

ASSOCIATION BETWEEN RACE, HOUSEHOLD INCOME AND GRIP STRENGTH IN MIDDLE- AND OLDER-AGED ADULTS

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Background: Poor grip strength is an indicator of frailty and a precursor to functional limitations. Although poor grip strength is more prevalent in older disabled African American women, little is known about the association between race and poverty-related disparities and grip strength in middle-aged men and women.

Methods: We examined the cross-sectional relationship between race, socioeconomic status as assessed by household income, and hand grip strength in men and women in the Healthy Aging in Neighborhoods of Diversity across the Life Span study. General linear models examined grip strength (maximum of two trials on both sides) by race and household income adjusted for age, weight, height, hand pain, education, insurance status, family income, and two or more chronic conditions.

Results: Of 2,091 adults, 422(45.4%) were male, 509(54.8%) were African American, and 320 (34.5%) were living in households with incomes below 125% of the federal poverty level (low SES). In adjusted models, African American women had greater grip strength than White women independent of SES (low income household: 29.3 vs 26.9 kg and high income household: 30.5 vs. 28.3kg; $P < .05$ for both); whereas in men, only African Americans in the high income household group had better grip strength than Whites (46.3 vs. 43.2; $P < .05$).

Conclusions: The relationship between grip strength, race and SES as assessed by household income varied in this cohort. Efforts to develop grip strength norms and cut points that indicate frailty and sarcopenia may need to be race- and income-specific. *Ethn Dis.* 2016;26(4):493-500; doi:10.18865/ed.26.4.493.

INTRODUCTION

Hand grip strength is a performance-based measure associated with physical function that predicts risk for loss of independence among community-dwelling older adults.¹⁻¹⁰ Based on the disablement process,¹¹ poor grip strength is considered an impairment that precedes functional limitations and disability. Moreover, because poor grip strength is associated with several adverse health outcomes,⁴ some investigators have proposed this measure as a clinical indicator of health decline^{4,12} as well as an early marker of age-related functional decline that is amenable to interventions.

Although a growing body of research examines grip strength and its relationship to physical function,¹⁻⁴ little work has focused on race and SES-related disparities in grip strength.^{2,13,14} Using data from the Survey of Health, Aging and Retirement in Europe, educational status

and wealth was associated with grip strength in middle- to older-aged men and women.² That is, stronger grip strength was observed in men and women who had more education or wealth. These associations were especially apparent in the lowest quintiles of SES. However, when examining race-differences in grip strength over time in the Study of Women's Health Across the Nation, a decline in grip strength was observed in women who were postmenopausal relative to those who were premenopausal. However, the association between menopausal status and grip strength did not vary by race.¹³ Examining strength and muscle quality in a group of community-dwelling older adults, Blacks had stronger grip strength than Whites.¹⁴ Taken altogether, findings from previous work examining race- or SES-related differences in grip strength indicate that Blacks and those with greater financial resources have stronger grip strength than Whites and those with fewer financial resources.

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While these results have advanced our understanding of disparities in grip strength among older adults, they have been limited to certain populations, including moderately-to-severely disabled women,⁸ perimenopausal women,¹³ and a narrow age range of well-functioning older adults.¹⁴ Less is known about race and SES disparities in functional status including grip strength in middle age adults.¹⁵⁻¹⁷

Efforts to understand race- and SES-related disparities in grip strength suffer from a major problem in health disparities research—con-

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founding of race and SES.^{15,18,19} Race and SES are highly intertwined and both are independently and strongly associated with grip strength.^{2,8,13} Disentangling the effects of race and SES has been difficult because racial minorities typically belong to the low SES group.^{15,18} While the confounding of race and SES is normally addressed by using multivariable modeling, this may be inadequate due to the small number of participants in some of the race/SES groups.^{18,20} Therefore, investigators have begun

to address this issue in their study design by ensuring that there are sufficient numbers of participants within each SES, race, and age group.²¹

Accounting for the confounding of race and SES in study designs may reveal insights to the nature of disparities in grip strength in community-dwelling adults. In this study, we sought to determine the cross-sectional relationship between race, SES as assessed by household income, and hand grip strength in men and women in the Healthy Aging in Neighborhoods of Diversity across the Life Span (HANDLS) study. Specifically, we anticipated that African American and high household income adults would have stronger grip strength than White and low household income adults. We also expected that these relationships would vary by age.

METHODS

Study Population

The HANDLS study is a Baltimore-based epidemiologic, longitudinal study of a fixed cohort of community-dwelling African American and White adults examining the influences and interaction of race and SES on the development of age-associated disparities in health outcomes. Participants were aged 30-64 years at initial enrollment and were drawn from 13 neighborhoods – contiguous US census tracts – in Baltimore City that reflect socioeconomic and racial diversity. Participants were sampled representatively using a heuristic study design, which was a factorial cross of four factors (age, sex, race

and SES) with approximately equal numbers of participants per “cell.”²¹ Individuals who identified with neither African American nor White race were excluded from the study.

HANDLS was conducted by investigators in the Health Disparities Research Section, Laboratory of Epidemiology and Population Sciences of the Intramural Research Program at the National Institute of Aging at the National Institutes of Health (NIH). The study was approved and monitored for human subject protection by the National Institute of Environmental Health Sciences at the NIH. All participants provided written informed consent and received an honorarium for participation. The baseline wave of HANDLS was completed in 2009 yielding 3,720 African American and White participants. This present sample consists of 2,091 African American and White adults who had complete data on hand grip strength.

Measures

Hand grip strength was assessed by trained technicians using a hand Jamar Hydraulic hand dynamometer (Model No. 5030J1 Sammons Preston Rolyan, Bolingbrook, IL) with the participant in a seated position with the elbow of the tested side resting on a table at approximately 160°. Hand grip strength was measured twice in each hand with a 15 to 20 second rest in between trials. If the participant reported surgery within the past three months, or if they had pain and/or arthritis that would impede their ability to successfully complete the hand grip test, the test was not performed. During the testing, participants were strongly encouraged to use

the greatest amount of force possible. The highest measure in the dominant hand was recorded in kilograms.

The main independent variables were race and household income. Participants self-identified as either African American or White, but not both. Poverty status was determined by applying a set of income thresholds that vary by family size and composition issued in 2004 by the U.S. Department

of Health and Human Services Poverty guidelines to report annual income levels. Every participant was assigned a poverty status based on the federal poverty level (FPL). Low household income was defined as an income level at or below 125% of the FPL.

Demographic variables included age (years), sex (1=male; 0=female), and education (<12 years, 12 years, ≥12 years). Health-related factors

included insurance (1=yes; 0=no); hand pain within the past three months (1=yes; 0=no), body weight (in pounds), body height (in inches), and two or more health conditions. Participants reported whether they were told by a physician if they had the following health conditions: diabetes, stroke, hypertension, emphysema, asthma, bronchitis, osteoarthritis and rheumatoid arthritis. Each con-

Table 1. Baseline characteristics by race and poverty status among 2,091 participants in the Healthy Aging in Neighborhoods and Diversity across the Life Span Study

Characteristics	African Americans	White	Low Household Income	High Household Income
Men, n=940	(n=526)	(n=414)	(n=334)	(n=606)
Demographics				
Age, mean ± SD	47.6 ± 9.0	47.9 ± 9.4	47.1 ± 9.3	48.1 ± 9.1
Black, %	N/A	N/A	67.7	49.5 ^a
Low household income, %	43.0	26.1 ^a	N/A	N/A
Education level, %				
<High school graduate	36.3	30.8 ^a	46.8	26.8 ^a
High school graduate	37.1	31.6	32.2	36.6
>High school graduate	26.0	37.6	21.0	36.6
Insured, %	61.8	70.5 ^a	54.1	71.9 ^a
Health-related characteristics				
Hand pain within 3 Months, %	8.6	13.9 ^a	10.2	11.4
Body weight, lb, mean ± SD	189.0 ± 44.2	201.5 ± 46.8 ^a	184.9 ± 43.4	199.9 ± 46.3 ^a
Body height, in, mean ± SD	69.5 ± 2.7	69.6 ± 2.8	69.3 ± 2.7	69.6 ± 2.7
Two or more health conditions, %	24.1	23.2	27.0	21.9
Outcome measure				
Grip strength, mean ± SD	48.0 ± 10.1	46.6 ± 9.7 ^a	46.6 ± 10.0	47.9 ± 9.8
Women, n=1151	(n=631)	(n=520)	(n=439)	(n=712)
Demographics				
Age, mean ± SD	47.8 ± 9.5	47.7 ± 9.3	47.0 ± 9.4	48.2 ± 9.4
Black, %	N/A	N/A	60.6	51.3 ^a
Low household income, %	42.2	33.3 ^a	N/A	N/A
Education level, %				
<High school graduate	28.3	32.9	42.5	22.8 ^a
High school graduate	34.1	31.3	33.2	32.7
>High school graduate	37.6	35.8	24.4	44.6
Insured, %	70.8	72.0	59.3	78.8 ^a
Health-related characteristics				
Hand pain within 3 Months, %	15.0	20.1 ^a	17.5	17.2
Body weight, lb, mean ± SD	189.4 ± 51.6	183.1 ± 52.1 ^a	183.1 ± 53.5	188.7 ± 50.8
Body height, in, mean ± SD	64.6 ± 2.7	64.4 ± 2.6	64.4 ± 2.7	64.6 ± 2.7
Two or more health conditions, %	33.6	30.1	33.3	31.2
Outcome measure				
Grip strength, mean ± SD	31.7 ± 7.3	29.7 ± 6.6 ^a	30.3 ± 7.0	31.1 ± 7.1

a. P<.05.

SD, standard deviation; Health conditions include: diabetes, stroke, hypertension, emphysema, bronchitis, asthma, osteoarthritis, and rheumatoid arthritis.

dition was coded as a binary variable (1=condition present; 0=condition absent). These binary variables were summed to create a variable representing total number of health conditions. A dichotomous variable was created to identify participants who reported two or more health conditions compared to those who reported none or only one health condition.

Statistical Analyses

Student's *t* test and Chi-square tests were used to determine the mean and proportional differences between race and SES categories for demographic, health-related factors, and grip strength. Because there are sex differences in physical performance measures²² and body composition,¹⁴ analyses were stratified by sex. Three general linear models were used to examine the association between race, household income, and grip strength. The first model included age, body weight, body height, and hand pain within 3 months. The second model added education and insurance status. The final models included variables in model 2 plus two or more health conditions. *P*-values <.05 were considered statistically significant and all tests were two-sided. Analyses were conducted using SAS version 9.3 for windows (SAS Institute, Inc., Cary, North Carolina).

RESULTS

The distribution of the baseline characteristics by race and household income for men and women is shown in Table 1. Of the 2,091 participants, 55.3% were African American, 37.1%

Table 2. Adjusted mean grip strength by race and poverty status, 2,091 men and women in the Healthy Aging in Neighborhoods and Diversity across the Life Span Study

	Model 1	Model 2	Model 3
Men, n=940			
Mean grip strength, kg			
African Americans	48.0 ^a	47.9 ^a	48.0 ^a
White	46.2	46.3	46.2
Low household income	46.3 ^a	46.2 ^a	46.3 ^a
High household income	47.9	48.0	47.9
Women, n=1151			
Mean grip strength, kg			
African Americans	31.5 ^a	31.5 ^a	31.5 ^a
White	29.7	29.8	29.8
Low household income	30.1 ^a	30.2 ^a	30.2
High household income	31.1	31.1	31.0

Model 1 adjusted for age, body weight, height and hand pain. Model 2 adjusted for age, body weight, body height, hand pain, education level, and health insurance. Model 3 adjusted for variables in Model 2 plus two or more health conditions.

a. *P*<.05.

belong to low household income group, and 44.9% were male. African American men were more likely to have less than a high school education and less likely to have health insurance than White men. A smaller proportion of African American men reported hand pain in the past three months compared with White men. In addition, African American men had a lower mean body weight but higher mean grip strength than White men. Men who belonged to the low household income group were more likely to be African American, more likely to have less than a high school education, and less likely to have health insurance than men in the high household income group. Men in low income households had a lower mean body weight than men in high income households.

African American women were more likely to belong to the low household income group than White

women. African American women were less likely to report hand pain within the past three months and had higher mean body weight and grip strength than White women. Women in low income households were more likely to be African American, have less than a high school education, and less likely to have health insurance than women who belong to the high household income group.

The adjusted means for grip strength by race and by household income for men and women are shown in Table 2. To assess if the relationship between race and grip strength varied by household income, we included an interaction term representing race, and household income was included in the final sex stratified models. Because the interaction terms were non-significant in sex stratified models (men: *P*=.660; women: *P*=.309), we present only the models that examine the main effects of race and house-

hold income on grip strength for men and women. Among men, African Americans had stronger grip strength than Whites, adjusting for age, body weight, body height, hand pain, education, health insurance status, and two or more health conditions. Men in low income households had lower mean grip strength than men in high income households accounting for potential confounders. Among women, African Americans had stronger grip strength relative to Whites after accounting for age, body weight, body height, hand pain, education, health insurance status, and two or more health conditions. Women in low income households had lower mean grip strength than women in high income households independent of potential confounders.

The adjusted means for grip strength by race, household income and age for men are shown in Table 3. To determine if the relationship between race or household income and grip strength varied by age, we included an interaction term representing race and age, and household income and age in the final sex-stratified models. We observed a significant interaction between race and age among men ($P=.036$); therefore, we examined the relationship between grip strength and age by race among men. Among men who were aged ≤ 49 years, those in low income households had lower mean grip strength relative to those in high income households independent of age, body weight, body height, hand pain, education, health insurance status, and two or more health conditions. There were no race differences observed in grip strength in this age group. Among

men aged ≥ 50 years, African American men had higher mean grip strength than White men after controlling for age, body weight, body height, hand pain, education, health insurance status, and two or more health conditions. There were no household income differences observed in grip strength in this age group.

DISCUSSION

Our study provides evidence that African American adults had stronger grip strength than White adults. We also observed that men in low income households had lower grip strength relative to men in high income households. Further, for men aged ≤ 49 years, those in low income households had lower grip strength than men in high income households. For men aged ≥ 50 years, African Americans had greater grip strength than White men. These findings highlight

the importance of disentangling the effects of race, household income, and age to understand disparities in grip strength for men and women.

Hand grip strength is a key indicator of future adverse health outcomes⁴ and is essential to maintaining independence.^{1-3,5,23} Previous research has shown that hand grip strength is related to future adverse health outcomes such as poor physical performance which is known to be associated with independence. We found race differences in grip strength that corroborate with the work of previous investigators,^{13,14} but extend to middle-aged community-dwelling adults. One explanation for the greater grip strength in African American adults is that African Americans may have greater muscle mass⁸ and muscle quality¹⁴ than Whites. In this study muscle mass and quality were not obtained. However, African American women on average were 6 pounds heavier than White women

Table 3. Adjusted mean grip strength by race and poverty status for men by age in the Healthy Aging in Neighborhoods and Diversity Across the Life Span Study (n=940)

	Model 1	Model 2	Model 3
Aged ≤ 49 years, n=518			
Mean grip strength, kg			
African Americans	49.8	49.5	49.6
White	48.8	48.9	48.9
Low household income	48.1 ^a	47.8 ^a	48.0 ^a
High household income	50.5	50.7	50.5
Aged ≥ 50 years, n=422			
Mean grip strength, kg			
African Americans	45.8 ^a	45.9 ^a	46.0 ^a
White	43.2	43.2	43.2
Low household income	44.2	44.4	44.5
High household income	44.8	44.8	44.7

Model 1 adjusted for age, body weight, height and hand pain. Model 2 adjusted for age, body weight, body height, hand pain, education level, and health insurance. Model 3 adjusted for variables in Model 2 plus two or more health conditions.

a. $P < .05$.

suggesting that perhaps muscle mass may have played a role in racial differences in grip strength in women. However, African American men in this study weighed an average of 12 pounds less than White men. The reason that African American men weigh less than White men but have stronger grip strength is unclear. Additional efforts are needed to understand the relationship between muscle quality, muscle mass and disparities in grip strength in men.

Our study provides evidence that African American adults had stronger grip strength than White adults.

Our finding that African Americans had greater grip strength than Whites was inconsistent with the work of Haas and colleagues, which examined data from the Health and Retirement Study and found that African Americans had worse grip strength than Whites. After accounting for socioeconomic differences and health differences in childhood and adulthood,²⁴ Haas and colleagues hypothesized that historical persistent segregation and discrimination might account for race differences. One explanation for the differences in our findings and the Haas study is age difference between the two studies' participants. The age range for our study was aged 30 to 64 years at baseline; whereas the age range for the Haas

study was between 51 and 80 years. It is likely that the relationship between race and grip strength is modified by age. We observed that the relationship between race and grip strength was modified among men. African American men who were aged ≥ 50 years had greater grip strength than White men aged ≥ 50 . Selective survival may have affected the association between race and grip strength among older men in our study. It is also possible that the sicker African American men may not have participated in the study.²⁵ Additional work is needed to explain the race differences in grip strength in older African American men.

In addition to race differences in grip strength, we observed SES differences in grip strength among men. There is a lack of studies that have examined the relationship between SES and hand grip performance, especially on adult-aged women and men in minority groups; however our findings are consistent with prior work.^{2,3,26} For example, in the Survey of Health, Aging and Retirement in Europe, SES assessed by educational status and wealth was associated with grip strength in men and women aged ≥ 50 years.² In a representative cohort of 53-year-old British men and women in the 1946 Birth Cohort Study, poor grip strength was associated with lower SES³ and social factors such as childhood differences in social environments.²⁶ Although our findings extend to middle-aged African American and White adults, we only examined one aspect of SES (ie, household income).

Limitations

Our findings have some limitations. Although our sample is an

area probability sample of Baltimore City, it includes only African American and White adults aged between 30 and 64 years. It is unclear if these findings differ in suburban or rural areas in Maryland or elsewhere. However, these data have considerable strengths. Health status was determined by physical examinations by a physician, clinical laboratory assays, and extensive medical histories. We measured grip strength following a well-established protocol. That is, in this study the use of grip strength is an objective measure of physical performance that is not plagued with the biases inherent to self-report.^{2,27} That is, self-report measures can be influenced by race and SES-related factors such as social and cultural norms and expectations regarding the meaning of difficulty as well as health care resources and use.^{15,28,29} Another strength is that the HANDLS study participants are a socioeconomically diverse group of African American and White adults aged between 30 and 64 years.

CONCLUSION

Grip strength is an important indicator of functional status among community-dwelling adults. Our study found that grip strength varied by race, with African Americans exhibiting stronger grip strength than Whites. SES differences were observed among men whereby men who belong to low household income group had lower grip strength than men who belong to the high household income group. Race and household income differences in grip strength vary by age among men with household

income differences occurring in the younger age group and race differences occurring in the older age group. Additional research should consider the role of psychosocial factors and occupation in understanding the observed race and SES (assessed beyond household income) differences in grip strength among middle-aged adults.

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CONFLICT OF INTEREST

No conflicts of interest to report.

AUTHOR CONTRIBUTIONS

Research concept and design: Thorpe, Zonderman, Evans; Acquisition of data: Zonderman, Evans; Data analysis and interpretation: Thorpe, Simonsick, Zonderman, Evans; Manuscript draft: Thorpe, Simonsick, Zonderman, Evans; Statistical expertise: Thorpe; Acquisition of funding: Zonderman, Evans; Administrative: Zonderman, Evans; Supervision: Simonsick, Evans.

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