Protocol

The Effects of the 11th Street Bridge Park on Community Health in Washington, DC: Longitudinal Study Protocol for a Natural Experiment

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Abstract

Background: The built environment and urban design are now recognized as primary drivers of achieving an active and healthy lifestyle. Unfortunately, the benefits of large green-space developments are often not distributed equally, and low-income communities of color often endure unintended consequences.

Objective: We will examine the impact of a new Bridge Park on the longitudinal changes in the spacio-physical and spacio-behavioral characteristics of the built environment, as well as in individual-level physical activity patterns, food access, and security, and perceptions of neighborhood safety, gentrification, and social capital among 300 family clusters living in Washington, DC, Wards 6, 7, and 8.

Methods: The 11th Street Bridge Park is unique because it will link one of the more affluent DC regions (Ward 6: West of the Anacostia River) to the ward with the highest level of poverty (Ward 8: East of the Anacostia River). We will rely on a quasi-experimental design to examine the longitudinal impact of Bridge Park on community health over 3 years. Our study area comprises census tracts within a 1-mile radius of the Bridge Park, as well as 3 comparison census tracts that are not expected to be affected directly by the Park. ArcGIS (Esri) and audit tools will assess the built environment, while primary data will be collected by device-based and self-reported measures.

Results: This protocol was funded by the National Institute of Nursing Research (NIH/NINR R01 NR 021883; LD, principal investigator [PI]) in August 2025. Institutional Review Board approval (protocol NCR256815) was granted on December 29, 2025. Baseline park, playground, and trail audits began in June 2026 and were completed in August 2026. Recruitment for primary data collection began in August 2026.

Conclusions: Given the consistently strong relationship observed between poverty, low access to health-promoting environmental features, and poor health, findings disseminated from this project will inform other urban design projects to provide equitable and sustainable benefits to everyone living in the community.

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KEYWORDS

built environment; community design; community health; gentrification; health equity; health promotion; social capital

Introduction

Increasing population levels of daily physical activity have assumed considerable public health significance in the past 3 decades [1,2], and recent efforts have expanded from targeting individual behavior change toward addressing environmental risk conditions that affect a community more broadly [3]. Indeed, the built environment and urban design are now recognized as primary drivers of achieving an active and healthy lifestyle [4]. Unfortunately, the distribution of these health-promoting environmental resources is not uniform, and people living in low-resource and disinvested areas (urban and rural) bear a disproportionately higher burden of risk conditions and lifestyle-related chronic diseases, compared with their more affluent counterparts. Such environments may have limited park space or recreation, unsafe and neglected playgrounds, no sidewalks or bicycle lanes for active transport to work or school, and limited access to healthy food options. In fact, simply moving from a high-poverty area to a wealthier area can increase the overall availability of physical activity opportunities by 50% [5].

Policy, systems, and environmental (PSE) strategies for promoting physical activity and other healthy behaviors are gaining momentum within public health practice. The PSE framework comprises strategies for change that are both multisectoral and multilevel. These strategies work at a foundational level to address risk conditions within the communities where people live, work, learn, play, and receive health care [6]. Moreover, since PSE strategies are directed toward the entire community, they are more sustainable and can address imbalances in opportunities and outcomes better than interventions focused on the individual. Such PSE approaches, however, are more expensive and take longer to enact within communities. Thus, it becomes advantageous to identify naturally occurring "interventions" (ie, natural experiments) for which their impact on population behavior and health can be determined over time. The 11th Street Bridge Park [7] offers an elegant strategy for examining the effects of neighborhood change on community health in the communities surrounding it.

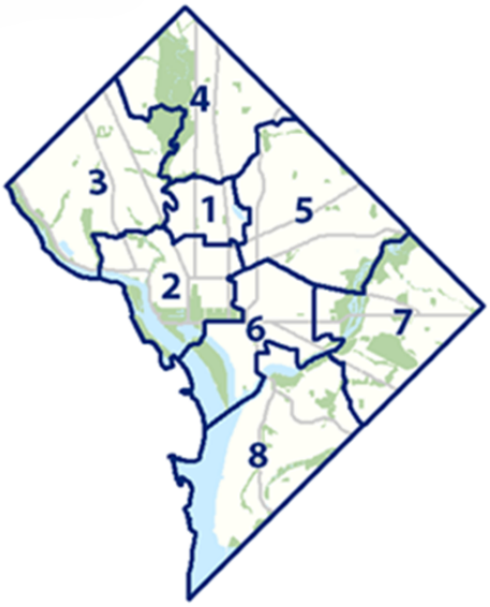
A primary concern when large-scale environmental improvements are made within a community is that of gentrification [8-11]. Gentrification is a phenomenon defined as the transformation of neighborhoods from low property value to high value. Specifically in the case of the 11th Street Bridge Park, there is a concern for what is known as the "green paradox"—that is, where increased green space and canopy cover create benefits to human health and the environment but also create opportunities for capital investments, which then drive up property values in surrounding areas and result in negative consequences for low-income people living in those very neighborhoods [12]. Where people live, work, and play has a substantial impact on their health. Gentrification often causes displacement of long-time residents and businesses, thereby making it a housing, economic, and public health issue that affects a community's history and culture and reduces social capital [8]. This phenomenon can shift a neighborhood's racial or ethnic composition, household income, and access to affordable housing. Evidence indicates that displaced populations typically have shorter life expectancy, higher prevalence of cancer, greater infant mortality, higher prevalence of asthma and other chronic diseases, as well as a disproportionate burden of environmental exposure to hazardous substances, food insecurity, and low access to safe parks and recreational facilities [8].

The 1986 World Health Organization's Ottawa Charter [13] defines health promotion as "the ability of people to have control over the determinants of their health." In the case of the built environment, however, people living in low-resource areas often lack the necessary personal, social, and community capital to advocate for improvements to their own neighborhoods. A community's engagement can enhance its ability to address its health needs. Indeed, community participation in any planning that would directly affect it appears to increase buy-in and can serve to identify social and health issues of priority among residents [14]. In addition, community participation has demonstrated a link to enhanced social capital and community capacity [15], which are essential to the sustainability of any community-based intervention.

Washington, DC, is divided into 8 geographic wards (Figure 1), and despite it being the capital of the United States, the differences between the wards with respect to education, income, public resources, and other social drivers of health are noteworthy, particularly when comparing the wards west of the Anacostia River to the wards east of the Anacostia River. The 11th Street Bridge Park is unique because it will link one of the more affluent DC regions (Ward 6: West of the Anacostia River) to the ward with the highest level of poverty (Ward 8: East of the Anacostia River). This project is a multisectoral effort, involving 3 schools of public health, several community nonprofit organizations, and numerous residents and stakeholders, that will address changes in the built environment in these 2 wards before and over the course of Bridge Park construction, as well as the effects of such changes on the health of the surrounding community.

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Figure 1. Wards in the District of Columbia.



Our approach is consistent with a systems-level ecological model and the PSE public health practice model that both emphasize multiple-sector, multiple-level action that directly affects important social drivers of health [16]. Moreover, we relied on the National Institute on Minority Health and Health Disparities Research Framework to structure our research strategy. This framework calls for research that encompasses different domains of influence (biological, behavioral, physical or built environment, sociocultural environment, and health care system), as well as different levels of influence (individual, interpersonal, community, or societal) within those domains [17].

Methods

Study Design

The 11th Street Bridge Park will be roughly the size of 3 football fields placed end-to-end. The Park will be built on the original pillars of the old freeway bridge crossing the Anacostia River between Wards 6 and 8 and will also connect to a new 16-foot-wide pedestrian and bicycle path that links with the Anacostia River trail [7]. Construction will begin in late 2026 with an expected park opening in 2028.

Study Aims

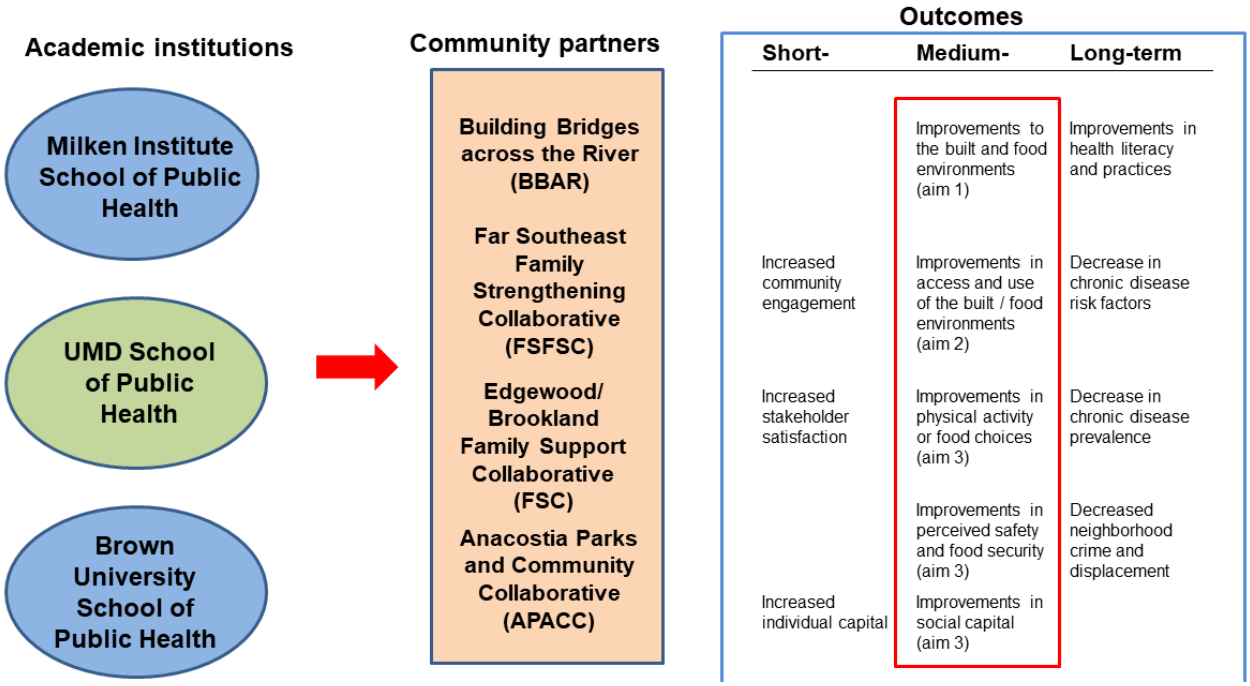
Our study aims are threefold: (1) to determine the impact of the 11th Street Bridge Park project on the built environments of Wards 6 and 8 that are within the sampling area (1-mile radius) surrounding the new park, (2) to determine the influence of this project on spacio-behavioral characteristics of the park itself, as well as of the sampling areas of Wards 6 and 8 surrounding the park, and (3) to determine the impact of the 11th Street Bridge Park project on individual- and family-level lifestyle behavior changes, as well as on perceptions of neighborhood safety and social connectedness, food security, and gentrification, using an intergenerational approach to gain perspectives across the life course.

Study Team

The project is led by investigators from the Milken Institute School of Public Health at the George Washington University, along with investigators from 2 other schools of public health at the University of Maryland and Brown University. These academic institutions will then join together with several community partners both west and east of the Anacostia River to execute the project aims (Figure 2).

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Figure 2. A conceptual model linking multiple sector action to positive changes in social, environmental, and behavioral drivers of community health. APACC: Anacostia Parks and Community Collaborative; BBAR: Building Bridges Across the River; FSC: Edgewood/Brookland Family Support Collaborative; FSFSC: Far Southeast Family Strengthening Collaborative.



Building Bridges Across the River (BBAR) is a nonprofit organization housed in Ward 8 that, in collaboration with the District Department of Transportation, oversees the 11th Street Bridge Park in achieving the following primary goals: (1) to build a healthy community in the neighborhoods surrounding the Park, (2) to restore health to the Anacostia River, (3) to enhance connection between the Wards 6 and 8 communities, and (4) to become an anchor for equitable and inclusive economic development in the surrounding neighborhoods.

Joining forces with BBAR is a second nonprofit community organization, the Far Southeast Family Strengthening Collaborative (FSFSC). The mission of the FSFSC is "to act as a catalyst to develop, nurture, and sustain partnerships of residents, agencies, and institutions in the Southeast community and to create a healthy socioeconomic environment through which every child and family has an opportunity to achieve their maximum potential and to lead a productive life." Among its many programs and services, the FSFSC maintains a Community Engagement Team. Through its projects and activities, the Community Engagement Team strives to build community capacity and bring families together to strengthen community networks. To that end, the FSFSC and the Community Engagement Team provide key elements to our study in their mission and values surrounding health promotion and human and community capital development. The FSFSC and their partner west of the river (Edgewood/Brookland Family Support Collaborative) will assist us in the identification and recruitment of families to participate in aim 3 of this project. In addition, we plan to train and use young people aged 18-25 years, participating in the Community Engagement Team's Workforce Development Program, as paid community-based research assistants.

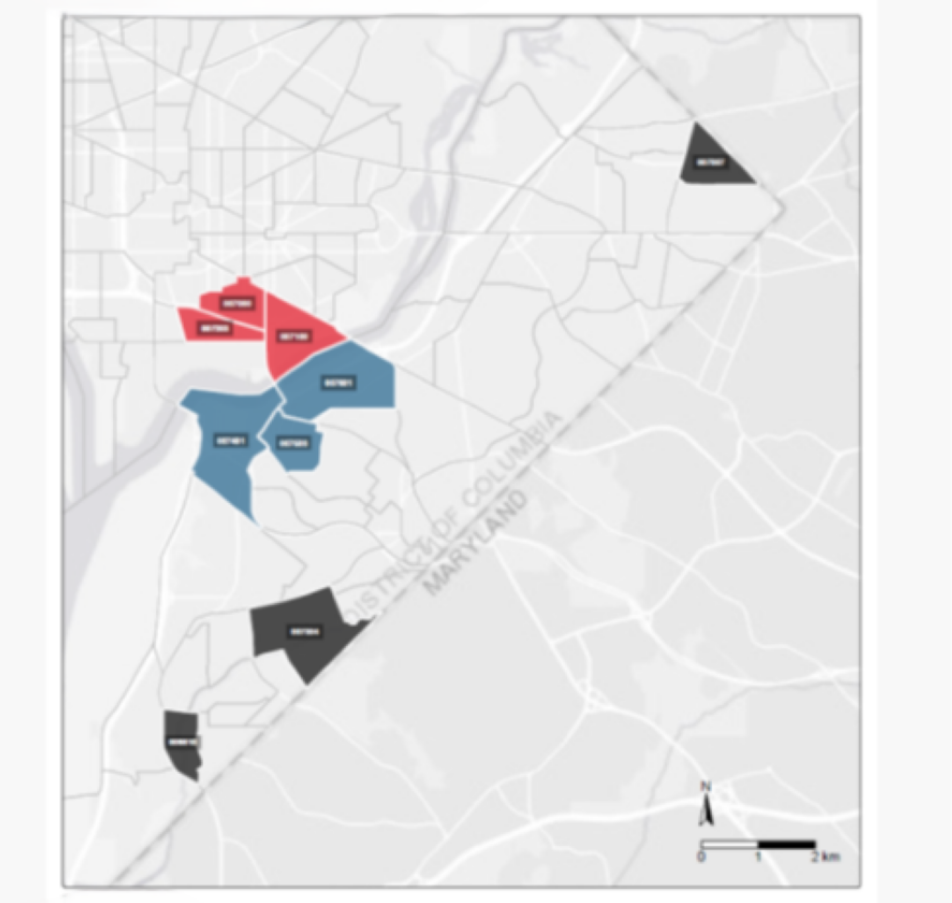
Finally, we have recently partnered with the Anacostia Parks and Community Collaborative, which is a network of community leaders and organizations working together to make the Anacostia River and its park system the best possible resource for residents of Wards 7 and 8 in the District of Columbia. The Anacostia Parks and Community Collaborative will continue to advise us in our selection of parks, playgrounds, and trails for auditing in addressing aims 1 and 2.

Study Area

We plan to use census tracts within a 1-mile radius of the Bridge Park as our study area (Figure 3). Mapping techniques using RStudio (Posit) and ArcGIS were used to define this study area, as well as 2 comparison census tracts in Ward 8 and 1 comparison tract in Ward 7 that are not expected to be affected directly by the Bridge Park. Past research focused on urban built environments (including both food and park space environments) uses a 1-mile radius, as this is commonly defined as a feasible and 10-minute accessible walkability radius among diverse urban populations [18,19].

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Figure 3. Study area (red and blue census tracts) along with 3 comparison areas (black census tracts) for Wards 6, 7, and 8.



Study Design

We plan a quasi-experimental longitudinal study with data collection occurring before the construction of the Bridge Park (baseline) and then once per year (April-October) over 3 years. We will use objective environmental audits and ArcGIS monitoring to address changes in the spacio-physical and spacio-behavioral characteristics of the study area surrounding the Bridge Park and will also rely on device-based and self-reported data from 300 family clusters to determine behavioral changes in physical activity and diet, as well as in perceptions of neighborhood safety, food security, and social capital resulting from the Bridge Park construction. Importantly, we will also monitor several objective indicators and self-reported perceptions of gentrification throughout the study to determine their influence on our environmental, social, and behavioral outcomes of interest. Table 1 provides a list of study variables, along with their method of assessment and timing of assessment.

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Table 1. Measures of assessment by specific aim, timing, and outcome of interest.

Aims	Characteristics	Method of assessment	Time point of measurement
AIM 1: to determine the impact of the 11th Street Bridge Park on the built environments of Wards 6 and 8 that are within the study area (1-mile radius) surrounding the new park	• Number and quality score of playgrounds • Number and quality score of bike/walking paths, sidewalks, and Capital Bikeshare • Number of community gardens and urban farms • Number of farmers' markets • Number of corner stores (including Healthy Corner Stores authorized by DC Central Kitchen) • Number of grocery stores • Number of fast food restaurants	• PARA[a] • SOPARC[b] • ArcGIS monitoring • DC Office of Urban Agriculture • DC Office of Planning, Food Policy Division	• Baseline and once a year for over 3 years • ArcGIS: Baseline and following park completion
AIM 2: to determine the influence of this project on the spacio-behavioral characteristics of the park itself, as well as of the study area surrounding the park	• Number of people using park features (playgrounds, bike/walking paths, Capital Bikeshare, and kayak or canoe launches) • Number of people actively commuting • Number of people using farmer's markets • Number of people owning a community garden	• PARA • SOPARC • DC Office of Urban Agriculture	• Baseline and once a year for over 3 years
AIM 3: to determine the impact of the 11th Street Bridge Park project on individual- and family-level lifestyle behavior changes, as well as perceptions of neighborhood safety, food security, and social capital using an intergenerational approach in 300 family units	• Physical activity (steps/day; self-reported MVPAc) • Fruit or vegetable consumption • Sugar-sweetened beverage consumption • Food security • Perceived neighborhood safety • Perceived gentrification • Perceived social capital	• Fitbit (Fitbit Inc) and IPAQ[d], PAQ-C[e], PAQ-A[f] scores • EATS[g] Food Scan and YRBSS[h] • BEVQ-15[i] and YRBSS • 18-item Household Food Security Survey Module • Perceived Neighborhood Safety Scale • DC crime data • NCGS[j] • ICERace-Income[k] • Adapted SASCAT[l]	• Baseline and once per year over 3 years

[a]PARA: Physical Activity Resource Assessment.

[b]SOPARC: System for Observing Play and Recreation in Communities.

[c]MVPA: moderate-to-vigorous intensity physical activity.

[d]IPAQ: International Physical Activity Questionnaire.

[e]PAQ-C: Physical Activity Questionnaire for Older Children.

[f]PAQ-A: Physical Activity Questionnaire for Adolescents.

[g]EATS: Eating at America's Table Study.

[h]YRBSS: Youth Risk Behavioral Surveillance Survey.

[i]BEVQ-15: a 15-Item Beverage Intake Questionnaire.

[j]NCGS: Neighborhood Change and Gentrification Scale.

[k]$ICE_{Race\text{-}Income}$: Index of Concentration at the Extremes for Race and Income.

[l]SASCAT: Short version of the Adapted Social Capital Assessment Tool.

Study Population

We plan to recruit 300 family clusters, distributed equally within the census tracts comprising the study area and the comparison tracts. Each family cluster will comprise at least a parent or guardian and 1 child aged 10-15 years of age. To ensure an adequate representation of older participants, we will also enroll a grandparent or other older (>60 years) household member if

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available. Thus, family clusters will have no fewer than two members and no more than three members from different generations. To be eligible for the study, families must live within the census tracts surrounding the 1-mile radius of the Park (the study area) or in one of the comparison communities, with plans to remain in their residence over the subsequent 3-4 years. Children will be aged 10 to 15 years, which will allow for the accurate self-report of the behavioral variables of interest and will allow us to follow adolescents to age 18 without changing surveys. Adults will be >18 years of age, with no upper age limit.

Study participants will be recruited from community centers, after-school programs, the Children's Hospital clinic in Ward 8, the DC Healthy Community's website, churches, and other religious establishments. We will advertise (in English and Spanish) through newspapers, fliers, and social media (X [X Corp] @DCBridgePark and Facebook), as well as by newsletter and in-person visits. To ensure that our eligible study samples are representative of their ward population, we will compare our enrolled study sample with ward-specific census data and then use more targeted recruitment methods if supplementation is needed. The FSFSC currently works with over 800 families within Wards 7 and 8; the Edgewood-Brookland Family Support Collaborative serves over 200 families in Wards 5 and 6; while the Bridge Park newsletter currently reaches about 8200 households within Wards 6, 7, and 8. An enrollment goal of about 5 families per month per ward should allow us to meet our recruitment goal.

Assessment of the Built and Food Environments

For ArcGIS, we will use secondary data sources from Open Data DC and ParkServe about our spacio-physical characteristics of interest (playgrounds, green spaces, hiking trails, sidewalks, food vendors, community gardens, corner stores, etc) to track changes in these features within the study area and the comparison areas before and after Bridge Park completion. We will also analyze raster data from satellites to track greater environmental changes related to air pollution and greenness. Change detection analyses, using pretrained deep learning models in ArcGIS Pro 3.5, can describe and quantify differences between images of the same area at different times. The output from change detection is a "difference raster" where each pixel contains the type or magnitude of change. We plan to supplement these data with those from the DC Office of Urban Agriculture and the DC Office of Planning, Food Policy Division, in assessing the food environment.

The System for Observing Play and Recreation in Communities [20] is a validated direct observation audit tool for assessing park and recreation areas, including the socio-physical characteristics (eg, accessibility, usability, safety, supervision, and organization) of the spaces, as well as the socio-behavioral characteristics (eg, use of specific features by estimated age, sex, and ethnic groupings). The System for Observing Play and Recreation in Communities will be supplemented with the Physical Activity Resource Assessment audit instrument, which addresses the presence and quality of various park and playground amenities (tennis courts, ballfields, drinking fountains, picnic tables, and trash receptacles) [21]. Audit data will be collected at baseline and then once per year (controlling for seasonality) over 3 years by pairs of observers over the course of one week. Data will be collected 3 times/day on 4 days of the week (2 weekdays and 2 weekend days) and entered directly into Microsoft spreadsheets by trained research assistants. We have identified 9 park areas to be audited—3 in our study census tracts west of the Anacostia River (Virginia Ave SE Park, Garfield Park, and Marion Park/Providence Park); 3 in the study tracts east of the river (Anacostia Park [2 locations] and Berry Farm); and 1 park in each of the 3 comparison tracts (Oxon Run [2 locations] and Marvin Gaye Park).

Physical Activity Assessment

We will assess physical activity in each family cluster once per year over 3 years using both device-measured and self-reported approaches. Participants will first wear a Fitbit for 4 weeks, after which they will complete the self-reported physical activity survey that captures the previous 7 days. In this way, we will have some temporal overlap between device-measured and self-reported physical activity.

Step counts represent the fundamental unit of human movement; they are intuitive and easily understandable, and they translate well into public health recommendations [22]. Steps per day will be collected via Fitbit Charge 2 devices over 4 weeks (controlling for seasonality). Fitbit devices provide a valid and reliable measurement of daily step count as an estimate of accumulated physical activity in children, adolescents, and adults over longer periods of time [23]. Fitbits were chosen to minimize participant burden (eg, ability for family to charge and sync devices themselves at home) over extended wear periods. Moreover, adherence to wearing a Fitbit is often greater than that with accelerometers because there is no need to remove it from the wrist [24]. Participants will be instructed to wear the devices on the nondominant wrist at all times, including when they sleep, shower or bathe, or swim. Each Fitbit will be assigned a unique numeric identifier. We will create a generic account for each profile before providing it to participants during their scheduled baseline visit. Profiles will be linked to Fitabase (Small Steps Labs, LLC), a web-based interface that allows remote access and data download of participants' Fitbit data. Similar to other studies, we will include all days with >599 daily minutes of waking wear time within each participant's 4-week study protocol and a minimum of 1000 steps/day [25]. Valid wear time will be defined as having had at least 4 days of wear (3 weekdays and 1 weekend day) per week.

Self-reported physical activity in adults will be assessed with the International Physical Activity Questionnaire–Short Version [26]. This 7-item self-administered questionnaire queries physical activities performed during the previous 7 days. Frequency (days), duration (min), and intensity (metabolic equivalents of tasks [METs]) of moderate- and vigorous-intensity activities (work or leisure time), as well as of walking and sitting, are combined to derive a volume measure, expressed as MET-min/week. Self-reported physical activity among children and adolescents will be assessed using the self-administered Physical Activity Questionnaire for Older Children (PAQ-C) [27] and the Physical Activity Questionnaire

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for Adolescents (PAQ-A) [28]. The PAQ-C is a 9-item, 7-day physical activity recall instrument designed for use in elementary and middle school-aged children. Each item is scored on a 5-point scale to derive a composite score, with the mean of the composite score being the PAQ-C summary score (ranging from 1 to 5). The PAQ-A is a slightly modified version of the PAQ-C (without the "recess" item) designed for high school students. It is administered and scored in a similar manner as the PAQ-C, except that the composite score is based on 8 items rather than 9. Summary scores for the PAQ-A also range from 1-5. The International Physical Activity Questionnaire, PAQ-C, and PAQ-A were chosen over other surveys, such as the Global Physical Activity Questionnaire [29] and the ACT24 (activities completed over 24 hours) tool [30], because there are validated versions for adults, adolescents, and children, and they assess the previous 7 days rather than only 24 h (thus allowing for a fuller temporal overlap with the Fitbit data).

Assessment of Diet and Food Security

Fruit and Vegetable Consumption

The National Institutes of Health Eating at America's Table Study quick food scan is a self-administered 10-item screener that will assess adult fruit and vegetable consumption over the past 30 days [31]. The information collected from the screener can be used to estimate the total number of servings of fruits and vegetables consumed daily (times/day) by converting each reported frequency (times per month, week, or day) into a daily average. Fruit and vegetable consumption among children and adolescents will be assessed by a self-administered, 6-item, 7-day recall taken from the Youth Risk Behavioral Surveillance Survey [32].

Sugar-sweetened beverage (SSB) consumption will be assessed with the 15-Item Beverage Intake Questionnaire [33], which estimates habitual daily intake (kcal, grams consumed) of water, total beverages, and SSBs across 15 beverage categories. The SSB category comprises regular soft drinks, juice drinks, sweet tea, coffee or tea with cream and/or sugar, mixed alcoholic drinks, meal replacement drinks, and energy drinks. Participants are asked to indicate the frequency (ranging from never or less than once per week up to 3+ times/day) and quantity (ranging from <6 fl oz up to >20 fl oz) that they consumed in the past month. Beverage intake responses can range from 0 fl oz to 60 fl oz (eg, 3 times per day, 20 fl oz each time) per day. Consumption of SSB over the past 7 days among children and adolescents will be assessed by 1 question from the Youth Risk Behavioral Surveillance Survey [32].

Food Security

This will be assessed with the 18-item US Household Food Security Survey Module [34], which classifies the experience among both adults and children living in the household. This module is the gold-standard assessment tool used to ascertain the experience of food security at the household level. We will administer the survey to the head of household using a 12-month recall period, with each affirmative response receiving one point (scored 0-18 points). We will classify households as experiencing the following: (1) high food security (0 points), (2) marginal food security (1-2 points), (3) low food security (3-7 points), or (4) very low food security (8-18 points). We will classify households experiencing high and marginal food security as experiencing food security, and households experiencing low and very low food security as experiencing food insecurity [35].

Perceptions of Neighborhood Safety, Gentrification, and Social Capital

Changes in perceived neighborhood safety will be assessed by four questions: (1) How safe from crime do you consider your neighborhood to be? (2) How safe do you feel walking around your neighborhood during the day? (3) How safe do you feel walking around your neighborhood at night? and (4) Would you say that most people in your neighborhood could be trusted? For each question, respondents will rate their level of perceived safety on a visual analog (100 mm) scale. At one end of the scale is the rating "not at all" (0 mm), and at the other (100 mm), the rating "extremely." Respondents will be asked to draw a mark through the 100 mm scale at the point that best represents their level of perceived safety. We can compare these perception ratings over time with yearly crime statistics for these same census tracts as a way of validation.

The Neighborhood Change and Gentrification Scale (NCGS) [36] asks respondents to report on whether they agree or disagree with a series of statements related to changes that may have occurred in the neighborhood over the previous years. The NCGS comprises 10 items, each scored on a 5-point Likert scale (1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree). Self-reported data from the NCGS will be supplemented with secondary data that track objective indicators of gentrification. The American Community Survey will provide sociodemographic and economic data at the census tract level, as well as for the whole of DC and the United States. Ward-level estimates for the same time period will be obtained from the DC Office of Planning, as well as from the DC Census Bureau. We will also consider changes in the Index of Concentration at the Extremes, which specifically assesses racialized economic segregation in terms of spatial concentrations of racial and economic privilege vs disadvantage within a given area [37,38]. Objective data on home ownership, income, employment, and voter registration will also be obtained. Importantly, these publicly available data will allow us to monitor indicators of gentrification that may affect our study results.

The Social Capital Assessment Tool [39] is a multifaceted instrument designed to collect social capital data at the household, community, and organizational levels. It is an integrated survey that measures individuals' and groups' opportunities and constraints by focusing on the social assets and networks that determine their access to resources. A short version of the Adapted Social Capital Assessment Tool has demonstrated adequate reliability and validity in 4 low-income countries in which both individual and cognitive social capital demonstrated consistent relationships with child nutritional status [40]. The short version of the Adapted Social Capital Assessment Tool contains 8 questions about (1) membership in various community groups, (2) financial or emotional support from family, friends, and community, and (3) community cohesion and trust. Answers to all questions are coded as

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"yes"=1 or "no"=0, and the scores are then totaled over all 8 questions, with higher scores indicating greater social capital.

Other Secondary Data Sources

The DC Office of Urban Agriculture will provide yearly data reports on the number of urban farms, community gardens, and farmers' markets existing throughout the different wards. The DC Office of Planning, Food Policy Division will provide data reports on locally owned food businesses, healthy corner stores, grocery stores, and fast-food outlets. DC Crime Data Report summaries will allow us to objectively track crime throughout the study areas surrounding Bridge Park. In addition, these data can help to validate participants' perceptions of neighborhood safety.

Statistical Analysis Plan

Our overall hypothesis is that the 11th Street Bridge Park will result in significant improvements in several behavioral outcomes having to do with daily step counts and self-reported physical activity (primary outcomes), diet, and perceptions of neighborhood safety, food security, and social capital (Table 1). To test this hypothesis, we will use a 3-year longitudinal evaluation that compares outcomes between 3 groups defined by census tract location in relation to the construction of the Bridge Park. In particular, group 1 will be defined as the 3 census tracts in Ward 6 on the western side of the Anacostia River; group 2 will be the 3 tracts in Ward 8 on the eastern side; and group 3 will be 2 control tracts in Ward 8 and 1 in Ward 7 that are not proximate to the Bridge Park and are not expected to be influenced directly by the Bridge Park opening.

Longitudinal modeling based on linear and generalized linear mixed effects models will be used with fixed main effects for group and time, and fixed interaction effects for group-by-time to estimate our primary target parameters for causal inference, which will be the differences in slopes between group 1 and group 3 and between group 2 and group 3, respectively. This model structure will enable us to account for group differences at baseline through the group-specific intercepts. It will enable us to model the effects of bridge construction by comparing change over time from baseline (preconstruction) to the yearly postconstruction time points for the outcomes through the time slopes in each group. The inclusion of a control group (group 3) will enable us to estimate secular trend effects, while the group-by-time interaction terms estimate differences in change over time compared to the control group to estimate our primary causal effects of interest. To account for the hierarchical nature of our study design, random effects will be used to represent heterogeneity specific to family clusters and individual changes over time within a family cluster. Census tracts will be modeled as fixed effects, and we will compare standard likelihood ratio tests for the main group-level slope comparisons to sensitivity analyses based on small-sample corrected cluster-robust Wald tests (eg, as described in the R package clubSandwich) to account for possible residual clustering at the census tract level, Kenward-Roger df corrections, or cluster-specific bootstraps with resampling of family clusters within census tracts. Since moving from 1 intervention group to another is not expected to occur much (if at all) by the design of our study, our study involves a point treatment and will be analyzed using an intent-to-treat approach. Therefore, all models will be adjusted for differences in important baseline sociodemographic factors that may influence physical activity and other health behaviors—namely, age, race, sex, level of educational attainment, and changes in indicators of gentrification using direct regression adjustment or propensity score weighting. Data will be analyzed using SAS for Windows 9.4 (SAS Institute, Inc) and the R statistical programming language (version 4.6; R Foundation). Univariate statistics (mean [SD] and frequencies [%]) will be generated on all study variables to assess their distributions and to provide descriptive statistics for the study populations. At baseline, simple correlations among the study variables will be assessed using the Pearson correlation coefficient. Cross-sectional differences in selected study variables between the study and comparison census tracts will be assessed using ANOVA or chi-square tests.

Power Calculations for Aim 3

Our primary outcome variable for aim 3 is physical activity (steps/day). On average, Americans take approximately 5000 steps/day [41]. To assess statistical power, we conducted a Monte Carlo simulation study with 500 replications from a multilevel linear mixed-effects model based on the proposed study design with 100 family clusters within each of the 3 wards with 3 individuals per family observed at 4 time points (baseline and 3 postbaseline time points in yearly increments until 4 years). The simulated model contained random intercepts for family and random intercepts and slopes over time for individuals within families. The fixed effects included an intercept and slope for time, main effects for groups 1 and 2, and 2 interaction terms between group and time, with group 3 as the reference group. The outcome was simulated on the log scale to enable us to express effect sizes in terms of percent changes in steps/day over time from baseline to 3 years postbaseline in increments of yearly units of time. It was assumed that there would be no change in the mean over time from the baseline of 5000 steps/day in the comparison communities, while our power calculation aims to identify the power associated with 10%, 20%, or 30% increases in steps/day by the end of the study within the study area by testing the significance of the difference in slopes by group. Power was calculated as the proportion of the 500 simulation replicates in which a 2 df chi-square test of the group-by-time interaction was rejected at a 5% significance level. These calculations indicate that 100 families per ward would allow us ample power ($1 - \beta = 0.96$) to differentiate a 20% or more increase in step counts.

Ethical Considerations

All researchers and research assistants have taken the Human Investigations Training Course either online (through the National Institutes of Health [NIH]) or in person through George Washington University. Eligible participants will scan the QR code from the study advertisement to gain access to and sign the consent form. The parent or a guardian will be provided with the study information required for informed consent and will decide whether to allow their child to participate. Study information will also be described in age-appropriate terms to the eligible child, who must verbally express their willingness

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to participate. Participants can also complete all study surveys via REDCap. All surveys used in this study have been translated into Spanish. Other than census tract number, age, sex, and race, we will not gather any identifiable information on participants that could link them to survey responses. Families will each receive up to US $300 in gift cards (US $100 gift card/year) for their participation and return of Fitbits.

Study data will be managed using REDCap electronic data capture tools hosted at George Washington University. REDCap is a secure, web-based application designed to support data capture for research studies, providing: (1) an intuitive interface for validated data entry, (2) audit trails for tracking data manipulation and export procedures, (3) automated export procedures for seamless data downloads to common statistical packages, and (4) procedures for importing data from external sources. REDCap uses various methods to protect and secure data stored in the database. All electronic data will be stored on a password-protected computer. No individuals, other than the professionals directly involved in the study, will be allowed to read data forms. Investigators will be required to respect the confidentiality code. No subjects are identified by name in any of the published literature and only by code in major data storage areas. The master list of participants and ID numbers will be kept in a password-protected computer file on a secure network drive at George Washington (GW). To date, we have never had a violation of confidentiality.

Results

This protocol was funded by the National Institute of Nursing Research (NIH/NINR R01 NR 021883, LD, principal investigator [PI]) in August of 2025. Institutional Review Board approval (protocol NCR256815) was granted on December 29, 2025. Baseline park, playground, and trail audits began in June 2026 and were completed in August 2026. Recruitment for primary data collection began in August 2026. The population and sociodemographic composition of the census tracts that will be included in the study are shown in Table 2. As indicated, participants in the Ward 8 and 7 census tracts have a markedly greater proportion of Black and African American residents and a greater level of poverty relative to participants in Ward 6 census tracts. In addition, 12% (10,784/89,870 and 10,446/87,048, respectively) of residents in Wards 7 and 8 are without a high school diploma vs 4% (3231/80,772) in Ward 6. Unemployment is 10% (8705/87,048) in Ward 8, 8% (7190/89,870) in Ward 7, and 4% (3231/80,772) in Ward 6, and the proportion of people owning homes is 24% (20,892/87,048) in Ward 8 vs 36% (29,078/80,772) in Ward 6.

Table 2. Selected sociodemographic characteristics by ward and census tract (2020-2024 ACS[a] 5-year estimates)[b].

	Ward 6 census tracts			Ward 8 census tracts			Comparison of census tracts		
	007000	007100	007203	007401	007503	007601	007304 (Ward 8)[c]	009810 (Ward 8)[d]	007807 (Ward 7)
Population, n	2392	3153	3361	1249	2188	4240	5288	2109	2477
Female, n (%)	1268 (52.6)	1513 (48.3)	1849(55.1)	906 (72.5)	1138 (52.2)	2756(65.2)	2803 (53.1)	1286 (60.7)	1263 (51.4)
Age (years), n (%)									
<18	407 (17.1)	473 (14.8)	370 (10.9)	262 (20.9)	656 (30.1)	1145(26.8)	1639(31.3)	738 (35.2)	545 (21.7)
18-64	1555 (65.2)	2396 (75.7)	2790(83.2)	749 (59.5)	1378 (62.8)	2459(58.1)	2908(55)	1097(52.2)	1645 (66.4)
65+	431 (17.7)	300 (9.5)	198 (5.9)	250 (19.6)	153 (7.1)	636 (15.1)	740 (13.7)	266 (12.6)	272 (11)
African American, n (%)	335 (13.6)	1513 (47.6)	1008(29.8)	1174(93.9)	2057 (94.2)	3519(82.8)	4886 (92.4)	2025(96.)	2237(90.3)
Households, n	1066	1528	1923	670	984	1875	2222	948	935
Persons per household, n	1.98	2.06	1.68	1.86	2.10	2.21	2.23	2.18	2.59
Below poverty level, n (%)[e]									
<18 years	215 (8.7)	0 (0)	0 (0)	462 (37.2)	372 (17.2)	1967(46.4)	3675(69.5)	1181(56.2)	867 (35.2)
>65 years	359 (15.1)	410 (13)	706 (21.1)	453 (36.3)	1006(46.3)	1314(31.2)	159 (3)	717 (34.2)	503 (20.3)

[a]ACS: American Community Survey.

[b]Source: American Community Survey 5-year Estimates, 2009-2024. United States Census Bureau American Fact Finder website [42].

[c]Closer to the study area.

[d]Farther from the study area.

[e]Estimated percentages are present with a high margin of error, but (X) or no actual number is reported.

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Discussion

Overview

As stated previously, we will leverage a naturally occurring intervention to study changes in the built environment and their effects on several domains of community health. Typically, built environment interventions focus on a single environmental change (eg, complete streets, biking or walking trails, or traffic calming measures) and a single outcome (eg, physical activity, walkability, or food access). Several systematic reviews examining the effects of such changes in the built environment on community physical activity patterns generally report positive findings in both adults and in children [43-45]. We plan to examine several concomitant environmental changes resulting from the new Bridge Park and their effects on multiple behavioral and social indicators of health. One systematic review of self-described "natural experiments" (involving policy and/or environmental changes) cited the utility of such studies for examining complex and multifactorial public health issues (eg, obesity prevention) and for providing "real-world" evidence in situations in which a large randomized-controlled trial is not feasible or ethical [45]. Natural experiments often are criticized for their inability to eliminate bias—particularly bias due to confounding [46], lack of a control group [45], or weak evaluation methods [47]. Our study addresses these limitations by (1) controlling for multiple sources of known and measurable confounding variables (notably, indicators of gentrification) using sophisticated multivariable statistical techniques, (2) using comparison communities not expected to be directly affected by the Bridge Park, and (3) using a longitudinal study design with multiple data collection points over 3 years.

Our approach is consistent with a systems-level ecological model and the PSE public health practice model that both emphasize multiple-sector, multiple-level action that directly affects important social drivers of health [16]. Expertise from investigators at 3 schools of public health, combined with that of our community partners, adds a substantial level of joint scientific- and practice-based rigor that will use a range of objective and self-reported methods to collect primary data, which will be supplemented with secondary data from publicly available sources managed by DC government and the US Census.

Anticipated Outcomes

We anticipate that the environmental outcomes (spacio-physical and spacio-behavioral changes) proposed in aims 1 and 2 will demonstrate improvements within 1 year post completion within the study area, but not in the comparison census tracts. A 20% improvement in daily step counts would have strong clinical and public health significance [48] and may take up to 2 or 3 years to observe. Meaningful improvements in food choices and perceived food security, social capital, and neighborhood safety may also take up to 3 years to occur. With regard to changes in perceived gentrification, we note that there will be anticipated benefits to the Ward 8 community resulting from the ongoing work of BBAR and their Equitable Development Plan. These benefits include greater access to affordable housing, workforce development, and small business growth, which are important social drivers of health and human capital. Whether these benefits will be distributed equally across the different census tracts in Ward 8 is not clear. The BBAR staff will collect data on these outcomes and provide us with annual reports so that we can account for any effects that changes in these factors may have on our behavioral health outcomes.

Potential Challenges

There are also some potential challenges that need to be considered with this study. Recruitment of participants from low-resource areas is an issue in any study. Should we fall behind in our recruitment targets, we will work closely with BBAR and the FSFSC's Community Engagement Team to devise targeted strategies for enhancing recruitment in the different study census tracts. Training and hiring research assistants from the FSFSC Workforce Development Program (who are members of the community) and a research assistant who is fluent in Spanish will also help us achieve our recruitment goals. Maintaining the study sample for aim 3 over 3 years may be challenging due to changes in residence or attrition. First, our chosen statistical method (linear mixed effects model) is fairly robust in handling certain types of missing data (eg, missing at random). Additionally, we use a preventive strategy during the screening process to identify any barriers (ie, anticipated relocation outside of the study area) that may hinder a participant from completing the study. We take note of these potential barriers and use participant-targeted approaches to address them to minimize the risk of attrition. As important is the presence of the entire research staff within the communities (hosting meetings and giving talks) as much as possible. We have been successful in retaining participants in our past community intervention studies by maintaining close contact with them. Study visits for Fitbit set-up will be scheduled based on the participants' availability, with reminders of upcoming visits and data collection periods being texted or emailed. If a study visit is missed or canceled, it will be rescheduled within 1 week.

Construction delays may also be a challenge to completing our study aims promptly. We do not foresee problems collecting baseline data within our proposed timeline, and, if necessary, we could shorten our follow-up period if construction is delayed. Even with a shortened follow-up, improvements in the built environment features (aims 1 and 2) and step counts (aim 3) should be apparent, even though health status, social capital, or policy changes may take longer.

The ability to synchronize Fitbit data with a cellphone requires participants to have internet. If there is limited or no internet within the participants' home, we will encourage them to go to the local public library or recreation center, where internet is available for free. Further, there is often conflict on whether to use research-grade or commercial wearable trackers for the objective measurement of physical activity. Whereas Fitbit tends to overestimate steps relative to Actigraph (Ametris) accelerometers, there is evidence of adequate agreement between devices [49]. There is also concern that proprietors of wearable devices will change the algorithms for converting raw data into motion counts over time; however, this issue also occurs when using research-grade accelerometers. Fortunately, any changes

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in algorithms with the Fitbit will likely affect only the calculations of moderate-to-vigorous physical activity and sleep and not step counts.

Conclusions

By leveraging a large, naturally occurring environmental improvement project that will link 2 socioeconomically different wards in Washington, DC, we can provide evidence of the positive and unintended consequences of the 11th Street Bridge Park to the communities affected by it. Given the consistently strong relationship observed between poverty, low access to health-promoting environmental features, and poor health, findings disseminated from this project could help to inform other urban design projects to provide equitable and sustainable benefits to everyone living in the community.

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Generative AI Use

The authors declare that generative AI was not used in the preparation of this manuscript.

Authors' Contributions

Conceptualization: LD
Funding acquisition: LD
Methodology: LD, GH, KM, AE, JS, ST
Visualization: KM
Writing – original draft: LD
Writing – review & editing: LD, GH, KM, AE, JS, ST

Conflicts of Interest

None declared.

Multimedia Appendix 1

Peer review report by HPC - Health Promotion in Communities Study Section, Social and Community Influences on Health Integrated Review Group, National Institute of Nursing Research (National Institutes of Health, USA).
[PDF File (Adobe PDF File), 131 KB-Multimedia Appendix 1]

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Abbreviations

ACT24: activities completed over 24 hours
BBAR: Building Bridges Across the River
FSFSC: Far Southeast Family Strengthening Collaborative
GW: George Washington
MET: metabolic equivalents of task
NCGS: Neighborhood Change and Gentrification Scale
NIH: National Institutes of Health
PAQ-A: Physical Activity Questionnaire for Adolescents
PAQ-C: Physical Activity Questionnaire for Older Children
PI: principal investigator

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PSE: policy, systems, and environmental
SSB: sugar-sweetened beverage

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