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ENHANCING HEALTH THROUGH BUILT ENVIRONMENT IMPROVEMENT: A SOUTHERN NEVADA HEALTH IMPACT ASSESSMENT CASE STUDY

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Abstract

Background: Health Impact Assessment (HIA) is a public health tool to evaluate how choices made outside the health sector can affect health. HIAs are utilized in transportation, housing, planning, and other fields. Since the built environment can impact community health outcomes, including physical activity rates, injuries, and overweight and obesity, an interdisciplinary team composed of public health, planning, transportation, and land use professionals conducted an HIA in Las Vegas, Nevada.

Methods: The HIA consisted of (1) screening, (2) scoping, (3) assessment, (4) recommendations, (5) reporting, and (6) monitoring and evaluation. It examined proposed physical improvements to a 0.66 mile stretch of a major arterial roadway in the City of Las Vegas where nearby residents experience many health inequities. Collection and analysis of land use and survey data, analysis of secondary data, and literature reviews were completed to predict potential health effects produced by built environment changes. Stakeholder feedback informed each HIA step.

Results: The HIA generated recommendations to improve physical activity, reduce pedestrian and bicyclist injury rates, and decrease obesity and overweight prevalence, by presenting "good," "better," and "best" physical infrastructure improvements. The process and resulting recommendations enhanced collaboration among health and non-health sectors.

Conclusions: Data and analysis revealed that the proposed changes could improve walkability and bikeability and reduce pedestrian and bicyclist injury. By encouraging active transportation through bicycling and walking, the plan could, over time, contribute to reduced overweight and obesity. The HIA facilitated inter-sector cross collaboration and the integration of health into future decision-making.

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Introduction

Connections between land use and health are well documented. One prominent area of research is the use of urban planning and infrastructure changes to increase rates of active transportation within neighborhoods. Enhancing neighborhood walkability and bikeability can increase rates of physical activity through exercise (physical activity for physical fitness) and active transport (physical activity for transportation) (Grasser et al., 2013; Prins et al., 2016; Sallis et al., 2016). The relationship between regular physical activity and human health is likewise well documented (Centers for Disease Control and Prevention [CDC], 2022b). Benefits of physical activity include improved cognition and thinking, weight management, reduced chronic disease risk, strengthened muscles and bones, and improved quality of life (CDC, 2020b). Unfortunately, only about half of U.S. adults engage in the recommended amounts of aerobic physical activity (CDC, 2020a). And about $117 billion are spent annually on healthcare costs associated with physical inactivity (CDC, 2020b).

Prioritizing physical activity in a community can have economic, safety, and workforce benefits (CDC, 2022a). Walkable communities can enhance safety for all users (CDC, 2020b; Reynolds et al., 2009). Some of the most common measures of neighborhood walkability include net residential density, street connectivity, land use mix, and the proportion of retail land-area to retail-building-floor area (also known as Retail Floor Area Ratio) (Adams et al., 2015; Frank et al., 2010; Grasser et al., 2013; Sallis et al., 2016; Wei et al., 2016). In addition, availability of sidewalks, overall aesthetics, and users' perceptions of these features, including safety, are also related to walking and rates of physical activity (Barnett et al., 2017). Similarly, bikeable communities are associated with increased rates of bicycling (Winters et al., 2016), and certain types of infrastructure improve safety (Reynolds et al., 2009; DiGioia et al., 2017; Pucher & Buehler, 2016).

It must be acknowledged that active transport may increase crash risk in terms of absolute numbers, as "[t]he more a person travels, the more they are exposed to the potential risk of a traffic-related injury or death" (Merlin et al., 2020). Bicyclists and pedestrians are vulnerable road users and make up a disproportionate share of crashes (The League of American Bicyclists, 2018). There were 6,516 pedestrian fatalities and 938 bicyclist fatalities in the U.S. in 2020 (National Center for Statistics and Analysis [NCSA], 2022). Pedestrian fatalities from motor vehicle crashes increased by 46% between 2011 and 2020 while bicyclist fatalities increased by 38% in the same period (National Highway Traffic Safety Administration, n.d.). Improving pedestrian and bicyclist infrastructure can substantially reduce these fatalities (Schneider et al., 2017; United States Department of Transportation, 2014).

Although land use and health are linked, integrating health into planning and design decisions remains a challenge (Nieuwenhuijsen et al., 2020). Health Impact Assessment (HIA) is a tool that can help identify and inform health implications of choices, plans, and projects that traditionally do not consider health (National Research Council [NRC], 2011; CDC, 2016; The Pew Charitable Trusts, n.d.). Regular use of HIAs could lead to more consistent integration of health into decisions made by other sectors and better prioritization of health equity (Morley et al., 2016). Land use decisions are especially conducive to HIAs because HIAs can enhance collaboration between the health and planning sectors, improve land use plans, and catalyze more systematic assessments of health in land use choices (Wernham, 2011).

An HIA on proposed built environment improvements along a 0.66 mile stretch of a major arterial roadway was conducted in the City of Las Vegas. Residents near the stretch exhibited various health disparities. The primary aim of the HIA was to advance the integration of health and equity into regional land use decisions through analysis and collaboration. This paper provides an adapted report of the HIA and its findings in the context of HIA and Health in All Policies work.

Methods

This HIA consisted of all six steps: (1) screening, (2) scoping, (3) assessment, (4) recommendations, (5) reporting, and (6) monitoring and evaluation, along with stakeholder engagement throughout (NRC, 2011; The Pew Charitable Trusts, 2014). A Research Team (RT) consisting of University of Nevada, Las Vegas School of Public Health faculty and students partnered with a Working Group (WG) representing the Southern Nevada Health District (SNHD); City of Las Vegas – Department of Public Works (CLV DPW); Nevada Minority Health & Equity Coalition; the Regional Transportation Commission of Southern Nevada (RTC); and the Nevada Institute for Children's Research & Policy to complete the HIA. The HIA was supported by a Racial and Ethnic Approaches to Community Health Grant from the CDC, which was awarded to the SNHD.

In screening meetings, the RT and WG identified land improvement projects that were in the planning stage that could benefit from the use of HIA. Screening discussions of the RT and WG also generated selection criteria for a proposed project. The project had to (1) be within a Las Vegas ZIP Code with residents who experience health disparities, (2) be in the appropriate phase of planning so that recommendations could be considered, (3) contain built environment features studied in literature, (4) potentially impact the health determinants and outcomes of interest (5) potentially impact connectivity to schools, parks, and transit, (6) highlight existing processes at CLV DPW into which health considerations could be integrated, (7) be executable with available time and resources, and (8) serve as a case study to build a project scoping tool (PST) to bring health concerns into future land use decisions.

The RT and WG chose the Charleston Medical District Improvement Plan because it met all of these selection criteria. This project was a 0.66 mile stretch of a major East-West arterial road in the Medical District within the City of Las Vegas. This area is home to numerous medical facilities, including a major public hospital, a dental school, medical school facilities, and a mix of commercial, retail, and other land uses. It also has a relatively high prevalence of pedestrian activity. The proposed improvement plan at the time included adding bicycle lanes, enhanced crosswalks, pedestrian activated beacons, signage, trees, and landscaping; narrowing vehicular travel lanes; reducing speed limits; and acquiring rights of way to improve and widen existing sidewalks.

The HIA examined demographic and health-related data from adjacent Census Tracts. The residents of these adjacent Tracts are at higher risk for negative health outcomes compared to many other parts of Southern Nevada (Healthy Southern Nevada, 2022).

The activities associated with each of the six HIA steps are summarized in **Table 1**.

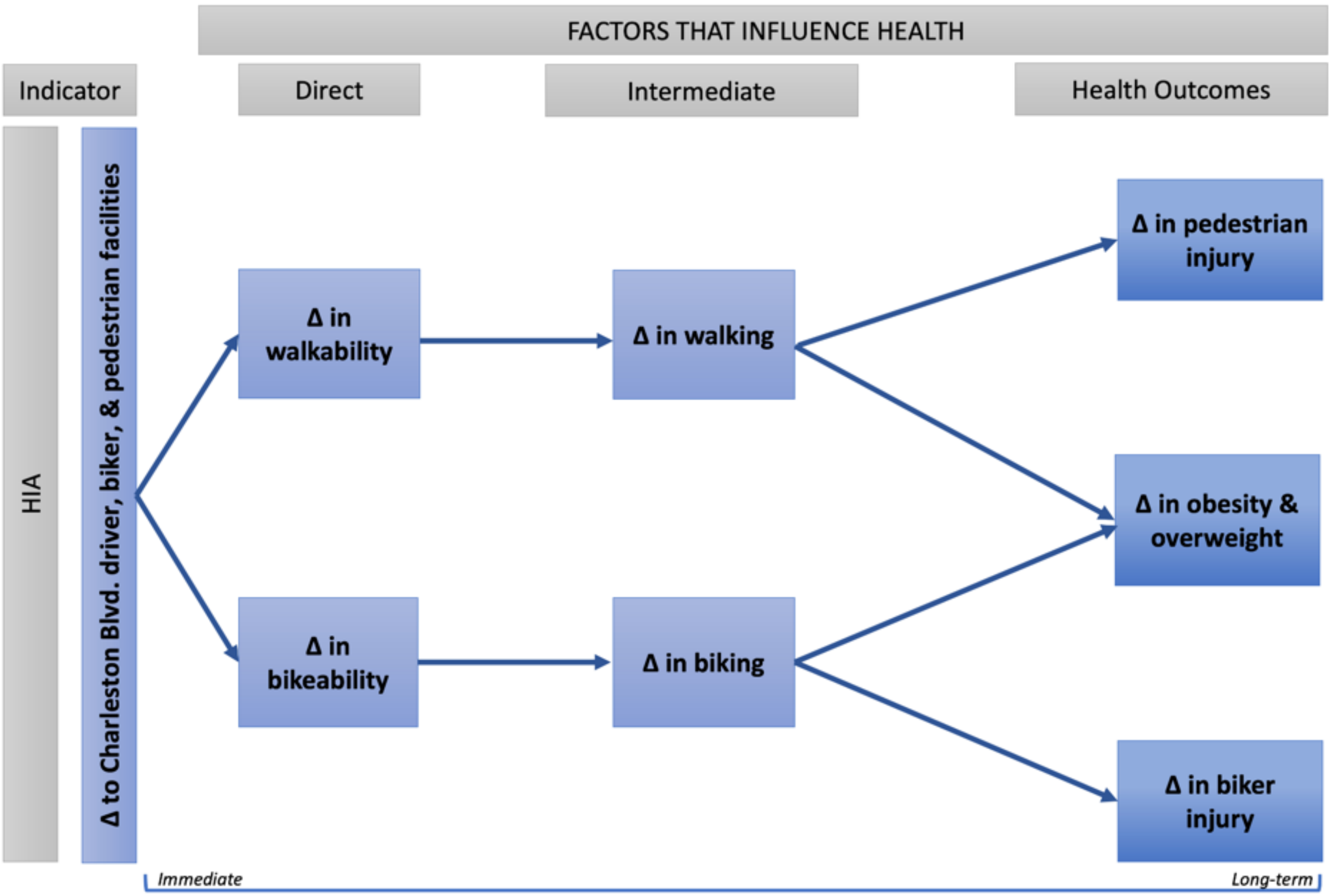
Table 1. Summary of Health Impact Assessment Steps

Screening	The RT and WG met to determine selection criteria and choose an appropriate project from numerous improvement plans that were in planning stages.
Scoping	The RT and WG selected HIA goals and objectives and key health concerns to examine. The HIA aimed to reveal the baseline conditions of the area and then determine potential impacts if certain recommendations were implemented. Five key focus areas identified were: 1) health equity, 2) walkability, 3) bikeability, 4) pedestrian and bicyclist injury, and 5) overweight and obesity. The RT and WG crafted research questions to guide assessment of direct, intermediate, and downstream health outcomes in these focus areas. See **Figure 1** for the pathway diagram linking the proposed decisions to health outcomes.
Assessment	The assessment was a three-step process: 1. *Examine baseline conditions of the Census Tracts immediately adjacent to the project corridor based on the key focus areas.* a. Health equity & obesity/overweight: Secondary data from the American Community Survey (ACS) and the City Health Dashboard were used to examine socio-demographic, economic, and health factors, including median household income, adult physical inactivity, obesity, and health insurance status (United States Census Bureau [USCB], n.d.; City Health Dashboard, 2019). b. Walkability & Walking: Walkability was assessed through primary data on five segments of the project corridor using the 54-item Microscale Audit of Pedestrian Streetscapes (MAPS), Abbreviated Version (Cain et al., 2017). Walking rates were assessed using secondary data from the CLV DPW, RTC, and the ACS commuting database (USCB, 2017). c. Bikeability & Bicycling: Bikeability was assessed by evaluating bicycle infrastructure using the Bicycle Level of Traffic Stress secondary data metric (Alta Planning and Design, 2017) and through primary data using the Active Neighborhood Checklist (Active Neighborhood Checklist, 2011). Bicycling rates were assessed using secondary data: the ACS commuting database (USCB, 2017) and RTC information on the number of bicycles brought onto buses that traverse the project corridor. d. Pedestrian & Bicyclist Injury: Injury rates were determined utilizing secondary motor vehicle crash data from the Nevada Department of Transportation. 2. *Conduct an intercept survey of pedestrians in the area during varying times of the day over three weeks in June and July 2019.* Primary data obtained included demographics, reasons users were in the area, primary modes of transportation, perceptions of safety and available infrastructure, and preferences regarding pedestrian and bicycle infrastructure.

Table 1. Summary of Health Impact Assessment Steps (continued)

	3. *Assess project impacts through a series of literature reviews*. The RT searched Google Scholar for relevant systematic reviews and meta-analyses to examine how the proposed built environment features relate to physical activity and downstream health indicators like overweight, obesity, and injury. Sample search terms included walkability, pedestrian, sidewalk, bikeability, bicycle, bicycling, bike lane, speed, injury, traffic, health, built environment, obesity, overweight, and BMI.
Recommendations	The RT used findings from the assessment, WG suggestions, and feedback from a stakeholder input session to develop recommendations to improve the project corridor. The stakeholder session was attended by the RT, WG, and representatives from organizations like the county school district, health-focused community organizations, academia, and the state public health department. It included discussion of the HIA's screening, scoping, and assessment; how to encourage bicycling and walking in the area; community members' involvement in land use decisions; and better connections between the land use and health sectors. Final recommendations were organized into "good," "better," and "best" categories to maximize health outcomes in each focus area but also enhance flexibility and feasibility for project partners.
Reporting	A final report summarizing the HIA and key recommendations was made available to the WG. WG members were asked to share the final report with their partners and networks. The RT also presented the HIA's findings to regional, health-focused community coalitions and to transportation-focused community partners in Spring 2019.
Monitoring & Evaluation	Monitoring: To support continued monitoring of the project area, the RT developed a system of tracking spreadsheets to outline applicable indicators and provide relevant data sources. These spreadsheets were provided to WG partners. They could be used periodically to monitor land use modifications and changes to priority health behaviors and outcomes. As HIA partners developed the PST, they also continued to track land use changes and health indicators in the area. Evaluation: The RT completed a process evaluation through an anonymous survey of the WG and a facilitated face-to-face discussion between the RT and WG. The survey and discussion evaluated the execution of each step of the HIA, the HIA's potential to improve community and cross-sector collaboration, and the opportunities for stakeholders to engage in the HIA process.

Figure 1. Charleston Medical District Pedestrian Improvement Plan Pathway Diagram Linking Proposed Decisions to Health Outcomes



Results

Baseline Conditions

After analyzing available secondary data, the RT found that project area residents were more racially and ethnically diverse than the overall average for the City of Las Vegas. Some adjacent Census Tracts had lower high school graduation rates, higher rates of unemployment, poverty, and uninsured status, and lower median incomes (USCB, n.d.; City Health Dashboard, 2019). Some Census Tracts likewise had higher rates of obesity and chronic health conditions like diabetes and high blood pressure compared to City of Las Vegas and national averages (USCB, n.d.; City Health Dashboard, 2019). Area residents also had higher rates of high-risk health behaviors, including smoking and physical inactivity (City Health Dashboard, 2019). Average life expectancy in all Census Tracts in the project area was well below that of city and national averages (City Health Dashboard, 2019). See **Table 2** for demographic and health-related baseline characteristics for the project area's adjacent Census Tracts.

Table 2. Demographic and Health-Related Baseline Information for Residents in Census Tracts Adjacent to Charleston Corridor, with Comparisons to the City of Las Vegas and the 500-City Average

	Census Tract 2.03 Value (90% confidence interval)	Census Tract 3.01 Value (90% confidence interval)	Census Tract 2.04 Value (90% confidence interval)	City of Las Vegas Value (90% confidence interval)	500-City Average
Social and Economic Factors					
Median Age (years)*	35.3 (30.7-39.9)	37.6 (32.1-43.1)	45.2 (43.6-46.8)	37.4 (37.1-37.7)	-
Education (Population 25 years and over)					
High school graduate or higher*	76.1% (70.3-81.9)	73.9% (68.5-79.3)	84.9% (75.4-94.4)	84% (83.5-84.5)	-
Bachelor's degree or higher*	18.4% (11.8-25)	5.4% (2.5-8.3)	36.7% (24.7-48.7)	23.2 (22.6-23.8)	-
Race & Ethnicity					
White*	52.2% (40.7-63.7)	32.1% (24.2-40.0)	69.7% (56.4-83.0)	62.7% (62.1-63.3)	-
Black or African American*	17.3% (11.1-23.5)	46.4% (39.9-52.9)	3.7% (0.8-6.6)	12.2% (11.8-12.6)	-
American Indian, Alaskan Native*	0.5% (0-1.1)	0.2% (0-0.6)	0.2% (0-0.7)	0.7% (0.6-0.8)	-
Asian*	9.3% (4.4-14.2)	2.6% (1.0-4.2)	18.8% (6.6-31.0)	6.7% (6.4-7.0)	-
Native Hawaiian, Other Pacific Islander*	0.6% (0-1.5)	0.3% (0-0.9)	0.7% (0-2.0)	0.7% (0.6-0.8)	-
Some Other Race*	16.0% (7.0-25.0)	16.0% (9.5-22.5)	3.4% (0-6.8)	12.3% (11.7-12.9)	-
Two or More Races*	4.2% (1.9-6.5)	2.4% (0.4-4.4)	3.5% (0.5-6.5)	4.8% (4.5-5.1)	-
Hispanic*	40.4% (33.4-47.4)	39.9% (33.5-46.3)	23.5% (10.3-36.7)	32.7% (32.2-33.2)	-
Economic Factors					
Children in Poverty	54.5% (37.8-71.3)	47.6% (32.5-62.6)	12.5% (0-32.7)	23.7%	21.4%
Households with Excessive Housing Cost	53% (42.7-63.2)	43% (34.1-52)	34.1% (19.0-42.9)	37.4%	36.3%

Economic Factors					
Median Household Income*	$32,476 (24,069-40,883)	$30,000 (23,586-36,414)	$66,111 (57,137-75,085)	$53,159 (52,282-54,036)	-
Unemployment	16.4% (8.9-23.8)	13.4% (6.8-20.0)	3.8% (0.4-7.1)	8.8%	6.9%
Uninsured	27.8% (20.4-35.3)	31.0% (24.9-37.1)	27.5% (16.0-38.9)	18.1%	12.4%
Below 100% of the Federal Poverty Level*	40.9% (30.5-51.3)	41.0% (32.5-49.5)	11.2% (0-23.2)	16.2% (15.6-16.8)	-
Food Insecurity+	26.7%	27.9%	7.3%	-	-
No Vehicle Access+	23.4%	31.4%	0.0%	-	-
Physical Environment					
Average Daily Concentration of Air Particulate Matter (PM 2.5)	7.7/m³	7.7/m³	7.7/m³	6.9/m³	8.8/m³
Walkability Index (2019)	37.4	55	39.3	40.6	41.3
Limited Access to Healthy Foods	96.7% (96.3-97.2)	36.5% (35.0-37.9)	47.0% (44.6-49.5)	57.2%	65.9%
Health Behaviors					
Current Adult Smoking	25.8% (23.9-27.7)	29.5% (27.9-31.1)	15.0% (13.0-17.0)	20.5%	17.2%
Adult Physical Inactivity	37.3% (35.5-39.1)	42.9% (41.5-44.3)	25.9% (23.8-28.0)	29.9%	26.2%
Health Outcomes					
Adults with High Blood Pressure	37.8% (37.1-38.5)	45.8% (45.1-46.5)	37.8% (36.7-38.9)	31.8%	29.6%
Adults with Diabetes	15.0% (14.4-15.6)	19.9% (19.2-20.6)	12.2% (11.4-13.0)	11.2%	10.0%
Average Life Expectancy at Birth in 2015 (years)	71.2 (68.7-73.7)	69.3 (66.8-71.8)	65.1 (59.4-70.8)	77.4	79.1
Adult Obesity	33.5% (32.7-34.3)	41.0% (40.3-41.7)	24.0% (23.1-24.9)	28.2%	29.7%

Definitions:

- Children in Poverty – Children living in households ≤100% of the Federal Poverty Level
- Housing Cost, Excessive – Households where ≥30% of household income is spent on housing costs
- Unemployment – Population aged ≥16 years that is unemployed but seeking work
- Uninsured – Current lack of health insurance among people aged 0-64 years
- Air Pollution-Particulate Matter – Average daily concentration of fine particulate matter (PM2.5) per cubic meter
- Walkability – Neighborhood amenities accessible by walking as calculated by Walk Score®
- Limited Access to Healthy Foods – Population living more than ½ mile from the nearest supermarket, supercenter, or large grocery store
- Adult Physical Inactivity – No leisure-time physical activity in past month among adults aged ≥18 years
- Food Insecurity – Estimated percentage of population that experienced food insecurity at some point during the year
- No Vehicle Access – Estimated percentage of households without a vehicle

The five segments assessed for walkability using the MAPS Abbreviated Audit (primary data collection) (Cain et al., 2017) earned scores between 19-32, indicating the area was "somewhat walkable." The main project area received the highest walkability score of all the segments assessed, likely because it had a high land use mix, including many retail and healthcare destinations. The audit revealed that the area needed improvement in the perception of safety and sidewalk width to accommodate multiple pedestrians and/or mobility device users.

Data on the rate of walking to work in the Census Tracts immediately surrounding the project was not available. However, a recent equity analysis indicated that the area just north of the project falls into parts of the Las Vegas Valley experiencing the highest inequity. The area just south falls into parts experiencing the second highest inequity. Inequity was measured, in part, based on (1) household percentages with no car for daily use, (2) household income below 200% of the federal poverty level, (3) non-white population, and (4) under 18 and over 64 years population (RTC, 2017). These characteristics are associated with higher rates of walking to work (McKenzie, 2014). Pedestrian counts obtained by CLV DPW at two intersections within the project area during peak times (7am-8am and 5pm-6pm) on multiple dates between 2002 and 2015 indicated a relatively high presence of pedestrians in this area. This walking data was compared with national and regional walking data. Nationally, 2.7% of all work trips are made by walking (USCB, 2017). In Las Vegas overall, 1.8% of residents report walking to work, which is slightly higher than the entirety of Clark County (1.7%) (RTC, 2017).

The bikeability assessment conducted by the RT found no physical separations or painted markings for designated bike paths or bike lanes and no signage to alert drivers to share the roadway. According to secondary data, bicycling in the area would be uncomfortable for most, meaning only avid bicyclists, often termed the "strong and fearless," would voluntarily cycle along this stretch (Geller 2009; Alta Planning and Design, 2017).

Bike lanes crossed the segment only once through an intersecting street and the nearest bike routes were over a mile away.

Bicycling rates for the project-adjacent Census Tracts were not available. However, because of the project's proximity to parts of the Las Vegas Valley with high inequity (RTC, 2017), demographic factors indicated that nearby residents would be more likely to bicycle to work than others in the region. RTC secondary data (2017) indicated that between January 2015 and February 2019, about 3,514 bicycles were loaded onto the public bus route running East-West along Charleston Boulevard in and beyond the project area. This bicycling data was also considered in light of other secondary national and local biking data. Only 0.6% of all work trips are made by bicycle nationally (USCB, 2020) and in Las Vegas, about 0.5% of residents bicycle to work, which is slightly higher than the 0.4% in Clark County (RTC, 2017).

Nevada Department of Transportation (NDOT) secondary crash data indicated that 3.7% of motor vehicle crashes between 2015 and 2017 along this segment involved a pedestrian (NDOT, n.d.), which is well above the national average of 1.1% (Campbell et al., 2016). Of the 11 pedestrian crashes in the corridor, seven involved vehicles turning right, suggesting increased hazards to pedestrians in the project area (NDOT, n.d.). There were three bicycle crashes along this segment between 2015 and 2017 (NDOT, n.d.). All three crashes were classified as "injuries" or "injuries reported by the person" and two of them involved a driver turning right at an intersection (NDOT, n.d.).

Community Input

An intercept survey involved primary data collection and was completed by 81 participants. It was developed by the RT with WG guidance and implemented by RT partners. Surveyors approached individuals who were outside and were walking, biking, standing, or otherwise in the project area. People were approached to participate at various points in time (7:30 am – 8 pm) and on multiple days of the week (Mondays-Fridays) over a three-week period in June and July 2019. Individuals who expressed interest in participating received research study information and a survey. Surveyors collected completed information. If participants requested help, surveyors assisted by orally reading questions and/or recording answers. This survey was deemed exempt by the University of Nevada, Las Vegas Institutional Review Board. The RT then examined the collected data.

The highest proportion of participants resided in surrounding ZIP Codes (89101, 89102, and 89106), which are some of the ZIP Codes experiencing the greatest health inequities in the region ("Health Equity Index," 2022). Most participants self-identified as white (43%), followed by African American (24%), and Hispanic or Latino (22%). Over half reported using automobiles as their primary mode of transportation (53%), followed by public transportation (36%), and walking (8%). About a quarter reported that they walk in the area most days of the week and over 40% reported they walk less than once per month. At the time of the intercept survey, participants were walking to get to work (27%), seek healthcare services (26%), and connect to public transportation (18%).

Only about 9% of survey participants said they were walking there that day because they lived in the area, which is adjacent to Census Tracts experiencing health inequities. This may potentially limit the conclusions that can be drawn from the survey about nearby residents. However, proposed project changes would impact all area users, including residents. In addition, other survey participants may also be members of communities experiencing inequities. For example, about 26% of respondents said they were in the area for medical reasons. Some of them may have been in the project area to visit the county's public hospital. This hospital sees 10% uninsured, 18% Medicare, 48% Medicaid, and 5% government insured patients and provides almost $41 million of uncompensated care annually (American Hospital Association, 2023).

About 74% of participants in the intercept survey believed that cars traveled too fast in the area to feel safe walking or bicycling. Only 22% reported that existing bicycling infrastructure was sufficient for safety. Participants identified the top three area safety concerns as: (1) vehicle speeds (59%), (2) distracted driving (58%), and (3) potential for crime (48%). When shown detailed pictures of bicycle and sidewalk infrastructure and asked which they would most likely use to walk and bicycle, participants most commonly chose bicycle lanes raised higher than street level and lower than sidewalk level (43%; n=74) and 10-foot-wide sidewalks, with 8 feet dedicated to the sidewalk and 2 feet to a landscape buffer (43%; n=75). **Table 3** presents detailed survey results.

Table 3. Pedestrian Intercept Survey Results

Main Form of Transit Used (n=73)	
Automobile	53%
Public Transit	36%
Walking	8%
Wheelchair/scooter	1%
Other	1%
How Often You Walk in the Area (n=81)	
Less than once per month	41%
1-3 times per week	21%
1-3 times per month	12%
Most days of the week	26%
Reasons for Walking in the Area Day of the Survey (n=79)	
I go to school in this area	10%
I live in this area	9%
I work in this area	27%
I'm connecting to another bus route	18%
Other:	37%
Other/Medical	26%
Other/Errands	2%
Other/Roaming	3%

Road Design Options "I Feel"		
Cars are too fast for:	*Pedestrians (n=79)*	*Bicyclists (n=79)*
Strongly Agree	37%	44%
Agree	37%	29%
I Don't Know	5%	6%
Disagree	14%	11%
Strongly Disagree	8%	9%
I feel safe from traffic while:	*Walking (n=78)*	*Bicycling (n=80)*
Strongly Agree	13%	3%
Agree	24%	11%
I Don't Know	9%	43%
Disagree	33%	20%
Strongly Disagree	21%	24%
I feel enough infrastructure exists for safety in:	*Walking (n=80)*	*Bicycling (n=78)*
Strongly Agree	14%	10%
Agree	36%	12%
I Don't Know	3%	17%
Disagree	21%	23%
Strongly Disagree	26%	38%
Safety Concerns (n=81)		
Speed of cars/trucks	59%	
Motorists	58%	
Distracted driving	58%	
Potential for crime	48%	
Too many cars/trucks	35%	
Narrow sidewalks	33%	
Conflicts or collision with cars/trucks	28%	
Not enough lighting	25%	
Not enough other people out walking	20%	
Poles/light posts in the sidewalk	20%	
Overgrown bushes/vegetations	14%	
I have no safety concerns	6%	
Other *"Other" written-in concerns: Crosswalks too far apart, older adult population usability, not enough shade/trees*	11%	

Project Impacts

Available data and literature supported the prediction that walkability and associated walking behaviors would likely increase under the plan, especially for populations experiencing inequities. Literature suggests that objectively measured built environment features, such as street connectivity, diversity of land uses, and population and employment density, are consistently associated with walking and neighborhood walkability. In addition, perceptions of the built environment (e.g., perceived sidewalk availability, safety, and aesthetics) correlated more strongly with physical activity than objective measures (Barnett et al., 2017).

Objective measures of walkability include land use mix and street connectivity (Khanal & Mateo-Babiano, 2016), gross population density (Grasser et al., 2013), Walk Score (Hall & Ram, 2018; Walk Score, 2019), and design and diversity (Ewing & Cervero, 2010). The area contained existing features that support walkability (e.g., access to services and destinations, public transit, high land use mix, and jobs/housing balance). The proposed changes, including improved 10-foot sidewalks, landscaping, crosswalks, and slower posted travel speed limits, could improve perceived walkability. Furthermore, because populations experiencing health inequities walk more – particularly as transit – walking among the population residing adjacent to the project area would be even more likely to increase.

Available data and literature also supported the projection that the plan could enhance bikeability and increase bicycling rates. Bikeability and bicycling rates are closely related to: (1) availability of bicycle infrastructure, including separating bicyclists and motorists (Pucher & Buehler, 2008; Pucher et al., 2010), (2) higher density, more connectivity, and greater land use mix (Saelens et al., 2003), and (3) enforcement of traffic laws to reinforce policies that favor bicycle travel over motor vehicle travel (Pucher et al., 2010). The amount of infrastructure necessary to increase bicycling rates is not fully understood (Buehler et al., 2012); however, one model suggests that a one-mile increase in bicycle lanes per 100,000 people is linked to about a 0.07% increase in bicycle commuting (Nelson & Allen, 1997); another suggests that every additional urban mile of bicycle lanes per square mile generates a 1% bicycling increase (Dill & Carr, 2003). Since the original plan focused on separating vehicles and bicyclists, it could enhance the level of comfort for bicyclists. Increased bicycle infrastructure and connectivity would likely yield increased bicycle commuting. Given the uncertainty about the exact connection between bicycle infrastructure and bicycling rates and the fact that the project would create less than 1 mile of new bicycle lanes, the RT expected changes to bicycling rates under the plan to be small. The RT also concluded that there would be an increased likelihood of bicycling in this area compared to other parts of Las Vegas and Clark County because of the high bicycle counts data, area demographics, and survey participants' indications of insufficient bicycling infrastructure in the area. Over time, adding more infrastructure could increase bicycle commuting rates, particularly as connectivity grows.

Given that changes in walkability

and bikeability predicted increases in both walking and bicycling, the RT likewise predicted reductions in the downstream health effects of injury and overweight. Several infrastructure changes show promise in the literature for reducing pedestrian and bicyclist injury. Interventions such as reduced motor-vehicle speeds (Cairn et al., 2014), improved traffic or pedestrian signals, separation of pedestrians from traffic with fencing or refuge islands, and increased roadway lighting (Retting et al., 2003) are linked to pedestrian crash reductions. A meta-analysis by Bunn and colleagues (2003) found a pooled rate ratio of 0.89 for pedestrian injury with use of traffic-calming measures.

Literature findings specifically for bicycle injury reduction were less clear. It is possible that increasing the numbers of bicyclists on the road could likewise increase the probability of bicycle versus motor-vehicle crashes; however, there is a nonlinear relationship between number of bicyclists on the road and injury rates (Kondo et al., 2018). This is likely due to the "safety in numbers" phenomenon, in which more bicyclists on the road actually seems to offer protection from motorists, perhaps because it makes motorists more aware of bicyclists in general (Kondo et al., 2018; Prati et al., 2018). Bicycle versus motor-vehicle crashes are more likely to occur at intersections or roundabouts, in areas of high vehicle speed, where there is insufficient lighting at night, in the presence of high traffic volumes, in the presence of obstacles (such as road signs), or where there are entrances/exits to the roadway, such as driveways, parking lots, or tunnel entrances (Kondo et al., 2018; Morrison et al., 2019; Prati et al., 2018; Reynolds et al., 2009). Dedicated bike lanes are a common intervention to reduce bicycle crashes, but evidence that bike lanes alone reduce bicyclist injury is lacking (Mulvaney et al., 2015). Morrison et al. (2019) suggest that this is because bicycle lanes decrease risk of crashes at different rates depending on the type of bicycle lane and other roadway infrastructure. Bicycle lanes appear to be most effective at reducing crashes where vehicle speeds are high, traffic lanes are narrow, and bus or tram routes are present (Morrison et al., 2019). The best protection of bicyclists has been found with paved, bike-only tracks with a high degree of separation from the roadway, adequate lighting, and low-angled grades (Reynolds et al., 2009). Reducing vehicle speed limits and providing dedicated bike paths separated from traffic are ubiquitous recommendations in the literature for reducing risk of bicycle crashes (Morrison et al., 2019; Prati et al., 2018; Reynolds et al., 2009).

Overall, the RT predicted that plan-related changes would likely reduce pedestrian injuries, but impacts on bicyclist injury were difficult to determine. Bicycle crashes could increase under the plan with more bicyclists, but the addition of a bicycle lane and bicycle signage as well as decreased speed limits could also decrease bicycle injuries (and possibly crashes) compared to the existing infrastructure. Pedestrian and bicyclist injury projections would likely disproportionately apply to populations experiencing health inequities, including those residing adjacent to the project, because such populations tend to walk and cycle at higher rates, particularly for utilitarian purposes.

The RT also concluded that a healthier neighborhood built environment under the recommended plan could contribute to reductions in overweight and obesity. It would likely be in a limited way, however, because overweight and obesity are extremely complex; due to the size of the project and the fact that persons residing near the project area were already overburdened by obesity and overweight, reductions may be harder to realize. Research shows a strong link between walkability and obesity, as well as hypertension and Type 2 diabetes outcomes; it also strongly supports a relationship between measures of urban sprawl and obesity outcomes (Chandrabose et al., 2019). It appears that improved perception of walkability is most important (as opposed to objectively measured walkability) when it comes to improving health outcomes (Barnett et al., 2017; Chandrabose et al., 2019). Despite the fact that walking only to proximate destinations may not be enough to reduce obesity (Chandrabose et al., 2019), it could be that even improving residents' perceptions of walkability in the area could contribute to overall increases in walking and therefore improved health outcomes. The literature connecting bicycling and overweight and obesity outcomes was also promising, but inconclusive. One study conducted in a low-income community found that adults who bicycled were less likely to be overweight or obese than the general population (Noyes et al., 2014). Others found associations between bicycling to work and reduced obesity risk (Brown et al., 2013; Wojan & Hamrick, 2015). Suminski et al. (2014) found that bicycle-promoting policies were associated with more bicycle infrastructure, a higher percentage of adults bicycling to work, and lower rates of overweight and obesity.

To summarize, the plan was expected to increase walkability through wider sidewalks, enhanced landscaping, improved crosswalks, and decreased motor vehicle speed limits. Such changes would build on the area's existing features that favor walkability, including high residential and employment density, mixed land use, and public transit access. This, along with plans for enhanced bicycle infrastructure, could increase both walking and bicycling rates. Thus, the project could also contribute to reductions in overweight and obesity, while simultaneously reducing risk of injury.

Recommendations & Reporting

The RT combined assessment findings, WG suggestions, and feedback from a stakeholder input session to determine the focus of recommendations, namely separation of vehicles in time and space from pedestrians and bicyclists, reduction of speed limits, traffic calming, improved pedestrian and bicyclist infrastructure, enhanced connectivity, improved visibility, and enhanced aesthetics – categories identified in the literature as relevant to bikeability and walkability (Retting et al., 2003). Recommendations were presented as "good," "better," and "best" to provide best-case scenario ideas for health-enhancing improvements, but also allow for flexibility given budgeting or other constraints. For example, to help separate vehicles from pedestrians, it was suggested that it would be "good" to retain the proposal to install and maintain 10-foot sidewalks; "better" to install and maintain 10-foot sidewalks plus add pedestrian islands at a proposed crosswalk and paint driveways to alert drivers to yield; and "best" to install and maintain 10-foot sidewalks, add pedestrian islands at a proposed crosswalk, consolidate driveways, and add driveway pavement markings. To help add bicycle infrastructure, a "good" suggestion was to add ample bicycle parking; "better" to add ample bicycle parking near popular destinations and bicycle-specific traffic signals; and "best" to add ample bicycle parking near popular destinations, bicycle-specific traffic signals, and bicycle lockers closer to destinations. To reduce motor vehicle speeds, we suggested it would be "good" to retain the proposal to reduce posted speed limits to 35 miles per hour (MPH) and reduce lane width to 11 feet; "better" to reduce it to 30 MPH, reduce lanes to 11 feet, and add radar signs; and "best" to reduce it to 20 MPH, reduce lanes to 11 feet, add radar signs, and approve future buildings that promote more pedestrian- and bicyclist-oriented frontage. Further examples of recommendations will be included in a separate manuscript describing a project scoping tool (PST) generated from this analysis (manuscript in progress). These and other detailed recommendations were included in the final HIA report and shared with other partners (UNLV, 2019).

Monitoring and Evaluation

During the in-person process evaluation discussion, WG members expressed that the HIA helped them understand the "how" behind connecting health implications to planning decisions. One weakness the group noted during the evaluation discussion was the ability to quantify health impacts more, e.g., a specific type of bike lane reducing crashes by a specific percent. The WG process evaluation survey (n=11) yielded generally positive feedback. Survey respondents strongly agreed that because of the HIA they had a better understanding of the HIA tool and were more likely to recognize the link between built environment and health. A majority reported thinking that the HIA would benefit the community. All respondents either "strongly agreed" or "agreed" that the HIA (1) met its aims and objectives, (2) was beneficial to them and their organizations, and (3) the process valued their input during feedback discussions. Most respondents also indicated that they were given adequate opportunity to provide HIA comments and that the benefits of the HIA outweighed the time associated with WG participation. Survey results were mixed about whether HIA recommendations would be considered during plan implementation. The RT and WG continued to refer to and discuss the HIA and to track changes to land use and health indicators as it worked on the PST to aid with future land use decisions.

Discussion

This HIA focused on the Charleston Medical District Improvement Plan, which proposed modifications to the built environment. It relied on data on baseline conditions, pedestrian and bicyclist use and injury, built environment audits, an intercept survey, literature reviews, and stakeholder feedback. Using this analysis, it was determined that implementation of the plan could help improve walkability and bikeability, reduce crashes involving pedestrians and bicyclists, and increase physical activity through active transport – especially among residents living adjacent to the project area. This HIA produced evidence-informed alternatives to modify the plan to further improve health determinants and outcomes of interest. These recommendations were shared with project partners and stakeholders, and monitoring of plan implementation and health behaviors and outcomes continues.

This HIA provides a practical example of how to connect land use and public health in the context of a specific project. Literature indicates that improving a community's built environment is likely to encourage physical activity for that area's population (Carlson et al., 2019; Cambra & Moura, 2020; Forsyth & Krizek, 2010; Stappers et al., 2018; Wei et al., 2016). The focus on physical activity and its connection to chronic disease is a major avenue for collaborations between the health and planning sectors (Frank et al., 2019). Literature also indicates that land use choices impact pedestrian and bicyclist crashes and injuries (Cairns et al., 2014; Prati et al., 2018). However, HIAs are often not used in transportation planning, which instead tends to focus on assessing monetary costs and associated project benefits (Nieuwenhuijsen et al., 2020).

While HIAs have promise to bridge this gap and enhance the planning process and its outcomes (Wernham, 2011; Nieuwenhuijsen et al., 2020), land use HIAs can be highly contextual (Nieuwenhuijsen et al., 2020; Waheed et al., 2018). This HIA used existing data, literature, and feedback to generate actionable recommendations to promote walkability and bikeability, and thereby help address physical activity rates, injury, and obesity. Through this process, the HIA demonstrated how Southern Nevada could meld health and land use considerations and also fostered connections for future collaboration in this area. Many WG participants indicated that the process helped make practical connections between these sectors. The outcomes of this HIA were consistent with their potential, as articulated by Wernham (2011): enhanced collaboration and improved plans. The HIA outcomes were also consistent with findings that primary HIA benefits include building cross-sector relationships and raising awareness of health issues among decision-makers (Bourcier et al., 2015; Dannenberg et al., 2008; Sohn et al., 2018).

A remaining challenge for HIAs is how to integrate health concerns into decisions of other sectors systematically (Morly et al., 2016). This HIA focused on one short stretch of a roadway in a large urban area. However, one goal of this HIA at the outset was to build capacity and interest in integrating health concerns in transportation and land use decisions more broadly. There is growing interest in tools that can help shape how transportation projects are developed and prioritized and some indication that they may promote projects that support active transportation (Chirstofa et al., 2020).This HIA served as an entry point for continued collaboration among the partners to create a PST for future built environment project decisions to assess existing baseline conditions and built environment infrastructure in a geographic area through a process that necessitates less time and fewer resources than an HIA. Dannenberg's and colleagues'(2008) suggestion to incorporate recommendations as a formal step between the assessment and reporting steps is now integral to an HIA. The recommendations generated during this HIA are central to the PST. This HIA suggests that HIA-generated recommendations may be used beyond one specific HIA to inform subsequent projects and to integrate health concerns into land use decisions more systematically.

This HIA also encountered a challenge experienced in other HIAs: how to prioritize health equity (Morley et al., 2016). Health equity was central to the structure of this HIA, since it was part of a larger project focused on improving health in geographic areas where residents were experiencing health inequities – areas that included disproportionate numbers of African American and Latinx residents. This resulted in a project that considered disparities in the HIA assessment, conducted an intercept survey, and fostered close collaboration with stakeholders who engaged with these communities in other contexts. In the typology of integrating health equity into transportation-related HIAs, this HIA focused on populations experiencing disparities, examined disparities, worked with stakeholders and incorporated stakeholder ideas, and aimed to build stakeholder capacity (Cole et al., 2019). These efforts enriched the HIA process and outcomes. However, with additional resources, deeper community engagement in this HIA process may have enhanced the ability to integrate experiences and perspectives from the resident populations directly into the HIA process and perhaps also into the PST.

Finally, this HIA process, including conversations of the WG, the process evaluation, and the stakeholder feedback event, revealed broader considerations adjacent to this plan and other built environment projects. Improving bikeability and walkability can be a slow and long-term process. This work requires initial investment and sustained efforts, which can make it difficult to catalyze these types of projects given competing interests for local infrastructure funding. Sustained collaborations across mutually beneficial projects may effectuate true change. In addition, walkability is especially influenced by land use mix. Questions of land use can involve stakeholders beyond governmental transportation and planning departments. This can pose additional challenges.

Collaborative efforts, such as the PST, which aim to bolster existing processes with practical and contained health-focused-analysis, may help address some of the sustainability and equity concerns articulated in the literature and echoed through this HIA. As this HIA demonstrates, HIAs can spark partnerships (Chirstofa et al., 2020) and can be indispensable in establishing collaborations, articulating priorities, uncovering data, generating recommendations, and discovering existing decision-making processes that can serve as a foundation for sustained and equity-focused systems change work. Moving beyond any one HIA is also important to further systematic change and make progress in Health in All Policies efforts.

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