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SHORT COMMUNICATION

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Asthma status moderates the relationship between neighbourhood disadvantage and obesity in African American adolescent females

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Summary

Introduction: Significant health disparities exist in asthma and obesity for African American youths. Successful interventions present an opportunity to address these disparities but require detailed study in order to ensure generalizability. This study investigated the intersection of obesity, neighbourhood disadvantage, and asthma.

Methods: Data were extracted from 129 African American females ages 13 to 19 years (mean = 15.6 years [SD = 1.9]). Obesity was measured via body mass index (BMI). Asthma status was based on clinical diagnosis and/or results of the International Study of Asthma and Allergies during Childhood (ISAAC) questionnaire. The concentrated disadvantage index (CDI) assessed neighbourhood disadvantage.

Results: Findings showed that 21.5% (n = 28) of participants were clinically defined as having asthma, 76.2% (n = 99) had obesity, and 24.9% (n = 31) were classified without obesity. The mean BMI was 35.1 (SD = 9.1) and the mean CDI was 1.0 (SD = 0.9). CDI and obesity were significantly associated in participants without asthma, but not in those with asthma. Multivariable linear regression results showed a significant interaction between CDI and asthma (t value = 2.2, P = .03).

Conclusion: In sum, results from this study found that asthma moderated the relationship between neighbourhood disadvantage and obesity.

KEYWORDS
African American adolescent, asthma, BMI, neighbourhood disadvantage

1 | INTRODUCTION

Asthma and obesity have reached epidemic proportions in the United States and both significantly impact health. African American adolescent females largely carry the burden of obesity with rates higher than any other race; 22% of African American youths are living with obesity compared with 12% of White youths, and 37% and 23% are classified as overweight, respectively.[1] Similar racial disparities exist in asthma prevalence (14% of African American youths versus 7% of White youths).[2,3] The parallel trend of increasing rates of asthma and obesity has prompted researchers to explore potential relationships between these two conditions. Surprisingly, only a limited number of studies have examined the association between obesity and asthma among African Americans in particular, and the findings have produced inconsistent results.[4,5] The specific relationship between asthma and obesity among African American adolescent females remains largely unknown, requiring further inquiry into mechanisms that may influence their association. An inflammatory mechanism has been postulated between the two, whereby release of cytokines into circulation that bind to immune cells in the lungs, leading to bronchoconstriction and lung edema.[6] Obesity also leads to airway restrictions mechanically, as chest weight limits an individual's ability to expand the chest wall, and thus asthmatic symptoms via mass effect.[7]

One additional potential contributory mechanistic factor linking obesity and asthma is neighbourhood disadvantage. Neighbourhood disadvantage may relate to asthma and obesity via many mechanisms, including lack of green space to exercise, fears of crime leading to limited exercise habits, and reduced preventative healthcare access. All of these factors lead to higher obesity, and thus asthma via the aforementioned mechanisms. In addition, living in a higher stress (higher neighbourhood disadvantage) community may lead to chronic stress, and thus directly impact obesity and asthma,[8] both of which are perpetuated separately (as explained) and individually via inflammatory mechanisms.

Neighbourhood disadvantage has emerged as a major contextual social determinant of health, with contributions to asthma and obesity as well as numerous additional racial health disparities.[9-11] Such work often considers urban/suburban environments, though study of rural communities has also demonstrated a high prevalence of obesity in adolescents, regardless of socioeconomic status, age, and race/-ethnicity as compared with adolescents living in newer suburbs.[12] Generally, higher neighbourhood disadvantage is associated with worse outcomes for health conditions. While prior work has evaluated the unique role of neighbourhood disadvantage on obesity and asthma, these studies used single item measures of disadvantage.[9,11,12] Research indicates, however, that it is more effective to measure these determinants at a composite level to fully capture their influence on health outcomes.[13]

The Concentrated Disadvantage Index (CDI) is a robust community-level measure of neighbourhood disadvantage that combines multiple widely used measures of socioeconomic status into one standardized score.[14] The CDI is derived from six poverty-related census variables, all of which are specifically selected to represent the multiple layers of social and economic (SES) determinants that characterize some impoverished, predominantly African American, urban communities.[14] Currently, only two studies have assessed the relationship between asthma and neighbourhood disadvantage using a composite score and only one included adolescents.[10,15] The two studies produced conflicting results,[10,15] necessitating further specific work to better understand adolescent health conditions. Additional research is needed to determine if the association between asthma and age differs with varying levels of neighbourhood disadvantage. Further, to date, no study has investigated the interplay of both asthma status and neighbourhood disadvantage on adolescent obesity levels and none among African American female adolescents.

Therefore, the purpose of this investigation was to explore the association between neighbourhood disadvantage (using the CDI) and obesity, among a sample of African American adolescent females, and to determine whether asthma moderates this relationship. The following hypothesis was explored: both neighbourhood disadvantage and asthma are positively associated with obesity level.

2 | METHODS

2.1 | Sample

This analysis is a secondary analysis using baseline clinical and demographic data collected in 2011 to 2015 from the Trim Teens Study, a larger intervention study, which examined genetic factors prior to, and asthma status, lung-specific/systemic inflammation, and adiposity following a diet and/or exercise lifestyle intervention.[16] The data collected (eg, asthma status and obesity level) and the demographic characteristics of the study participants met the sample requirements for the present study, determined a priori. Study participants were African American adolescent females with and without obesity, ages 13 to 19 years residing in New Orleans (NO) Metropolitan Statistical Area. Study exclusion criteria consisted of the following: (a) presence of other chronic pulmonary or systemic disease, (b) moderate or severe atopic dermatitis or allergic rhinitis, (c) severe or uncontrolled asthma based upon American Thoracic

Society standards and/or NIH guidelines, (d) acute lower respiratory infection in the last 2 weeks before baseline evaluation, and (e) -pregnant or nursing mother. Consent and assent was obtained in accordance with Louisiana State University Health Sciences Center (LSU Health)–NO Institutional Review Board protocol.

2.2 | Clinical data

All clinical data were collected by a physician and trained research nurses from the Clinical and Translational Research Center. Asthma status was defined as those who were clinically diagnosed by a physician and/or defined using the International Study of Asthma and Allergies during Childhood (ISAAC) Screening Questionnaire and the Asthma Control Test.[17] Asthma status as asthmatic or nonasthmatic. Body mass index (BMI) was evaluated using the 2000 CDC-BMI for age growth charts.[18] Obesity was defined as BMI > 95th percentile for age and dichotomized using BMI to determine obesity level.

2.2.1 | Concentrated Disadvantage Index

Neighbourhood disadvantage was measured using the CDI: a community-level measure of neighbourhood disadvantage.[14,19] The home address of each participant (N = 129) was geocoded to their census tract of residence using ArcGIS v10.2 (Environmental Systems Research Institute, Redlands, CA, USA). Higher CDI scores represent a greater level of neighbourhood disadvantage.[14] The CDI factor scores are standardized; thus, the mean for an entire community area (inclusive of multiple neighbourhoods) is 0 and the standard deviation is 1.

2.3 | Statistical analysis

Means and percentages of all covariates were calculated to describe sample characteristics. Table 1 provides population summary statistics. Bivariate relationships were assessed through simple linear regression prior to testing the hypothesized interaction effect. Multivariable linear regression analysis was used to assess the adjusted relationship between CDI and BMI, controlling for asthma and age. To address the possibility that the relationship between neighbourhood disadvantage and BMI was influenced by asthma, the interaction between CDI and asthma was also included, based on previously cited literature.[20] The full model used in hypothesis testing read as

TABLE 1 Demographic characteristics of the sample (n = 129)

	N	(%)
Nonasthmatic	101	78.5
Asthmatic	28	21.5
	Mean	SD
BMI	35.1	9.1
CDI	1.0	0.9
Age	15.6	1.9

Abbreviations: BMI, body mass index; CDI, Concentrated Disadvantage Index.

$$BMI = \beta_0 + \beta_1 (\mathrm{CDI}) + \beta_2 (\mathrm{asthma}) + \beta_3 (\mathrm{age}) + \beta_4 (\mathrm{CDI*asthma}) + \varepsilon i.$$

All analyses were conducted using SAS version 9.4 software (SAS Institute, Cary NC).

3 | RESULTS

Sample characteristics of the 129 participants are highlighted in Table 1. The mean age was 15.6 years old (SD = 1.9) and the mean BMI score was 35.1 (SD = 9.1), indicating that majority of the sample (76.2%) had obesity (n = 99), while 24.9% (n = 31) did not have obesity. The percentage of participants who were clinically defined as having asthma was 21.5% (n = 28). The mean CDI score was 1.0 (SD = 0.9). The main effect of CDI on BMI was significant ($F = 4.0$, $P < .05$), indicating that individuals living in highly disadvantaged neighbourhoods presented with higher BMI. This finding parallels existing research.[21,22] To further investigate this relationship, multivariable analysis was conducted.

Table 2 presents the findings from the multivariable linear regression model. The model assesses the relationship between BMI and CDI, controlling for age, asthma status, and the interaction term (CDI*asthma). Results showed that asthma ($t = -2.85$, $P < .01$) was

TABLE 2 Multivariable linear regression results for BMI status

	β Estimate	95% CI	SE	*t* value	*P* value
Age	−0.4	(−1.38, 0.58)	0.5	−1.0	.332
Nonasthmatic	−7.9	(−13.44, -2.35)	2.8	−2.9	.005*
CDI	−0.8	(−3.96, 2.36)	1.6	−0.5	.610
CDI × nonasthmatic	4.3	(0.34, 8.25)	2.0	2.2	.033*

Abbreviations: BMI, body mass index; CDI, Concentrated Disadvantage Index.
**P* < 0.05.

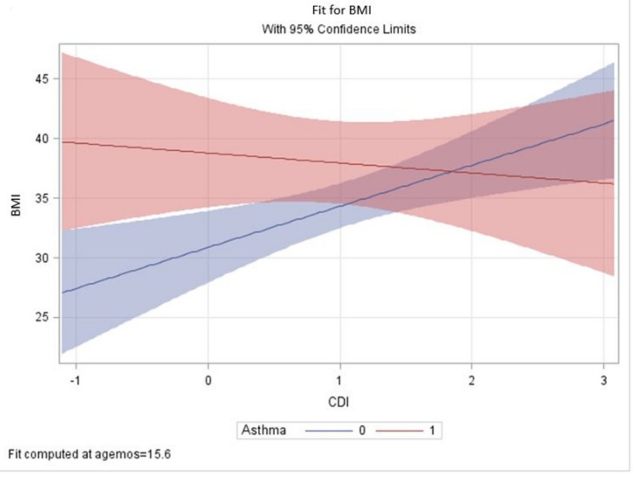

FIGURE 1 The interaction effect of asthma and CDI on BMI, when adjusted for age. BMI, body mass index; CDI, Concentrated Disadvantage Index; Agemos: Age

negatively associated with BMI. Furthermore, there was a significant positive interaction between CDI and asthma (t = 2.1, P < .05), indicating that the relationship between CDI and BMI was moderated by asthma status. No effect was observed for age in the model.

Figure 1 further illustrates the moderating effect of asthma on the relationship between CDI and BMI and graphically depicts this positive effect. The interaction term indicates that the probability of asthma status varies significantly when assessing the relationship between CDI and BMI. Specifically, for participants without asthma, as CDI increases (indicating greater neighbourhood disadvantage), so does BMI status. This effect was not seen in participants with asthma. Therefore, the findings indicate that asthma moderates the effect of CDI on BMI.

4 | DISCUSSION

This study found that asthma moderated the relationship between neighbourhood disadvantage and BMI level. The finding that African American adolescents (without asthma) residing in more disadvantaged neighbourhoods exhibited a higher BMI mirrors other studies.[21,22] An unanticipated finding is that among those with asthma, this relationship is reversed. One explanation is that medical care may differ for children with asthma as compared with obesity counselling. Counselling for individuals with higher obesity levels is frequently complicated by weight bias,[23] and thus the effectiveness of medical communication from providers may be reduced in obesity as compared with asthma, which is less marred by social stigma. Providers must be vigilant to not alienate their patients, particularly adolescent females of colour, who may already feel disconnect from their providers. Asthma and obesity health counselling may also differ in content or be perceived differently due to the divergent clinical courses of each condition. Obesity is a chronic disease with slow progression to mortality, whereas asthma has immediate mortality risks (ie, one asthma attack can lead to death at any time), especially in urban areas with high levels of air pollution. Individuals with asthma may require additional medical supervision and health discussions because of this same potential for an immediate death, and this increase in counselling may indirectly affect food intake and physical activity knowledge/practices.

Previous work has demonstrated that neighbourhood context is more important than individual characteristics (eg, household income and education level) in predicting obesity outcomes.[8] Individual characteristics may not be strong enough to overcome neighbourhood impact on obesity, yet able to do so in the case of asthma, for several reasons. All of these factors may contribute to the current findings. Clinicians should work to consistently educate families on the importance of obesity management, with the same level of attention and nonbias given to asthma management. All healthcare providers must remain objective and work thoughtfully to engage families in asthma and obesity management discussions with individuals from high-disadvantaged neighbourhoods.

Measured directly, neighbourhood disadvantage overall has demonstrated negative impacts on biological markers of health, including BMI, in African American women.[8] Thus, without interventions, the findings of the present study with adolescent females can be expected to persist into adulthood. The results presented here underscore the importance of neighbourhood equity as a contributor to general health outcomes, and therefore, support interventions for health policies and practice. Health interventions should emphasize improved neighbourhood safety, as higher neighbourhood disadvantage operationalized specifically as community violence, leads to poor health via disturbed sleep during childhood and adolescence,[24] and chronic stress, and self-imposed limitations (due to fear of victimization) on exercise and access to health resources throughout adulthood.[25] Improvements in community greenspaces may also improve exercise and thus reduce obesity. Previous work has demonstrated that perceptions of greenspace access are more important than actual access,[26] and thus future park/greenspace development should be paired with public health campaigns to improve awareness and interest in new developments. Interventions targeted directly to health care should include development of health centres in high-disadvantaged areas (eg, Federally Qualified Health Centers) and increased screening for obesity and asthma and improved retention in care for these chronic conditions at these centres.

When investigating determinants of risk for obesity in African American adolescent females, there are disparities in both asthma and poverty.[2,3,9,10] Research on this topic should continue to consider the interaction of both biological variables and social determinants, such as neighbourhood disadvantage. Further, neighbourhood disadvantage should be examined using robust metrics like the composite CDI.[14] Independent investigation on relationships between each variable will not account for interactions, which may mask associations between neighbourhood disadvantage and obesity. The risk of obesity attributable to the combined effects of asthma and neighbourhood disadvantage warrants further inquiry.

This observational study focused on a homogenous population of African American adolescent females. The models in this study adjusted for asthma, age, and CDI, which accounted for demographic covariates relevant to this study. However, it is possible that there are unmeasured confounders that could potentially be contributing to the reported findings. Additional studies examining this relationship should employ a larger and more diverse sample of participants, as the present study was skewed towards inclusion of participants from relatively higher CDI environments. In addition, this study is cross-sectional in design. Longitudinal studies may be able to establish temporality of neighbourhood disadvantage and asthma incidence and longer-term severity. Finally, future studies should uniformly assess asthma severity. The ISAAC relies on self-reported data and is subject to recall bias, and research teams may wish to rely solely on physician health records.

Future work should be undertaken to provide further context for the present findings. A longitudinal design would be useful to follow infants/young children through adolescence with data on BMI, CDI, and asthma incidence; this would provide information on the temporality of the relationship between these variables. In addition, CDI is a neighbourhood-level variable. Future work should consider the individual insurance status, education level, and income of participant caregivers in order to determine the persistent influence of CDI, given an individual family's particular access to health services and knowledge. Lastly, individual stress levels and mental health may be important measures to include in future research. Stress and mental health statuses have been associated with higher inflammation, a known contributor to asthma and obesity pathophysiology. Furthermore, adolescence represents a unique developmental and thus intervention time point. Previous work has demonstrated that adolescents in particular are likely to have higher screen time via engagement in video game activities,[27] and it is further well established that adolescence is a highly social time. Consequently, future interventions for obesity management should continue to frame exercise as a fun, social, intellectually challenging activity rather than pointing only to physical health benefits. Such interventions for obesity should target high-disadvantage neighbourhoods specifically. Overall, it is important to acknowledge individual- and community-level variables that may impact overall health status. With this comprehensive knowledge, health disparities in asthma, obesity, and neighbourhood disadvantage can be deconstructed in efforts to move towards a more equitable, healthy national community.

In conclusion, asthma status moderates the relationship between neighbourhood disadvantage and obesity in African American adolescent females. These findings indicate the importance of the intersection between asthma and neighbourhood disadvantage when considering obesity disparities among adolescent female minorities. This study also highlights the utility of the CDI to elucidate the complex interplay of various SES determinants associated with asthma and obesity. More importantly, these findings can inform the development of targeted asthma care programmes to improve prevention, screening, and treatment for children residing in disadvantaged neighbourhoods.

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