Add Health Ancillary Study Proposal Form

Part I. Basic Study Information

1. Today's date: 9/26/2023

2. Full study title:

   > Linking Incidents of Fatal and Non-Fatal Firearm Violence to the Add Health Study

3. Principal investigator

   - Name: ███████████
   - Institution: ████████████████████████
   - Address: ███████████████████████████
   - Phone: ██████████
   - E-mail address: █████████████████

4. Collaborator(s)

   - Name: ███████████
   - Institution: █████████████████
   - Address: █████████████████████
   - Phone:
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- Brief abstract describing the study (200 words maximum):

Exposure to firearm violence has emerged as a critical public health issue in the United States. Increasingly, research suggests that direct or vicarious exposure to firearm violence affects individuals' mental and physical well-being. Across the United States, individuals are exposed to firearm violence in multiple ways, including fatal and non-fatal community-based shootings (i.e., citizen-on-citizen firearm violence) and fatal and non-fatal police-on-citizen shootings (i.e., police-on-citizen firearm violence). However, limited research has linked objective geospatial measures of firearm shootings to rich individual-level longitudinal data, precluding a fuller understanding of how these events impact Americans' mental and physical well-being. We propose the linkage of data on (1) community-based fatal and non-fatal firearm shootings at the census tract level from The American Violence Project and (2) longitude and latitude measures of police on citizen fatal and non-fatal injurious firearm shooting data from the Gun Violence Achieve to Wave V of the National Longitudinal Study of Adolescent to Adult Health (Add Health). By merging these datasets, we will gain a unique opportunity to comprehensively investigate the health implications of multiple forms of exposure to firearm violence on a diverse cohort of individuals.

5. Proposed start dates:

> 4/1/2024

6. Proposed end dates:

> 4/1/2026

7. Estimated cost (please work with the Ancillary Study Coordinator to develop this):

> ~$15,000 (Add Health staff links >30 variables)

8. Proposed funding source and planned date of submission to external funding agency:

> Funds from: Johns Hopkins Center for Gun Solutions; New Jersey Gun Violence Research Center

9. Does this study involve the support or collaboration of a for-profit corporation, or do you intend to patent any process or product of the analysis (see Section G above)?

☐ Yes
☒ No

Part II. Use of Previously Collected Geocodes

1. Do you propose to use previously-collected respondent geocode data?

☒ Yes
☐ No *(skip to Section III)*

2. What types of geocode data do you propose to use?

Mark all that apply.

Geocode	Wave I	Wave II	Wave III	Wave IV	Wave V
State					X
County					
Census tract					X
Block group					
Latitude and longitude					X

*The data we will link includes geocodes at the (a) census-tract level for the American Violence Project data, (b) longitude and latitude for the police shooting data extracted from the Gun Violence Archive, and (c) state level for policy variables. Our data have been collected for the years 2014-2020 across datasets. For this project, we will link data from the years 2015-2018 to correspond with Wave V of the Add Health study. Because our data collection is ongoing, we can collect data for future years when Wave VI of the Add Health study is released.

Part III. Use of Previously-Collected Biospecimens

1. Do you propose to use archived biospecimens?
   ☐ Yes
   ☒ No *(skip to Section IV)*

2. Please indicate in the table below the type and amount of biospecimen needed and the number of respondents for whom biospecimens are requested.

Type of Biospecimen	Amount Needed	Number of Respondents
Wave V Serum		
Wave V Plasma		
Wave V DNA		

3. Provide a justification for the amount of biospecimen and number of respondents needed.

N/A

4. What are the respondent selection criteria?

N/A

5. What assay(s) will be performed by the ancillary study?

N/A

6. During what study years will the biospecimens be assayed by the ancillary study?

N/A

7. Can previously thawed and refrozen biospecimens be used for the assay?
   ☐ Yes
   ☐ No *(If no, provide references to supporting studies)*

8. Provide a description of your plans for handling and storage of samples:

N/A

9. Provide a description of your plans for the final disposition of samples after analyses are completed:

N/A

Part IV. Genomic Information

1. Do you propose to use genomic materials (any data from Add Health respondents' DNA)?
   ☐ Yes
   ☒ No *(skip to Section VI)*

2. What specific gene(s), genotype(s), or SNPs will be investigated and by what methods of genotyping?

   > N/A

3. State the genetic hypothesis of interest:

   > N/A

4. What is/are the primary dependent variable(s)?

   > N/A

5. What is/are the primary independent variable(s)?

   > N/A

Part V. Advantages for and Burden on Add Health

1. What is the advantage, both to you and Add Health, of conducting the study within the Add Health population as opposed to another population?

   The Add Health dataset is the best existing data to link fatal and non-fatal firearm shooting measures. Importantly, Add Health is one of the only nationally representative datasets with geocode identifiers available to link data during data collection on objective measures of fatal and non-fatal shootings (2016-2018). In addition, our data collection is ongoing, enabling future linkages to ongoing Add Health Waves (i.e., Wave VI). The primary advantage to the research community is that this linkage will build the first dataset that includes objective data on geospatial measures of fatal and non-fatal shootings (including citizen-on-citizen shootings and police-on-citizen shootings), with individual data that includes variables on a robust set of health outcomes. In addition, because of the longitudinal nature of Add Health, it enables researchers to control for earlier life experiences that may be relevant to the relationship between firearm violence exposure and health.

   The main benefit to Add Health is that this ancillary data linkage will bring in the first comprehensive measures of geocoded data on both non-fatal and fatal (as well as citizen-on-citizen and police-on-citizen) firearm shootings to the Add Health dataset. This will include two data sources: (1) community fatal and non-fatal shootings (citizen-on-citizen) and (2) police on-citizen fatal and non-fatal firearm shootings. The other benefit to Add Health is that our research team's data collection efforts are ongoing and, therefore, can be linked to Wave VI of Add Health data when those files are released. For the Add Health community, this will enable a study of Add Health sample members exposure to firearm violence at multiple time points (i.e., Wave V and Wave VI).

2. What types of assistance will the ancillary study require from the Add Health staff? This information will be used to estimate the amount of Add Health staff time to be spent on the project.

   It will be requested that Add Health staff perform the data linkage (rather than a research team member traveling to North Carolina to perform the data linkage). The study team will provide the data in accessible files (i.e., CSV; .dta; .sas7bdat) with a numeric census-tract identifier – 11 digit code for the community firearm shooting and longitude and latitude coordinates for the police shooting data extracted from the Gun Violence Archive. The lead investigator ▮▮▮▮▮▮ has been in touch with the Add Health ancillary staff, including Caroline Jackson and Brian Frizzelle, to discuss the feasibility of linking both data files to the geocodes based on Add Health sample member residential address.

3. What burden, if any, will this study place on Add Health sample members?

   There will be no burden on Add Health sample members. Existing data will be linked to Wave V based on available geocode information by Add Health staff.

Part VI. Assurances

1. What new ancillary study data will be integrated into the Add Health database? Please **specify the number and type(s) of variables that will become available to Add Health users**. (E.g., adding 2 variables for each of 10 years means that you are adding 20 new variables). Any request to later amend this information must be communicated formally to the Add Health PI.

   Please see the two tables below for the variables to be linked for the years 2015-2018 and the description of the variables. **We estimate 68 total variables.**

Community Firearm Shooting Data from the American Violence Project				Fatal and Non-fatal Injurious Police Shootings from Gun Violence Achieve			
Variable Name	Years	Total Variables	Linking variable	Variable Name	Years	Total Variables	Linking variable
Non-Fatal Community Shootings	2015, 2016, 2017, 2018	4	Census Tract ID	Date of event	2015, 2016, 2017, 2018	4	Longitude & Latitude
Fatal Community Shootings	2015, 2016, 2017, 2018	4	Census Tract ID	Police agency type (local police, sheriffs office, national policy, multiple police, other)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Response type (event in officer view, 911 dispatch, call by subject, unknown)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Behavioral Health Related (yes or no)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Incident Type officer is responding too (shooting, assault, automobile accident, disorderly conduct, domestic disturbance, investigation, robbery, burglary, stolen	2015, 2016, 2017, 2018	4	Longitude & Latitude

				vehicle, suicidal or behavioral crisis, suspicious person, traffic stop, trespassing, warrant or arrest, weapon complaint, well-being check, other.			
				Victim Age in years	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Victim gender (male, female, transgender, unknown)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Victim race/ethnicity (non-Hispanic White, non-Hispanic Black, Hispanic, other, unknown)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Officer Duty Status (on-duty, off duty, other)	2015, 2016, 2017, 2018	4	Longitude & Latitude
				Count of number of persons shot	2015, 2016, 2017, 2018	4	Longitude & Latitude
				State Policy: Permit to Purchase Statute	2015, 2016, 2017, 2018	4	State
				State Policy: Concealed Carry Weapon Statute	2015, 2016, 2017, 2018	4	State
				State Policy: Stand Your Ground Statute	2015, 2016, 2017, 2018	4	State
				State Policy: Violent Misdemeanor Statute	2015, 2016, 2017, 2018	4	State

				State Policy: Gun Ownership Rate	2015, 2016, 2017, 2018	4	State

American Violence Data

Variable Name	Description
Non-Fatal Community Shootings	A non-fatal shooting took place in the census tract of an Add Health Sample Member
Fatal Community Shootings	A fatal shooting took place in the census tract of an Add Health Sample Member

Gun Violence Achieve – Police Shootings Data

Variable Name	Description
Date of event	Date of police fatal or non-fatal shooting
Behavioral Health Related	Abstractors documented specific objective or subjective but explicitly stated indicators of: • a named behavioral health condition that was potentially relevant to the situation, • dispatch to a mental health call, • positive toxicology results, • reports of victim as suicidal or alleged to have attempted "suicide by cop"
Incident Type officer is responding too	Refers to the stated reason for the initial police-involved interaction. When a situation evolved from what was originally stated, abstractors attempted to indicate the most up-to-date expectation of the incident, from law enforcement officer's perspective, at a time just prior to the interaction. Options include: shooting, assault, automobile accident, disorderly conduct, domestic disturbance, investigation, robbery, burglary, stolen vehicle, suicidal or behavioral crisis, suspicious person, traffic stop, trespassing, warrant or arrest, weapon complaint, well-being check, other).
Victim Age	Entered as specified, where applicable, otherwise juvenile (0-17), adult (18+), or unknown
Victim gender	Includes man, woman, transman or transwoman (subsequently collapsed into transgender), nonbinary (no cases submitted), or unknown.
Victim race/ethnicity	Entered as explicitly stated in publicly available source. Unknown or unspecified indicates information withheld by authorities or not explicitly reported by journalists. Options include: non-Hispanic White, non-Hispanic Black, Hispanic, other, unknown
Officer Duty Status	All duty statuses refer to the officer(s) who fired shots during the injurious incident. Options include: on-duty, off duty, other
Count of number of persons shot	The number of persons shot in a given event
State Policy: Permit to Purchase Statute	If a state has a statute requiring a permit to purchase a firearm

State Policy: Concealed Carry Weapon Statute	If a state has a statute allowing for concealed weapon carrying
State Policy: Stand Your Ground Statute	If a state has a statute for stand your ground law
State Policy: Violent Misdemeanor Statute	If a state has a statute prohibiting firearm purchase among individuals convicted of violent misdemeanors
State Policy: Gun Ownership Rate	The rate of gun ownership in a given state.

2. In what month and year should the Add Health project staff expect to receive the ancillary study data?

The project data are available to be sent to Add Health project staff as soon as the study is approved. Based on the 4-6 week timeline for study approval, we anticipate sending the data to be linked in December 2023. We are prepared to send the data sooner if the Add Health staff approves the data linkage before this period.

3. What constructs, if any, will be used to create the ancillary study data (e.g., if a standardized scale will be used, what is the reference for that scale)?

There are no constructs or standardized scales to be linked in this proposal.

4. Provide investigator qualifications and prior involvement in Add Health, if any:

Dr. ▮▮▮▮▮▮▮▮▮ has been an Add Health investigator with an active contract since 2017 (Current ▮▮▮▮▮▮▮▮▮▮ Dr. ▮▮▮ has previously used the Add Health ancillary study to link the CDC mRFEI data to Wave IV of the Add Health Study. Dr. ▮▮▮ has used the Add Health data extensively, having published over two-dozen peer-reviewed studies using the Add Health Data. In addition, he and Co-I ▮▮▮▮ ▮▮▮▮ are currently funded by the Network on Life-Course and Health Dynamics in the 21st Century to use the Add Health data to study the relationship between historical redlining and violent victimization. Dr. ▮▮▮▮ (Co-I) and Dr. ▮▮▮▮▮ (Co-I) have published numerous articles studying violence and health with the Add Health data in collaboration with Dr. ▮▮▮ Dr. ▮▮▮▮ (Co-I) created the fatal and non-fatal community shootings database by extracting data from the American Violence Project. Dr. ▮▮▮▮ is funded by the National Science Foundation to continue the extraction of fatal and non-fatal community violence data through 2025 (▮▮▮▮▮▮▮ Dr. ▮▮▮▮ (Co-I) created the database of fatal and non-fatal police shootings by extracting data from the Gun Violence Archive. Dr. ▮▮▮▮▮ (Co-I) is the Co-Director of the ▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮▮ and a nationally renowned gun violence expert. Dr. ▮▮▮ and Dr. ▮▮▮ oversaw and advised on the database creation of fatal and non-fatal police shootings as part of ▮▮▮▮▮ dissertation. Co-Is ▮▮▮▮▮▮▮▮▮▮▮▮▮▮ currently have a manuscript under review using data from the augmented GVA database on patterns of fatal and non-fatal injurious police shootings in the U.S. from 2015-2020.

5. Provide the name, position, and contact information (address, phone and fax numbers, e-mail address) of individual who will receive, complete, and submit annual progress report form:

▮▮▮▮▮▮▮▮▮▮▮▮▮▮

Part VII. Description of the Proposed Ancillary Study

Please provide a narrative description of the proposed study. Do not exceed 5 single-spaced pages in length, excluding references (please use Arial 11-pt font). Include the following:

1. Specific Aims

Below we write three specific aims that we seek to accomplish in our study assessing fatal and non-fatal firearm violence (using data on community-based gun violence [citizen-on-citizen] and fatal and non-fatal injurious police-on-citizen firearm violence). Importantly, beyond our focus on health and health behaviors, the rich Add Health data will enable Add Health researchers to examine the relationship between exposure to firearm violence and a range of social and behavioral outcomes. For all aims described below, our focus will be on outcomes measured at Wave V, although measures from earlier Add Health Waves will be used as covariables in statistical analyses.

Aim 1: Examine the Relationship between Fatal and Non-Fatal Firearm Violence Events and Individuals' Mental and Physical Health
Firearm violence is a pressing public health concern in the United States, with devastating consequences for individuals and communities. The first aim of this research is to investigate the relationship between exposure to fatal and non-fatal firearm violence events (including community-based shootings and police-on-citizen shootings) and individuals' mental and physical health outcomes. Specifically, we will examine the association between these shooting events and mental health measures, including depressive symptoms and perceived stress at Wave V in the Add Health data. Additionally, we will explore the impact of firearm violence on physical health, as indicated by general self-rated health and functional limitations at Wave V.

Aim 2: Examine the Relationship between Fatal and Non-Fatal Firearm Violence Events and Individuals' Health Behaviors
Health behaviors play a critical role in shaping overall health outcomes and can be influenced by the prevalence of exposure to violence in communities. The second aim of this study is to examine the relationship between fatal and non-fatal firearm violence events (including community-based shootings and police-on-citizen shootings) and individuals' health behaviors. Specifically, we will investigate how exposure to firearm violence events is associated with health behaviors such as sleep patterns (i.e., hours of sleep, trouble sleeping), substance use (i.e., alcohol use, tobacco use, illicit drug use), and dietary habits (i.e., fast-food and sugary beverage consumption). Understanding the impact of firearm violence on these health behaviors is essential for developing targeted interventions and preventive strategies aimed at improving the well-being of individuals in communities affected by gun violence exposure.

Aim 3: Examine the Relationship between Fatal and Non-Fatal Firearm Violence Events and Individuals' Health Measured by Biomarkers
The third aim of this research is to explore the relationship between fatal and non-fatal firearm violence events and individuals' health measured by biomarkers. Biomarkers provide objective indicators of physiological processes and can shed light on the biological pathways through which different types of firearm violence exposure may affect health. Specifically, we will focus on c-reactive protein (CRP) levels, which serve as an inflammatory marker, and blood pressure, a well-established indicator of cardiovascular health. By examining the associations between firearm violence and these biomarkers, we aim to gain insights into the potential long-term health consequences of exposure to firearm violence for individuals.

2. Brief background and significance

Firearm violence is a significant public health issue in the United States (Bauchner et al., 2017) that resulted in 48,830 deaths in 2021, including 20,958 fatalities from homicide (Goldstick et al., 2021). Beyond the toll of fatal shootings, thousands of individuals experience non-fatal gunshot victimization or are vicariously exposed to firearm violence in their local community each year by witnessing or hearing about an event of firearm violence. Exposure to firearm violence in one's community can occur from a multitude of sources. For

instance, a common way of firearm violence exposure is community-based violence, in which there are incidents of fatal or non-fatal firearm violence between citizens (i.e., citizen-on-citizen firearm violence). Likewise, in light of several high-profile events of police shootings of citizens, there is a growing awareness among the potentially harmful repercussions of fatal or non-fatal shootings of police on citizens (i.e., a police officer fatally or non-fatally shoots a citizen) (Leibbrand et al., 2020; Magee et al., 2022; Semenza et al., 2021a; Semenza et al., 2023; Vasan et al., 2021).

Consequently, personal or vicarious exposure to fatal or non-fatal firearm violence from either source (i.e., citizen-on-citizen; police-on-citizen) in one's local community can significantly impact physical, psychological well-being (Buggs et al., 2022; Goin et al., 2020, Smith et al., 2020) as well as health behaviors such as sleep, diet, and patterns of substance use (Goin et al., 2020; Semenza et al., 2021). However, research on exposure to firearm violence and health has been severely restricted due to limitations with existing data sources. First, many studies rely on ecological data, linking aggregate levels of firearm violence to population health (Semenza et al., 2021a, 2021b). However, these data cannot measure individual-level health responses to ecological indicators of firearm violence. Second, much of the existing individual-level data relies on self-reported personal or vicarious exposure to firearm violence but lacks information on objective gun violence measures in one's community (Hsu et al,. 2020; Leibbrand et al., 2021; Mitchell et al., 2021; Turner et al., 2019). Third, research studies often cannot disentangle the impacts of fatal and non-fatal firearm shootings on health. There are reasons to expect that the health ramifications might differ depending on whether there was an incident of fatal firearm violence in one's community or a non-fatal incident. Finally, research rarely discerns if the source of the firearm shooting was from a citizen (i.e., citizen-on-citizen firearm violence) or if the shooting source was from a police officer (i.e., police-on-citizen firearm violence), and what details surrounded that shooting (e.g., race/ethnicity of the victim).

To overcome these limitations, we propose to link novel data from two sources described below in section 4. This data linkage will create the first dataset with fatal and non-fatal shootings stemming from community-based violence and police on-citizen shootings linked to rich individual-level data capturing health among adults in the United States. We will use this novel dataset to assess the impacts of firearm violence exposure on mental and physical health and health behaviors of adults in the United States. While we focus on linking existing firearm violence data to Wave V, a benefit of this proposal is that future data linkage to continue this work is possible. To elaborate, both Add Health and the data extractions from the American Violence Project and police shootings from the Gun Violence Archive are ongoing; therefore, additional data linkage can be performed at the release of the Wave VI Add Health data, enabling a novel assessment of the impacts of firearm violence exposure at multiple periods of the life course.

3. Conceptual framework and hypotheses

Gun violence is a critical public health issue in the United States due to its profound impact on mortality and morbidity rates (Galea & Abdalla, 2022; Grinshteyn & Hemenway, 2019; Price & Khubchandani, 2023). Beyond the direct impacts of gun violence on victims, exposure to gun violence, including firearm homicides and non-fatal firearm injuries – especially those that occur in one's local community – can be a traumatic and stress-inducing event that can significantly harm physical health, mental health, and health behaviors (Hsu et al., 2020; Leibbrand et al., 2021; Smith et al., 2020; Turner et al., 2019). Indeed, witnessing or hearing about gun violence incidents can lead to fear, anxiety, and feelings of helplessness among community members (Buggs et al., 2020 Leibbrand et al., 2021; Turner, et al., 2019). This heightened insecurity, vigilance, and trauma can impact people's overall well-being and disrupt their daily lives, resulting in increased stress levels and compromised mental health. Studies have shown that individuals exposed to community gun violence are more likely to experience symptoms of post-traumatic stress disorder (PTSD) and other mental health disorders (Bancalari et al., 2022; Slovak & Singer, 2001). Moreover, the constant fear of becoming a victim of gun violence can increase avoidance behaviors and limit individuals' physical activity (e.g., freedom to move about their surroundings unencumbered or unafraid), adversely affecting their health, quality of life, health behaviors, and potentially result in maladaptive coping behaviors.

Importantly, the source of the firearm violence might also be important in determining the repercussions of vicarious exposure to a firearm event. For instance, firearm violence often occurs in a form of what is known as community-based violence. In other words, a citizen commits fatal or non-fatal act of firearm violence on another citizen in a community. Such events result in thousands of firearm deaths yearly and many more

firearm injuries. Additionally, fatal and non-fatal firearm violence occurs annually from police-on-citizen shootings (i.e., a police officer fatally or non-fatally shoots a citizen in a community).

Regardless of the source, such exposure to firearm violence can significantly harm the health of community members who reside close to where the firearm violence occurred. Even so, there is a lack of available data that links geocoded measures of objective fatal and non-fatal firearm events (stemming from either citizen-on-citizen or police-on-citizen) with rich individual-level longitudinal data, such as those collected by the Add Health study.

Based on the above literature, we specify the following research questions to be addressed in our study:
Q1: What is the relationship between fatal and non-fatal firearm violence events at the and individuals' mental health (depressive symptoms; perceived stress) and physical health (general self-rated health; functional limitations)?
Q2: What is the relationship between fatal and non-fatal firearm violence events and individuals' health behaviors (sleep, substance use, dietary patterns)?
Q3: What is the relationship between fatal and non-fatal firearm violence events and individuals' health measured by biomarkers (i.e., c-reactive protein; blood pressure)?

4. Data and/or biological materials requested or to be collected

The data linkage will not collect any new data or biological materials. Rather we will link existing data already available to the researchers through previous data extraction projects. We describe the two sources of data in greater detail below.

Community Firearm Violence from American Violence Project
First, we will link data on community-based fatal and non-fatal firearm shootings extracted by the research team from the American Violence Project (americanviolence.org). American Violence gathers shooting data from the Gun Violence Archive, which uses over 7,500 sources to collect shooting data, including the event data and geocoded shooting location. Using these data, we will link the total number of fatal and non-fatal shooting events at the census tract level from 99 cities for 2015-2018 to Wave V of the Add Health study. The 99 cities are listed in Appendix A. Shooting events are characterized as a count of fatal shooting incidents and non-fatal shootings within a given census tract in a given year.

Data on fatal firearm mortality were originally extracted from the Gun Violence Archive by the American Violence Project at Princeton University. AmericanViolence.org is supported by Arnold Ventures as part of the Violence and Inequality Project based at Princeton University. The development of the original version of the website was supported with funding from the Bill & Melinda Gates Foundation and NYU's Marron Institute of Urban Management.

The American Violence Project is designed to be a public resource that will make data on violence accessible to public officials, journalists, researchers, and the public at large, allowing users to analyze trends in violence at multiple geographic levels (neighborhoods and cities) and over different timeframes (month to month, year to year, decade to decade). The research team has extracted data from the American Violence Project and created tract-level counts of total shootings (fatal and non-fatal) by extracting all incidents from the American Violence Project and aggregating by census tract and year (Semenza et al. 2023a). Dr. █████████ is funded by the National Science Foundation to continue the extraction of fatal and non-fatal community violence data through 2025 (Award #█████████. Dr. █████████ and colleagues have recently published a peer-reviewed manuscript using this data (Semenza et al., 2023b).

Fatal and non-fatal Police on Citizen Shootings
Second, we will link data on fatal and non-fatal shootings from police officers to citizens extracted from the Gun Violence Archive by Co-I █████████████████████████ Data representing incidents and victim characteristics were extracted and compiled from the Gun Violence Archive linked articles and other publicly available sources. The Gun Violence Archive is a database of fatal and non-fatal US gun violence events, identified from approximately 7,500 media, law enforcement, government, and commercial sources daily since 2013. Incidents are cataloged by date, location, and gun violence type (e.g., "officer-involved"). Data abstraction occurred from July 2021 to April 2022 for shootings by police occurring from January 1, 2015,

through December 31, 2020. The abstraction team comprised 14 public health students from the Johns Hopkins Bloomberg School of Public Health. Abstractors received standardized training and a randomly assigned subset of 14,155 incidents.

Additionally, a blinded 10% of incidents were repetitively assigned for quality assurance. The median case assignment was 1,100 (range: 460 to 5,525). Cases were restricted to include only incidents of shots fired by one or more law enforcement officers, resulting in injuries to people who were not responding officers. Accidental discharges, policing occupational injuries, injuries by bullet alternatives exclusively (e.g., rubber bullets), shootings without injury, and self-inflicted injuries were excluded. GVA-designated "suicide by cop" shootings (i.e., shootings presumed to have been intentionally provoked) were retained. Abstracted variables included situational characteristics (e.g., response type, incident type, shooting location, weapon involvement), victim demographics (e.g., gender, age, race, ethnicity), victim characteristics (e.g., housed or unhoused, armed status, and weapon type, injury outcome), and a limited set of shooting-officer characteristics (e.g., on- or off-duty status, alone or accompanied, agency affiliation). Abstractors additionally identified and described incidents in which mental or behavioral health conditions were explicitly named in association with the shooting or its initiating incident. These cases were re-reviewed and confirmed. Each shooting event is coded to the date of the recorded event and geocoded using the longitude and latitude of where the event was reported to have occurred.

5. Sample size and justification (i.e., formal power calculation)

Power analyses conducted in G*Power 3.1 (Faul et al. 2009) indicate that a multiple regression with 15 parameters detecting a small effect size with 80% statistical power and an alpha level of 0.05 requires a sample of 954. Considering the large sample at Wave V of the Add Health study and the large number of cases in each dataset that we propose to link to Wave V, we anticipate that the study will be adequately powered. Brian Frizzelle has already checked the linkage of the American Violence Project data at the census tract level to Wave V data and determined that based on census-tract boundaries, we will link between 2,550 and 4,429 cases. The police shooting data is national, with longitude and latitude indicators enabling varying buffer ranges. A map of the distribution of all police shooting events is provided in Appendix B. We anticipate that this will enable a linkage to many Add Health respondents based on residential addresses and our study will be adequately powered for all variables.

6. Analysis Plan for each aim

For each study aim, we will use multiple regression analyses with the focal predictor variable of interest being the exposure to a shooting from either community firearm violence or a police-on-citizen shooting. We will be able to measure the Add Health sample member's exposure to the police shooting in terms of time (how recent was the shooting event to the data collection data at Wave V) and geography (how close was the shooting event to the respondent's home address). While there are numerous variables that can be explored at Wave V, our aims will focus on health and health behaviors measured by the following characteristics:

Physical health
- **General Self-Rated Health** (H5ID1)
- **Physical Limitations** (H5ID4)

Mental Health
- **Depression Symptoms** (H5SS0A; H5SS0B; H5SS0C; H5SS0D; H5SS0E)
- **Perceived Stress** (H5MN1; H5MN2; H5MN3; H5MN4)
- **Suicidal Behavior** (H5MN8; H5MN9)

Health Behaviors
- **Sleep** (H5ID15; H5ID16; H5ID17; H5ID18)
- **Diet** (H5ID21; H5ID22)

Biomarker
- **Blood pressure** (H5BPCLS5)
- **Hemoglobin H1c** (H5CHBA1C)

- **C-Reactive Protein** (H5CCRP)

8. Study timeline

Below is the study timeline. We anticipate that the Add Health ancillary form will be submitted by September 29, 2023. Based on the standard timeline, we anticipate approval and receipt of data approximately six to twelve months after the application date (between March 2024 and September 2024).

Following receipt of data, we anticipate a one-year period to analyze the data and complete the proposed three study aims (approximately four months per study aim). Thus, we anticipate the completion of data analysis and the study aims between March 2025 and September 2025.

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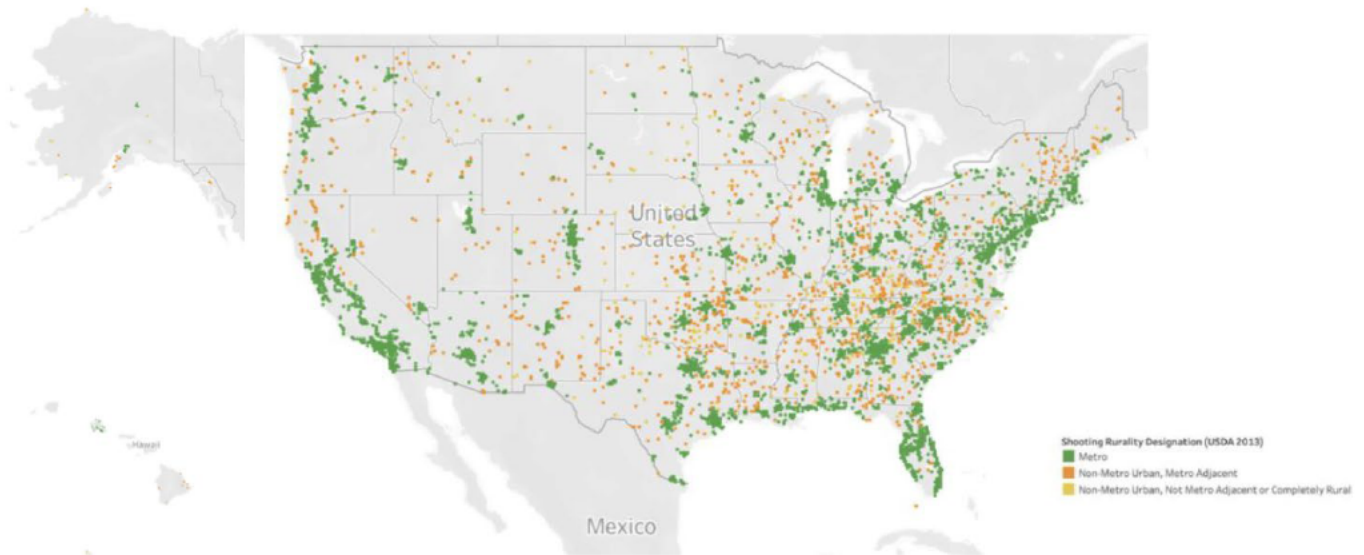
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Please email the completed proposal to:

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Carolina Square, Suite 210
123 West Franklin Street
Chapel Hill, NC 27516
Phone: 919-962-6094
addhealth_ancillary@unc.edu

	State	City		State	City		State	City
1	AK	Anchorage	35	FL	Tampa	69	NY	Rochester
2	AL	Birmingham	36	GA	Atlanta	70	OH	Cincinnati
3	AZ	Chandler	37	HI	Honolulu	71	OH	Cleveland
4	AZ	Glendale	38	IL	Chicago	72	OH	Columbus
5	AZ	Mesa	39	IN	Fort Wayne	73	OH	Toledo
6	AZ	Phoenix	40	IN	Indianapolis	74	OK	Oklahoma City
7	AZ	Scottsdale	41	KS	Wichita	75	OK	Tulsa
8	AZ	Tucson	42	KY	Lexington	76	OR	Portland
9	CA	Anaheim	43	KY	Louisville	77	PA	Philadelphia
10	CA	Bakersfield	44	LA	Baton Rouge	78	PA	Pittsburgh
11	CA	Chula Vista	45	LA	New Orleans	79	TN	Memphis
12	CA	Fremont	46	MA	Boston	80	TN	Nashville
13	CA	Fresno	47	MD	Baltimore	81	TX	Arlington
14	CA	Irvine	48	MI	Detroit	82	TX	Austin
15	CA	Long Beach	49	MN	Minneapolis	83	TX	Corpus Christi
16	CA	Los Angeles	50	MN	St. Paul	84	TX	Dallas
17	CA	Oakland	51	MI	Kansas City	85	TX	El Paso
18	CA	Riverside	52	MI	St. Louis	86	TX	Fort Worth
19	CA	Sacramento	53	NC	Charlotte	87	TX	Garland
20	CA	Santa Ana	54	NC	Durham	88	TX	Houston
21	CA	San Bernardino	55	NC	Greensboro	89	TX	Irving
22	CA	San Diego	56	NC	Raleigh	90	TX	Laredo
23	CA	San Francisco	57	NC	Winston-Salem	91	TX	Lubbock
24	CA	San Jose	58	NE	Lincoln	92	TX	San Antonio
25	CA	Stockton	59	NE	Omaha	93	TX	Plano
26	CO	Aurora	60	NJ	Jersey City	94	VA	Chesapeake
27	CO	Colorado Springs	61	NJ	Newark	95	VA	Norfolk
28	CO	Denver	62	NM	Albuquerque	96	VA	Virginia Beach
29	DC	Washington	63	NV	Henderson	97	WA	Seattle
30	FL	Hialeah	64	NV	Las Vegas	98	WA	Spokane
31	FL	Jacksonville	65	NV	North Las Vegas	99	WI	Madison
32	FL	Miami	66	NV	Reno	100	WI	Milwaukee
33	FL	Orlando	67	NY	Buffalo			
34	FL	St. Petersburg	68	NY	New York			

Appendix B: Map of persons injured from shootings by police in the United States, 2015-2020

Shooting Rurality Designation (USDA 2013)
- Metro
- Non-Metro Urban, Metro Adjacent
- Non-Metro Urban, Not Metro Adjacent or Completely Rural

Add Health Ancillary Study Proposal Form

Add Health — The National Longitudinal Study of Adolescent to Adult Health

Part I. Basic Study Information

1. Today's date: 2/28/2024

2. Full study title:

   > Gentrification, Retail Environments, and Chronic Disease Risk

3. Principal investigator

   - Name: ███████
   - Institution: ████████████████
   - Address: ████████████████████
   - Phone: ███████
   - E-mail address: ██████████

4. Collaborator(s)

   - Name: █████████████
   - Institution: ███████████████
   - Address: ██████████████
   - Phone: (████████████
   - E-mail address: ████████████████████

   - Brief abstract describing the study (200 words maximum):

   > Evidence is emerging about associations between gentrification and health, but this research is limited by lack of longitudinal data. Studies to date mainly use cross-sectional or repeated cross-sectional designs, creating selection bias because 1) new residents are included in analyses and 2) original residents who stay in gentrifying neighborhoods may have more resources than those who move. Longitudinal research following original residents is needed to understand impacts on health and health equity. To address this important gap, we propose leveraging the nationally representative, longitudinal design of Add Health to examine differences in individuals' neighborhood environments, behaviors, and health outcomes among participants who experienced gentrification vs. those who did not. This study will link measures of gentrification that have been proposed for use in national public health studies for Waves 1, 3, 4, and 5 and food and tobacco retail environment measures derived from expert-informed protocols for Waves 3 and 4. We will then analyze associations between gentrification and changes in retail environments, health behaviors, social determinants of health, and chronic disease risk biomarkers. Future research can use linked data to examine associations between gentrification and additional social, behavioral, and health outcomes, as well as between retail access and these outcomes.

5. Proposed start dates:

> 4/1/2024

6. Proposed end dates:

> 6/30/2025

7. Estimated cost (please work with the Ancillary Study Coordinator to develop this):

> $12,547

8. Proposed funding source and planned date of submission to external funding agency:

> Already-acquired research funds from the National Cancer Institute of the National Institutes of Health will be used (Cancer Control Education Program-█████████ Advancing Science & Practice in the Retail Environment-█████████).

9. Does this study involve the support or collaboration of a for-profit corporation, or do you intend to patent any process or product of the analysis (see Section G above)?

☐ Yes
☒ No

Part II. Use of Previously Collected Geocodes

1. Do you propose to use previously-collected respondent geocode data?

⊠ Yes
☐ No *(skip to Section III)*

2. What types of geocode data do you propose to use?

Mark all that apply.

Geocode	Wave I	Wave II	Wave III	Wave IV	Wave V
State					
County					
Census tract	X		X	X	X
Block group					
Latitude and longitude					

Part III. Use of Previously-Collected Biospecimens

1. Do you propose to use archived biospecimens?
   ☐ Yes
   ☒ No *(skip to Section IV)*

2. Please indicate in the table below the type and amount of biospecimen needed and the number of respondents for whom biospecimens are requested.

Type of Biospecimen	Amount Needed	Number of Respondents
Wave V Serum		
Wave V Plasma		
Wave V DNA		

3. Provide a justification for the amount of biospecimen and number of respondents needed.

4. What are the respondent selection criteria?

5. What assay(s) will be performed by the ancillary study?

6. During what study years will the biospecimens be assayed by the ancillary study?

7. Can previously thawed and refrozen biospecimens be used for the assay?
   ☐ Yes
   ☐ No *(If no, provide references to supporting studies)*

8. Provide a description of your plans for handling and storage of samples:

9. Provide a description of your plans for the final disposition of samples after analyses are completed:

Part IV. Genomic Information

1. Do you propose to use genomic materials (any data from Add Health respondents' DNA)?
   ☐ Yes
   ☒ No *(skip to Section VI)*

2. What specific gene(s), genotype(s), or SNPs will be investigated and by what methods of genotyping?

3. State the genetic hypothesis of interest:

4. What is/are the primary dependent variable(s)?

5. What is/are the primary independent variable(s)?

Part V. Advantages for and Burden on Add Health

1. What is the advantage, both to you and Add Health, of conducting the study within the Add Health population as opposed to another population?

There are several advantages both to this research team and to Add Health. First, Add Health contains a wide array of contextual data, along with psychosocial factors and health behaviors and outcomes. This means both that the aims proposed in this study can take advantage of this rich data, and that future work by Add Health researchers can use the measures we link to answer a wide variety of further research questions. For example, future research could examine associations between gentrification and additional biomarkers. In addition, future research could examine whether changes in food and tobacco retail access are related to changes in behavior and outcomes, questions that cannot currently be answered because food retail data are not longitudinally consistent and tobacco retail data are not linked with Add Health. Second, the longitudinal design of Add Health is needed to study potential health impacts of gentrification. Evidence so far is limited because most studies have not been able to track the outcomes of movers, who may move because of displacement and may be more negatively affected than those who stay. Third, Add Health is nationally representative, enhancing the generalizability of our findings. Finally, the timing of Add Health data collection means that researchers can assess the potential impacts of several waves of gentrification, including during the 1990s, 2000s, and 2010s. These time periods saw gentrification occur in different ways. While our research will focus on the early 2000s, future research may uncover different associations, which may provide additional insights.

2. What types of assistance will the ancillary study require from the Add Health staff? This information will be used to estimate the amount of Add Health staff time to be spent on the project.

The ancillary study will require assistance from Add Health staff to link census tract-level variables.

3. What burden, if any, will this study place on Add Health sample members?

This study will not place a burden on Add Health sample members. Only data that has already been collected will be used for data linkage and analysis.

Part VI. Assurances

1. What new ancillary study data will be integrated into the Add Health database? Please **specify the number and type(s) of variables that will become available to Add Health users**. (E.g., adding 2 variables for each of 10 years means that you are adding 20 new variables). Any request to later amend this information must be communicated formally to the Add Health PI.

> 1) Variables to calculate eligibility to gentrify at Waves 1, 3, and 4 (3 variables)
> 2) Variables to calculate gentrification status at Waves 3, 4, and 5 (9 variables)
> 3) Retail density measures for grocery stores, convenience stores, warehouse clubs/supercenters, dollar stores, specialty stores, fast food outlets, and tobacco retailers at Waves 3 and 4 (14 variables)
> 4) Racialized economic segregation at Waves 1, 3, 4, and 5 (4 variables)
> 5) Variables indicating changes in racial composition at Waves 3, 4, and 5 (9 variables)

2. In what month and year should the Add Health project staff expect to receive the ancillary study data?

> April 2024

3. What constructs, if any, will be used to create the ancillary study data (e.g., if a standardized scale will be used, what is the reference for that scale)?

> 1) Gentrification measure proposed by Hirsch and Schinasi (2019)
> 2) Racialized economic segregation, as conceptualized by Krieger et al. (2018)
> 3) Retail density measures, using protocols developed by Hirsch et al. (2021) and Golden et al. (2021)

4. Provide investigator qualifications and prior involvement in Add Health, if any:

> ██████████ PhD is a Research Assistant Professor in the █████████████████████████ ████████████████████ is a faculty fellow at ████████████████████████████, holds a data use contract with Add Health, and has published 12 studies using Add Health data. He is also ████████████ ████████████████████████████ recently funded by the National Institute on Aging.

5. Provide the name, position, and contact information (address, phone and fax numbers, e-mail address) of individual who will receive, complete, and submit annual progress report form:

> ██

Part VII. Description of the Proposed Ancillary Study

Please provide a narrative description of the proposed study. Do not exceed 5 single-spaced pages in length, excluding references (please use Arial 11-pt font). Include the following:

1. Specific Aims

2. Brief background and significance

3. Conceptual framework and hypotheses

4. Data and/or biological materials requested or to be collected

5. Sample size and justification (i.e., formal power calculation)

6. Analysis Plan for each aim

7. Study timeline

8. Literature references

Please email the completed proposal to:

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Description of the Proposed Ancillary Study

Specific Aims
The following specific aims are planned using linked measures.

Aim 1. Analyze associations between experiencing gentrification and **change in access to store types** (grocery stores, convenience stores, warehouse clubs/supercenters, dollar stores, specialty stores, fast food outlets and tobacco retailers).
　　Aim 1a. Test potential moderating effects of residential mobility, self-reported race/ethnicity, racialized economic segregation, and urbanicity.

Aim 2. Analyze possible **mediating pathways between experiencing gentrification and chronic disease risk biomarkers**, including metabolic syndrome and waist circumference. Potential mediators include percentage of healthy food retailers, fast food consumption, food insecurity, housing insecurity, racial discrimination, and stress.
　　Aim 2a. Test potential moderating effects of variables found to be moderators in Aim 1 and/or in tests of the total effect of gentrification on chronic disease risk biomarkers.

Aim 3. Analyze **associations between experiencing gentrification and tobacco use**, including potential mediation through tobacco retailer density.
　　Aim 3a. Test potential moderating effects of variables found to be moderators in Aim 1 and/or in tests of the total effect of gentrification on tobacco use.

Background and Significance
Evidence is emerging about associations between gentrification and health, but this research is limited by lack of longitudinal data.[1] Studies to date mainly use a cross-sectional or repeated cross-sectional design, leading to selection bias because 1) new residents (i.e., gentrifiers) are included in analyses and 2) original residents who stay in a neighborhood that gentrifies may have more health-enhancing resources than those who move.[1,2] **Longitudinal research following original residents who move *from* gentrified neighborhoods is needed to understand potential impacts on health and health equity.**[1]

There is limited but consistent evidence that gentrification is negatively associated with neighborhood-level food access.[3] A recent rapid evidence assessment evaluated 10 studies that examined gentrification and neighborhood food environments, all of which concluded that gentrification negatively affected at least one food environment domain (e.g., availability, affordability, or cultural relevance).[3] While these ecological analyses are helpful for characterizing neighborhood change, **individual-level food access may be a more useful construct in the context of health given the potential of gentrification-related displacement** because new food retailers will not be available to those who are displaced.[1] One quantitative study has analyzed the impact of gentrification on individual rather than neighborhood-level food availability.[4] However, this study only measured changes for residents' *original* neighborhoods, missing potentially different changes for movers.[4] **Following movers is important in future studies given the need to study residents' well-being *after* gentrification and potential displacement.**[1]

Impacts of gentrification on metabolic health are unclear. Similar to other research on gentrification and health outcomes, findings are mixed with different studies indicating health-harming associations with BMI,[4] obesity[4] and self-reported chronic health conditions including hypertension;[5] health-enhancing associations with hypertension,[6] type 2 diabetes,[7] obesity,[7] and hypertension and diabetes control;[8] and null associations with BMI,[9–11] obesity,[9,10] and metabolic syndrome.[12] **However, this research has been limited by most studies' inability to follow residents over space and time.** Only three studies have done so and these have been limited in scope, focusing on New York City[4,10] and Los Angeles County.[8] **Our study would be the first to analyze associations between gentrification and metabolic health on a national scale.**

We are not aware of any studies that assess associations between gentrification and tobacco retail or tobacco use. Given the overall increase in commercial activity in gentrifying areas,[13] evidence for increases in

unhealthy food sources,[9] and evidence for displacement to lower-cost, higher-poverty areas[14] that tend to have higher exposure to tobacco retail,[15] gentrification may be associated with increased tobacco retailer access. This is concerning given the associations of tobacco retailer availability with tobacco use[16,17] and the high burden of tobacco related chronic disease among Black and low-income populations.[18]

Finally, **the effects of gentrification on health are heterogeneous and mechanisms connecting gentrification and health are not well-understood.** Existing quantitative literature that examines associations between gentrification and health has found mixed results among the general population[1,2,19,20] but negative associations with health among Black, elderly, and low-income individuals.[1,2,8,19,21,22] Research is needed that examines differential associations between gentrification and health by exposure to structural racism and mechanisms that may explain them. **This research will fill an important gap and contribute to the field's understanding of gentrification's association with original residents' access to food and tobacco retail, dietary behavior, tobacco use, social determinants of health, and chronic disease risk.** Study findings may inform policy efforts related to affordable housing, food environments, and tobacco retail environments, and could work to address the high burden of chronic disease and chronic disease inequities.

The gentrification measures that will be linked to Add Health can also be used to examine associations between gentrification and other health outcomes, behaviors, and contexts, and retail density measures can be used to test hypotheses about food and tobacco retail environments that are only possible with longitudinally consistent retail data. The proposed research and future research using these measures can provide further understanding of the ways gentrification and the built environment may be related to health and health equity.

Conceptual Framework and Hypotheses
This ancillary study draws on several theories to inform its conceptual framework:
1) The neighborhoods and health framework, which emphasizes the importance of place for health.[23]
2) Weathering, which posits that discrimination and poverty-related chronic stress produces health inequities.[24]
3) Theory specific to gentrification and health, which highlight physical and symbolic displacement as pathways by which gentrification affects health; view gentrification in a historical context that emphasizes the role of policies that created neighborhood disinvestment as a precursor to gentrification, creating a cycle of devaluation and revaluation; and highlight unique vulnerabilities for people of color due to exposure to systemic racism.[25–27]

Figure 1 depicts our conceptual model, which incorporates these theories.

Figure 1. Conceptual Model
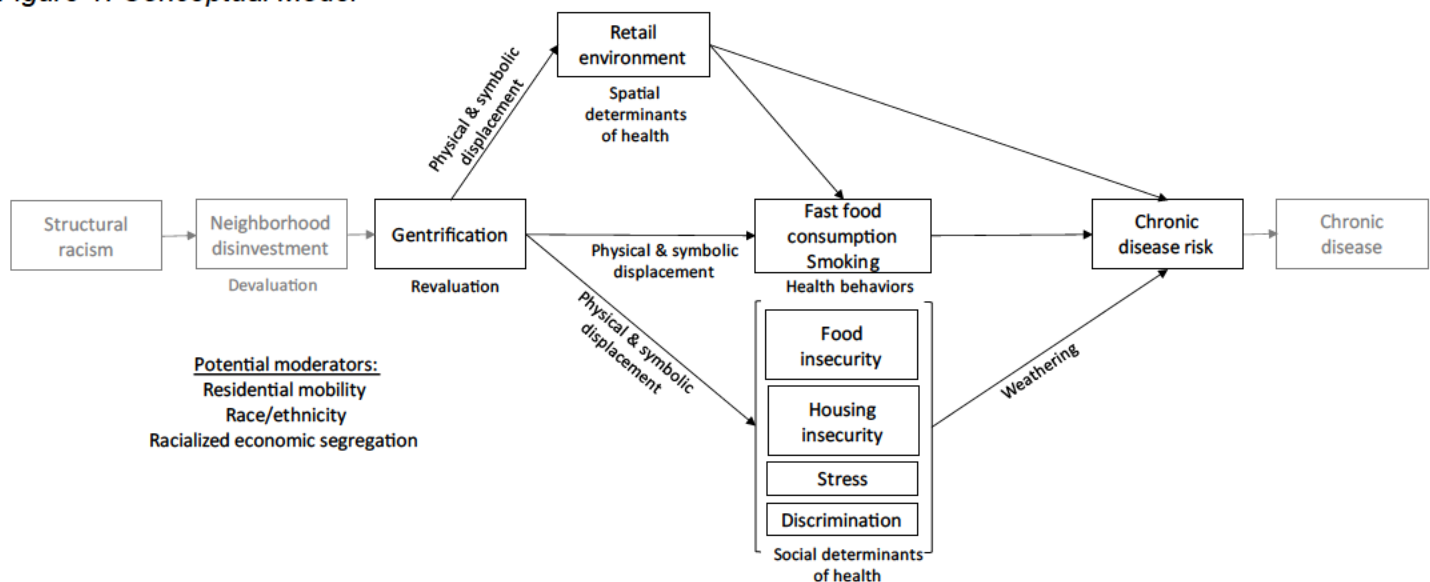
Data
Table 1 delineates the data to be linked via participants' census tracts. All measures will use the Longitudinal Tract Data Base to produce estimates that are consistent with 2010 census tract boundaries.[28,29] The aims proposed here will only use measures from Waves 3 and 4 of Add Health, selected to align with Wave 4 biomarker data. We also include variables at Waves 1, 3, 4, and 5 in response to feedback on our concept proposal indicating interest in measures that span a longer timeframe.

Table 1. Variables to Link, by Wave

Wave 1	Wave 3	Wave 4	Wave 5
Area-level percentile rank measures, used to assess gentrification			
Median household income	Median household income	Median household income	
	Change in % of residents aged 25+ with a bachelor's degree	Change in % of residents aged 25+ with a bachelor's degree	Change in % of residents aged 25+ with a bachelor's degree
	Change in median rent	Change in median rent	Change in median rent
	Change in median home value	Change in median home value	Change in median home value
Store type density measures			
	Grocery store density	Grocery store density	
	Convenience store dens.	Convenience store dens.	
	Warehouse club/supercenter density	Warehouse club/supercenter density	
	Dollar store density	Dollar store density	
	Specialty store density	Specialty store density	
	Fast food outlet density	Fast food outlet density	
	Tobacco retailer density	Tobacco retailer density	
Measures of segregation and racial change			
Racialized economic segregation	Racialized economic segregation	Racialized economic segregation	Racialized economic segregation
	Change in % Black	Change in % Black	Change in % Black
	Change in % Hispanic	Change in % Hispanic	Change in % Hispanic
	Change in % White	Change in % White	Change in % White

Measures
Eligibility to gentrify and **gentrification status** will be calculated using a definition proposed by Hirsch and Schinasi for use in national public health studies.[30] This definition is based on measures developed originally by Freeman[31] and Ding et al.,[32] which were designed to capture housing cost increases and socioeconomic change using census data. This measure has several benefits. First, it reflects hypothesized mechanisms. Second, it is relatively simple to calculate for all census tracts in the U.S. Third, it is comparable with other studies on gentrification and health—some studies use the exact measure[30,33–35] and others use measures that are similar.[8,10,14,36–38] The ancillary study committee expressed interest in non-binary measures of gentrification, noting implications of the sensitivity of existing gentrification measures. To address this, we propose linking **percentile rank variables** which can be used to calculate gentrification measures at multiple cutoffs. Census tracts in a core-based statistical area (CBSA) will be compared with each other, and tracts that are outside of a CBSA will be compared with other tracts in their state.[30] **Eligibility to gentrify** will be assessed with the percentile rank of each census tract compared to its surrounding area in terms of **median household income**, linked at Waves 1, 3, and 4. **Gentrification status** will be assessed with the percentile rank of each census tract compared to its surrounding area in terms of increases in the **percentage of residents with a bachelor's degree, median rent, and median home value**, linked at Waves 3, 4, and 5.

For our analyses we will use Hirsch and Schinasi's proposed cutoffs,[30] identifying tracts as eligible to gentrify if the percentile rank for median household income is less than 75, and as a sensitivity test, less than 50. We will primarily use a binary measure of gentrification, defining a tract as gentrified if the percentile rank for increase

in share of residents with a bachelor's degree is greater than 50, *and* the percentile rank for the increase in median rent *or* home value is greater than 50. As a sensitivity test, we will examine moderate and intense gentrification separately, defining intense gentrification with more rapid increases in housing costs (percentile rank for median rent or home value > 75). **Because percentile ranks will be linked, other researchers can use alternative cutoffs or treat the measure as continuous.**

Density measures for each store type will be calculated as the number of each store type per 1,000 people, a common strategy for retail density measures to aid interpretability.[39–41] The number of each store type will be measured using National Establishment Time Series (NETS) data for all retail types and Data Axle for fast food outlets. Two sources will be used because although the NETS data we have access to have already undergone a substantial cleaning process, these data do not include fast food. For all **food source density measures**, we will identify store types using a protocol developed for use with longitudinal health studies with NETS data based on Standard Industrial Classification (SIC) codes and industry chain lists.[42] For **tobacco retailer density measures**, we will use counts by census tract that have already been calculated using a detailed protocol using NAICS codes, SIC codes, store names, and state-level policy data.[43]

Racialized economic segregation will be calculated using the Index of Concentration at the Extremes (ICE) for the interaction of race and income. The original ICE measures economic segregation and is calculated as $ICE = (A – P)/T$, where A = high-income population in an area, P = low-income population in the area, and T = the area's total population.[44] Values range from -1 to 1, where -1 indicates that all residents are in the least privileged group and 1 indicates all residents are in the most privileged group. For racialized economic segregation, A represents the high-income White population and P represents the low-income Black, Hispanic/Latino, or non-White population.[45,46] The ICE has several advantages, including its utility at multiple geographic scales and the fact that it makes visible both concentrated disadvantage and concentrated advantage.[45] The *combined* ICE measure also avoids multicollinearity issues, simplifies the number of analyses that must be run, and captures the phenomenon of racialized economic segregation that is a key component of American inequality.[45] Following Krieger et al., we will use the 20th and 80th percentile to delineate low and high income groups.[45] We will use high-income White as the advantaged group and low-income non-White as the disadvantaged group. This categorization method misses possible variation in effects of gentrification on segregated communities that are primarily Black, Latine, Asian, or another non-White racialized group. However, because we use the combined racialized economic segregation measure, we will still be able to detect possible varying effects of gentrification on poor communities of color generally.

Finally, **change in racial/ethnic composition** will be linked. Gentrification is tied to changes in neighborhood racial composition, but the extent to which racial change occurs is not consistent across gentrifying neighborhoods.[47] Future research could assess the differential effects of gentrification under different racial change dynamics, as has been done in previous work.[21] This is important given the need to more closely analyze racialization in gentrification research.[27,47]

Sample Size and Justification
This study will use a subpopulation of at least 2,455 individuals who lived below the national median household income in adolescence and in gentrifiable census tracts at Wave 3. This sample size is estimated based on comparing census tracts to counties, where tracts are defined as gentrifiable if the tract-level median income is less than the county-level median income. It is expected to increase when gentrification measures are linked. Power calculations for Aim 1 indicate that power will be sufficient for most store types. Based on the test of not-close fit for RMSEA,[48] 167 and 631 participants are needed to achieve 80% for Aims 2 and 3, respectively.

Analysis
Aim 1. Linear regression with an interaction term for time and gentrification will be run for each store type. This interaction term will estimate change in store type availability from Wave 3 to 4 for individuals whose Wave 3 tracts gentrified versus those whose tracts did not. Non-gentrified but gentrifiable tracts are the counterfactual for gentrified tracts, and the outcome of interest is the *difference in effect* of change over time on retail density. A similar econometric modeling approach has been taken in similar studies focused on original residents.[4,49,50] Gentrification is not random; it is influenced by distance to the city center, racial and socioeconomic

composition, and the built environment.[20,47,51,52] To improve non-gentrified census tracts as a counterfactual, we will use fixed effects for Wave 3 tracts. We will also include controls for age, income, and education at both waves and college enrollment at Wave 3 because these factors are likely to influence neighborhood selection, which in turn influences propensity to experience gentrification, propensity to move, and retail access.

Aim 1a. Potential moderators, including residential mobility, self-identified race/ethnicity, and racialized economic segregation, will be assessed with stratified models. Cluster-robust standard errors will be used to account for the Add Health cluster random sampling design.[53] Wave 4 longitudinal weights will be used.[53]

Aims 2 and 3. Logistic and linear regression will be used to test gentrification's association with metabolic syndrome, waist circumference, and smoking. Structural equation modeling (SEM) will be used to test all *a, b,* and mediating (*a*b*) pathways and remaining direct effects. We may re-specify the SEMs as model fit is assessed, as is general practice in SEM.[54] Any re-specification will be theoretically justified.[54] Age, income, and education at Wave 4 and college enrollment at Wave 3 will be included as covariates. Model fit will be assessed with the X^2 test, root mean square error of approximation (RMSEA), comparative fit index (CFI) and Tucker-Lewis index (TFI).[55] Cluster-robust standard errors and Wave 4 cross-sectional weights will be used.[53] *Figure 2* shows the initial path diagram that will be tested in two SEMs in Aim 2; metabolic syndrome and waist circumference will be tested in separate models. Fast food consumption, food insecurity, housing insecurity, discrimination, and stress will be assumed to be correlated. *Figure 3* shows the initial path diagram that will be tested in Aim 3. Covariates and correlations among mediators are omitted for visual parsimony.
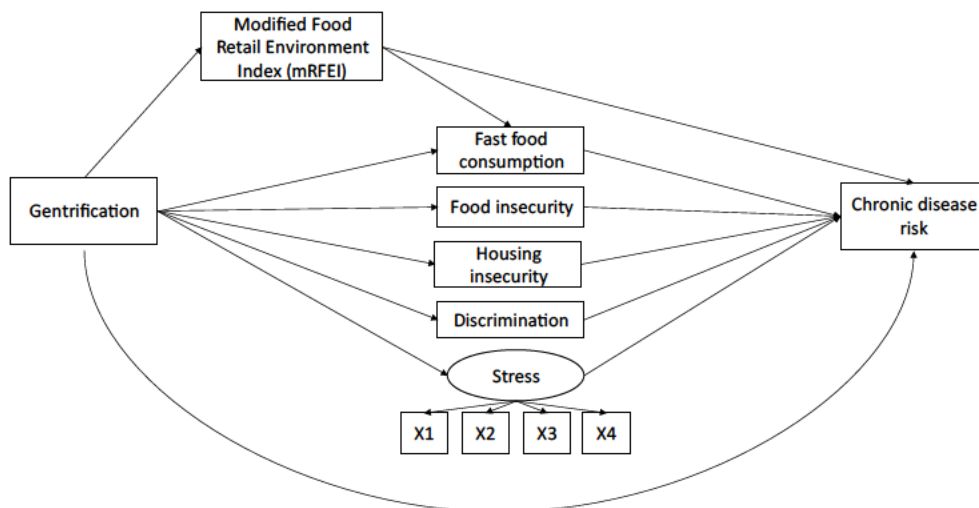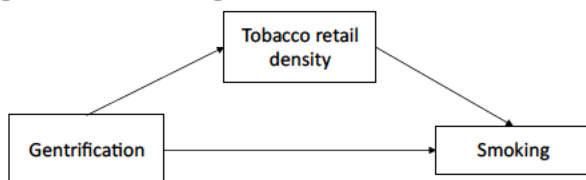
Figure 2. Path Diagram for Aim 2

Figure 3. Path Diagram for Aim 3

Aims 2a and 3a. In analyses of total effects, separate models with interaction terms for each potential moderator will assess the extent to which effects are heterogeneous. Only moderators that are significant at this step or that are found to be moderators in Aim 1 will be examined in Aims 2 and 3. Multiple comparison group SEM will be used to test moderation for identified moderators.

Study Timeline
We anticipate that data will be ready for linkage by April 2024. Assuming the linkage process takes six months, analyses will be conducted in late 2024 and through 2025.

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