

# Examining the Built Environment for Healthy Living via Virtual Street Audits

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**ABSTRACT:** During the fall 2019 and spring 2020 semesters, 156 MPH students enrolled in the Integrative Learning Experience at the University of Alabama at Birmingham School of Public Health explored concepts of the built environment and health by auditing 2500 street segments in 4 urban neighborhoods in Birmingham, Alabama. In teams of 4 to 5, in-class and online students worked collaboratively to assess 63 built environment variables related to transportation, land use, advertisement, and neighborhood physical disorder. This type of “community assessment” is the first stage of the Evidence-based Public Health Framework and consistent with the applied nature of an MPH degree. Authors conducted secondary data analysis of final team assignments to demonstrate how students translated observations and ratings into practical recommendations for neighborhood improvements to promote physical activity. Students recommended improvements in neighborhood infrastructure and services, specifically: creating exercise space, providing outdoor exercise equipment, improving neighborhood safety, and cultivating a culture of health. The Integrative Learning Experience course encouraged students to use their knowledge and skills to prioritize recommendations to improve neighborhood conditions. Variable ratings and observations increased student awareness of the built environment and its potential to impact individual and community health. Moreover, the project helped students make connections between proximal outcomes, such as improving neighborhood walkability, and distal outcomes, such as improved health outcomes among residents. Finally, this project modeled for students the use of evidence-based strategies for making data-informed decisions, which are essential skills for new and emerging public health professionals.

**KEYWORDS:** Environment and Public Health, health equity, healthy lifestyle

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## Background

According to the Centers for Disease Control and Prevention,<sup>1</sup> the neighborhood where a person lives has a major impact on their health and well-being. Neighborhoods are comprised of man-made structures, features, and facilities, which are collectively known as the *built environment*. The built environment can either encourage or discourage physical activity through attributes like walkability, land use, and active transportation options.<sup>2-5</sup>

Historically, racial and ethnic minorities and individuals with low incomes are more likely to live in neighborhoods with built environments that limit physical activity.<sup>4</sup> These same neighborhoods also frequently have high rates of *neighborhood disorder*, which has been associated with poorer physical and mental health outcomes and riskier health behaviors.<sup>6-8</sup> Gracia<sup>9</sup> defined neighborhood disorder as “observed or perceived physical and social features of neighborhoods that may signal the breakdown of order and social control, and that can undermine the quality of life” (p. 4325).

During the fall 2019 and spring 2020 semesters, 156 MPH students enrolled in the Integrative Learning Experience at the

University of Alabama at Birmingham<sup>10</sup> School of Public Health explored concepts of the built environment and health by auditing 2500 street segments in 4 urban neighborhoods in Birmingham, Alabama. In teams of 4 to 5, in-class and online students worked collaboratively to assess 63 built environment variables related to transportation, land use, advertisement, and neighborhood physical disorder. The purposes of this study are to (1) describe an innovative, project-based learning experience for public health students and (2) demonstrate how students translated observations and ratings into practical recommendations for neighborhood improvements to promote physical activity.

## Integrative Learning Experience

MPH students complete the Integrative Learning Experience (ie, MPH Capstone course) during their final semester of enrollment before graduation. This course represents a culminating experience that allows students to demonstrate a synthesis of foundational public health competencies. Backgrounds and experiences of students enrolled in the MPH Capstone course were richly unique; students comprised a population



**Table 1.** Student demographics at the University of Alabama at Birmingham.

	NUMBER	PERCENT
Gender		
Male	8242	36.5
Female	14 320	63.5
Race/Ethnicity		
White	12 966	57.5
Black or African American	4746	21.0
Asian	1,466	6.5
Non-resident Alien	1084	4.8
Hispanic/Latino	1050	4.6
Two or more races	826	3.7
Unknown	358	1.6
American Indian or Alaskan Native	59	0.3
Hawaiian or Pacific Islander	8	0.03
Geographic location		
Alabama	17 034	75.5
Other U.S. states	4440	19.7
Other countries	1089	4.8

Source. 2020 to 2021 Facts & Figures.

that is consistently rated among the most diverse campuses in the United States.<sup>11</sup> Considering the catchment area of student recruitment as well as Birmingham's commitment to postsecondary education through the Birmingham Promise, it is highly likely that one or more students in the MPH Capstone course had familial connections to the urban neighborhoods in Birmingham.<sup>12</sup> A breakdown of student demographics can be seen in Table 1.

### *Capstone course*

Within the Capstone course students from all public health concentrations complete a project designed to use previously developed skills to assess different aspects of a community's assets, environment, and health. For the built environment project, MPH students rated variables related to transportation, land use, advertising, and physical disorder in order to make recommendations to improve neighborhood conditions. This type of "community assessment" is the first stage of the Evidence-based Public Health Framework<sup>13</sup> and consistent with the applied nature of an MPH degree.

Based on guided readings, results of variable ratings, and priority health concerns identified by the Jefferson County Department of Health (JCDH), students prepared neighborhood specific reports that described community-level issues

that could potentially affect health and advance health equity. According to the Robert Wood Johnson Foundation,<sup>14</sup> health equity means:

[that] everyone has a fair and just opportunity to be as healthy as possible. This requires removing obstacles to health such as poverty, discrimination, and their consequences, including powerlessness and lack of access to good jobs with fair pay, quality education and housing, safe environments, and health care. (para. 1)

Through written and oral presentations, teams proposed and prioritized realistic public health actions, interventions, programs, or policies that would improve community health. The emphasis on audience-specific reports reflects an increasing emphasis by the Council on Education for Public Health (CEPH) that graduates possess both theoretical and practical knowledge.

### *Conceptual framework*

Instructors framed this built environment project around the concept of project-based learning, a student-centered approach to pedagogy that engages student learners in active exploration of real-world challenges and problems. According to Rottman and Rabidou,<sup>15</sup> project-based learning provides opportunities for students to explore content and directly apply new

knowledge through critical thinking and reflection. Comparable to experiential learning, project-based learning allows students to draw connections between academic content and their own lives, which can be particularly important for culturally and linguistically diverse learners.<sup>16</sup>

The concept of neighborhood disorder is largely influenced by the broken windows theory, which states that visible signs of disorder and misbehavior encourage further disorder and misbehavior, including serious crimes.<sup>17</sup> Subsequently, the broken windows theory has been used by public health researchers to assess the relationship between neighborhood condition and the physical, mental, and behavioral outcomes of residents. Despite a recent critique of the impact of neighborhood disorder on health,<sup>18</sup> there remains support for examinations of the built environment to assess barriers and facilitators to physical activity.<sup>2,19,20</sup>

Instructors recognized that this Capstone course would provide students an opportunity to explore aspects of the built environment that either encouraged or discouraged health-promoting activities within discrete areas of interest (ie, neighborhoods) using tools and resources available to emerging public health practitioners. Due to the composition of the course, including both online and in-person students, instructors identified a learning activity that could be completed remotely but would still engage the learner and facilitate team-based work.

Furthermore, instructors proposed that the practical, hands-on nature of the course as well as the concept of the built environment would be attractive to students from all public health concentrations (ie, health policy, health behavior, environmental, epidemiology, biostatistics) and foster synergy between team members based on differing disciplinary perspectives. Finally, instructors suggested that exploring the built environment of neighborhoods in Birmingham, Alabama might reveal ways in which “racist policies, a history of segregation, and decades of neighborhood disinvestment have led to poor health outcomes and inequalities for communities of color and communities experiencing poverty.”<sup>21</sup> (p. vi).

### *Overview of the built environment project*

At the beginning of the semester, instructors assigned specific readings to familiarize students with the concept of the built environment and to demonstrate how environmental factors can influence health outcomes. Additionally, instructors invited faculty members from the University of Alabama at Birmingham School of Public Health to discuss the built environment from their own areas of expertise. Topics included environmental factors, land use, and urban planning (Environmental Health); city planning, features of the built environment, and physical activity (Health Behavior); using big data to understand health disparities (Biostatistics); historical connections between the built environment and disease spread and social-ecological modeling (Epidemiology); and

Health in All Policies, transportation, and zoning (Health Policy and Organization). Students also heard from representatives of the Regional Planning Commission of Greater Birmingham to discuss community-based plans regarding future land use, new development, transportation, housing, parks, trails and open spaces, utilities, and economic development.

Instructors contextualized the built environment project by discussing the historical significance of Birmingham, Alabama to the Civil Rights movement. Instructors noted that brutality against non-violent protesters in the 1960s, including firemen turning hoses on demonstrators and the bombing of the 16th Street Baptist Church that killed 4 black girls in 1963, led to public outrage and produced political pressure to ensure passage of the Civil Rights Act of 1964.<sup>22,23</sup>

Instructors also described how historically discriminatory housing policies have been implemented in the United States to maintain and reinforce patterns of racial segregation and wealth disparity. For example, beginning in the 1930s, the Federal Housing Authority divided residential, commercial, and industrial areas based on mortgage lending risk through a process called *redlining*. Neighborhood assessments were based on quality of housing, sales and rental rates, land quality, and population of the neighborhood. Neighborhoods that included African American and immigrant communities were graded as *Hazardous*, or the riskiest category of loans, and outlined on maps in red.<sup>24</sup> According to Revill,<sup>25</sup> black families in Birmingham were funneled into redlined communities in which “the budget for community esthetics were slashed, leaving roads unpaved and yard overgrown” (para. 3). The practice of redlining was abolished in 1968 with the passage of the Fair Housing Act U.S. Department of Justice (USDOJ)<sup>26</sup>; however, the legacy of discriminatory lending practices continues to this day.<sup>27</sup>

Solomon et al<sup>28</sup> stated, “historic and ongoing displacement, exclusion, and segregation (in the United States) continue to prevent people of color from obtaining and retaining their own homes and accessing safe, affordable housing” (para. 1).

## **Methods**

### *Setting*

Alabama is a culturally rich and economically diverse state with approximately 4.8 million residents spread across 67 counties. Located in Jefferson County, the Greater Birmingham Metropolitan Area is densely populated with more than 1 million residents.<sup>29</sup> However, the city of Birmingham, which is comprised of 99 neighborhoods, has a population of just 212,000. Birmingham is urban with a large minority population (72% Black/African American, 24.3% White, and 3.4% Hispanic or Latino of any race.<sup>29</sup>

According to a 2019 report, Alabama ranks as the sixth most economically poor state in the United States.<sup>30</sup> Nearly 17% of the population lives below the federal poverty level



**Figure 1.** Map of neighborhoods.

compared to approximately 13.1% nationally, and 26% of Alabama's children live in households below the federal poverty level.<sup>31</sup> Additionally, Alabama placed 47th in health status among all states in 2019,<sup>32</sup> with ratings among the lowest in the country for obesity, diabetes, cardiovascular disease, stroke, heart attacks, fruit consumption, vegetable consumption, and physical activity.<sup>33</sup> Lack of education, poverty, inadequate transportation, and limited access to care all contribute to the poor health status of the state.

#### Site selection

Students in the Capstone course audited 4 neighborhoods in Birmingham: East Lake, Kingston, North Titusville, and Bush Hills (see Figure 1). These communities were selected as Demonstration Zones for "Healthy Alabama 2030: Live HealthSmart Alabama," in alignment with the strategic plans of the City of Birmingham and the University of Alabama at Birmingham. Live HealthSmart Alabama is a pilot project that outlines targeted policy, system, and environment changes to improve Alabama's health through physical activity, good nutrition, and prevention/wellness.

Demonstration Zones included neighborhoods that represent some of the poorest communities in the state, with poverty rates approaching 40% and African American populations of 69% to 94%.<sup>31</sup> Data and recommendations from this student project were shared with the Built Environment subcommittee of Live HealthSmart Alabama for consideration during the neighborhood improvement planning phase, which involved community members from each of the targeted neighborhoods. The following neighborhoods were selected as the first Demonstration Zones due to their proximity to the university, with the goal of positively affecting residents' lives:

*East Lake.* The East Lake neighborhood is located northeast of downtown Birmingham and is part of the larger East Lake Community. Of its 3177 residents, 89% are African American. The median household income of East Lake is \$37 400.<sup>34</sup>

*Kingston.* The Kingston neighborhood is also located northeast of downtown Birmingham and is part of the larger East Birmingham Community. Of its 1851 residents, 94.1% are African American. The median household income of Kingston is \$24 200.<sup>35</sup>

*North Titusville.* The North Titusville neighborhood is located west of downtown Birmingham and is part of the larger Titusville Community. North Titusville is also directly adjacent to the University of Alabama at Birmingham campus. Of its 2228 residents, 96.7% are African American. The median household income of North Titusville is \$17 300.<sup>36</sup>

*Bush Hills.* The Bush Hills neighborhood is also located west of downtown Birmingham and is part of the larger 5 Points West community. Birmingham-Southern College, a small, liberal arts college in Birmingham is located in the Bush Hills neighborhood. Of its 4077 residents, 69.3% are African American. The median household income of Bush Hills is \$30 000.<sup>37</sup>

#### Instrumentation

Conventionally, street or windshield audits are conducted by a team of trained auditors who walk or drive through neighborhoods and collect data on neighborhood conditions using standardized audit instruments. While reliable, this method is costly and time-consuming, and was impractical for students

**Table 2.** Variable categories and types.

CATEGORIES	VARIABLES TYPES	SAMPLE QUESTIONS	RESPONSE OPTIONS
Transportation	Bike lanes	What kind of traffic signal is provided?	Traffic signal, stop sign, yield sign, multiple, none
	Bike racks		
	Pedestrian walkways	What is the condition of the road?	Poor, Fair, Good, Cannot tell
	Sidewalk presence and condition		
	Roadway conditions	In what condition is the sidewalk or pedestrian path?	Poor, Fair, Good, Under repair, No sidewalk or paved trail
	Marked crossings		
	Bus stops		
	Types of intersections Number of lanes		
Land use	Housing structures available	Is there any recreational land use?	Yes, No
	Use of industrial land use		
	Schools	Is there a library	Yes, No
	Churches		
	Playgrounds	Are there any tobacco, vape, or electronic cigarette stores accessible from the street segment?	Yes, No
	Slopes of segments		
Advertising	Billboards	Do any billboards advertise healthy foods?	Yes, No
		Do any billboards advertise alcohol?	Yes, No
Neighborhood disorder	Trees and shade	Do you see burned out or abandoned buildings in the block face	Yes, No
	Abandoned cars		
	Abandoned buildings		
	Building conditions		
	Storm drains	Do any buildings have bars on the windows and/or doors?	Yes, No
	Bars on windows		

completing the Capstone course online. Therefore, instructors selected the Computer Assisted Neighborhood Visual Assessment System (CANVAS) to allow students to perform street audits virtually.

Funded by the National Institute of Health, CANVAS relies extensively on Google Maps and Google Street View to provide a panoramic, street-level view of a selected street segment. CANVAS allowed instructors to choose street locations, designate variables to be rated, and assign selected street segments to students. Students could move up and down the street, fully rotate 360°, and zoom in and out while CANVAS stored entered data on variable ratings, monitored progress, and measured reliability of the data. To use CANVAS, students needed internet access and a user account which instructors issued through a joint user agreement. User fees were nominal; other costs associated with the project included consultation with one of the developers of CANVAS.<sup>38</sup>

Instructors selected 63 built environment variables that measured different aspects of neighborhood physical disorder

and had been pre-tested by previous users of CANVAS in urban environments.<sup>7</sup> These variables were derived from several existing audit instruments (eg, the Irvine-Minnesota Inventory, Pedestrian Environment Data Scan [PEDS]) and comprised the *codebook* for the project. Specific variable types and sample questions can be seen in Table 2.

### Learning CANVAS

Before auditing assigned neighborhoods, students reviewed the codebook of built environment variables and practiced with CANVAS by assessing 10 pilot street segments. This exercise increased student confidence with the technology and improved consistency between student ratings. It also provided instructors an opportunity to address questions and reconcile differences in scoring. Finally, instructors reviewed the criteria for establishing inter-rater reliability among teams. Inter-rater reliability is used to ensure data accuracy among ratings for street segments<sup>39</sup>; it is calculated based on the level of

agreement and disagreement among scores. For this project, variables were compared both within and across teams to establish reliability of agreement (moderate agreement > 0.4).

### *Street audits*

Using CANVAS, students audited 16 street segments per week for 5 weeks, reporting on all 63 variables per street segment. Even though students were assigned to teams, street audits were conducted individually so that scores could be compared to one another. Inter-rater reliability score possibilities ranged from -1 to 1, with values below 0 indicating disagreement and values above 0 indicating agreement. Values closer to the extremes determined the strength of disagreement or agreement with variable statements. Values closer to 0 showed inconsistencies between team members and required arbitration from course instructors.

Once students submitted individual scores through CANVAS, teams used consensus scores and observations to describe neighborhood conditions and propose recommendations that aligned with JCDH's community health assessment, *Community Matters*.<sup>40</sup> In general, students' built environment recommendations addressed key priority areas for Jefferson County related to transportation, crime/violence, environmental concerns, infrastructure, and light.<sup>40</sup>

### *Methodology*

Our team reviewed student team assignments based on deductive coding of variable ratings. Specifically, the team looked for student documentation of qualities of physical disorder and other conditions of the built environment. The purpose of our analysis was to demonstrate how students translated observations and ratings into practical recommendations for neighborhood improvements to promote physical activity. The team used data tables to manage text segments from student assignments and the sorting function in Microsoft text-to-table to arrange categories. Consistent with best practices in qualitative methodology, the team used multiple methods of verification (ie, peer debriefing, audit trail, author reflexivity) to ensure qualitative rigor.<sup>41</sup> Under the Common Rule, this project was classified as quality improvement for course design.

## **Findings**

Based on street audits and observations, teams submitted final assignments with recommendations for specific public health actions, interventions, programs, and policies that would begin to address concerns raised in JCDH's *Community Matters* assessment. Student observations varied by assigned street segments and neighborhoods but generally reflected areas of neglect and disrepair. For example, the majority of teams rated the quality of streets and sidewalks as fair or poor, noting that these 4 neighborhoods were some of the oldest in Birmingham (see Figure 2).

To promote physical activity, students recommended improvements in neighborhood infrastructure and services. However, they noted that these improvements would require a significant commitment to and reinvestment in these neighborhoods by the city of Birmingham and Jefferson County. For this analysis, our team divided proposed recommendations into the following 4 themes: creating exercise space, providing outdoor exercise equipment, improving neighborhood safety, and cultivating a culture of health. For each theme, we provide representative quotes to highlight findings.

### *Creating exercise space*

Students reported that many of the neighborhoods had incomplete or truncated sidewalks; sidewalks in need of repair; limited tree canopies for shade; and insufficient curb cuts to accommodate wheelchairs, strollers, and pedestrian traffic. Students observed few public parks, playgrounds, walking trails, and bike lanes. To address individual and community health, students advocated for municipal investments in sidewalks, bike lanes, parks, and green spaces. Teams noted that opportunities for physical activity can reduce stress, enhance interpersonal relationships, and improve mental health. One team observed, "A neighborhood that lacks an outdoor space, like a park, or even a walking trail, robs its members of a means of exercise, relaxation, mental health safe space, and sense of community connectedness." Another team noted, "Community sponsored recreational areas can provide designated areas for safe contact with nature and the outside environment, thus reducing stress and highlighting relaxation as an important part of holistic health."

### *Providing outdoor exercise equipment*

From a land use perspective, teams noted that abandoned property or empty lots could be converted to outdoor fitness areas to promote physical activity.<sup>42</sup> One team further recommended the city invest in "outdoor exercise equipment (OEE) to build healthier communities." According to Sami et al,<sup>43</sup> the placement of OEE in parks significantly increased physical activity levels among park users. Students observed that an investment in OEE as a preventative health measure would be less expensive than the cost of treatment. Additionally, OEE would provide neighborhood residents access to fitness activities within walking distance from their homes and without a costly gym membership. Finally, instructional signage could be posted to encourage proper use of equipment, including QR codes with instructional videos since most users have some sort of mobile device.<sup>44</sup>

### *Improving neighborhood safety*

Students identified vacant lots and boarded up or abandoned homes across each of the residential neighborhoods. Similarly,



**Figure 2.** Example street view images.

students observed that businesses in some commercial areas were flanked by abandoned storefronts and shuttered buildings as well as sections of neighborhoods that lacked sufficient, functional street lighting. Teams suggested that adequate street lighting may encourage residents to engage in physical activity in the evening. At the macro-level, teams indicated that real or perceived threats to personal safety could discourage physical activity.

Several teams reported on efforts by the Birmingham Land Bank Authority to remove deteriorated residential and commercial properties and reinvest in the communities through the Blight Elimination Program. To discourage predatory development and resident displacement, students encouraged JCDH to “work with community-based organizations to implement rent control or Fair Market Rent vouchers to make up the difference between fair market rent and 30% of most residents’ income.”<sup>45</sup>

### *Cultivating a culture of health*

Students reported areas in all 4 neighborhoods in which litter and trash had been dumped, especially in empty lots and alleys. Discarded materials ranged from furniture and appliances to paper, plastic, glass, and Styrofoam. Several teams identified significant amounts of uncollected trash on streets and sidewalks, which could serve as barriers to physical activities like walking, jogging, or cycling. Moreover, students observed that litter can pose health risks for residents by attracting disease

carriers (eg, rats, mosquitoes) and negatively impact the neighborhood esthetic, further discouraging physical activity. Student teams proposed the city place more trash cans in public areas and establish more regular pickup routes as first steps toward reducing the amount of solid waste in neighborhood streets. One team stated:

In order to address issues of litter within Jefferson County, our group recommends cooperative efforts of both governmental and private agencies to make disposal of unwanted items easier. This would include: improving collection and disposal mechanisms (e.g., use of automated garbage trucks to reduce collection cost and increase efficiency); provision of additional convenient recycling facilities; working with local waste disposing companies and local governments to require curbside trash pickup by municipality; as well as, holding litterers accountable for their actions through increased enforcement of existing ordinances. In addition, Jefferson County government should establish a Solid Waste Service Needs Assistance program for qualified residents who struggle with the cost associated with legal garbage disposal.<sup>38,54-57</sup>

Students further noted that neighborhood improvements to promote physical activity should not operate in a vacuum. Rather, physical activity, good nutrition, and a healthy body weight are essential parts of a person’s overall health and well-being.<sup>46</sup> Regarding the physical environment, students observed that a number of billboards and other outside advertising endorsed unhealthy choices like fast food, cigarettes, and sugar sweetened beverages. Similarly, students reported that the

majority of restaurants in these 4 neighborhoods were fast food establishments. While indirectly related to physical activity, students suggested that the neighborhood environment can contribute to “the development of unhealthy behaviors, resulting in chronic health problems among residents.”<sup>47</sup> (p. 1644). One team stated:

These unhealthy food options are contributing to the prevalence of obesity, heart disease, and diabetes in the community. . . We thus suggest providing more healthy food options in the community and replacing billboard ads to focus on the importance of a healthy and balanced diet.

Citing HealthyPeople 2020b,<sup>48</sup> the team concluded, “Access to foods that support healthy eating patterns contributes to an individual’s health throughout his or her life” (para. 2); these changes are therefore necessary for improving health, promoting physical activity, and enhancing residents’ overall quality of life.

## Discussion

Students who completed the Capstone course during fall 2019 and spring 2020 semesters engaged in a hands-on, practice-based learning activity by examining the built environment in targeted neighborhoods of Birmingham, Alabama. Using an innovative, virtual street auditing system, students worked individually and in teams to assess built environment variables in order to propose recommendations for neighborhood improvement. In addition to engaging learners from all public health disciplines, the Capstone project facilitated team learning among students across teaching modalities (ie, in-class, online) and challenged them to look at health equity through the lens of the built environment.

Consistent with accreditation standards, the Capstone project afforded students the opportunity to collect and analyze data, prioritize health considerations, and make informed recommendations regarding public health programs and policies. Moreover, the project required students to link their recommendations to priority health concerns of JCDH and to articulate their findings to different stakeholder groups. In addition to completing the course assignment, student findings and recommendations were shared with Live HealthSmart Alabama to support actual improvement efforts in designated neighborhoods.

### *Limitations of the built environment project*

Despite these successes, the Capstone project had its challenges. The program software itself illustrates one of the most obvious limitations to a virtual street auditing system. Google Street View images are based on the most current data available; some images were old or incomplete. It can take months or even years before images are updated in the system; therefore, virtual observations are only as reliable as the accuracy of the images. While physical conditions of neighborhoods can

change over time, they frequently remain the same, especially in older and under-resourced neighborhoods.<sup>49</sup> We acknowledge that this delay is a limitation of the current study. Physical improvements to neighborhoods, like the ones planned by Live HealthSmart Alabama, require on-the-ground, individual audits to confirm neighborhood conditions in real-time and community feedback to decide which improvements are priorities for residents.

Additionally, despite the use of a codebook and inter-rater reliability, virtual audits revealed the potential subjectivity of individual audits. For example, students reached a high level of agreement with identifying the existence or absence of physical features (eg, bike racks, number of street lights); however, based on a student’s frame of reference, their quality rating of a feature (eg, road condition) might vary widely from their peers.<sup>50</sup> Environmental context was a popular topic of discussion among students, especially for those from rural or underserved areas in the United States and developing nations around the world whose experiences were vastly different from their urban peers. For circumstances in which variable ratings differed, students and instructors had to defer to group consensus due to the sheer number of records produced by students.

Upon further review, instructors conceded that 63 variables per street segment may have been too many for students and instructors to manage in the given time period. Moreover, a statistical sampling of street segments in a neighborhood rather than all street segments may have been sufficient to yield similar conclusions and recommendations. Written reflections by students further suggested that fewer variables would have made the assignment more manageable, given the time constraints to learn the program and audit street segments.

### *Limitations of the research*

As previously noted, students addressed 63 variables of the built environment, which resulted in student recommendations for neighborhood improvements to promote physical activity. However, variable ratings and student observations for the course addressed issues other than physical activity, and student team proposals were limited to specific street segments within specific neighborhoods. This narrow view may have prevented students from seeing the bigger picture of neighborhood improvement. Additionally, this course employed project-based learning as its conceptual framework. Experts have identified numerous benefits of project-based learning including cultivation of professional skills and engagement in problem-solving and knowledge construction.<sup>51,52</sup> Nevertheless, project-based learning is only one approach to learning; a different pedagogical approach to the built environment may have led to divergent and/or better student outcomes.

Our team conducted secondary analysis of teams’ proposed recommendations based on their initial assessment of neighborhood conditions. Our review of recommendations was removed from the original data analysis process and represents



just one of many ways in which these data could be interpreted. Additionally, student feedback was limited; it focused primarily on student experiences of using CANVAS. Students generally described CANVAS as user-friendly but noted that images tended to pixelate or blur when zooming in. Students observed that their introduction to CANVAS was sufficient for the purpose of learning, but further training would be necessary to complete a more robust evaluation. As a research team, our priority was to assess how students translated observations and ratings into practical recommendations for neighborhood improvements to promote physical activity. Nevertheless, further review of the student learning experience would have strengthened overall study results.

## Conclusions

Where a person lives determines how a person lives, and, regrettably, some neighborhoods lack the necessary supports to promote physical activity. The targeted neighborhoods in this Capstone course were no exception. Students noted that the built environment of these 4 neighborhoods lacked parks and other recreational spaces; had uneven or poorly maintained streets and sidewalks; failed to provide safe and easily accessible fitness options; and perpetuated unhealthy behaviors through outdoor advertising and limited availability of healthy food choices. Through classroom presentations, readings, and discussions, students learned that neighborhood conditions are frequently the result of discriminatory zoning policies, like redlining, that reinforce racial segregation and perpetuate economic and health disparities.<sup>53</sup>

Despite methodological challenges (eg, outdated images, subjectivity of individual audits), the Capstone project encouraged students to use their knowledge and skills to prioritize recommendations to improve neighborhood conditions. Based on variable ratings and observations as well as written and oral presentations, participation increased student awareness of the built environment and demonstrated to students that a comprehensive assessment of the built environment can help shape policies and practices that directly affect individual and community health. Moreover, the project helped students make connections between proximal outcomes, such as improving neighborhood walkability, and distal outcomes, such as improved health outcomes among residents. Finally, the Capstone project modeled for students the use of evidence-based strategies for making data-informed decisions, which are essential skills for new and emerging public health professionals.

The Capstone project was designed to accommodate both in-person and online students for the purpose of exploring the built environment remotely at the street level view using CANVAS. This technology and approach to instruction would be useful to faculty members who are interested in designing asynchronous online or hybrid course offerings. CANVAS and course materials could be adapted to assess other geographic locations. Future researchers and practitioners are

encouraged to build upon these findings by engaging students in public health, environmental sciences, and other disciplines in virtual street audits of urban and rural locations using CANVAS. Investigators may also consider the use of a quasi-experimental design to compare findings of in-person and online ratings.

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## Author Contributions

Conception and design: MF, LCM, and MN. Development of methodology: MF, LCM, MN, and SJM. Acquisition of data: LCM and MN. Analysis and interpretation of data: MF, LCM, MN, and MK. Analysis and interpretation of data: MF, LCM, MN, SJM, and MK. Data visualization: AN and MN. Writing, review, and/or revision of manuscript: MF, LCM, MN, SJM, and MK. All authors read and approved the final manuscript before submission.

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