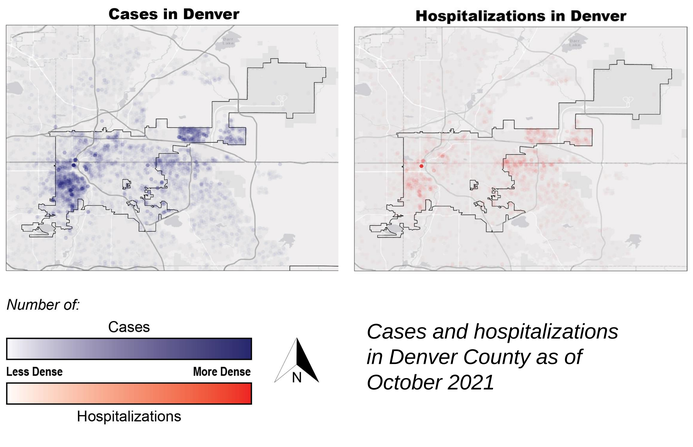
Association Between the Neighborhood Built Environment and COVID-19 Hospitalization

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BACKGROUND

- The COVID-19 pandemic has been marked by its disparate impacts on residents in lower income neighborhoods.
- To better understand reasons for disparities in disease severity, we asked: **To what extent does the neighborhood built environment independently predict COVID-19 hospitalizations for people with SARS-CoV-2?**



Cases and hospitalizations in Denver County as of October 2021

METHODS

- Observational, retrospective analysis of all individuals ≥ 18 years-old diagnosed with SARS-CoV-2 infection within the University of Colorado Health (UCH) and Denver Health (DH) healthcare systems from May 1, 2020, through December 31, 2020.
- Variables extracted from electronic medical records: Date of positive SARS-CoV2 test, Hospitalization within 2 weeks of positive test, Home Address, Age, Gender, Race, Ethnicity, Height, Weight, Tobacco Use, Medical Condition (Asthma, COPD, Hypertension, Diabetes, Kidney Disease, HIV)
- Addresses matched with environmental variables (see Table 1); cohort limited to 8 counties in Metro Denver; addresses for shelters and other group living facilities excluded; cases without physical addresses excluded (i.e. PO Boxes, homeless; nonexistent addresses)
- Odds of hospitalization for COVID-19 among SARS-CoV-2-positive individuals were analyzed in univariate and multivariable logistic regression models, controlling for patient characteristics and medical conditions

All authors report no conflicts of interest. Contact info: sarah.rowan@dhha.org

Among those with SARS-CoV-2 in Metro Denver, living in an apartment and in areas with higher levels of PM2.5, higher transit scores, higher housing burden, and more overcrowding were found to be independent risk factors for hospitalization when controlling for income and medical risk factors. Higher Bike Scores® were associated with lower risk for hospitalization.

Table 1. Environmental Variables

Variable	Description	Data source	Geography
Neighborhood built environment: Density and crowding			
Residential density	Households per square kilometer area of tract	ACS[1]	Census tract
Percent overcrowding	Ratio of households with greater than 1 person per room*	ACS	Census tract
Multi-family building	Unit number in the provided address	UCH and DH Datasets	Individual
Percent multi-family units	Ratio of residential buildings not single units, mobile homes, boats, or RVs*	ACS	Census tract
Neighborhood built environment: Environmental hazards			
Particular Matter $_{2.5}$ Level ($PM_{2.5}$)	2016 Annual Average $\mu g/m^3$ of $PM_{2.5}$ (particulate matter)	2020 Environmental Protection Agency (EPA) Environmental Justice Screen	Census tract
Proximity to highway	Euclidean distance between home address and any highway in the region less than 0.25 mile (202 m)	Colorado Department of Transportation, 2021	Individual
Neighborhood built environment: Environmental amenities			
Normalized Difference Vegetation Index greenness (NDVI)	Raw NDVI (Normalized Difference Vegetation Index) raster value	United States Geological Survey (USGS) eMODIS NDVI Raster (U.S. Geological Survey, n.d.)	Individual, raster value
Park access	Home address located within 0.5 mile (804 m) from the nearest park centroid; distance calculated based on street network	DRCOG, 2019[2]; US Census Bureau Parks Dataset	Individual, network distance-based
Park acreage	Area of parks (square kilometers) intersecting with a .25 mile (402 m) network service shed around each address	DRCOG, US Census Bureau Parks Dataset	Individual, network distance-based
Neighborhood built environment: Mobility			
Walk Score ®	Each address was searched and the walk, bike, and transit scores were recorded. For addresses that did not return results, a raster was interpolated based on the surrounding data points and the missing values were assigned based on location	Walk Score ® Database (WalkScore, 2021)	Individual
Bike Score ®		Walk Score ® Database (WalkScore, 2021)	Individual
Transit Score ®		Walk Score ® Database (WalkScore, 2021)	Individual
Potential confounders			
Social Vulnerability Index (SVI)	Composite SVI score including several socioeconomic variables	2018 Center for Disease Control (CDC) SVI Dataset for Colorado	Census Tract
Percent housing burdened households	Ratio of households paying greater than 30% of their income on rent*	ACS	Census tract
Percent essential workers	Essential based on the US Dept. of Homeland Security Cybersecurity & Infrastructure Security Agency (CISA) guidelines on essential jobs.*	ACS, U.S. Department of Homeland Security, 2020	Census tract

Table 2. Characteristics of individuals w/ SARS-CoV-2 diagnosed at UCH and DH

	Overall (N = 23,308)
Age in years (Median, IQR)	44, 30-56
Gender (n,%)	
Women	12,828 (55)
Men	10,480 (45)
Race/Ethnicity (n, %)	
White, non-Hispanic	11,171 (48)
Black, non-Hispanic	1327 (6)
Asian, non-Hispanic	718(3)
Hawaiian/Pacific Islander	58(0.2)
AI/AN, non-Hispanic	69 (0.3)
Hispanic (all races)	8305 (36)
Mixed Race	205(0.9)
Unknown	1455(6)
Hospitalized (n,%)	5576(24)
BMI (Median, IQR)	30.1, 25.2-33.8
Missing BMI (n,%)	4101(18)
Health Conditions (n,%)	
Tobacco Use	2668 (11)
Hypertension	3615 (15)
Diabetes	2165 (9)
Lung Disease	2772(12)
Kidney Disease	881(4)
HIV	135(0.6)
Health System (n, %)	
University of Colorado	16,849(72)
Denver Health	6459(28)

RESULTS

Table 3. Odds of hospitalization for individuals with SARS-CoV-2 infection, controlling for income and medical risk factors

	Adjusted OR*	95%CI	P-value
Apartment	**1.20**	**1.08-1.33**	**<0.001**
PM2.5	**1.35**	**1.25-1.47**	**<0.001**
Percent Overcrowding	**30.18**	**8.49-107.62**	**<0.001**
Percent Multifamily	**0.76**	**0.61-0.94**	**0.002**
Percent Housing Burdened	**1.4**	**1.01-1.92**	**0.04**
Percent Essential Workers	**0.28**	**0.15-0.52**	**<0.001**
Percent Transit Essential Workers	2.25	0.49-10.26	0.317
Bike Score®	**0.995**	**0.992-0.998**	**0.002**
Walk Score®	0.999	0.997-1.002	0.512
Transit Score®	1.011	1.007-1.015	**<0.001**
Highway Distance	1.02	0.94-1.11	0.611
NDVI	0.999	0.999-1.00	0.177
Park Acreage w/in ¼ mile	0.04	0.0002-7.69	0.23
Park w/in ½ mile	**1.138**	**1.05-1.24**	**0.002**

*Adjusted Odds Ratios, additional variables in model include age, gender, race, ethnicity, Social Vulnerability Index, BMI, smoking status, lung disease, hypertension, diabetes, kidney disease, and HIV

LIMITATIONS

- Only two healthcare systems included; hospitalizations higher than among all SARS-CoV-2 positive cases in Metro Denver
- Complete health data not available for all individuals
- Unmeasured differences may exist
- Hospitalizations not necessarily for COVID-19
- Differential access to testing may affect results
- Analysis conducted prior to vaccine roll-out
- Individuals with missing variables removed from analysis
- Model does not control for spatial autocorrelation

CONCLUSIONS

- **COVID-19 disease severity may be worsened by environmental features around a person's home.**
- **Improvements in neighborhood features to minimize pollution and improve bikeability could have significant health benefits.**
- **Increasing housing availability and affordability could also improve health and response to infection.**