Discrimination, Racial Bias, and Telomere Length in African-American Men

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Background: Leukocyte telomere length (LTL) is an indicator of general systemic aging, with shorter LTL being associated with several chronic diseases of aging and earlier mortality. Identifying factors related to LTL among African Americans may yield insights into mechanisms underlying racial disparities in health.

Purpose: To test whether the combination of more frequent reports of racial discrimination and holding a greater implicit anti-black racial bias is associated with shorter LTL among African-American men.

Methods: Cross-sectional study of a community sample of 92 African-American men aged between 30 and 50 years. Participants were recruited from February to May 2010. Ordinary least squares regressions were used to examine LTL in kilobase pairs in relation to racial discrimination and implicit racial bias. Data analysis was completed in July 2013.

Results: After controlling for chronologic age and socioeconomic and health-related characteristics, the interaction between racial discrimination and implicit racial bias was significantly associated with LTL (b=−0.10, SE=0.04, p=0.02). Those demonstrating a stronger implicit anti-black bias and reporting higher levels of racial discrimination had the shortest LTL. Household income-to-poverty threshold ratio was also associated with LTL (b=0.05, SE=0.02, $p<0.01$).

Conclusions: Results suggest that multiple levels of racism, including interpersonal experiences of racial discrimination and the internalization of negative racial bias, operate jointly to accelerate biological aging among African-American men. Societal efforts to address racial discrimination in concert with efforts to promote positive in-group racial attitudes may protect against premature biological aging in this population.

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Introduction

African-American men experience disproportionately greater chronic disease burden and accelerated declines in health compared to other racial and gender groups in the U.S.[1–4] Overall life expectancy for African-American men is 69.7 years, compared to 75.7 years for white men.[4] African-American men experience aging-related diseases earlier in life and suffer greater severity and worse consequences of disease compared to other groups.[5,6] These racial disparities in health may be traced to disproportionately greater psychosocial stressors experienced by African-American men, particularly those uniquely tied to racial minority status.[7–10]

Racial discrimination constitutes a qualitatively distinct stressor, which continues to be salient and pervasive in the lives of African Americans.[11,12] Several studies have found that experiences of racial discrimination, in domains such as employment, housing, education, and legal contexts, as well as more routine experiences of being treated with less courtesy or respect are perceived as being stressful.[12–14] These experiences may affect disease risk via mental health pathways as well as through maladaptive behavioral coping mechanisms.[15–20] Racial

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discrimination can also have more direct effects on health through its impact on biological systems engaged in the stress response.[21] Self-reports of racial discrimination have been associated with a range of biological markers of stress, including neuroendocrine risk markers for poor health outcomes, glucocorticoids, and pro-inflammatory cytokines.[15,21–24] Further, negative psychological responses coupled with the experience of racial discrimination may have particularly deleterious effects on disease vulnerability.[25] Holding a negative evaluation of one's own racial group may constitute an additional source of psychosocial stress and may moderate the effect of racial discrimination.[26–29] Adopting negative in-group racial attitudes may lead to poor self-concept by impeding positive racial identity formation. These characteristics may compromise the ability to cope with stressors, particularly those associated with race, and increase vulnerability to psychosocial challenges.[30–34]

Along these lines, experiences of racial discrimination and in-group racial bias may have negative implications for aging at the biological level. In particular, there is growing interest in studying telomere length in the development and progression of aging-related diseases.[35–37] Telomeres are repetitive sequences of DNA at the ends of chromosomes that protect against DNA degradation. In eukaryotes, the DNA sequences at the terminal end of the lagging strand are lost during replication.[38,39] By capping the ends of chromosomes, telomere attrition occurs in most adult somatic cells with each mitotic cycle, resulting in an annual loss of 50–100 base pairs. In this respect, telomeres are important in supporting chromosomal stability, and critically short telomeres are associated with cellular senescence. Accordingly, telomere length has been posited to be a marker of replicative history and aging at the cellular level.[40,41] Telomere length from leukocytes are generally preferred to telomere length from other cell types as they may reflect overall immune health, and has been posited to be a marker of general systemic aging of the organism. Leukocyte telomere length (LTL) has been associated with several aging-related health outcomes such as cardiovascular disease, diabetes, dementia, Alzheimer's disease, and arthritis, as well as earlier mortality, in addition to their associated risk factors (e.g., biological, behavioral, and environmental).[42–46] Importantly, studies suggest that psychosocial and physiologic stressors can lead to accelerated LTL shortening and may be a mechanism that helps to explain differences in the onset of chronic diseases.[47–49] For example, depression, financial stressors, strains associated with caregiving, and health behaviors such as exercise and smoking have all been associated with LTL.[50–54]

Together, research suggests that identifying factors that affect LTL can be informative in examining variations in disease risk and understanding racial disparities in health.[55–57] Although some cross-sectional studies have found no racial differences in LTL or that African Americans may in fact have longer LTL,[58–60] other recent studies have found that African Americans have shorter telomeres and/or undergo a faster rate of LTL shortening compared to whites.[55–57,60] For example, although perhaps initially having longer LTL than whites, a recent study found a steeper inverse association between chronologic age and LTL for African Americans.[60] Similarly, a longitudinal cohort study found that African Americans had a faster rate of telomere shortening compared to whites.[57]

As a marker of cumulative stress and physiologic wear and tear, LTL may be a particularly relevant biological marker of health to study in relation to racial minority stressors that are experienced throughout the life-course.[61] The current study is the first to examine whether experiences of racial discrimination and in-group racial bias are associated with LTL in a community sample of African-American men. In-group racial bias was measured using the black–white Implicit Association Test (IAT), an experimental technique that assesses unconscious racial attitudes.[62,63] The IAT measures the speed with which participants match images of faces and words with positive and negative valence with their respective categories (African American/white and good/bad). Faster pairings are posited to be more closely associated with representations in memory. National studies have found that 70% of people in the U.S. display an implicit anti-black bias, including about half of African Americans, making on average faster categorizations when mapping the African American–bad and white–good pairing condition in comparison to the African American–good and white–bad condition.[64] The IAT may be a more valid measure of in-group racial bias compared to explicit reports given that it is not susceptible to environmental or other extraneous factors, and because performance is not influenced by the provision of socially desirable responses.[64]

Consonant with racial identity frameworks, this study tested whether there would be a significant interaction between racial discrimination and implicit racial bias, with racial discrimination having a steeper negative association with LTL among those holding a greater implicit anti-black bias. Specifically, it was hypothesized that those reporting high levels of racial discrimination and who display an implicit anti-black bias would have the shortest LTL among black middle-aged men.

Methods

Study Design and Procedures

Data were from a cross-sectional study of African-American men. A total of 95 African-American men were recruited between

February 2010 and May 2010 from the San Francisco Bay Area. Eligibility criteria for participation were (1) self-identification as an African-American man; (2) aged between 30 and 50 years; (3) U.S. nativity and parental U.S. nativity; (4) absence of serious or unstable disease (e.g., cancer, HIV/AIDS, tuberculosis, hepatitis); and (5) ability to read, write, and understand English.

Participants were recruited from socioeconomically diverse neighborhoods and at outlets where the population was most accessible, including churches, barbershops, and community events; through self-referral from posted advertisements; and via word of mouth. Eligible participants were provided with an appointment date and time to meet study staff in a private location in a nonclinical setting (e.g., university room, church). Study procedures were (1) a brief face-to-face interview assessing basic demographic characteristics; (2) a minimally invasive physical exam; (3) administration of the IAT; and (4) a computer-assisted self-interview including more sensitive measures of racial discrimination, psychological factors, and socioeconomic measures. The physical exam included the collection of anthropometric data and dried blood spots (DBS). Collection of DBS samples entailed pricking the finger with a micro-lancet, wiping away the first drop of blood, and applying four subsequent drops, each approximately 50 μL to filter paper.[65] Blood samples were allowed to dry and stored at −80°C.

Participants provided informed consent and were compensated with a $70.00 gift card. All study procedures were approved by the University of California San Francisco Committee on Human Research.

Leukocyte Telomere Length Assay

The Blackburn laboratory at the University of California, San Francisco, conducted LTL assays. The protocol was adapted from previously published methods.[66–69] Genomic DNA was purified from DBS using QIAamp DNA Investigator Kit. This kit is used to obtain high-quality DNA that can be used in downstream analysis such as quantitative PCR (qPCR), which is the most commonly used method to obtain average telomere length. An average of 56 ng (range: 12 ng–340 ng) of total DNA was obtained from six of 3-mm punched spots. Telomere length was measured twice, each time using half of the obtained DNA. The average coefficient of variation between the two runs was 6.3%. A recent study reported very high correlations between telomere length from DBS and telomere length from both whole blood (R^2=0.741) and peripheral mononuclear blood cells (R^2=0.789).[70] Technical information on the LTL assay procedure is presented in Appendix A (available at www.ajpmonline.org). The mean LTL in this study is consistent with expected values based on a prior study of midlife men that used the same line of control cells.[71]

Implicit Association Test

Implicit racial bias was assessed using the black–white IAT administered to participants via computer using Inquisit software. The IAT is a continuous measure that ranges from −1 to +1, with a score of zero representing neutral. Increasing scores less than zero indicate a stronger pro-black bias, whereas those greater than zero reflect a stronger anti-black bias. Test–retest reliability of the IAT has been shown to be high.[64]

Supporting the validity of the IAT as a measure of unconscious racial bias, a study found that those with a stronger anti-black bias reported greater explicit prejudice against blacks and also had greater negative interactions with a black experimenter as rated by an independent judge.[72] Research on the IAT in health domains have focused on provider bias and its potential role in the treatment and outcomes of patients[73,74]; however, studies on implicit racial bias in relation to an individual's own health status are in their infancy. One study reported that lower racial bias is associated with lessened stress response, and greater anti-black bias is associated with decrements in executive function among white participants when interacting with blacks.[75,76] There is a paucity of research examining the IAT specifically in African-American samples. A study of African Americans found that in-group racial bias predicted greater attentional impairment when interacting with whites.[77] A recent study found a positive association between racial discrimination and hypertension risk among African Americans with an implicit anti-black bias.[78]

Racial Discrimination

Racial discrimination was measured using the situation version of the Experiences of Discrimination (EOD) questionnaire.[79] Participants were asked whether they had experienced discrimination because of their race in nine situations: getting a job; at work; getting housing; getting medical care; getting service at a store or restaurant; getting credit, bank loans, or a mortgage; on the streets or in other public settings; or from the police or in the courts. The total number of situations in which racial discrimination was reported ranged from 0 to 9. The EOD is a commonly used and validated measure of racial discrimination.[79,80]

Sociodemographic Characteristics

Sociodemographic variables that were examined included self-reported age and poverty ratio calculated as the ratio of household income to the poverty threshold based on family size, with higher ratios reflecting lower levels of poverty.[81] Categorical variables were educational attainment (high school or less versus some college or more) and employment status (employed versus unemployed). These variables were dichotomized based on the frequency of responses and because using more detailed categories did not change results. Relationship status (currently married, never married, or formerly married); occupation (nonmanual, manual, or unemployed) coded from self-reported primary job; and insurance status (insured or uninsured) based on current coverage were also examined but excluded because they were not significantly related to LTL and did not show evidence of confounding the relationship between primary predictors and LTL.

Health-Related Variables

The number of physical health conditions was assessed using a checklist of 22 common diseases (e.g., cardiovascular diseases, diabetes, cancer, renal disease). Scores in this sample ranged from 0 to 9, with 0 being the most commonly reported (33.7%). The most frequently reported conditions were seasonal allergies, chronic back or neck problems, and other chronic pain. Doctor-prescribed medication use in the past week was assessed using a single item (yes versus no). Current smokers were defined using CDC-recommended criteria as those who reported smoking at

least 100 cigarettes in their lifetime and currently smoking at least "some days."[82] Waist–hip ratio was calculated by dividing waist circumference by hip circumference in inches.[83]

Data Analysis

Two outlying LTL values of 4.00 kilobase pairs (kb) and 6.91 kb (3.56 times the SD below and 3.18 times the SD above the mean) were excluded from analyses.

Ordinary least squares (OLS) regressions were used to examine continuous measures of racial discrimination, implicit racial bias, and their interaction in relation to LTL. Sociodemographic factors were added to the model in a single block group, followed by health-related covariates. Regression diagnostics consistently revealed one extremely influential observation that had the highest Cook's D (0.11; cut-off: 0.04) and DFITS (1.18; cut-off: 0.69), which indicate observations with the greatest residual and leverage. Accordingly, this observation was deleted from the analyses, resulting in a total analytic sample size of 92 participants. Including this observation in analyses lessened the magnitude of associations but did not result in substantively different conclusions. Analyses were completed in July 2013 using SAS, version 9.3, statistical software. Data analysis was completed in July 2013.

Results

Leukocyte telomere length values ranged from 4.80 to 6.44 kb (M=5.54; SD=0.38). Participants reported experiencing racial discrimination in several different situations. Only six participants (6.5%) reported not experiencing discrimination in any of the nine situations. Sixteen participants (17.4%) reported racial discrimination in 1–3 situations; 31 participants (33.7%) in 3–6 situations; and 39 participants (42.4%) in 7–9 situations. Most commonly reported was racial discrimination from the police or in the courts, which was endorsed by 79 (85.9%) of the African-American men in this study. This was followed by racial discrimination in getting a job (n=67, 72.7%) and at work (n=65, 70.7%). In this sample, 58 participants (63%) had IAT scores less than zero, reflecting an implicit pro-black bias; 34 participants (37%) had IAT scores greater than zero, reflecting an implicit anti-black bias.

Descriptive analyses revealed high levels of unemployment (54.3%). Furthermore, 29.2% participants were below the poverty threshold and 28.1% had poverty ratios between 1.00 and 1.99. Less than half of participants (42.7%) had poverty ratios of 2.00 or above. Additional sociodemographic characteristics of the sample are presented in Table 1.

In bivariate analyses, there was no association between racial discrimination or implicit racial bias on LTL. Significant bivariate relationships with demographic variables were the following: increasing age was associated with shorter LTL; greater household income to poverty threshold was associated with longer LTL; and prescription drug use was associated with shorter LTL.

Table 1. Distribution of characteristics in the sample of African-American men

Characteristic	M (SD) or n (%)
Leukocyte telomere length (kb)	5.54 (0.38)
Racial discrimination	5.55 (2.73)
Implicit racial bias	−0.14 (0.35)
Age[***]	43.86 (5.72)
Poverty ratio[**]	1.95 (2.24)
Education, n (%)	
High school or less	38 (41.3)
Some college or more	54 (58.7)
Employment status, n (%)	
Employed	42 (45.7)
Unemployed	50 (54.3)
Smoking, n (%)	
Noncurrent	41 (44.6)
Current	51 (55.4)
Health conditions	1.73 (1.89)
Prescription medications,[**] **n (%)**	
No	63 (68.5)
Yes	29 (31.5)
Waist–hip ratio	0.92 (0.07)

*$p<0.05$, **$p<0.01$, ***$p<0.001$, indicating significant bivariate relationships with leukocyte telomere length

Supplementary analyses revealed no significant relationships between demographic variables and implicit racial bias.

There were no main effects of racial discrimination (b=−0.02, SE=0.02, p=0.28) and implicit racial bias (b=−0.09, SE=0.11, p=0.44) in an OLS regression model examining LTL that included these two variables, but as predicted there was a significant interaction between them (b=−0.10, SE=0.04, p=0.02; Table 2, Model 1). This interaction remained significant after controlling for sociodemographic factors (Model 2) as well as health-related variables (Model 3). Age, poverty ratio, and prescription drug use remained significant covariates in the final model.

Predicted LTL values were calculated for varying levels of racial discrimination and implicit racial bias. Values of 4, 6, and 8 were chosen to represent low, moderate, and high levels of racial discrimination, which correspond to quartile values. The median value on the IAT among participants with values less than zero (−0.31)

Table 2. Linear regressions predicting leukocyte telomere length in kilobase pairs among African-American men, b (SE)

	Model 1	Model 2	Model 3
Intercept	5.68 (0.09)***	6.20 (0.30)***	6.57 (0.53)***
Racial discrimination	−0.03 (0.02)	−0.01 (0.01)	−0.02 (0.01)
Implicit racial bias	0.51 (0.27)	0.53 (0.26)*	0.54 (0.26)*
Discrimination × bias	−0.10 (0.04)*	−0.10 (0.04)*	−0.10 (0.04)*
Age		−0.01 (0.01)*	−0.02 (0.01)*
Poverty ratio		0.06 (0.02)**	0.05 (0.02)**
Some college versus high school or less		−0.08 (0.08)	−0.08 (0.07)
Unemployed versus employed		−0.09 (0.08)	−0.08 (0.08)
Current versus nonsmoker			0.00 (0.08)
Health conditions			0.01 (0.02)
Medication: yes versus no			−0.22 (0.08)**
Waist–hip ratio			−0.23 (0.53)
R^2	0.08	0.27	0.33

*$p<0.05$, **$p<0.01$, ***$p<0.001$

and greater than zero (value=0.13) were chosen to represent those with an implicit pro- versus anti-black bias, respectively. Mean values were used for continuous covariates, and the overall proportion of participants belonging to a group for categorical covariates was used in order to calculate LTL values for the average participant. Figure 1 illustrates that among participants with a pro-black bias, there was a slight positive relationship between racial discrimination and LTL. In contrast, among those with an anti-black bias, there was an inverse relationship between racial discrimination and LTL.

Discussion

African-American men face unique psychosocial stressors that contribute to worsening health. Among these challenges are legally sanctioned forms of discrimination, such as "stop-and-frisk" policies, and pervasive racial profiling across multiple domains, ranging from the judicial system to healthcare contexts.[84–87] Studies also indicate that African-American men are susceptible to racial discrimination in obtaining jobs and in mortgage markets, although expressly prohibited by law[88–92]; in addition to everyday social insults and aggressions through interpersonal interactions.[12,14,93] Results from this study suggest that such experiences result in physiologic tolls among those who have internalized negative racial group attitudes.

Specifically, racial discrimination was associated with shorter LTL among African-American men with an implicit anti-black bias. African-American men with an implicit bias against their own group may be compromised in their ability to psychologically manage or cope with stress resulting from racial discrimination.[94–96] Holding an anti-black bias in tandem with the experience of externally perpetrated racial discrimination may represent threats to both self- and group identity and together have especially detrimental consequences for telomeric aging.[27,31] In contrast, holding a pro-black bias may serve as a buffer against racial stressors.[27,97]

Results are consistent with prior studies that have found that those with a bias against their own racial group are more vulnerable to the impact of racial stigma, and that greater in-group identification and positive racial

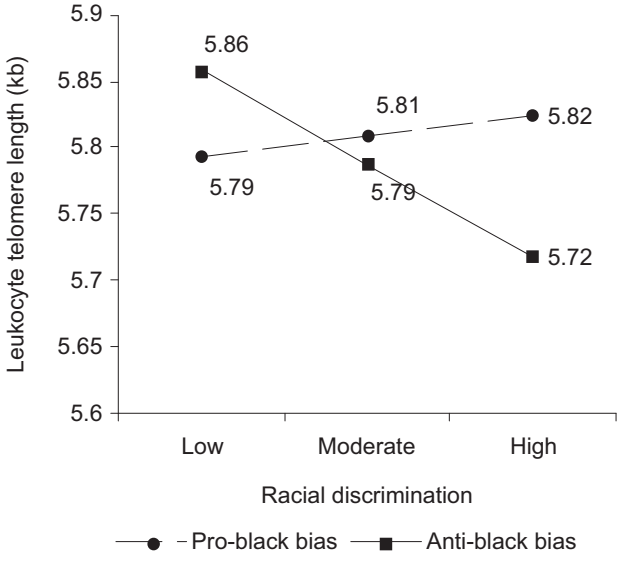

Figure 1. Predicted leukocyte telomere length by racial discrimination and implicit racial bias among African-American men

Note: Quartile values were chosen to represent low (4); moderate (6); and high (8) levels of racial discrimination. Median values for participants with values less than zero and greater than zero on the Implicit Association Test were chosen to represent those with an implicit pro-black and anti-black bias, respectively.

evaluation may lessen the negative impact of racial discrimination.[27,31,96–98] One possible interpretation is that those who internalize negative racial group attitudes may be more likely to perceive that experiences of discrimination against the target group are deserved. Conversely, among those with a pro-black bias, interpreting adverse experiences as being racially motivated may have self-protective properties by deflecting from personal deficiencies and through attribution of blame to external factors.[99,100]

The finding of a significant interaction between racial discrimination and implicit racial bias is supportive of theories of minority stress and discrimination, which highlight both personally mediated and internalized forms of racism as risk factors for poor health.[7,9,10] Results are also in accordance with frameworks that integrate the role of racial identity as a moderator of the effect of racial discrimination.[28] Dimensions of racial identity have been found to play a key role in whether individuals interpret negative experiences as being racially motivated, and subsequently also influence the extent to which self-reports of racial discrimination are appraised as being stressful.[101,102] Among those with an anti-black bias, racial discrimination may represent an additional source of threat; whereas among those with a pro-black bias, reports of racial discrimination may reflect a greater awareness of issues of systemic social inequality and may not necessarily be perceived as sources of stress.

In addition to these main findings, this study contributes methodologic and technical knowledge, and evidence for other substantive associations. This study assayed LTL from DBS, which future research using community samples may employ as a minimally invasive alternative to venipuncture.[65] DBS can be readily collected in non-clinical settings and can facilitate studies including biomarkers of health. Results also contribute to evidence indicating that socioeconomic factors affect biological aging,[103–105] extending research in this area by showing that poverty is associated with LTL in a sample exclusively of African-American men. Endemic socioeconomic disparities experienced by African Americans may also contribute to LTL shortening in this population.

The cross-sectional design of this study limits inferences regarding the causal direction of associations. For example, it is possible that worse health associated with shorter LTL could result in greater perceptions of racial discrimination. Although a number of socioeconomic and health-related covariates were controlled for in analytic models, there are additional unmeasured constructs (e.g., neighborhood factors) such that alternative explanations cannot be discounted. Possible analytic concerns include those related to sample size and the selection and operationalization of covariates, which may have resulted in spurious findings. The purposive sampling of African-American men from the San Francisco Bay Area also limits the generalizability of findings to the broader community in this area, as the characteristics of participants differed from those of the underlying population. Generalizability to other groups is also limited, including to women, the elderly, and those residing in other geographic regions. Accordingly, replication of these findings in other samples is warranted.

Despite these caveats, results are suggestive of potential pathways that have not been previously examined, and offer new directions for measurement and research on the health of African-American men. This study merges perspectives from different disciplines and demonstrates the importance of integrating research on in-group racial bias in studies of racial discrimination and health. Incorporating this typically understudied aspect of racial minority stress can further elucidate reasons for pervasive racial disparities in aging and the disproportionately greater disease burden faced by African-American men. Findings suggest that racial discrimination in concert with the internalization of racial bias has pernicious effects on biological aging, and that this is one pathway through which social inequities generate greater disease vulnerability in this population.

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Appendix

Supplementary data

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