REVIEW ARTICLE

Perceived Neighborhood and Cardiovascular Disease Risk

Nathan Lee

Gilbert High School, 312 Gretten St, Gilbert, Iowa, 50105, USA; nathanlee11000@gmail.com

ABSTRACT: Growing up in disadvantaged neighborhoods is associated with poor adult health indicators, such as elevated C-reactive proteins (CRP) and Body Mass Index (BMI). In addition, perceptions of the neighborhood are often related to residents' cardiovascular disease (CVD). Gender and race are also significantly associated with CVD risk. It is necessary to find out how these factors affect CVD risk, as finding the extent to which gender and race affect CVD risk increases the correlation between poor health indicators and disadvantaged neighborhoods. Previous studies have focused on the immediate environment, such as parenting and school environment. However, environmental contexts such as neighborhood disadvantage and neighborhood disorder have not often been considered contributing factors for elevating cardiovascular disease risk. To address this issue, a nationally representative sample (n=11,371) of the United States was used to examine gender and racial differences in the cardiovascular disease risk indicators in young adulthood. This study also analyzes the effects of perceived neighborhood disorder and neighborhood disadvantage in earlier life on the risk of heart disease in young adulthood. Findings show that gender differences resulted in significantly different CRP levels, and racial differences resulted in significantly different BMI. Interestingly, lower perceived neighborhood disorder is significantly related to greater CRP levels and BMI, whereas neighborhood disadvantage was not associated with cardiovascular disease risks. With these new findings, it is important to protect the groups that are more likely to be affected by CVD risk. By providing extra resources, like screenings and support groups, targeted groups will be less affected by this disease. This research aims to bridge the gap in understanding how external social factors and biological predispositions affect heart disease risk.

KEYWORDS: Biomedical and Health Sciences; Neighborhood Disorder; Neighborhood Disadvantage; Cardiovascular Disease.

Introduction

Research on cardiovascular disease (CVD) predictors has focused on exposures to risk factors beyond biological or behavioral factors.[1] One potential predictor beyond these traditional factors is exposure to early adversity. An important source of early adversity often involves living in socioeconomically disadvantaged neighborhoods.[2] Even after accounting for family socioeconomic status (SES) and other influential factors, growing up in underprivileged neighborhoods remains linked to adult obesity, inflammation, and abnormal cortisol levels, persisting into adulthood.[3] These factors significantly contribute to cardiovascular disease, diabetes, and cancer.

Research has recently focused on how other neighborhood characteristics influence stress and health.[4] Aspects of the neighborhood environment that have been increasingly studied are perceived neighborhood disorder. Neighborhood conditions such as perceived neighborhood disorder and cohesion represent important psychosocial contexts affecting physical and mental health.[5] Empirical studies found that higher perceived neighborhood disorder has been associated with increased physiological dysregulation even after controlling neighborhood SES.[6] On the contrary, people living in cohesive neighborhoods have fewer chronic health conditions,[7] including a reduced risk of cardiovascular disease.

CRP, BMI, and Cardiovascular Disease:

This section provides an overview of the role of C-reactive proteins (CRP) in cardiovascular health. CRP is a protein produced by the liver in response to inflammation. Inflammation protects against injuries such as cuts and infections.[8] One may notice swelling a few days after receiving a paper cut on a finger. That is, the body uses inflammation to protect the cut from infection. However, inflammation can also harm the body instead of healing it. Prolonged inflammation can lead to the development of certain diseases.

Extant research has indicated that there is a positive correlation between the likelihood of developing cardiovascular diseases and CRP levels.[9] Under typical circumstances, the human body maintains a consistently low concentration of CRP. However, an elevated level of these proteins is commonly observed in individuals with compromised health. This signals inflammation in the body, and this inflammation can point to several different diseases, including heart attacks, strokes, and peripheral artery disease.[10] In particular, increased CRP levels are linked to inflammatory processes associated with cardiovascular disease and mortality. Since cardiovascular diseases often result from unnatural inflammation along the arteries and major organs, CRP is a good indicator of these diseases. Cardiovascular diseases are often caused by a blockage in the arteries due to high cholesterol or other substances, but inflammation can also contribute. This inflammatory response often leads to blood cells and plaque buildup in the arteries, which can cause cardiovascular diseases. Thus, CRP levels can predict inflammation and consequently signal various cardiovascular diseases.[11]

Aside from the CRP, Body Mass Index (BMI) is a strong indicator of cardiovascular disease. A prior study analyzed the correlation between the risk of cardiovascular diseases and obesity levels using Body Mass Index (BMI) thresholds.[12] In this study, a BMI of over 30 kg/m² was labeled overweight. By comparing the risk of cardiovascular diseases between overweight and non-overweight individuals, the research aimed to compare the cardiovascular disease risks between these two groups. Those with obesity tend to have more blood volume in the arteries and veins throughout their body. Consequently, they are more likely to develop stroke volume, which increases stroke output. This condition could lead to various cardiovascular diseases, such as heart failure. Other studies have shown a similar result. Another study analyzed obesity as an independent predictor of cardiovascular diseases.[13] They found that BMI, measured by Metropolitan relative weight (MRW), was a significant predictor of cardiovascular disease [r=0.99]. Regression coefficients were calculated to ascertain the association between BMI and the risk of CVD after adjusting for age and other risk factors, such as cholesterol, cigarette smoking, and cholesterol.

Neighborhood Characteristics and Cardiovascular Disease Risks:

Recently, researchers have been exploring the origins of cardiovascular health inequalities within a broader context, looking into social and economic aspects of residential and neighborhood settings.[14] These aspects can be indicated by neighborhood disorder and disadvantage. Since the resident's opinions can only determine the social aspect of neighborhoods, neighborhood disorder is a statistical value that accurately represents the social side of different residential areas. Economic aspects can be found more simply, as objective statistics show whether the neighborhood's economic status is high or low. Neighborhood disadvantages do so by providing the socioeconomic status (SES), number of single-parent households, and crime rate, all of which can influence the economic status of the neighborhood. Studies have primarily examined how variations in social structures between neighborhoods affect health outcomes within these communities. According to these studies, neighborhoods tend to influence the CRP levels of their residents, but depending on the specifics of those neighborhoods, the indicated factors may differ.

According to a Psychosomatic Medicine Society study, neighborhoods' SES is inversely correlated with the CRP levels of their residents.[15] Compared to previous studies, these residents were individuals aged 30-54. However, some variables need to be adjusted to isolate the SES of the neighborhoods. Some participants had histories of heavy smoking and alcohol consumption, so the researchers needed to adjust the data to determine the correlation between SES and CRP levels accurately. Additionally, they found additional data that further emphasizes the relationship between CRP levels. The study mentioned, "Independent of personal income or educational attainment, midlife adults living in less advantaged neighborhoods often exhibit higher levels of circulating proinflammatory markers than residents of more affluent areas. This association may help explain the increased risk of athero neighborhoods often exhibit higher levels of circulating proinflammatory markers than residents of more affluent areas. This association may help explain the increased risk of atherosclerotic cardiovascular morbidity and mortality conferred by low community-level SES."[15]

Socio-structural Factors and Cardiovascular Disease Risks:

Gender and race are also associated with CRP levels.[16] A group of researchers aimed to determine whether gender differences correlate with different levels of CRP.[17] To ensure that BMI and age did not affect their results, they matched men and women of similar ages and BMI and compared their respective CRP levels. This study concluded that CRP levels were higher in women than men, with a p-value of less than 0.0005, indicating significant results. In another study, researchers found that African American subjects tended to have higher CRP levels than White subjects, and women tended to have higher CRP levels than men of the same race among the older population.[18]

Similarly to CRP levels, BMI levels may also be affected by gender and race. In a study performed only on Japanese children, the gender of the patients was studied to determine whether there was a correlation between BMI and gender.[19] There was a significant association between genders and BMI in both age groups studied. In both age groups studied, there was a significant association between different genders and BMI. For children 9-10, the boys had an r-value of 0.779, showing a fairly strong correlation, with a p-value of less than 0.0001. The girls, however, had a p-value of less than 0.0001 and an r-value of 0.975, showing a much stronger correlation with BMI than the boys. Similar results were demonstrated with children aged 12-13: boys, $r = 0.786, p < 0.0001$; girls, $r = 0.975, p < 0.0001$. Since the gender correlations are different from male to female, this demonstrates that the gender differences are significant in BMI.

In addition to gender differences, race may also be associated with differences in BMI. For example, a prior study divided participants into different ethnic and racial groups and measured their BMI.[20] The results showed significant differences in BMI among the different racial groups. A different study, which focused on the difference in BMI between White subjects and Black subjects, also showed that race acts as a predictor of BMI.[21] The study showed that Black subjects tended to have a higher BMI, regardless of whether they were female or male. "59% of Black females were obese (class I or greater) compared with 36% of White females, 40% of Black males, and 39% of White males".[21]

Gaps in the Literature:

In longitudinal follow-up samples, few studies have examined the association between neighborhood environment and cardiovascular disease risk factors, such as CRP and BMI. A previous study discovered that neighborhood measures like deprivation, problems, safety, and disorder correlated with CRP levels in a cross-sectional analysis.[22] However, after adjusting for race, the significance of these neighborhood associations diminished. There was an indication of a positive relationship between neighborhood SES and CRP, specifically for Whites, whereas this association was not observed

DOI: 10.36838/v6i11.11

among African Americans.[23] These studies have focused only on neighborhood structural disadvantages. Given recent findings related to neighborhood characteristics such as perceived neighborhood disorders and cardiovascular disease risk, examining neighborhood disadvantage in earlier life and current neighborhood disorder would provide a clearer picture of the environmental attributes of CVD risk.

Hypothesis:

Based on the previous study, I have formulated the following hypotheses and research questions.

First, I will examine gender differences in CRP and BMI. Based on the literature, I expect that women would have higher levels of CRP, whereas men would have higher levels of BMI.

Second, I expect to find racial differences in CRP and BMI. African Americans would report higher CRP and BMI compared to Whites.

In addition, I hope to answer the following two research questions.

Is neighborhood disadvantage during adolescence associated with CRP and BMI?

In adulthood, is neighborhood disorder associated with CRP and BMI?

Methods

The Add Health study comprises around 15,000 young adults representing the nation and investigates the impact of health behaviors from adolescence through young adulthood. University of North Carolina-Chapel Hill's IRB reviewed and approved the study, with written consent obtained for all data collection phases. Participants have been tracked from grades 7 through 12 in 1995 until early adulthood in 2008–09 across four data collection waves. Among the participants, 1,159 lacked CRP data. The final analysis focused on White and Black participants using post-stratification sample weights, resulting in an analytic sample of 11,371.

Among the five waves of Add Health, this study focused on the first and fourth waves since those two waves contain data regarding neighborhood disadvantages and CRP concentrations. Wave 1 was collected in 1994-1995, and Wave 4 was collected in 2008. The only variables from Wave I used in the present analyses are the subjects' race/ethnicity, gender, and parental education. Wave IV was collected when respondents were almost 24-32 years old (14 years after Wave I). Of the eligible respondents from Wave I, 93% were re-located, and 80% were re-interviewed, resulting in 15,701 in-home interviews. Wave IV blood samples were obtained at the end of each interview. The fourth wave included questions about their health outcomes, such as CRP and BMI, among individuals transitioning from adolescence to young adulthood.

Neighborhood disadvantage. Based on the variable Add Health needed to create a data table, specific methods of Add Health are used as measurements for these different variables. One of these was "neighborhood disadvantage". The researchers standardized and added multiple factors of neighborhoods from the 1990 U.S. Census. These factors included the proportion of female-led households with children under the age of 18, the proportion of African Americans, the proportion of nonelderly residents with below-average incomes, the proportion of households receiving public assistance, and the unemployment rate.

The census-tract level indicators comprised household income below the federal poverty line, households receiving public assistance, civilian unemployment rate, the percentage of individuals aged 25 or older without a high school diploma or equivalency, and the proportion of female-headed households.[24] The index of neighborhood disadvantage divides each of the four percentages by ten, adds poor and mother-only households, subtracts home ownership and college-educated residences, and divides by four. Thus, a unit increase in the scale is equivalent to a rise of ten percent in each of the components: the prevalence of poor households, mother-only households or non-owner-occupied units, and adults without a college degree.

Neighborhood Disorder. Perceived neighborhood disorder was assessed by adolescent respondents, indicating to what extent they agree with statements like: "Use recreation centers in the neighborhood," "Happy to live in the neighborhood," and "People in this neighborhood look out for each other." Items were reverse coded and summed so that higher scores indicate higher scores indicating higher levels of perceived neighborhood disorder. The items have been found to have moderate reliability (Cronbach's alpha = 0.60).

CRP. In-depth Add Health hs-CRP assay and disorder control documentation is available online.[25] In a cross-validation study, values from dried blood spots and paired plasma samples were highly correlated (r=.98). Consistent with previous studies, I used a continuous, log-transformed variable of hs-CRP that included the full range of values. In follow-up sensitivity analyses, the first author tested all models using a log-transformed continuous hs-CRP< 10 mg/L as the outcome variable.

BMI. Weight is measured as a continuous variable, ranging from low to high levels. The degree of overweight is indicated by BMI, the ratio of weight to height squared ($[kg/cm^2] \times 10^4$). BMI at Wave 4 is based on weight and height measurements obtained by trained interviewers.

Data Analysis

All statistical analyses were performed using Statistical Package for Social Sciences software (SPSS), version 26. Before the main analysis, descriptive analyses were conducted to describe the demographic characteristics. Second, an independent t-test examined gender and racial differences in CRP and BMI (Hypothesis 1-2). Third, the author used a linear regression model to investigate the effect of neighborhood disadvantage and neighborhood disorder on cardiovascular disease risk factors such as CRP and BMI in adulthood (Hypothesis 3-4). Age, gender, and race are included as covariates. Before the regression analysis, a correlation matrix of all variables was calculated to assess multilinearity. To check multicollinearity, I examined VIF values and eigenvalues. The range of VIF was from 1 to 4. In addition, the condition index, calculated from the eigenvalues of the correlation matrix, was less than 10, indicating low multicollinearity. Each hypothesis was tested using a two-tailed analysis at the α=.05 level of statistical significance.

DOI: 10.36838/v6i11.11

Results

Table 1: Presents the mean, standard deviation, and beta values for the participants' scores. Respondents included 2,317 females and 2,724 males. Regarding race, most participants (N=4,280, 66%) were White. The race category was recorded into two categories (1=White, 2=African American) to test racial differences.

Variable	N	Mean ± Std. Dev.	Minimum	Maximum
CRP	4,545	5.181 ± 9.237	.08	205.01
BMI	5,042	29.144 ± 7.488	14.40	70.30
Neighborhood_Disorder	6,503	32.899 ± 42.550	1.00	106.00
Disadvantage	6,428	9.073 ± 1.460	1.00	13.00
Age	6,485			
Sex	5,041			
White	6,485			
AA	6,485			

Table 1 reports the descriptive statistics of variables used in the regression analysis, shown in Table 2. For both Tables 1 & 2, CRP stands for C-reactive protein, BMI stands for Body Mass Index, and AA stands for African American. Additionally, Disadvantage indicates neighborhood disadvantage. The variables Age, Sex, White, and AA can be found in Wave 1 of Add Health. The variables CRP, BMI, Neighborhood_Disorder, and Disadvantage can be found in Wave 4. This table shows that 46% of the participants were female, and 66% of the participants identified as White.

Results from the independent samples t-tests indicated that gender was significantly associated with the levels of CRP (Table 2) (t[6503] = 10.458, p < 0.001), indicating that young female participants had higher CRP compared to male participants. The t-tests of BMI, on the other hand, did not show a significant difference between the CRP levels of men and women (Table 2) (t[6503] = 0.742, p = 0.458.)

The table below shows that race was significantly associated with BMI (Table 2). The t-tests indicate that African American participants reported significantly higher levels of BMI than White participants (t[6485] = 3.959, p<0.001). The participants' race, however, did not show a significant difference in CRP levels (t[6485] = 1.643, p = 0.101).

Table 2: Regression Analysis Between Neighborhood Disorder and Cardiovascular Disease Risks.

Variable	*CRP*			*BMI*		
	B	Std. Err	Beta	*B*	Std. Err	Beta
Neighborhood_Disorder	.013***	.003	.062	.008***	.003	.045
Disadvantage	-0.15	.101	-.002	-.063	.078	-.012
Age	-.001	.004	-.002	.000	.003	.002
Sex	3.066***	.293	.164	.167	.224	.011
White	-.714	.487	-.035	-.699	.375	-.043
AA	.874	.532	.039	1.460***	.406	.083

Table 2 reports the regression results showing the association between neighborhood disorder and cardiovascular disease risks. The symbol β stands for the standardized model parameter(s), and B stands for the unstandardized regression coefficient. Cardiovascular disease risks are measured by two proxies: CRP and BMI. The intercept for each CRP and BMI are 5.524 and 30.628, respectively. This table indicates that neighborhood disorder is linked to an increased risk of cardiovascular disease, whereas neighborhood disadvantage does not show a significant association with cardiovascular disease risk. *, **, and *** represent significance levels of 0.10, 0.05, and 0.01, respectively. Additionally, besides White & AA, no other variables represented a different race in the data.

Multiple Hierarchical linear regression was conducted to evaluate the extent to which neighborhood disorder and neighborhood disadvantage predict the CRP levels of the participants. Multiple Hierarchical linear regression is extremely useful in data sets with multiple predictors for multiple outcomes. Separated into multiple steps, the regression model can block predictors, eliminating control variables and analyzing the correlation between the chosen predictor and the chosen outcome. The overall model was significant (p<.001).

After controlling for age, gender, and race, the association between neighborhood disorder and CRP was significant (See Table 2, β=.013, p<.001). That is, when participants reported higher neighborhood disorder, their CRP levels were higher. On the other hand, the neighborhood disadvantage was not significant (β=-.15, ns).

About BMI, the association between neighborhood disorder and BMI seemed to be significant (Table 2, β=.008, p<.001). The higher the perceived neighborhood disorder, the higher their BMI scores were. However, the neighborhood disadvantage was insignificant (β=-.063, ns).

Discussion

In the present study, we examined whether peoples' perceptions of disorder of neighborhood and neighborhood disadvantage in earlier years were related to cardiovascular disease risk indicators. As expected, people perceiving their neighborhoods as having lower levels of disorder exhibited significantly greater CRP and BMI. Neighborhood disadvantage was not significantly associated with cardiovascular disease risks. These findings were observed among a representative U. S. sample, even after adjusting for race/ethnicity, age, and gender.

Similar to the previous literature, gender differences are associated with CRP levels and BMI. According to the literature, women tend to have higher CRP levels than men.[17] Since higher CRP levels are commonly associated with cardiovascular diseases, as both this study and other pieces of literature show,[3] genders can be associated with cardiovascular disease as well as CRP levels. Given this finding, targeted interventions such as screening young women more often than men could help them prevent developing CVD. In this way, women who are more likely to have higher levels of CRP can get more access to screening that could potentially prevent cardiovascular diseases.

Consistent with the literature, racial differences are associated with BMI.[20] Since BMI also correlates with the risk of cardiovascular diseases, race could be a possible predictor of cardiovascular diseases. Higher BMI is often correlated with higher levels of inflammation, resulting in elevated CRP levels. Studies have shown that some lifestyle factors (i.e., food consumption), genetic predisposition, and socioeconomic status can contribute to differences.[17] Future studies could factor this into account when examining racial differences. This differential CRP and BMI levels may lead to racial disparity in health outcomes.

Interestingly, there was no evidence of a significant effect of adolescent neighborhood disadvantage on CRP and BMI. While other studies have shown consistent findings, the results from the Add Health study did not show this effect. Since participants may have moved out of these neighborhoods or

DOI: 10.36838/v6i11.11

had gotten used to living in them for so long, their perspectives on how the neighborhood disadvantages affected them may be less extreme than they are. Many of the issues in disadvantaged neighborhoods may not seem as volatile to the residents as those in more situated neighborhoods. Future studies should examine the participants' perspectives regarding their level of comfort and adjustment to see if these findings hold.

Many different factors could explain neighborhood disorder's influence on CRP and BMI. Due to the various lifestyles and social groups in neighborhoods, the way the residents interact socially is a possible reason why residents of the same neighborhood have different CRP levels and BMI. Less social interaction may cause higher CRP levels and BMI, so creating an environment where the residents often interact with each other could develop healthier lifestyles and more positive mindsets.

Limitation

The study limitation includes attrition, with only 74% of participants participating in wave 4 interviews. In addition, CRP and BMI were only measured in adulthood, so their previous levels could not be controlled, and causal inferences could not be made. In the present study, perceptions of neighborhood disadvantage were not significantly related to CRP or BMI. Future tests of these questions should use a broader range of neighborhood characteristics that may relate more directly to measures of physical health.

Conclusion

These findings suggest that neighborhood disorder's strength is significantly associated with CVD risk factors. Initiatives that foster trust and mutual support within neighborhoods could potentially encourage greater community participation in physical activities and healthy lifestyles. Achieving these goals could involve interventions targeting neighborhoods with low social disorder. For instance, creating open spaces for teenagers to play and facilitating spaces for people of all ages to exercise and interact could be instrumental. In addition to the strength of neighborhood disorders, gender, and racial differences have been found to be associated with CVD risk factors. To combat this, extra screenings and resources should go toward more vulnerable groups, balancing out their likelihood of developing cardiovascular diseases. These endeavors underscore the significance of enhancing neighborhood social resources, emphasizing their pivotal role in bolstering community well-being and delivering enduring benefits to residents.

Acknowledgments

I would like to thank Dr. Jeong Eun Lee at Iowa State University for her hard work in helping me both construct and write this paper. Her help was vital in allowing me to use different studies to connect to my own research, and it also allowed me to write my paper in a proper and well-outlined format. Without the guidance I received while writing this paper, I wouldn't have been able to write down my results or make the tables to go along with them.

References

1. Suglia, S. F., Campo, R. A., Brown, A. G., Stoney, C., Boyce, C. A.,Appleton, A. A., ... & Watamura, S. E. (2020). Social determi nant of cardiovascular health: Early life adversity as a contributor to disparities in cardiovascular diseases. The Journal of Pediatrics, 219, 267-273.
2. World Heart Federation. (2017). Risk factors. Retrieved August 1, 2018, from https://www.world-heart-federation.org/resources/ris k-factors/.
3. Johns Hopkins Medicine. (n.d.). *Fight inflammation to help preven t heart disease*. https://www.hopkinsmedicine.org/health/wellness-and-prevention/fight-inflammation-to-help-prevent-heart-disea se#:~:text="But%20sustained%20low%20levels%20of,you%20ha ve%20a%20heart%20attack.
4. Cummings, E. M., Goeke-Morey, M. C., Schermerhorn, A. C., M errilees, C. E., & Cairns, E. (2009). Children and political violenc e from a social ecological perspective: Implications from research on children and families in Northern Ireland. *Clinical child and fa mily psychology review*, 12, 16-38.
5. Sampson, R. J. (2003). The neighborhood context of well-being. P erspectives in Biology and Medicine, 46(3), S53-S64.
6. Schultz, W. M., Kelli, H. M., Lisko, J. C., Varghese, T., Shen, J., Sa ndesara, P., ... & Sperling, L. S. (2018). Socioeconomic status and cardiovascular outcomes: challenges and interventions. *Circulatio n*, 137(20), 2166-2178.
7. Berkman, L. F., Glass, T., Brissette, I., & Seeman, T. E. (2000). Fro m social integration to health: Durkheim in the new millennium. *Social science & medicine*, 51(6), 843-857.
8. Mayo Clinic. (2022, April 20). C-reactive protein (CRP) test. http s://www.mayoclinic.org/tests-procedures/c-reactive-protein-test/ doctors-departments/pdc-20385229.
9. Ridker, P. M., Bassuk, S. S., & Toth, P. P. (2003). C-reactive protei n and risk of cardiovascular disease: evidence and clinical applicat ion. *Current Atherosclerosis Reports*, 5, 341-349.
10. Beckerman, J. (2022, August 19). *C-reactive protein (CRP) testing for heart disease*. WebMD. Retrieved November 22, 2023, from htt ps://www.webmd.com/heart-disease/heart-disease-c-reactive-pr otein-crp-testing.
11. Johns Hopkins Medicine (n.d.). Assessing cardiovascular risk wi th C-Reactive protein. https://www.hopkinsmedicine.org/health/ treatment-tests-and-therapies/assessing-cardiovascular-risk-with -c-reactive-protein
12. Ortega, F. B., Lavie, C. J., & Blair, S. N. (2016). Obesity and cardi ovascular disease. *Circulation Research*, 118(11), 1752-1770.
13. Rashid, M.N., Fuentes, F., Touchon, R.C. and Wehner, P.S. (200 3), Obesity and the Risk for Cardiovascular Disease. Preventive C ardiology, 6: 42-47. https://doi.org/10.1111/j.1520-037X.2003.01 358.x
14. Browning, C. R., Cagney, K. A., & Iveniuk, J. (2012). Neighborh ood stressors and cardiovascular health: Crime and C-reactive pro tein in Dallas, USA. *Social Science & Medicine*, 75(7), 1271-1279.
15. Petersen, K. L., Marsland, A. L., Flory, J., Votruba-Drzal, E., Mu ldoon, M. F., & Manuck, S. B. (2008). Community socio econom ic status is associated with circulating interleukin-6 and C-reactiv e protein. *Psychosomatic Medicine*, 70(6), 646-652.
16. Doran, B., Zhu, W., & Muennig, P. (2013). Gender differences i n cardiovascular mortality by C-reactive protein level in the Unit ed States: evidence from the National Health and Nutrition Exa mination Survey III. American Heart Journal, 166(1), 45-51.
17. Khera, A., McGuire, D. K., Murphy, S. A., Stanek, H. G., Das, S. R., Vongpatanasin, W., ... & de Lemos, J. A. (2005). Race and gen der differences in C-reactive protein levels. *Journal of the American College of Cardiology,* 46(3), 464-469.
18. Rogowski, O., Zeltser, D., Shapira, I., Burke, M., Zakut, V., Mard i, T., ... & Berliner, S. (2004). Gender difference in C-reactive pro tein concentrations in individuals with atherothrombotic risk fact ors and apparently healthy ones. *Biomarkers*, 9(1), 85-92.
19. Morimoto, A., Nishimura, R., Sano, H., Matsudaira, T., Miyashi

ta, Y., Shirasawa, T., ... & Tajima, N. (2007). Gender differences in the relationship between percent body fat (% BF) and body mass index (BMI) in Japanese children. *Diabetes research and clinical pra ctice*, 78(1), 123-125.
20. Paeratakul, S., White, M. A., Williamson, D. A., Ryan, D. H., & Bray, G. A. (2002). Sex, race/ethnicity, socioeconomic status, and BMI in relation to self-perception of overweight. *Obesity Research*, 10(5), 345-350.
21. Clark DO, Unroe KT, Xu H, Keith NR, Callahan CM, Tu W. (2016) Sex and Race Differences in the Relationship be tween O besity and C-Reactive Protein. Ethn Dis. doi: 10.18865/ed.26.2.1 97. PMID: 27103770; PMCID: PMC4836900.
22. Nazmi, A., Roux, A. D., Ranjit, N., Seeman, T. E., & Jenny, N. S. (2010). Cross-sectional and longitudinal associations of neighbor hood characteristics with inflammatory markers: findings from th e multi-ethnic study of atherosclerosis. Health & place, 16(6), 11 04-1112.
23. Pollitt, R. A., Kaufman, J. S., Rose, K. M., Diez-Roux, A. V., Zen g, D., & Heiss, G. (2007). Early-life and adult socioeconomic sta tus and inflammatory risk markers in adulthood. European journ al of epidemiology, 22, 55-66.
24. Ross, C. E., & Mirowsky, J. (2001). Neighborhood disadvantage, disorder, and health. *Journal of health and social behavior*, 258-276.
25. Whitsel, E., Cuthbertson, C. C., Tabor, J. W., Potter, A. J., Wener, M. H., Killeya-Jones, L. A., & Harris, K. M. (2012). Add Health Wave IV Documentation: Measures of inflammation and immun e function.

Author

Nathan Lee, a junior at Gilbert High School in Gilbert, IA, graciously acknowledges the honor of having his research paper selected for a slide show presentation at the 2024 Heartland Regional Junior Science and Humanities Symposium (JSHS). With a genuine passion for the medical field, especially in supporting those battling heart disease, Nathan is determined to expand his knowledge and skills by studying Biology and Public Health in college.

DOI: 10.36838/v6i11.11