Family Poverty Accounts for Differences in Lower-Extremity Amputation Rates of Minorities 50 Years Old or More with Diabetes

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Rates of leg amputations in diabetics are known to differ among racial/ethnic groups, but the relationship between family poverty and the risk of amputation has not been fully addressed. One-hundred-seven diabetic patients, all 50 or more years old and all from ZIP code tabulation area 778, underwent their first amputations at one hospital. Linear regression evaluated differences in age and atherosclerosis severity among African-American, Hispanic-American and other patients. χ^2 statistics evaluated differences among African-American, Hispanic-American and other patients, with respect to sex and type of amputation. χ^2 statistics evaluated differences among fractions of African- American, Hispanic-American and other patients, with respect to those residents 50 years old and older and those of poor families. Patient groups did not differ in regard to age, atherosclerosis severity, sex or type of amputation (P>0.05). The percents who were African-American, Hispanic-American, and other (33%, 21%, and 47%, respectively) differed markedly from those of persons 50 or more years old [13%, 7%, and 79%, (w=0.81, P<0.00001)] and mirrored those of poor families [37%, 19%, and 44% (w=0.08, P>0.05)]. Family poverty accounts for differences in diabetic amputation rates of African Americans, Hispanic Americans and other persons 50 or more years old.

Key words: poverty ■ amputations ■ diabetes ■ race ■ ethnicity

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Diabetes afflicts Hispanic Americans and African Americans more than it does other Americans.[1-3] Amputations always occur within hospitals and are evaluated in the pathology department; they can serve as monitors of the incidence of complications of diabetes. Lower-extremity amputation rates have, for this reason, been measured before and studied on several occasions.[4-6] Racial and ethnic comparisons of amputation rates have not been fully performed with specific regard to family poverty. Because St. Joseph Regional Health Center's pathology department receives about three-fourths of hospital-based pathology specimens for the 778 ZIP code tabulation area (ZCTA), where it is centrally located, it seemed reasonable to compare rates of lower-extremity amputation among African Americans, Hispanic Americans and others in the 778 ZCTA. The study showed that, whereas fractions of African-American, Hispanic-American and other amputees differed from those seen among the general population, they mirrored those of poor families.

RESEARCH DESIGN AND METHODS

Research Setting and Study Population

The 2000 U.S. census[7] collected the following data concerning the 778 ZCTA. Of the 248,630 total residents, 55,019 were at or over the age of 50; 34,245 were African Americans and 39,922 were Hispanic Americans. Of the 34,245 African Americans, 7,265 were at or over the age of 50; and of the 39,922 Hispanic Americans, 4,097 were at or over the age of 50. Only 552 persons were both African-American and Hispanic-American, which is less than 0.25% of all persons. Of 56,224 families, 4,920 earned less than $10,000 in 1999. Of those 4,920 families, 1,802 were African-American families and 952 were Hispanic-American families. Centrally located is the St. Joseph Regional Health Center, whose pathology laboratory receives about three-fourths of the anatomic pathology specimens for all hospitals in the 778 ZCTA.

Patients

Pathology accession logs from 1998–2002 from the St. Joseph Regional Health Center were reviewed for lower-extremity amputations. Patients were included if any one of their diagnoses at admission was diabetes mellitus; if they were 50 years old or older at the time of the procedure; if the amputation was nontraumatic; if they lived in the 778 ZCTA; if they had not had a prior lower-extremity amputation; and if, on review of histologic slides, gangrene, osteomyelitis or ischemic infarction was documented. Histologic sections of arteries were evaluated for atherosclerosis severity as follows: arterial occlusion of up to 25% was grade 1; grade 2 was 26–75%; grade 3 was >75% but not complete; and grade 4 was 100%. The type of operation (above-knee or below-knee), race (African-American or not), sex, age and ethnicity (Hispanic-American or not) were recorded. Names and slide numbers were then obliterated, eliminating the possibility of identifying individual patients. The study was approved by the Institutional Review Board of St. Joseph Regional Health Center.

Statistical Analyses

Linear regression[8] evaluated the relationships among age and type of amputation, sex, race and ethnicity. Linear regression also evaluated the relationships among atherosclerosis severity and age, type of amputation, sex, ethnicity and race. In linear regression, the importance of an independent variable is expressed as f^2: f^2 of 0.02 is small, f^2 of 0.15 is medium and f^2 of 0.35 is large.

χ^2 statistics[9] evaluated the relationship between racial/ethnic background and sex and type of operation. χ^2 statistics[10] compared the fractions of African-American, Hispanic-American and other patients with those of 778 ZCTA residents 50 or more years old and the poorest families residing in the 778 ZCTA. For these statistics, the size of differences between expected and observed fractions is expressed as w:w of 0.10 is small, w of 0.30 is medium and w of 0.50 is large.[11]

RESULTS

Patient Characteristics

One-hundred-seven patients (46 men and 61 women) met the inclusion criteria. Thirty-five underwent above-knee amputations and 72 underwent below-knee amputations. Thirty-five patients were African Americans and 22 were Hispanic Americans, while none were both African-American and Hispanic-American. The patients had a mean of 71.21 years of age and a median of 70 years of age, with a range of 50–98 years and a standard deviation of 12.52 years.

Regression on Age (Table 1)

Adjusted for sex, patients who underwent below-knee amputations were 5.57 years younger, on average, than patients who underwent above-knee amputations (f^2=0.05, P<0.05). Adjusted for the type of operation, women were 6.39 years older, on average, than men (f^2=0.07, P<0.05). After sex and the type of operation were taken into account, ethnicity (f^2<0.01, P>0.05) and race (f^2=0.02, P>0.05) each had a small relationship with age that could be explained by chance. There was no reason to think that minority patients differed with respect to age.

Regression on Atherosclerosis Severity (Table 3)

The older the patient was, the worse his or her atherosclerosis was (f^2=0.06, P<0.05). This effect was moderately small. After age was taken into account, amputation type (f^2=0.02, P>0.05), sex (f^2<0.01, P>0.05), ethnicity (f^2<0.01, P>0.05) and race (f^2=0.03, P>0.05) each had a small relationship with atherosclerosis that could have been explained by

Table 1. Results of Linear Regression on Age of Operation, Sex, Ethnicity and Race

Variable	R^2	f^2	F	Degrees of Freedom
Operation	0.04	0.05	4.85*	1, 105
Operation, sex	0.11	0.07	7.52*	1, 104
Operation, sex, ethnicity	0.12	<0.01	0.87**	1, 103
Operation, sex, ethnicity, race	0.13	0.02	2.00**	1, 102

Final Equation	Coefficient	Standard Error
Intercept	71.32	
Operation	-5.57	2.46
Sex	6.39	2.33

All calculated values are rounded to the nearest 0.01; * P<0.05; ** P>0.05

chance. There was no reason to think that minority patients suffered more from atherosclerosis, based on examining the amount of arterial occlusion.

Contingency Tables for Sex and Type of Operation (Table 3)

Sixty-three percent of African-American patients, 59% of Hispanic-American patients and 52% of other patients were women. There was no reason to think that these groups differed with respect to the sex of the patients (w=0.10, P>0.05). Sixty percent of African-American amputees, 77% of Hispanic-American amputees and 68% of other amputees underwent below-knee operations. There was no reason to think that these groups differed with respect to the type of amputation (w=0.13, P>0.05).

Comparisons with U.S. Census Values for 778 ZCTA (Table 4)

The percentages of African-American, Hispanic-American and other patients were 33%, 21% and 0.47%, respectively. For persons 50 or more years old, the values were 14%, 8% and 0.79%, respectively. For poor families, the values were 37%, 19% and 44%, respectively. The proportions do not sum to 100% because of rounding. The patient fractions differed markedly from those of persons 50 or more years old (w=0.81, P<0.000001) and mirrored those of poor families (w=0.08, P>0.05). Patients differ, with respect to race and ethnicity, from similarly aged residents; this difference disappears after taking into account race and ethnicity of poor families who support poor parents.

CONCLUSIONS

African-American, Hispanic-American and other patients did not differ in regard to age at amputation after sex and type of operation were taken into account. African-American, Hispanic-American and other patients did not differ significantly in regard to severity of atherosclerosis after age was taken into account. No significant differences were found among African-American, Hispanic-American and other patients as to the fractions that were women or had below-knee operations. The fractions of patients who were minorities were far greater than those of persons who were 50 or more years old; they differed hardly at all from those of poor families. There is no reason to believe that racial/ethnic differences exist in regards to the risk of amputation after taking family poverty into account.

The results provide an opportunity to understand other studies and extrapolate conclusions. Lavery et al.[6] found 146.59 amputations for African Americans, 94.08 amputations for Mexican Americans and 60.68 amputations for non-Hispanic whites per 10,000 patients. African Americans had, relative to non-Hispanic whites, a 2.42 relative risk; Mexican Americans had, relative to non-Hispanic whites, a 1.55 relative risk. Resnick et al.[5] found that, considering nontraumatic primary lower-extremity amputations in general, the ratio for African Americans to whites was 2.14. Karter et al.[12] studied 62,432 diabetic patients insured through Kaiser Permanente. Although many differences were seen between African-American, Hispanic-American and white patients, lower-extremity amputation rates were the same. The theory that economics may play a role in the risk of complications is supported by Kington and Smith.[1]

Several studies suggest that biological differences in African Americans and Hispanic Americans may account for differences in the incidence of diabetes.[4,13-15] Age is atherogenic;[16] the female sex, premenopausally, is antiatherogenic.[17] After taking sex and amputation type into account, racial/ethnic background bore a small relationship to age that was explainable by chance. With age accounted for, racial/ethnic background bore a small relationship to atherosclerosis that was explainable by chance. Patient groups had small differences in regards to

Table 2. Results of Linear Regression of Atherosclerosis Score on Age, Operation, Sex, Ethnicity and Race

Variable	R^2	f^2	F	Degrees of Freedom
Age	0.05	0.06	5.99*	1, 105
Age, operation	0.08	0.02	2.40**	1, 104
Age, operation, sex	0.08	<0.01	<0.01**	1, 103
Age, operation, sex, ethnicity	0.08	<0.01	0.15**	1, 102
Age, operation, sex, ethnicity, race	0.10	0.03	2.80**	1, 101

Final Equation	Coefficient	Standard Error
Intercept	0.95	
Age	0.02	0.01

The atherosclerosis score is a semiquantitative measure of arterial occlusion by atherosclerosis. All calculated values are rounded to the nearest 0.01; * P<0.05; ** P>0.05

sex and operation type that were explainable by chance. Patient groups with small differences that are explainable by chance are similar. African-American, Hispanic-American and other diabetic amputees are similar with respect to age, severity of atherosclerosis, sex distribution and operation type. Poverty, much more than biology, explains large differences in lower-extremity amputation rates.

Many out-of-hospital factors contribute to the incidence of complications.[2,15,17,18] Diet, proper footwear, appropriate assessment of foot injuries and timely medical intervention all impact the probability of a lower-extremity amputation. Such factors require professional assistance from nurses and dieticians and adequate supplies, such as glucose test strips and good nursing home care; it is unreasonable to suggest that monetary influences do not deleteriously affect patients with diabetes. As the racial/ethnic distribution of patients in this study reflects that of poor families and not that of persons 50 or more years old, it indicates that controlling these out-of-hospital factors may prevent amputations. This is vital information: mortality after amputation is higher among minority patients.[19]

The patients in this study comprised the vast majority of amputees with diabetes in the 778 ZCTA. Of seven nonpsychiatric hospitals with inpatient facilities in the 778 ZCTA, all but one sent specimens to St. Joseph Regional Health Center. Several clinicians asked if patients at this particular hospital differed from those in this study. Because this might imply that this hospital, unlike others in the 778 ZCTA, was not treating indigents—even those with an emergent condition requiring amputation—hospital records were obtained with the support of the chief executive officer. Twenty patients met the inclusion criteria; these patients did not differ from those at St. Joseph Regional Medical Center with respect to sex, age, amputation type, race or ethnicity, either on univariate or multivariate analysis. Including them in this study would have altered none of its conclusions. There was no reason whatsoever to believe that this hospital failed to treat patients in need, regardless of income, age, race or ethnicity. Rather, the blame lies with a healthcare system that inadequately cares for impoverished, elderly, diabetic Americans.

In sum, fractions of African-American, Hispanic-

Table 3. Two-by-Three Contingency Tables of Sex vs. Race and Ethnicity and Type of Operation vs. Race and Ethnicity, with Associated χ^2 and w Values

	African-American	Hispanic-American	Other	χ^2	w
Above-the-knee	14	5	16		
Below-the-knee	21	17	34		
				1.85*	0.13
Men	13	9	24		
Women	22	13	26		
				1.04*	0.10

All calculated values are rounded to the nearest 0.01; * P>0.05 with two degrees of freedom

Table 4. Frequency Distribution of Observed Diabetic Amputees, Stratified by Race and Ethnicity, the Expected Values if the Fractions Reflected Those Seen in 778 ZCTA Residents 50 or More Years Old, the Expected Values if the Fractions Reflected Those Seen among 778 ZCTA Families Earning Less than $10,000 and the Associated χ^2 and w Values.

	African-American	Hispanic-American	Other	χ^2	w
Observed	35	22	50		
Expected, if fractions were those of persons 50 or more years old	14.13	7.97	84.90	69.89*	0.81
Expected, if fractions were those of the poorest families	39.19	20.70	47.11	0.71**	0.08

All calculated values are rounded to the nearest 0.01; * P<0.00001 with two degrees of freedom; ** P>0.05 with two degrees of freedom

American and other patients with diabetes who underwent their first lower-extremity amputations differed from those of the general population and mirrored those of poor families. African-American, Hispanic-American and other patients differed little in regard to sex, operation type, age and atherosclerosis severity. The findings suggest that better care for indigent, elderly patients with diabetes is important to prevent horrible complications for them and their families.

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