disparities exist regardless of age, sex, comorbid conditions, and location of

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amputation. Further studies are needed to highlight disparities by race and ethnicity to identify potentially modifiable risk factors, decrease frailty, and improve outcomes.

## Introduction

Lower extremity amputation in elderly patients (age ≥65 years) can be devastating. Compared with their younger counterparts, elderly patients tend to have more comorbidities and poorer preoperative functional status, which in turn increases morbidity and mortality.[1] In the United States, the number of patients undergoing lower extremity amputation is growing and is expected to double in the coming decade.[2] A majority (54%) of these amputations are secondary to peripheral arterial disease (PAD) and diabetes mellitus (DM).[2] This rise in amputations is owing to the changing demographics in the United States, which is related to both increasing age and comorbidities.[3] Census data projects by 2030 over 20% of the population will be 65 and older.[4] Furthermore, African Americans and Hispanic Americans are the fastest growing groups in the United States, and they are expected to add more to the population than non-Hispanic Whites over the next decade.[5] Additionally, they have a markedly higher prevalence of DM and PAD and associated morbidities compared with non-Hispanic Whites making them at high risk for an amputation.[6] Therefore, the amputation rates in those above the age of 65 is expected to only rise in the years ahead.

Racial disparities among the surgical population is well established. In vascular patients, Hispanic and African American populations are known to have an increased morbidity and mortality after coronary artery bypass grafting and abdominal aortic aneurysm repair.[6–9] Studies have shown that the amputation risk secondary to PAD is 2 to 3 times higher in Hispanics than non-Hispanic Whites.[2,5] African American patients have a higher incidence of PAD and other comorbidities, such as chronic kidney disease and DM, which makes them higher risk for amputation.[10] Additionally, these patients have higher 30-day post amputation mortality. Multiple studies have tried to understand the reasons for these disparities; however, the reasons remain unclear.

Frailty is a clinical syndrome that is defined as a state of decreased physiologic reserve contributing to functional decline and adverse outcomes.[11] The modified frailty index (mFI) is a simplified scoring model adapted from the Rockwood frailty score and has been established and validated as a predictor of adverse outcomes and predictor of readmission rates.[12,13] Furthermore, frailty is increasingly used for preoperative assessment and risk-stratifying patients.[12,13] We have demonstrated the role of frailty in predicting outcomes in patient undergoing surgery for carotid disease or aortic aneurysm repair.[14,15] Although frailty is an independently well-established marker for postoperative outcomes, the role of frailty and race is unclear. We aimed to assess whether race is associated with frailty status in geriatric patients undergoing lower-limb amputation, and further whether this leads to an increased risk of high mortality and morbidity after amputation. We hypothesized that minority race and ethnicity will correlate with higher rates of frailty and resulting worse clinical outcomes.

## Methods

A 3-year (2012–2014) retrospective analysis of American College of Surgeons National Surgical Quality Improvement Program database inquiring for all patients with peripheral vascular disease undergoing lower extremity amputation. The study was exempt from the institutional review board review.

### Patient population

We included all adults, age ≥65 years patients with a diagnosis of PAD who underwent surgical procedure for a lower extremity amputation (transmetatarsal [common procedural technology (CPT) code: 28805], below-the-knee [BKA: CPT codes: 27880, 27881], or above-the-knee amputation [AKA; CPT codes: 27950, 27951]). Patients undergoing amputation for trauma or orthopedic reasons were excluded. We also excluded patients with missing variables for diagnosis, procedure, or calculation of frailty from the study cohort.

### Data

We collected data regarding patient demographics (age, sex, race, and ethnicity), comorbidities, operative procedures, and 30-day postoperative complications, postoperative mortality, and readmission.

### Calculation of mFI

The mFI-11 was calculated using the 16 variables from NSQIP as defined by Velanovich et al defining the following 11 factors: functional status, history of DM, chronic obstructive pulmonary disease, congestive heart failure, myocardial infarction, angina, hypertension, transient ischemic attack, stroke, peripheral artery disease, and mental status (delirium).[16] Frailty score was calculated as a ratio of the number of positive factors divided by the total number of factors (11). Although all patients had peripheral artery disease, it just gave all patients 1 positive factor. A cutoff limit of 0.27 is defined as frail status.[17,18]

### Outcomes

The primary outcome measure was association of race and ethnicity with frailty status. The secondary outcome measures were 30-day complications, mortality, and readmission. The data was abstracted for the following complications: myocardial infarction, cardiac arrest, cerebrovascular accident, renal failure, deep venous thrombosis, pulmonary embolism, unplanned intubation, pneumonia, wound disruption, and surgical site infection.

### Statistical analysis

We performed descriptive statistics to report the data. Continuous parametric variables are reported as a mean (with standard deviation), continuous nonparametric variables are presented as a median (with interquartile range), and categorical variables are reported as a proportion. Student's $t$ test and Mann-Whitney $U$ test were performed to evaluate the differences between the 2 groups regarding parametric and continuous nonparametric variables, respectively. We used Pearson $\chi^2$ statistic to analyze the differences among categorical variables. Alpha was set at 5% and a $P$ value of less than .05 ($P < .05$) was

considered statistically significant. A multivariate logistic regression analysis was constructed for outcome measures. All analyses were performed using the Statistical Package for Social Services (SPSS, version 24; IBM Corporation, Armonk, NY).

## Results

A total of 4,218 patients were included of whom 29% ($n$ = 1,223) were frail. There was no difference in age ($P$ = .15) or sex ($P$ = .38) between frail and nonfrail patients. However, frail patients were more likely to be of African American ($P$ = .001) race and Hispanic ethnicity ($P$ = .005) compared with nonfrail patients. Table I demonstrates the demographics of the study population stratified by frail and nonfrail.

Table II demonstrates the type of procedure between the 2 groups. BKA was the most common type of amputation in both groups. Frail and nonfrail groups were similar to the type of amputation performed.

On multivariate regression analysis for all factors contributing to frail status such as age, sex, race, body mass index, albumin, functional status, comorbidities (hypertension, DM, chronic obstructive pulmonary disease, coronary artery disease, hyperlipidemia, and congestive cardiac failure), and insurance status, we found that African Americans and Hispanics were more likely to be frail compared with Whites and non-Hispanics, respectively. Age was not associated with frail status. Table III demonstrates the results of regression analysis for frail status.

Table IV demonstrates the results of 3 separate regression analyses performed controlling for sex, race, body mass index, albumin, functional status, comorbidities (hypertension, DM, chronic obstructive pulmonary disease, coronary artery disease, hyperlipidemia, and congestive cardiac failure), insurance status, and type of procedure (transmetatarsal, BKA, and AKA) for each outcome measure (30-day complications, 30-day mortality, and readmission) among frail patients. Frail African Americans and Hispanics were more likely to have 30-day complications and readmission compared with Whites and non-Hispanics, respectively. There was no racial or ethnic difference in 30-day mortality between frail patients.

## Discussion

We analyzed longitudinal data from American College of Surgeons National Surgical Quality Improvement Program database over a 3-year period to assess the role of frailty and race in patients undergoing lower extremity amputation. To our knowledge, this study focusing on race, ethnicity, and frailty in the geriatric amputee is the first of its kind. We found that African American and Hispanic patients were more likely to be frail and to have a corresponding increased rate of complications and readmission after their procedures compared with White race and White non-Hispanics, respectively. These results were significant while controlling for contributing factors such as age, comorbidities, and social and economic factors as well as insurance status.

The association of race and ethnicity and frailty has been established in the geriatric literature; however, it is lacking in surgical patients. Previous studies demonstrate frailty more frequently in African Americans.[19,20] While the research on frailty among Hispanic Americans is limited, there is a recognized strong association between ethnicity and frailty.[21,22] The reasons for these disparities are thought to be owing to higher prevalence of comorbidities, differences in access to care, and a socioeconomic environment with lower incomes and lower educational attainment.[6,22,23] In our study, 33% of African Americans and 35% of Hispanic patients were frail, while 28% of White patients were frail. These differences in frailty can possibly be explained by socioeconomic conditions and access to quality health care We did control for insurance status in our study, but the NSQIP data does not have further socioeconomic variables to analyze, and further studies are needed to elucidate and break down socioeconomic factors in this patient population undergoing amputations. It is well established that African Americans seek out primary care less often than other races,[24] and behavioral risk factors (physical activity and obesity), sociodemographic factors (income, education, race, and ethnicity), and racially specific factors (socially isolated neighborhoods) have also been described as contributing factors for adverse outcomes.[25,26]

In general, studies in vascular patients with PAD suggest that the rate of BKA is slightly higher than that of AKA.[27] In our study, we found similar trends in our nonfrail patients; however, in frail patients, the rate of BKA and AKA were comparable. Specifically, there was no difference in the extent of amputation between frail and nonfrail patients, although there was a trend toward a higher rate of AKA in frail patients, perhaps indicating a lower baseline functional status. This was not statistically significant. The higher rate of AKA in frail patients again likely is a surrogate for the low physiologic reserve in these patients and functional dependence, which might have prompted surgeons to offer AKA over the BKA to ensure wound healing. Subanalyses based on race showed no difference in the type of amputation between the racial groups suggesting that frailty, more than race, may influence level of amputation. More evidence explaining racial and ethnic difference based on type of amputation among surgical patients is needed.

The association between frailty and a higher rate of perioperative complications is well established.[11,14,15,17,18] We wanted to focus only on frail patients and assess factors contributing to outcomes among frail patients. Furthermore, among frail patients undergoing surgery, the additional impact of race and ethnicity has not been established. In our study, independent regression analyses for complications, readmission, and mortality in only frail patients found that African Americans and Hispanics were more likely to have complications and readmission after lower extremity amputation. This suggests that race and ethnicity have an additive impact to frailty on clinical outcomes.

Our study has important limitations. This is a retrospective analysis of a national surgical quality database and not a randomized control trial. We tried to minimize the potential confounders and selection bias using multivariable analysis. There are, however, potential variables not accounted for owing to limitations of the NSQIP database. In addition, the database offers only a 30-day follow-up, prohibiting analysis of longer-term data that may help additional important information. Despite these limitations, we feel our study still

highlights the potential combined influence of both racial and ethnic disparities and frailty on surgical outcomes in vascular patients undergoing amputation.

In conclusion, race and ethnicity are associated with and appear to be additive to frailty status in geriatric patients undergoing lower limb amputations. These disparities exist regardless of age, sex, comorbid conditions, and location of amputation. Therefore, these combined factors need to be thoroughly assessed in comprehensive preoperative planning to develop a patient-centric appreciation of risk-benefit for informed decision-making.

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**Table I**

Demographic and admission characteristic of the study groups

| Characteristics | Frail (*n* = 1,223) | Nonfrail (*n* = 2,995) | *P* value |
|---|---|---|---|
| Age, mean ± SD | 73 ± 4 | 73 ± 9 | .15 |
| Male sex | 64% | 65.4% | .38 |
| White | 60% | 62.8% | .1 |
| African American, % | 29.5% | 24.5% | .001 |
| Hispanic, % | 10.9% | 8.2% | .005 |
| Comorbidities | | | |
| HTN | 74% | 76% | .17 |
| DM | 65% | 67% | .21 |
| CHF | 6% | 5.5% | .53 |
| COPD | 6% | 7% | .23 |
| h/o Stroke/TIA | 14% | 12% | .07 |
| h/o MI/angina | 18% | 15% | .01 |
| Delirium | 19% | 16.5% | .059 |
| Insured | 60% | 62% | .22 |
| BMI, mean ± SD | 21.5 ± 4.2 | 22.8 ± 3.9 | .09 |
| Albumin, <3.5 mg/dL | 30% | 25.4% | .01 |
| Functional dependence | 14% | 10.5% | .001 |

*BMI,* body mass index; *CHF,* congestive heart failure; *COPD,* chronic obstructive pulmonary disease; *HTN,* hypertension; *h/o,* history of; *MI,* myocardial infarction; *SD,* standard deviation; *TIA,* transient ischemic attack.

**Table II**

Type of procedure

| Characteristics | Frail (*n* = 1,223) | Nonfrail (*n* = 2,995) | *P* value |
|---|---|---|---|
| AKA, % | 37.8% | 35% | .09 |
| BKA, % | 37.2% | 38% | .62 |
| TMA, % | 25% | 27% | .2 |

*TMA,* transmetatarsal amputation.

**Table III**

Regression analysis for frail status

| Frail status | OR (95% CI) | *P* |
|---|---|---|
| African American | 1.6 (1.3–1.9) | .02 |
| Hispanics | 1.1 (1.05–2.5) | .03 |
| Age | 1.3 (0.7–3.1) | .51 |

*CI,* confidence interval; *OR,* odds ratio.

**Table IV**

Regression analysis for outcomes among frail status

| Outcomes | OR (95% CI) | *P* |
|---|---|---|
| 30-d complications in frail patients | | |
| African American | 3.2 (1.9–4.4) | .01 |
| Hispanic | 2.6 (1.9–3.1) | .04 |
| 30-d readmission in frail patients | | |
| African American | 2.9 (1.8–3.6) | .03 |
| Hispanic | 1.4 (1.1–2.7) | .025 |
| 30-d mortality in frail patients | | |
| African American | 1.5 (0.9–3.2) | .15 |
| Hispanic | 1.8 (0.8–4.4) | .21 |

*CI*, confidence interval; *OR*, odds ratio.