

Original Research

Changes in address and the Child Opportunity Index after delivery in a cohort of first-time mothers

Katherine E. Modrall, BS¹, Alexander R. Yusman¹, David Guise, BS², Olivia Abraham, BS¹, Alekhya Jampa, MBBS¹, Ligia Vasquez-Huot, BS³, Sara K. Quinney, PhD, Pharm D³, David M. Haas, MD, MS³

¹ Indiana University School of Medicine, ² Biostatistics and Health Data, Indiana University School of Medicine, ³ Obstetrics and Gynecology, Indiana University School of Medicine

Keywords: Social Determinants of Health, Racial disparities, Childhood outcomes, Pregnancy outcomes

<https://doi.org/10.54053/001c.133781>

North American Proceedings in Gynecology & Obstetrics

Vol. 4, Issue 1, 2025

Background

The Child Opportunity Index (COI) characterizes social determinants of health across the United States including education, health and environment, and social and economic factors. Analysis of how people changing addresses after having their first baby may change their COI category has not been reported.

Objective

The objective of the study was to determine the proportion of nulliparous pregnant persons who moved between the time of delivery and at the time of follow-up several years after delivery, to evaluate the changes in the COI over that time, and factors associated with changes.

Study Design

We performed a secondary analysis of data from participants at a single site in an ongoing prospective cohort study, the nuMoM2b Heart Health follow-up Study (HHS). Residential addresses at nuMoM2b delivery and at follow-up (~9 years) were compared to determine if the participant moved and to evaluate the COI changes. Descriptive characteristics at the time of delivery (age, race, income, pregnancy outcomes) and the COI trajectory were compared for those who did and did not move using chi-square and t-tests.

Results

410 participants were analyzed. 304 (74%) changed addresses resulting in changes in census tracts. Moving was associated with a lower mean maternal age (24.3 vs. 27.2 yrs, $p \leq 0.001$) and a lower average income (<200% federal poverty level (FPL), 62.3% vs 41.1%, $p \leq 0.001$) compared to the participants who did not move. 123 (40.5%) participants moved to a neighborhood with a higher overall COI quintile, 56 (18.4%) participants moved into a lower COI quintile, and 125 (41.1%) participants did not have a change in COI category. White participants who moved were significantly more likely to increase their COI category (55%) compared to non-White participants who moved (22.2%, $p \leq 0.001$). There were no differences in how COI changed between White and non-White participants who did not move.

Conclusions

The majority of the participants moved in the years after delivering their first child. The impact of moving on COI showed disparities; White participants were more likely to increase their COI if they moved compared to non-White groups. Understanding the influence of location-based social determinants of health may help with provision of resources aimed at resolving disparities in health for people after delivery of their first child.

INTRODUCTION

It has been proposed that an individual's zip code may be a better predictor of health outcomes than an individual's genetic code (Graham 2016). Location-based indices of social determinants of health have been developed to help understand the impact of one's zip code on health outcomes. One such index, the Child Opportunity Index (COI), characterizes social determinants of health across the United States including education, health and environment, and social and economic factors ("Child Opportunity Index (COI)," n.d.). The COI takes into account factors such as access to healthy food, green space, mean household income, and number of quality schools in each census tract into one comprehensive marker that describes the total "opportunity" of each census tract ("Child Opportunity Index (COI)," n.d.). The COI is calculated through scoring 29 different indicators that fall into three domains: education, health and environment, and social and economic factors. There is a COI score for each of the over 72,000 census tracts which are defined by the United States Census Bureau (Bureau, n.d.-a).

Previous research has identified a correlation between COI and adverse health outcomes at a single point in time including asthma (Beck et al. 2017), cardiometabolic risk (Aris, Rifas-Shiman, Jimenez, et al. 2021), elevated cortisol levels (Gunnar, Haapala, French, et al. 2022), and obesity (Thorpe and Klein 2022). While changes in socioeconomic status over time have been investigated, changes in COI, which is a more comprehensive marker of overall opportunity rather than SES, have not been analyzed over time for the same cohort of pregnant persons. For instance, COI includes many neighborhood characteristics that contribute to health which are not typically accounted for in measures of individual SES in studies. Additionally, very few studies have used the COI as an assessment of risk during pregnancy, and, to our knowledge, population mobility in a cohort of nulliparous pregnant persons has not been analyzed (Appleton et al. 2021). The COI can change either based on an individual changing their location by moving, or their environment or neighborhood may change around them due to structural or other factors over time.

The objective of the study was to determine the rate of nulliparous pregnant persons who changed addresses between the time of delivery and at the time of follow-up several years after delivery. The secondary objective was to evaluate the trajectory of the COI from original time of delivery to the follow up visit. We hypothesized that the COI would increase for the majority of pregnant persons over time since having a child often comes with increased responsibility and desire for upward mobility (Mollborn, Lawrence, and Root 2018).

MATERIALS AND METHODS

This was a single center sub cohort analysis using data from participants in an ongoing prospective cohort study, the Nulliparous Pregnancy Outcomes Study: monitoring mothers-to-be (nuMoM2b) (Haas, Parker, Wing, et al. 2015) and

the follow-up Heart Health Study (HHS) (Haas, Ehrenthal, Koch, et al. 2016). The nuMoM2b study was an observational cohort study that looked for predictors for adverse pregnancy outcomes in 10,038 nulliparous pregnant persons across the United States (Haas, Parker, Wing, et al. 2015). Adverse pregnancy outcomes that were analyzed included preterm birth, hypertensive disorders of pregnancy, small for gestational age at birth, stillbirth, and gestational diabetes. The nuMoM2b study took place from 2010 until 2013 at eight sites across the United States and involved three different study visits during pregnancy (Haas, Parker, Wing, et al. 2015). The follow-up nuMoM2b-HHS was a follow-up prospective study which looked at the effect of adverse pregnancy outcomes on long-term maternal cardiovascular health and involved interval phone contacts and an in-person study visit 2-7 years after the initial pregnancy ended (Haas, Ehrenthal, Koch, et al. 2016).

The sub-cohort analyzed was from individuals who participated in both the nuMoM2b study and HHS study at a single Midwest study site. We were limited to the single nuMoM2b site by Health Insurance Portability and Accountability Act restrictions, limiting our access to only our own site's participants' addresses. The addresses and demographic information during the nuMoM2b study were self-reported during pregnancy between 2010 and 2013 (Haas, Parker, Wing, et al. 2015). These characteristics, including address, were the ones recorded closest to the time of delivery. Race and ethnicity were self-reported and is analyzed as a marker for systemic racism. Income level and number of individuals in the household were also self-reported. The percentage of the Federal Poverty level was calculated from government data at the time of the delivery (Haas, Parker, Wing, et al. 2015).

The addresses and demographic information used for the HHS Study were self-reported from an interval contact form sent to participants starting October 2019 (Haas, Ehrenthal, Koch, et al. 2016). These data were collected even if the participant had moved out of state.

We excluded participants if one of their addresses recorded in the nuMoM2b or HHS databases could not be verified as accurate using census tract or Google Map data. The addresses were entered into the COI website (www.diversitydatakids.org accessed July 10th, 2023). The COI uses census tract data from the Centers for Disease Control (CDC) to determine the resources and the overall environment of the neighborhood that a child grows up in ("Child Opportunity Index (COI)," n.d.). The COI includes 29 factors across three different domains including education, health and environment, and social and economic (Noelke, McArdle, Baek, et al., n.d.). The education domain includes indicators such as the number of early education centers, third grade reading and math proficiency, and high school graduation rates (Noelke, McArdle, Baek, et al., n.d.). The health and environment domain includes indicators like access to healthy food and green space, walkability, hazardous waste dump sites, and health insurance coverage (Noelke, McArdle, Baek, et al., n.d.). The social and economic domain includes indicators like employment rate, commute duration, median household income, and poverty

rate (Noelke, McArdle, Baek, et al., n.d.). The complete technical documentation of the 29 factors used are explained on the COI website (Noelke, McArdle, Baek, et al., n.d.). We used the 2015 COI data for all participants and both nuMoM2b and HHS addresses to determine quintiles, with data normed nationally.

The COI categorizes opportunity level into 5 categories including very low, low, moderate, high, and very high, based on quintiles. After entering an address into the COI website, we recorded the census tract number, the overall COI category, education category, health and environment category, and social and economic category. We used the Childhood Opportunity Index 2.0 database to find the nationally normed childhood opportunity score for each census tract number (Noelke, McArdle, Baek, et al., n.d.). The COI scores ranged from 1 to 100 with 1 being the lowest opportunity index and 100 being the highest opportunity index. A value of 1 would refer to the first percentile of children living in the lowest overall opportunity neighborhood (Noelke, McArdle, Baek, et al., n.d.).

Descriptive characteristics of the cohort were recorded. Participants were considered to have moved if they had an address for their HHS activity which was different than at the time of the nuMoM2b delivery. The COI distributions were compared between those who did and did not move using chi-square testing. Additionally, changes in overall COI scores were analyzed for subgroups of those who did and did not move to determine if areas had improved or worsening COI scores. Change in COI scores were plotted for visual trends between those who did and did not move.

RESULTS

A total of 417 HHS participants had valid address information collected at the interval contact, 412 of whom also had valid addresses and data from the nuMoM2b study. We were unable to validate nuMoM2b addresses for 5 people in the cohort. One participant had moved out of the country and thus could not be coded to a US census tract, leaving 411 participants with complete data for moving (Figure 1). A total of 304 (74%) moved, having a different address at the HHS contact than at nuMoM2b. The mean age of participants was 25.1 (± 5.8) years. The participants were 57.8% Non-Hispanic White, 26.4% Non-Hispanic Black, 9.1% Hispanic, 0.7% Asian, and 6.0% Other (Table 1). "Other" self-reported group included those reporting mixed or multiple non-White groups. Due to lower numbers of those with self-reported race and ethnicity which were reported that were not White or Black, we chose to combine all non-White groups together for analysis. The overall COI category distribution at the nuMoM2b visit was: very low (45.6%), low (12.1%), moderate (13.1%), high (17.5%), and very high (11.7%) (Table 2). The overall COI category distribution at the HHS follow-up was: very low (34.5%), low (15.3%), moderate (9.6%), high (18.7%), and very high (21.8%).

Twenty-one participants (5.1%) moved outside of the state and one moved out of the country. That participant was thus excluded from analyses involving COI. Moving was

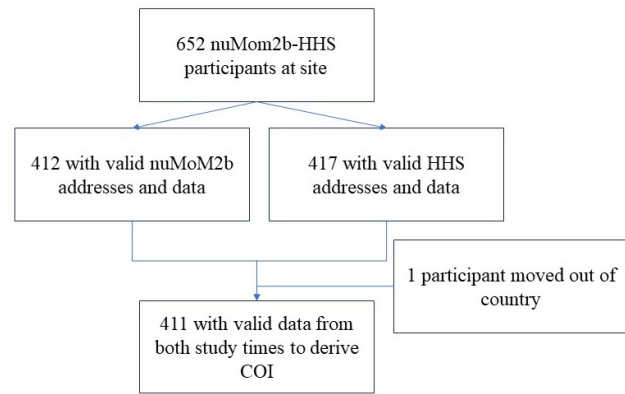


Figure 1. Flow diagram of participants in the analysis

HHS= Heart Health Study, COI= Child Opportunity Index

associated with a lower mean maternal age (24.3 vs 27.2, $p \leq 0.001$) and a lower average income ($< 200\%$ FPL, 62.3% vs 41.1%, $p \leq 0.001$). There was not a difference in a change in marital status between those who moved and did not move (20.1% vs 13.1%, $p = 0.11$). There were also no differences between those who moved and did not move in change in educational attainment (37.2% vs 28.0%, $p = 0.09$) or change in income as measured in percentage of the Federal Poverty Level (76.6% vs 74.3%, $p = 0.64$). There was no clear difference in self-reported race/ethnicity ($p = 0.058$) or the presence of adverse pregnancy outcomes ($p = 0.63$) in the cohort who moved compared to those who did not move (Table 1). Participants who moved were more likely to increase their COI category compared to participants who did not move (40.5% vs 19.6%, $p \leq 0.001$). Of the participants who moved, 123 (40.5%) moved to a neighborhood with a higher COI quintile, 56 (18.4%) participants moved to a lower COI quintile, and 125 (41.1%) participants did not have a change in COI category (Table 2).

A total of 244 (59.5%) participants had an increase in the nationally normed COI value. The mean COI value (standard deviation, range) increased from the time of the nuMoM2b study, which was 37.3 (31.2, 1-99), to HHS, which was 45.7 (33.7, 1-100). The participants who moved had a greater increase in COI score compared to the participants who did not move (+11.1 vs +2.0, $p \leq 0.001$, Table 2). Overall category distribution in COI component scores were similar between those who moved and those who did not move (Table 2).

White participants who moved addresses were significantly more likely to increase their COI category compared to non-White participants who moved addresses (55.0% vs 22.2%, $p \leq 0.001$, Table 3, Figure 2). There was no clear difference in change in COI category between White vs non-White participants who did not move addresses (21.5% vs 16.2%, $p = 0.82$, Table 3). Figure 3 displays the overall COI score change at the two timepoints for those who did and did not move.

Table 1. Demographic and characteristics of numom2b and HHS participants who moved vs did not move.

Characteristic	Overall cohort (N=411)	Participants who moved (N=304)	Participants who did not move (N=107)	P value
Maternal age at Delivery (years)	25.07 (5.8)	24.30 (5.6)	27.25 (5.7)	<0.001
% of Federal Poverty Level for income (N=390)				<0.001
<200% FPL	223 (57.2)	177 (62.3)	42 (41.6)	
≥200% FPL	167 (42.8)	107 (37.6)	59 (58.4)	
Did marital status change (yes)	75 (18.2%)	61 (20.1%)	14 (13.1%)	0.11
Did educational attainment increase (yes)	143 (34.8%)	113 (37.2%)	30 (28.0%)	0.09
Did % of Federal Poverty Level for income change (yes)	291 (76%)	216 (76.6%)	75 (74.3%)	0.64
Race/Ethnicity				0.058
Asian	3 (0.7)	1 (0.3)	2 (1.9)	
Hispanic	38 (9.1)	28 (9.2)	9 (8.4)	
Non-Hispanic Black	110 (26.4)	89 (29.3)	18 (16.8)	
Non-Hispanic White	241 (57.8)	169 (55.6)	70 (65.4)	
Other	25 (6.0)	17 (5.6)	8 (7.5)	
Averse Pregnancy Outcomes				
SGA	36 (8.8)	27 (9.0)	8 (7.8)	0.7
Stillbirth	3 (0.7)	3 (1.0)	0 (0.0)	0.3
Preterm Birth	49 (11.8)	11.5 (35)	14 (13.1)	0.67
Hypertensive Disorders	118 (28.5)	88 (29.1)	29 (27.4)	0.73
GDM	32 (8.0)	20 (6.8)	12 (11.7)	0.12
APO Composite	183 (43.9)	136 (44.7)	45 (42.1)	0.63

COI= childhood opportunity index

SGA= small for gestational age

GDM= gestational diabetes mellitus

APO Composite= All adverse pregnancy outcomes

Data are presented as n (%) or mean (standard deviation)

P values calculated for comparison of distribution between participants who moved and participants who did not move

STRUCTURED DISCUSSION

PRINCIPAL FINDINGS

In this longitudinal study of the nuMoM2b-HHS participants at a single study center, we found that the majority of people moved after having their first child, most to an area with a different COI. The change in COI for those who moved was associated with self-reported race and ethnicity. On average, overall COI values increased for those who moved between nuMoM2b and HHS, however, when analyzed by race and ethnicity, non-White participants had a much lower rate of COI improvement after moving compared to White participants. Additionally, the majority of participants moved in the few years between nuMoM2b and HHS.

RESULTS IN CONTEXT OF WHAT IS KNOWN

COI has begun to see increased use as a composite marker for social determinants of health, being a primary component of more than 40 studies at the time of this research (diversitydatakids.org 2023). Multiple studies have found

an association between COI and race and ethnicity. Minority participants have lower overall COI values than White participants in studies (Gunnar, Haapala, French, et al. 2022; Bergmann, Nickel, Hall, et al. 2022). This may be due to the relationship between the concentration of minority populations in urban centers and the decreased access to childhood opportunities that is often found in urban residence (Cushing et al. 2015; Miller and Votruba-Drzal 2013; Tieken 2017). A lower COI quintile has been associated with increased mortality among children and their care givers (Slopen et al. 2023). Specifically, children living in very low-opportunity neighborhoods were found to have approximately 1.30 times the mortality risk compared to those in low-opportunity neighborhoods. This improvement demonstrates how even modest increases in neighborhood opportunity can meaningfully affect health outcomes, particularly in reducing mortality risks for both children and caregivers (Slopen et al. 2023).

United States Census data show that the majority (70%) individuals in a similar age range of our participants moved at least once that led to changed census tracts (Bureau,

Table 2. COI Data for Participants who moved compared to participants who did not move

Characteristic	Overall cohort at nuMoM2b Visit (N=412)	Overall Cohort at HHS Visit (N=417)	Participants who moved (N=304)	Participants who did not move (N=107)	P value (moved vs not moved)
Nationally Normed COI Values (from 1 to 100)	37.3 (31.2, 1-99)	45.7 (33.7, 1-100)	+11.1 (31.8)	+2.0 (12.2)	0.008
Overall COI					0.38
Very low	188(45.6)	144 (34.5)	112 (36.8)	29 (27.1)	
Low	50 (12.1)	64 (15.3)	44 (14.5)	18 (16.8)	
Moderate	54 (13.1)	40 (9.6)	28 (9.2)	11 (10.3)	
High	72 (17.5)	78 (18.7)	58 (19.1)	20 (18.7)	
Very high	48 (11.7)	91 (21.8)	62 (20.4)	29 (27.1)	
Education Index COI					0.71
Very low	147 (35.7)	162 (38.8)	122 (40.1)	36 (33.6)	
Low	79 (19.2)	56 (13.4)	40 (13.2)	14 (13.1)	
Moderate	85 (20.6)	60 (14.4)	42 (13.8)	18 (16.8)	
High	71 (17.2)	49 (11.8)	37 (12.2)	12 (11.2)	
Very high	30 (7.3)	90 (21.6)	63 (20.7)	27 (25.2)	
Health and Environmental Index COI					0.58
Very low	244 (59.2)	148 (35.5)	107 (35.2)	36 (33.6)	
Low	63 (15.3)	70 (16.8)	51 (16.8)	18 (16.8)	
Moderate	64 (15.5)	67 (16.1)	49 (16.1)	18 (16.8)	
High	40 (9.7)	91 (21.8)	63 (20.7)	28 (26.2)	
Very high	1 (0.2)	41 (9.8)	34 (11.2)	7 (6.5)	
Social and Economic Index COI					0.38
Very low	172 (41.7)	137 (32.9)	107 (35.2)	27 (25.2)	
Low	57 (13.8)	59 (14.4)	40 (13.2)	17 (15.9)	
Moderate	39 (9.5)	46 (11.0)	34 (11.2)	11 (10.3)	
High	65 (15.6)	70 (16.8)	50 (16.4)	20 (18.7)	
Very high	79 (19.2)	105 (25.2)	73 (24.0)	32 (29.9)	

COI= childhood opportunity index

Data are presented as n (%) or mean (standard deviation, range)

P values calculated for comparison of distribution between participants who moved and participants who did not move.

n.d.-b). As our rate of moving was similar (74%), this suggests some measure of generalizability to our findings.

CLINICAL IMPLICATIONS

Our ability to determine how COI changes over time for parents and their children might allow us to better understand how pregnancy affects residential mobility from the time of delivery to the first decade of the child's life. Assessing COI at the time of delivery could allow providers to identify at-risk nulliparous pregnancies who are in situations where their location is less favorable to optimal health. This could lead to counseling people regarding neighborhood factors that could be changed to help improve the opportunity for optimal health for their new-

borns. It further could serve to increase resources for post-partum individuals in areas of low COI.

RESEARCH IMPLICATIONS

Future work may be directed at actual child health, comparing health and COI at birth with changes or developments in the child health and development later in life. Additionally, following addresses and COI change trajectory in relation to child health outcomes could be important to justify programs aimed at assisting families with elevating their location-based COI. Additionally, further validation of prior findings of COI association with adverse pregnancy outcomes, as well as expanding this work to other regions in the United States will be important (Abraham et al. 2023).

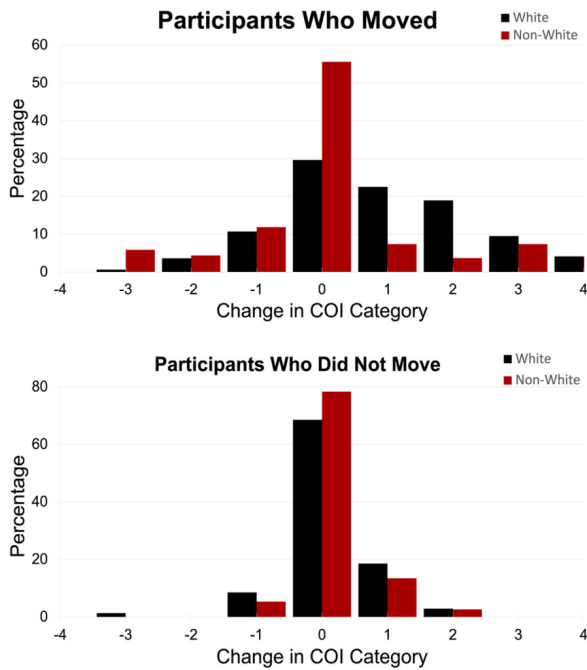


Figure 2. Direction, Degree of Change, and Disparities in COI category for those who moved and did not move

White participants who moved were more likely to increase their COI category compared to non-White participants (55% vs 22%, $p < 0.001$). There was no clear difference between White and non-White participants who did not move (21.5% vs 16.2%, $p = 0.82$).

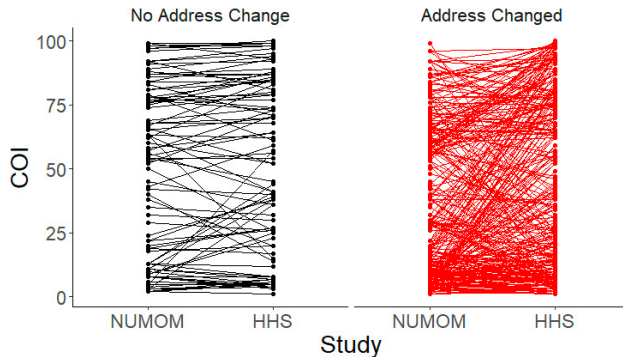


Figure 3. COI Trajectory from nuMoM2b to HHS Visit depending on if the address changed.

Each line represents one participant. COI= Childhood Opportunity Index. NUMOM= nu-MoM2b Visit. HHS = Heart Health Study Visit

STRENGTHS AND LIMITATIONS

Our study was limited by using a cohort of continuing participants from a pregnancy cohort. This reduced the number of participants available, however, enough participants were enrolled to produce significant results. Expanding this analysis to the entire nuMoM2b-HHS cohort would provide more generalizability as the eight clinical centers were distributed across the United States. This was unable to be accomplished, however, due to HIPAA issues sharing addresses for other study sites. The study is somewhat limited in that the COI is only available for United States census

tracts. This is a common limitation to location-based social determinants measures. We did not repeat some sociodemographic characteristics at the HHS follow-up, such as marital status and education level, which may have been associated with moving, as both play a role in the average moving rates for young Americans (“Migration of the Young, Single, and College Educated: 1995 to 2000,” n.d.). We also did not capture the number of times a person may have moved. Due to data limitations, we also were not able to capture non-health drivers that impact patient housing such as income, lending laws, prior realty legislation, structural racism in housing policies, and others. This study cannot unpack the complexity that goes into decisions to move and if moving, to what location.

CONCLUSION

In conclusion, this study found an independent association between COI increase and race and ethnicity in first time pregnant persons who moved. Systemic discrepancies in opportunity to increase COI may exist between White and non-White groups. Further studies focused on specific racial and ethnic groups may provide a path for the introduction of policies and treatments to reduce opportunity disparities.

CONFLICTS OF INTEREST

The authors report no conflicts of interest.

FUNDING

Support for the original nuMoM2b and HHS studies at Indiana University was provided by NIH, U10HD06037 and NIH, 1U10HL119991 (Haas). This project was funded, in part, with support from the Indiana Clinical and Translational Sciences Institute funded by UL1TR002529 from the National Institutes of Health. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health. The additional work to derive the Index scores and current analysis provided with internal department funding.

CLINICAL TRIAL REGISTRY

Not applicable

ACKNOWLEDGEMENTS

None

CORRESPONDING AUTHOR:

David Haas, dahaas@iupui.edu
Department of OB/GYN, Indiana University School of Medicine, 550 N. University Blvd, UH 2440, Indianapolis, IN 46202; (317)-944-1661

Table 3. Categorical change in COI for White vs non-White participants based on if the participant moved or not.

Did the Participant Move?	Change in COI Category	Total (N=411)	White (N=239)	Non-White (N=172)	P value
Yes	+4	12 (3.9)	7 (4.1)	5 (3.7)	<0.001
	+3	26 (8.6)	16 (9.5)	10 (7.4)	
	+2	37 (12.2)	32 (18.9)	5 (3.7)	
	+1	48 (15.8)	38 (22.5)	10 (7.4)	
	0	125 (41.1)	50 (29.6)	75 (55.6)	
	-1	34 (11.2)	18 (10.7)	16 (11.9)	
	-2	12 (3.9)	6 (3.6)	6 (4.4)	
	-3	9 (3.0)	1 (0.6)	8 (5.9)	
	-4	1 (0.3)	1 (0.6)	0 (0)	
No	+2	3 (2.8)	2 (2.9)	1 (2.7)	0.82
	+1	18 (16.8)	13 (18.6)	5 (13.5)	
	0	77 (72)	48 (68.6)	29 (78.4)	
	-1	8 (7.5)	6 (8.6)	2 (5.4)	
	-3	1 (0.9)	1 (1.4)	0 (0)	

COI= childhood opportunity index

Data are presented as n (%)

P values calculated for comparison of distribution between White participants and non-White participants.

A positive value for change in COI category represents moving to an area with a higher COI category. A negative value for change in COI category represents moving to an area with a lower COI category. A value of 0 represents moving to an area within the same COI category.

Submitted: January 01, 2025 EDT. Accepted: March 30, 2025

EDT. Published: March 30, 2025 EDT.



This is an open-access article distributed under the terms of the Creative Commons Attribution 4.0 International License (CCBY-NC-ND-4.0). View this license's legal deed at <https://creativecommons.org/licenses/by-nc-nd/4.0> and legal code at <https://creativecommons.org/licenses/by-nc-nd/4.0/legalcode> for more information.

REFERENCES

- Abraham, O. C., A. Jampa, S. K. Quinney, and D. M. Haas. 2023. "The Childhood Opportunity Index's Association with Adverse Pregnancy and Newborn Outcomes in Nulliparous Persons." *Am J Perinatol*, November. <https://doi.org/10.1055/a-2185-8882>.
- Appleton, A. A., B. Lin, E. A. Holdsworth, B. J. Feingold, and L. M. Schell. 2021. "Prenatal Exposure to Favorable Social and Environmental Neighborhood Conditions Is Associated with Healthy Pregnancy and Infant Outcomes." *Int J Environ Res Public Health* 18 (11): 6161. <https://doi.org/10.3390/ijerph18116161>.
- Aris, I. M., S. L. Rifas-Shiman, M. P. Jimenez, et al. 2021. "Neighborhood Child Opportunity Index and Adolescent Cardiometabolic Risk." *Pediatrics* 147 (2): e2020018903. <https://doi.org/10.1542/peds.2020-018903>.
- Beck, A. F., B. Huang, K. Wheeler, N. R. Lawson, R. S. Kahn, and C. L. Riley. 2017. "The Child Opportunity Index and Disparities in Pediatric Asthma Hospitalizations across One Ohio Metropolitan Area, 2011–2013." *J Pediatr* 190:200–206.e1. <https://doi.org/10.1016/j.jpeds.2017.08.007>.
- Bergmann, K. R., A. Nickel, M. Hall, et al. 2022. "Association of Neighborhood Resources and Race and Ethnicity With Readmissions for Diabetic Ketoacidosis at US Children's Hospitals." *JAMA Netw Open* 5 (5): e2210456. <https://doi.org/10.1001/jamanetworkopen.2022.10456>.
- Bureau, U.C. n.d.-a. "Glossary." Census.Gov. Accessed November 25, 2024. <https://www.census.gov/programs-surveys/geography/about/glossary.html>.
- . n.d.-b. "The Radius of Economic Opportunity: Evidence from Migration and Local Labor Markets." Census.Gov. Accessed August 16, 2023. <https://www.census.gov/library/working-papers/2022/adrm/CES-WP-22-27.html>.
- "Child Opportunity Index (COI)." n.d. Diversitydatakids.Org. Accessed July 11, 2023. <https://www.diversitydatakids.org/child-opportunity-index>.
- Cushing, L., J. Faust, L. M. August, R. Cendak, W. Wieland, and G. Alexeeff. 2015. "Racial/Ethnic Disparities in Cumulative Environmental Health Impacts in California: Evidence From a Statewide Environmental Justice Screening Tool (CalEnviroScreen 1.1)." *Am J Public Health* 105 (11): 2341–48. <https://doi.org/10.2105/AJPH.2015.302643>.
- diversitydatakids.org. 2023. "Bibliography of Peer-Reviewed Articles and Reports That Use the Child Opportunity Index." June 2023. https://www.diversitydatakids.org/sites/default/files/file/diversitydatakids.org_coi_bibliography_06-1-23_sorted.pdf.
- Graham, G. N. 2016. "Why Your ZIP Code Matters More Than Your Genetic Code: Promoting Healthy Outcomes from Mother to Child." *Breastfeeding Medicine* 11 (8): 396–97. <https://doi.org/10.1089/bfm.2016.0113>.
- Gunnar, M. R., J. Haapala, S. A. French, et al. 2022. "Race/Ethnicity and Age Associations with Hair Cortisol Concentrations among Children Studied Longitudinally from Early through Middle Childhood." *Psychoneuroendocrinology* 144:105892. <https://doi.org/10.1016/j.psyneuen.2022.105892>.
- Haas, D. M., D. B. Ehrental, M. A. Koch, et al. 2016. "Pregnancy as a Window to Future Cardiovascular Health: Design and Implementation of the nuMoM2b Heart Health Study." *Am J Epidemiol* 183 (6): 519–30. <https://doi.org/10.1093/aje/kwv309>.
- Haas, D. M., C. B. Parker, D. A. Wing, et al. 2015. "A Description of the Methods of the Nulliparous Pregnancy Outcomes Study: Monitoring Mothers-to-Be (nuMoM2b)." *Am J Obstet Gynecol* 212 (4): 539.e1–539.e24. <https://doi.org/10.1016/j.ajog.2015.01.019>.
- "Migration of the Young, Single, and College Educated: 1995 to 2000." n.d.
- Miller, P., and E. Votruba-Drzal. 2013. "Early Academic Skills and Childhood Experiences across the Urban–Rural Continuum." *Early Child Res Q* 28 (2): 234–48. <https://doi.org/10.1016/j.ecresq.2012.12.005>.
- Mollborn, S., E. Lawrence, and E.D. Root. 2018. "Residential Mobility Across Early Childhood and Children's Kindergarten Readiness." *Demography* 55 (2): 485–510. <https://doi.org/10.1007/s13524-018-0652-0>.
- Noelke, C., N. McArdle, M. Baek, et al. n.d. "Child Opportunity Index 2.0."
- Slopen, N., C. Cosgrove, D. Acevedo-Garcia, M. L. Hatzenbuehler, J. P. Shonkoff, and C. Noelke. 2023. "Neighborhood Opportunity and Mortality Among Children and Adults in Their Households." *Pediatrics* 151 (4): e2022058316. <https://doi.org/10.1542/peds.2022-058316>.
- Thorpe, D., and D.N. Klein. 2022. "The Effect of Neighborhood-Level Resources on Children's Physical Development: Trajectories of Body Mass Index and Pubertal Development and the Influence of Child Biological Sex." *J Youth Adolesc* 51 (5): 967–83. <https://doi.org/10.1007/s10964-021-01547-4>.
- Tieken, M. C. 2017. "The Spatialization of Racial Inequity and Educational Opportunity: Rethinking the Rural/Urban Divide." *Peabody J Educ* 92 (3): 385–404. <https://doi.org/10.1080/0161956X.2017.1324662>.