

Racial discrimination associated with higher diastolic blood pressure in a sample of American Indian adults

Zaneta M. Thayer¹  | Irene V. Blair² | Dedra S. Buchwald³ | Spero M. Manson⁴

¹Department of Anthropology, Dartmouth College, NH 03755

²Department of Psychology and Neuroscience, University of Colorado Boulder, CO 80309

³Elson S Floyd College of Medicine, Washington State University, WA 99163

⁴Center for American Indian and Alaska Native Health, University of Colorado Denver, CO 80204

Correspondence

Zaneta M. Thayer, Department of Anthropology, Dartmouth College, Hinman Box 6047, Hanover, NH 03755
Email: zaneta.thayer@dartmouth.edu

Funding Information

Grant sponsorship: This project was funded by NHLBI R01 HL073824 and GCRC NIH grant M01 #RR00051.

Abstract

Objectives: Hypertension prevalence is high among American Indians (AIs). AIs experience a substantial burden of interpersonal racial discrimination, which in other populations has been associated with higher blood pressure. The purpose of this study is to understand whether racial discrimination experiences are associated with higher blood pressure in AIs.

Materials and Methods: We used the Everyday Discrimination Scale to evaluate the relationship between discrimination and measured blood pressure among 77 AIs from two reservation communities in the Northern Plains. We used multivariate linear regression to evaluate the association of racial discrimination with systolic and diastolic blood pressure, respectively. Racial discrimination, systolic blood pressure, and diastolic blood pressure were analyzed as continuous variables. All analyses adjusted for sex, waist circumference, age, posttraumatic stress disorder status, and education.

Results: We found that 61% of participants experienced discrimination that they attributed to their race or ancestry. Racial discrimination was associated with significantly higher diastolic blood pressure ($\beta = 0.22$, $SE = 0.09$, $p = .02$), and with a similar non-significant trend toward higher systolic blood pressure ($\beta = 0.25$, $SE = 0.15$, $p = .09$).

Conclusion: The results of this analysis suggest that racial discrimination may contribute to higher diastolic blood pressure within Native communities. These findings highlight one pathway through which the social environment can shape patterns of biology and health in AI and other socially and politically marginalized groups.

KEYWORDS

cardiovascular disease, indigenous, native health, racism, stress physiology

1 | INTRODUCTION

Although originally founded as the scientific discipline to document distinct racial types, anthropologists have since been among the most staunch advocates for the argument that race is a social, rather than biologically meaningful, construction (Montagu, 1942). That said, there are substantial disparities in health, particularly with respect to chronic diseases, among racialized minorities in the US (Adler and Stewart, 2010). When discussed, such findings often reify popular conceptions regarding the biological reality of race. In particular, there is a tendency to assume that there are substantial genetic differences between socially described racial groups, and that these in turn contribute to disparities in health among groups (Gravlee, 2009; Madrigal, Blell, Ruiz, &

Otárpala-Durán, 2009). In response to these findings, many anthropologists now adopt a more nuanced approach to race; this involves acknowledging that race is a social construction, but that the social experience of race can have important impacts on biology and actually shape racialized inequalities in health (Gravlee, 2009; Kuzawa and Sweet, 2009; Thayer and Kuzawa, 2011). Research is therefore needed to understand the biological processes through which the social experience of race can shape patterns of human biology and health.

One pathway through which the social experience of race can impact biology is through physiological responses to interpersonal racial discrimination. In particular, repeated racial discrimination can contribute to chronic and continued activation of stress physiology systems (Dressler, Oths, & Gravlee, 2005; Jackson, Knight, & Rafferty,

2010; Turner, 2009). The impact of racial discrimination on blood pressure is frequently cited as an example of this pathophysiological process (Brondolo, Love, Pencille, Schoenthaler, & Ogedegbe, 2011; Dolezsar, McGrath, Herzig, & Miller, 2014), and has been well documented among African Americans and Hispanics (Beatty Moody, Waldstein, Tobin, Cassells, Schwartz, & Brondolo, 2016; Dolezsar et al., 2014; Krieger and Sidney, 1996). In this regard, a meta-analysis of 44 articles published between 1970 and 2012 found that perceived racial discrimination was associated with hypertensive status (Dolezsar et al., 2014). In sum, these findings suggest that health disparities among African Americans and Hispanics may be attributed, in part, to the experience of racial discrimination across the life course (Berger and Sarnyai, 2014; Lewis, Cogburn, & Williams, 2015).

Another population for whom interpersonal racial discrimination may impact health are American Indians (AIs). AIs, the subset of indigenous peoples living in the continental US, reflect diverse tribal backgrounds and cultures, but experience common social, political, and economic disadvantage (Kunitz, Veazie, & Henderson, 2014; Schultz, Walters, Beltran, Stroud, & Johnson-Jennings, 2016). These disadvantages are often manifested in the form of adverse health outcomes. Although data directly measuring blood pressure are limited for this group relative to others, prior research using self-report data has found that the prevalence of hypertension among AIs is among the highest of all ethnic/racial groups in the US, in both men (Centers for Disease Control and Prevention, 2003; Liao, Bang, Cosgrove, Dulin, Harris, Taylor, . . . Giles, 2011) and women (Liao et al., 2011). Although emerging research among AIs highlights the impact of socioeconomic disadvantage on health (Roh, Brown-Rice, Lee, Lee, Lawler, & Martin, 2015; Schell and Gallo, 2012), this work has largely neglected the potential additional contribution of racial discrimination to the risk and course of chronic disease.

Although the relationship between discrimination and blood pressure among AIs has not been investigated previously, there is some evidence to suggest that discrimination does influence other aspects of health among AIs. For example, among AI youth, discrimination, when combined with adolescent anger, has been related to early alcohol use (Les Whitbeck, Chen, Hoyt, & Adams, 2004; Whitbeck, Hoyt, McMorris, Chen, & Stubben, 2001) and depressive symptoms (Johansson, Muller, Samos, & Goldberg, 2013; Whitbeck, McMorris, Hoyt, Stubben, & LaFromboise, 2002). Among gay, lesbian, and bisexual AIs—referred to as two-spirited persons in Native communities—racial discrimination has been linked to greater physical pain and impairment (Chae and Walters, 2009). Lastly, AIs who experience discrimination in healthcare settings have been shown to receive standard care (Burgess, Ding, Hargreaves, van Ryn, & Phelan, 2008), such as less frequent monitoring of blood pressure (Gonzales, Lambert, Fu, Jacob, & Harding, 2014). None of these studies examined the relationship between discrimination and blood pressure among AIs. That relationship, if any, is therefore unclear.

Given this background, the purpose of our study is to evaluate whether self-reported racial discrimination is associated with higher clinically measured blood pressure among a sample of AIs from the

Northern Plains. This research can contribute to our understanding of how the social experience of race, a substantial source of stress for socially stigmatized groups, shapes patterns of human biology and health.

2 | METHODS

2.1 | Materials and Methods

Detailed sample characteristics can be found in a previous report (Thayer, Barbosa-Leiker, McDonell, Nelson, Buchwald, & Manson, 2016). Briefly, data for this analysis are derived from the Healing Hearts study of tribal individuals from two reservation communities in the Northern Plains. The purpose of Healing Hearts was to compare individuals with posttraumatic stress disorder (PTSD) to age, sex, and tribe matched non-PTSD participants to understand how PTSD may have shaped cardiovascular disease risk. Thus, within the Healing Hearts sample, approximately half of the participants had been diagnosed with lifetime PTSD. A primary exclusion criterion was overt cardiovascular disease. In addition, participants could not have a condition that would make it unsafe for them to travel to the clinical site in Aurora, Colorado, including unstable angina, myocardial infarction in the past week, severe obstructive lung disease, decompensated heart failure, severe coronary disease, or severe stroke. Although 197 individuals were recruited into the Healing Hearts study, discrimination data were only collected for 107 participants. Twenty-eight participants were then excluded from the analysis due to use of antihypertension medication, which would medically control blood pressure, and an additional two participants were missing one or more blood pressure measurements. This resulted in a final analysis sample of 77 individuals. Healing Hearts received approval from the Colorado Multiple Institutional Review Board and by the local tribal communities.

2.2 | Study measures

2.2.1 | Discrimination

The Williams Everyday Discrimination Scale (EDS; Williams, Yu, Jackson, & Anderson, 1997) was used to assess racial discrimination. Nine questions asked about specific discrimination experiences. In response to the preamble, "In your day-to-day life, how often do the following things happen to you?", participants indicated if they had been treated with less courtesy than other people; treated with less respect than others, etc. Response alternatives were presented on a 5-point Likert scale: never (0), less than once/year (1), a few times per year (2), a few times per month (3), at least once a week (4), or almost every day (5). An EDS score was calculated for each participant by summing scores across the 9 questions. Cronbach's alpha for the EDS score in this sample was 0.89, indicating high reliability (Gonzales et al., 2014).

In response to "What do you think is the main reason for these experiences?", participants answered "yes" or "no" with regard to ancestry, race, gender, height, weight, some other aspect of your appearance, sexual orientation, age, religion, education or income, or

other. For the purposes of this study, racial discrimination was defined as checking “yes” to ancestry or race, alone or in combination with other causes. A racial EDS score was created, such that the continuous EDS score was used for participants who cited ancestry and/or race as a cause, and “0” was used for participants who said they were discriminated against for reasons not including ancestry and/or race, or who reported no discrimination at all. Values for the racial EDS score ranged from 0 to 35 out of a possible 45.

2.2.2 | Blood pressure

Participants traveled to the University of Colorado Anschutz Medical Campus for a total of three days. Blood pressure was collected twice in the afternoon on two days using a standard mercury sphygmomanometer according to the protocol developed by the Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure (Anonymous, 1997). Systolic and diastolic values were collected at each time point, with measures averaged across the four collection points.

2.2.3 | Covariates

Participant sex, age (years), and education (college graduate or not) were included as covariates based on a prior meta-analysis that found these factors to be significant covariates in a model using racial discrimination to predict blood pressure (Dolezsar et al., 2014). Since half of the sample had PTSD, and PTSD has been associated with elevated blood pressure (Kibler, Joshi, & Ma, 2009), we also adjusted for PTSD. Waist circumference was added as an additional covariate given the relationship between this variable and elevated blood pressure (Janssen, Katzmarzyk, & Ross, 2004).

2.2.4 | Data analysis

All continuous variables were initially assessed for normality. Multiple linear regression was used to evaluate the study hypothesis that racial discrimination, as indexed by racial EDS score, was predictive of higher blood pressure. Racial discrimination was used to predict both diastolic

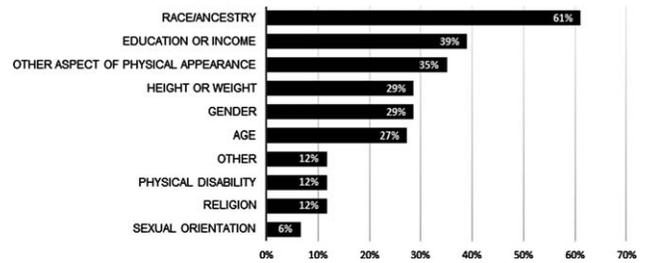


FIGURE 1 Percent of total sample reporting discrimination associated with each specific cause. Participants were allowed to select more than one cause

and systolic blood pressure, respectively, with both blood pressure measurements analyzed as continuous variables. Both analyses adjusted for waist circumference, sex, age, PTSD, and college education.

3 | RESULTS

Eighty-eight percent of the sample reported having experienced some form of discrimination (all causes). The most common reported cause of discrimination was race/ancestry (61% of total sample; 68% of those reporting discrimination; Figure 1). Sample characteristics, stratified by racial discrimination exposure, are summarized in Table 1. Among individuals reporting any racial discrimination experience, mean (SD) systolic blood pressure was 128.1 (15.4) mm Hg and diastolic blood pressure was 77.9 (10.4) mm Hg. Individuals not reporting racial discrimination had mean (SD) systolic and diastolic blood pressure values at 125.9 (11.7) mm Hg and 76.6 (7.4) mm Hg, respectively.

In multivariate regression models, racial EDS score, a continuous measure of racial discrimination exposure, was significantly associated with higher mean diastolic blood pressure ($\beta = 0.22$ mm Hg, SE = 0.09, $p = .02$; Table 2). Although it showed a similar effect size, mean systolic blood pressure was not significantly associated with racial EDS score ($\beta = 0.25$ mm Hg, SE = 0.15, $p = .09$).

TABLE 1 Summary statistics of study sample stratified by racial discrimination experience

	Total sample (N = 77)	No Racial discrimination (N = 30)	Racial discrimination (N = 47)
Age (year)	41.3 (9.4)	39.0 (8.3)	42.7 (9.9)
Women, N (%)	56 (71%)	20 (67%)	36 (73%)
Waist circumference (cm)	101.0 (15.9)	105.2 (16.8)	98.4 (14.9)
BMI (Kg/m ²)	30.8 (7.9)	32.0 (8.3)	30.2 (7.6)
Systolic blood pressure (mm Hg)	127.2 (14.0)	125.9 (11.7)	128.1 (15.4)
Diastolic blood pressure (mm Hg)	77.4 (9.4)	76.6 (7.4)	77.9 (10.4)
Racial EDS score	9.3 (10.4)	0	15.0 (9.5)
College graduates, N (%)	7 (9%)	1 (3%)	6 (13%)
Married, N (%)	29 (38%)	12 (40%)	17 (36%)
PTSD, N (%)	36 (47%)	13 (43%)	23 (49%)

Mean and SD for continuous variables; count and percentage for categorical variables.

TABLE 2 Regression models predicting diastolic and systolic blood pressure, respectively, in response to racial discrimination, as indexed by EDS score ($N = 77$)

	Diastolic blood pressure			Systolic blood pressure		
	β	SE	p	β	SE	P
Racial EDS score	0.22	0.09	0.02 ^a	0.25	0.15	0.09
Female	-8.59	2.10	<0.0001 ^a	-9.80	3.40	0.005 ^a
Waist circumference	0.04	0.06	0.5	0.17	0.10	0.11
Age	-0.18	0.11	0.12	-0.006	0.18	0.97
PTSD	1.31	1.96	0.50	1.84	3.17	0.56
College	1.10	3.67	0.76	2.27	5.95	0.70
Adjusted model R^2			0.22			0.09

^a $p < 0.05$.

4 | DISCUSSION

We found that diastolic blood pressure was positively associated with racial discrimination experience. Although the magnitude of the relationship between racial discrimination and blood pressure was similar for both systolic and diastolic values, this relationship only reached statistical significance for diastolic blood pressure. Systolic blood pressure is often considered the better predictor of cardiovascular disease (Franklin, 2007), but for individuals <50 years of age—the average age of the current sample—diastolic blood pressure has been found to be a stronger predictor of cardiovascular disease than systolic blood pressure (Franklin, Larson, Khan, Wong, Leip, Kannel, & Levy, 2001). The results of this analysis are therefore consistent with the hypothesis that racial discrimination may contribute to the high prevalence of cardiovascular disease observed in AIs (Harris, Nelson, Muller, & Buchwald, 2015).

AIs have the shortest life expectancy of any major racial or ethnic group in the US (Arias, Xu, & Jim, 2014), and a high prevalence of hypertension and stroke (Harris et al., 2015). However, the causes underpinning these health inequities are much more poorly understood compared to other groups. Important research in other, non-AI minority groups has highlighted the biological pathways through which social inequalities, such as racial discrimination, can impact health (Brondolo, Ver Halen, Pencille, Beatty, & Contrada, 2009; Dressler et al., 2005; Pascoe and Smart Richman, 2009; Salomon and Jaguszyn, 2008; Williams and Mohammed, 2013). In addition to blood pressure, research has found that racial discrimination is associated with elevated stress hormones such as cortisol (Berger and Sarnyai, 2014; Thayer and Kuzawa, 2015), decreased heart rate variability (Wagner, Lampert, Tennen, & Feinn, 2015), and higher allostatic load (Brody, Lei, Chae, Yu, Kogan, & Beach, 2014). This study therefore represents a first step toward ascertaining one of the biological pathways through which discrimination experienced by Native peoples may impact health within these communities.

Prior research evaluating the relationship between racial discrimination and blood pressure in non-Native populations has yielded some

inconsistent results. Some studies, such as the present one, reported the strongest associations with diastolic blood pressure; others noted impacts on systolic blood pressure; still others found neither or both (Brondolo et al., 2011; Couto, Goto, & Bastos, 2012). This inconsistency could be attributable to many things, such as differences in self-reported versus actually measured blood pressure, as well as differences in the use of specific discrimination scales (Lewis et al., 2015). There also appear to be differences in the relationship between discrimination and blood pressure across socially described racial groups. As an example, a meta-analysis found that the relationship between racial discrimination and diastolic blood pressure was positive for Blacks, but negative for Whites (Dolezsar et al., 2014). These results suggest that the experience of racial discrimination may have stronger and more negative impacts on blood pressure and other physiological systems (Zeiders, Doane, & Roosa, 2012) when experienced by racial minorities. This could reflect differences in anticipation of prejudice between minority and majority individuals (Sawyer, Major, Casad, Townsend, & Mendes, 2012), as well as greater exposure to racial discrimination across multiple domains, including housing, employment, and health care, among minorities (Krieger, 2012).

Although not addressing the relationship between racial discrimination and blood pressure directly, prior anthropological research has addressed how the social experience of race influences blood pressure. Gravlee et al., working in Puerto Rico, demonstrated that social classification of race, which shapes interpersonal interactions, was more strongly predictive of blood pressure than either objectively measured skin color (Gravlee, Dressler, & Bernard, 2005) or genetic ancestry markers (Gravlee, Non, & Mulligan, 2009). Sweet et al., working with a nationally representative sample of African Americans, found that individuals with darker skin and higher incomes had higher systolic blood pressure, while the relationship between incomes and systolic blood pressure was in the opposite direction for individuals with lighter skin (Sweet, McDade, Kiefe, & Liu, 2007). The results of our analysis are consistent with these prior studies in suggesting that sociocultural pathways are important mediators of the relationship between the construct of race and blood pressure (Dressler, Oths, Balieiro, Ribeiro,

& Dos Santos, 2012). Interestingly, in our analysis, all-cause discrimination was not significantly associated with diastolic or systolic blood pressure (data not shown). These findings suggest that racial discrimination is a particularly salient stressor among AIs, potentially due to the compounded experiences of colonization and historical trauma that shape individual reaction to, and experience of, racial discrimination in this cultural context (Fast and Collin-Vézina, 2010). Additional ethnographic research would be helpful for constructing culturally meaningful models of racial discrimination experience among Native communities.

Conducting studies that evaluate the impact of environmental influences, such as racial discrimination, on blood pressure is important to challenge deterministic approaches that assume health disparities, including but not limited to differences in hypertension, reflect inherent genetic differences between groups. Although many deterministic models, such as the Slavery hypothesis (Wilson and Grim, 1991), have been widely critiqued by anthropologists (e.g., (Madrigal et al., 2009), the idea that biological difference equates to genetic difference remains an attractively simple explanation for health disparities since it removes culpability from society (Kaufman and Hall, 2003). Ideally, studies would incorporate both genetic and environmental information together, to understand the independent or combined influences of these factors on the outcome of interest. As an example of this type of study, Boulter et al. reported that there was a significant interaction between an *Alu* insertion polymorphism in the angiotensin-1-converting enzyme gene with a measure of unfair treatment in predicting blood pressure among a sample of African Americans (Boulter et al., in press). Aside from interacting with genetic variation, discrimination and other environmental exposures may influence gene expression via changes in epigenetic regulation of genes (Thayer and Non, 2015). Additional research is necessary to understand how environmental exposures, the genome, and the epigenome interactively influence complex biological outcomes such as blood pressure.

Racial discrimination has been previously associated with depressive symptoms, substance abuse, and physical pain and impairment among AIs, alluding to the broad mental and physical impacts of this form of discrimination (Chae and Walters, 2009; Johansson et al., 2013; Whitbeck et al., 2001, 2002). Importantly, enculturation, which refers to cultural embeddedness as measured by practicing traditional culture and self-reported cultural identity, as well as actualization, which refers to a dimension of racial identity attitude development, had protective influences in these prior studies. This suggests that strong cultural identities and/or engagement in cultural institutions could potentially help to buffer the negative impacts of racial discrimination on blood pressure reported in the present study, and should be investigated in future studies.

While this study is notable for using the gold standard measurement approaches for both discrimination (Quah, 2016) and blood pressure (Tholl, Forstner, & Anlauf, 2004), there are nonetheless several limitations to this study that deserve acknowledgment. The data are cross-sectional, with discrimination experiences and blood pressure measured over the course of the same three-day period. However,

blood pressure was not collected immediately following the discrimination questionnaire, reducing the likelihood that recalling discrimination experiences may have elicited a stress response and elevated blood pressure in participants. That said, the experience of coming to the study site could be inherently stressful and may have therefore elevated blood pressure among all participants. In addition, other factors not adjusted for in the present analysis, including health behaviors such as physical activity, could also contribute to differences in blood pressure recorded here (Borrell, Kiefe, Diez-Roux, Williams, & Gordon-Larsen, 2013). Since the discrimination instrument was added after the study had already begun, discrimination data were missing for many participants in the larger Healing Hearts study. Finally, the use of a standardized discrimination scale, although useful for comparing the results of this study to those of prior studies in non-Native samples, is also limiting in that it may not capture locally salient models of social status and discrimination. Future research among AIs is needed to verify these reported relationships in larger samples, as well as from other reservation and nonreservation communities.

5 | CONCLUSION

Anthropologists have been documenting biological differences between socially described racial groups for many years. What makes contemporary work different from earlier approaches is an emphasis on how environmental exposures may shape patterns of variation, instead of the assumption that biological differences reflect inherent genetic differences between groups (Gravlee, 2009; Madrigal et al., 2009). This study contributes to growing inquiry into if and how racial inequalities in health may be mediated by interpersonal interactions, and whether social constructions of race shape biological differences (Berger and Sarnyai, 2014; Dolezsar et al., 2014; Gravlee, 2009; Lewis et al., 2015). The fact that racial discrimination was associated with diastolic blood pressure suggests that this is a particularly salient stressor among AIs. Unfortunately, indigenous peoples in the US and elsewhere have long experienced extreme poverty and social disenfranchisement, both of which contribute to continued experiences of racial discrimination (Gone and Trimble, 2012). Given that the life experiences of Native people vary substantially across urban, rural, and reservation communities, there is a need to characterize the different forms that racial discrimination may take across these settings, as well as how such experiences may affect the risk and course of chronic diseases.

ACKNOWLEDGEMENTS

We thank the study participants and the participating tribes for their contribution to this research. Alanna Purdy assisted with the literature review. This project was funded by NHLBI R01 HLO73824 and GCRC NIH grant M01 #RR00051. ZT analyzed the data for the analysis and drafted the manuscript. DB and SM designed the original study and led data collection. IB, DB, and SM provided critical comments on the manuscript.

REFERENCES

- Adler, N. E., & Stewart, J. (2010). Health disparities across the lifespan: Meaning, methods, and mechanisms. *Annals of the New York Academy of Sciences*, 1186, 5–23.
- Anonymous. (1997). The sixth report of the National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. *Archives of Internal Medicine*, 157, 2413–2446.
- Arias, E., Xu, J., & Jim, M. A. (2014). Period life tables for the Non-Hispanic American Indian and Alaska Native population, 2007–2009. *American Journal of Public Health*, 104, S312–S319.
- Beatty Moody, D. L., Waldstein, S. R., Tobin, J. N., Cassells, A., Schwartz, J. C., & Brondolo, E. (2016). Lifetime racial/ethnic discrimination and ambulatory blood pressure: The moderating effect of age. *Health Psychology*, 35, 333.
- Berger, M., & Sarnyai, Z. (2014). 'More than skin deep': Stress neurobiology and mental health consequences of racial discrimination. *Stress*, 1–32.
- Borrell, L. N., Kiefe, C. I., Diez-Roux, A. V., Williams, D. R., & Gordon-Larsen, P. (2013). Racial discrimination, racial/ethnic segregation, and health behaviors in the CARDIA study. *Ethnicity & Health*, 18, 227–243.
- Boulter, A. C., Quinlan, J., Miró-Herrans, A. T., Pearson, L. N., Todd, N. L., Gravlee, C. C., & Mulligan, C. J. (In press). Interaction of Alu Polymorphisms and Novel Measures of Discrimination in Association with Blood Pressure in African Americans Living in Tallahassee. *Human Biology*, 87.
- Brody, G. H., Lei, M.-K., Chae, D. H., Yu, T., Kogan, S. M., & Beach, S. R. H. (2014). Perceived discrimination among African American adolescents and allostatic load: A longitudinal analysis with buffering effects. *Child Development*, 85(3), 989–1002.
- Brondolo, E., Love, E. E., Pencille, M., Schoenthaler, A., & Ogedegbe, G. (2011). Racism and hypertension: A review of the empirical evidence and implications for clinical practice. *American Journal of Hypertension*, 24, 518–529.
- Brondolo, E., Ver Halen, N. B., Pencille, M., Beatty, D., & Contrada, R. J. (2009). Coping with racism: A selective review of the literature and a theoretical and methodological critique. *Journal of Behavioral Medicine*, 32, 64–88.
- Burgess, D. J., Ding, Y., Hargreaves, M., van Ryn, M., & Phelan, S. (2008). The association between perceived discrimination and underutilization of needed medical and mental health care in a multi-ethnic community sample. *Journal of Health Care for the Poor and Underserved*, 19, 894–911.
- Centers for Disease Control and Prevention. (2003). Health status of American Indians compared with other racial/ethnic minority populations—selected states, 2001–2002. *MMWR Morbidity and Mortality Weekly Report*, 52, 1148.
- Chae, D. H., & Walters, K. L. (2009). Racial discrimination and racial identity attitudes in relation to self-rated health and physical pain and impairment among two-spirit American Indians/Alaska Natives. *American Journal of Public Health*, 99, S144–S151.
- Couto, P. F., Goto, J. B., & Bastos, J. L. (2012). Blood pressure and interpersonal discrimination: systematic review of epidemiologic studies. *Arquivos Brasileiros De Cardiologia*, 99, 956–963.
- Dolezsar, C. M., McGrath, J. J., Herzig, A. J., & Miller, S. B. (2014). Perceived racial discrimination and hypertension: A comprehensive systematic review. *Health Psychology*, 33, 20.
- Dressler, W. W., Oths, K. S., Balieiro, M. C., Ribeiro, R. P., & Dos Santos, J. E. (2012). How culture shapes the body: Cultural consonance and body mass in urban Brazil. *American Journal of Human Biology*, 24, 325–331.
- Dressler, W. W., Oths, K. S., & Gravlee, C. C. (2005). Race and ethnicity in public health research: models to explain health disparities. *Annual Review of Anthropology*, 34, 231–252.
- Fast, E., & Collin-Vézina, D. (2010). Historical trauma, race-based trauma and resilience of indigenous peoples: A literature review. *First Peoples Child & Family Review*, 5, 126–136.
- Franklin, S. S. (2007). The importance of diastolic blood pressure in predicting cardiovascular risk. *Journal of the American Society of Hypertension*, 1, 82–93.
- Franklin, S. S., Larson, M. G., Khan, S. A., Wong, N. D., Leip, E. P., Kannel, W. B., & Levy, D. (2001). Does the relation of blood pressure to coronary heart disease risk change with aging? The Framingham Heart Study. *Circulation*, 103, 1245–1249.
- Gone, J. P., & Trimble, J. E. (2012). American Indian and Alaska Native mental health: Diverse perspectives on enduring disparities. *Annual Review of Clinical Psychology*, 8, 131–160.
- Gonzales, K. L., Lambert, W. E., Fu, R., Jacob, M., & Harding, A. K. (2014). Perceived racial discrimination in health care, completion of standard diabetes services, and diabetes control among a sample of American Indian women. *The Diabetes Educator*, 40, 747–755.
- Gravlee, C. C. (2009). How race becomes biology: Embodiment of social inequality. *American Journal of Physical Anthropology*, 139, 47–57.
- Gravlee, C. C., Dressler, W. W., & Bernard, H. R. (2005). Skin Color, Social Classification, and Blood Pressure in Southeastern Puerto Rico. *American Journal of Public Health*, 95, 2191–2197.
- Gravlee, C. C., Non, A. L., & Mulligan, C. J. (2009). Genetic Ancestry, Social Classification, and Racial Inequalities in Blood Pressure in Southeastern Puerto Rico. *PLoS One*, 4, e6821.
- Harris, R., Nelson, L. A., Muller, C., & Buchwald, D. (2015). Stroke in American Indians and Alaska Natives: A systematic review. *American Journal of Public Health*, 105, e16–e26.
- Jackson, J. S., Knight, K. M., & Rafferty, J. A. (2010). Race and unhealthy behaviors: chronic stress, the HPA axis, and physical and mental health disparities over the life course. *American Journal of Public Health*, 100, 933–939.
- Janssen, I., Katzmarzyk, P. T., & Ross, R. (2004). Waist circumference and not body mass index explains obesity-related health risk. *The American Journal of Clinical Nutrition*, 79, 379–384.
- Johansson, P., Muller, C. J., Samos, M. W., & Goldberg, J. (2013). The influence of perceived discrimination on health-related quality of life in an East Coast American Indian tribe. *Journal of Health Care for the Poor and Underserved*, 24, 1531–1541.
- Kaufman, J. S., & Hall, S. A. (2003). The slavery hypertension hypothesis: Dissemination and appeal of a modern race theory. *Epidemiology*, 14, 111–118.
- Kibler, J. L., Joshi, K., & Ma, M. (2009). Hypertension in relation to post-traumatic stress disorder and depression in the US National Comorbidity Survey. *Behavioral Medicine*, 34, 125–132.
- Krieger, N. (2012). Methods for the Scientific Study of Discrimination and Health: An Ecosocial Approach. *American Journal of Public Health*, 102, 936–944.
- Krieger, N., & Sidney, S. (1996). Racial discrimination and blood pressure: The CARDIA Study of young black and white adults. *American Journal of Public Health*, 86, 1370–1378.
- Kunitz, S. J., Veazie, M., & Henderson, J. A. (2014). Historical trends and regional differences in all-cause and amenable mortality among American Indians and Alaska Natives since 1950. *American Journal of Public Health*, 104, S268–S277.

- Kuzawa, C. W., & Sweet, E. (2009). Epigenetics and the embodiment of race: Developmental origins of US racial disparities in cardiovascular health. *American Journal of Human Biology*, 21, 2–15.
- Les Whitbeck, B., Chen, X., Hoyt, D. R., & Adams, G. W. (2004). Discrimination, historical loss and enculturation: Culturally specific risk and resiliency factors for alcohol abuse among American Indians. *Journal of Studies on Alcohol*, 65, 409–418.
- Lewis, T. T., Cogburn, C. D., & Williams, D. R. (2015). Self-reported experiences of discrimination and health: Scientific advances, ongoing controversies, and emerging issues. *Annual Review of Clinical Psychology*, 11, null.
- Liao, Y., Bang, D., Cosgrove, S., Dulin, R., Harris, Z., Taylor, A., . . . Giles, W. (2011). Surveillance of health status in minority communities—Racial and Ethnic approaches to community health across the US (REACH US) Risk Factor Survey, United States, 2009. *MMWR Surveillance summaries: Morbidity and mortality weekly report Surveillance summaries/CDC* (Vol. 60, pp. 1–44).
- Madrigal, L., Blell, M., Ruiz, E., & Otárpala-Durán, F. (2009). The Slavery Hypothesis An Evaluation of a Genetic-Deterministic Explanation for Hypertension Prevalence Rate Inequalities. *Health, Risk, and Adversity* (pp. 236–255). NED - New edition, 1 ed: Berghahn Books.
- Montagu, A. (1942). *Man's most dangerous myth: the fallacy of race*. New York: Columbia University Press.
- Pascoe, E., & Smart Richman, L. (2009). Perceived discrimination and health: A meta-analytic review. *Psychological Bulletin*, 135, 531–554.
- Quah, S. R. (2016). *International Encyclopedia Of Public Health*. Oxford: Elsevier Science.
- Roh, S., Brown-Rice, K. A., Lee, K. H., Lee, Y.-S., Lawler, M. J., & Martin, J. I. (2015). Stressors, coping resources, and depressive symptoms among rural American Indian older adults. *Social Work in Public Health*, 1–15.
- Salomon, K., & Jaguszyn, N. E. (2008). Resting cardiovascular levels and reactivity to interpersonal incivility among Black, Latina/o, and White individuals: The moderating role of ethnic discrimination. *Health Psychology*, 27, 473.
- Sawyer, P. J., Major, B., Casad, B. J., Townsend, S. S. M., & Mendes, W. B. (2012). Discrimination and the stress response: Psychological and physiological consequences of anticipating prejudice in interethnic interactions. *American Journal of Public Health*, 102, 1020–1026.
- Schell, L. M., & Gallo, M. V. (2012). Overweight and obesity among North American Indian infants, children, and youth. *American Journal of Human Biology*, 24, 302–313.
- Schultz, K., Walters, K. L., Beltran, R., Stroud, S., & Johnson-Jennings, M. (2016). “I’m stronger than I thought”: Native women reconnecting to body, health, and place. *Health & Place*, 40, 21–28.
- Sweet, E., McDade, T. W., Kiefe, C. I., & Liu, K. (2007). Relationships Between Skin Color, Income, and Blood Pressure Among African Americans in the CARDIA Study. *American Journal of Public Health*, 97, 2253–2259.
- Thayer, Z., Barbosa-Leiker, C., McDonell, M., Nelson, L., Buchwald, D., & Manson, S. (2016). Early life trauma, post-traumatic stress disorder, and allostatic load in a sample of American Indian adults. *American Journal of Human Biology*.
- Thayer, Z. M., & Kuzawa, C. W. (2011). Biological memories of past environments: epigenetic pathways to health disparities. *Epigenetics*, 6, 798–803.
- Thayer, Z. M., & Kuzawa, C. W. (2015). Ethnic discrimination predicts poor self-rated health and cortisol in pregnancy: Insights from New Zealand. *Social Science & Medicine*, 128, 36–42.
- Thayer, Z. M., & Non, A. L. (2015). Anthropology Meets Epigenetics: Current and Future Directions. *American Anthropologist*, 117, 722–735.
- Tholl, U., Forstner, K., & Anlauf, M. (2004). Measuring blood pressure: Pitfalls and recommendations. *Nephrology Dialysis Transplantation*, 19, 766–770.
- Turner, R. J. (2009). Understanding health disparities: The promise of the stress process model. *Advances in the conceptualization of the stress process*. New York: Springer. p 3–21.
- Wagner, J., Lampert, R., Tennen, H., & Feinn, R. (2015). Exposure to discrimination and heart rate variability reactivity to acute stress among women with diabetes. *Stress and Health*, 31, 255–262.
- Whitbeck, L. B., Hoyt, D. R., McMorris, B. J., Chen, X., & Stubben, J. D. (2001). Perceived discrimination and early substance abuse among American Indian children. *Journal of Health and Social Behavior*, 42, 405–424.
- Whitbeck, L. B., McMorris, B. J., Hoyt, D. R., Stubben, J. D., & LaFromboise, T. (2002). Perceived discrimination, traditional practices, and depressive symptoms among American Indians in the Upper Midwest. *Journal of Health and Social Behavior*, 43, 400–418.
- Williams, D. R., & Mohammed, S. A. (2013). Racism and health I: Pathways and scientific evidence. *American Behavioral Scientist*, 0002764213487340.
- Williams, D. R., Yu, Y., Jackson, J. S., & Anderson, N. B. (1997). Racial differences in physical and mental health socio-economic status, stress and discrimination. *Journal of Health Psychology*, 2, 335–351.
- Wilson, T. W., & Grim, C. E. (1991). Biohistory of slavery and blood pressure differences in blacks today. A hypothesis. *Hypertension*, 17, 1122.
- Zeiders, K. H., Doane, L. D., & Roosa, M. W. (2012). Perceived discrimination and diurnal cortisol: Examining relations among Mexican American adolescents. *Hormones and Behavior*, 61, 541–548.

How to cite this article: Thayer ZM, Blair IV, Buchwald DS, Manson SM. Racial discrimination associated with higher diastolic blood pressure in a sample of American Indian adults. *Am J Phys Anthropol*. 2017;00:1–7. <https://doi.org/10.1002/ajpa.23190>