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Walkability, Transit Access, and Traffic Exposure for Low-Income Residents With Subsidized Housing

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Objectives. We assessed the spatial distribution of subsidized housing units provided through 2 federally supported, low-income housing programs in Orange County, California, in relation to neighborhood walkability, transit access, and traffic exposure.

Methods. We used data from multiple sources to examine land-use and health-related built environment factors near housing subsidized through the Housing Choice Voucher Program and the Low Income Housing Tax Credit (LIHTC) program, and to determine these patterns' associations with traffic exposure.

Results. Subsidized projects or units in walkable, poorer neighborhoods were associated with lower traffic exposure; higher traffic exposure was associated with more transit service, a Hispanic majority, and mixed-use areas. Voucher units are more likely than LIHTC projects to be located in high-traffic areas.

Conclusions. Housing program design may affect the location of subsidized units, resulting in differential traffic exposure for households by program type. Further research is needed to better understand the relationships among subsidized housing locations, characteristics of the built environment, and health concerns such as traffic exposure, as well as which populations are most affected by these relationships. (*Am J Public Health.* 2013;103:673–678. doi:10.2105/AJPH.2012.300734)

Smart growth development strategies, which promote high-density, walkable neighborhoods with mixed land-use patterns, high accessibility to public transportation, and convenient local amenities, could encourage walking, cycling, and more active lifestyles and may be associated with potential health benefits such as a lower body mass index.[1–4] Such compact communities provide local amenities close to residences and can be associated with reduced vehicle travel and associated air pollution.[1,5] However, smart growth strategies also could exacerbate exposure to localized air pollution[6–9] because vehicle-related air pollutants, which are associated with health impacts such as heightened respiratory ailments, reduced lung function, and increased mortality, tend to be highly localized during the day in areas approximately 200 to 300 meters downwind of major roadways.[10,11]

The health implications of smart growth for disadvantaged groups remain unclear. Although many existing low-income urban neighborhoods are highly walkable, their built environments are less consistently associated with positive health outcomes and lower body mass index.[12] These suboptimal outcomes may be attributable to other neighborhood characteristics, such as higher levels of deprivation, crime, and safety concerns and fewer clean streets with trees, which may inhibit physical activity[13,14]; more traffic; and exposure to elevated, near-roadway concentrations of vehicle-related pollution.[15,16] Furthermore, smart growth developments that enhance local built environment amenities may increase market demand for nearby housing and decrease the availability of affordable housing.[3]

Although previous research examined the impact of overcrowding and poor housing conditions on the health of low-income residents of public housing,[17,18] few studies have examined the extent to which publicly subsidized housing for low-income residents is distributed in relation to health-related built environment factors such as neighborhood walkability, transit access, and traffic exposure. Furthermore, the spatial distribution of affordable units and their proximity to these amenities and hazards could vary systematically by whether the requirements and regulations of affordable housing programs seek to incentivize housing developers to provide low-rent units in new residential buildings or to disperse residents by providing them vouchers to obtain subsidized housing in the wider rental market.

We conducted the first comparative analysis of the spatial implications of 2 programs that provide housing units for low-income residents of Orange County in Southern California. Although historically a traditional suburban community, Orange County is rapidly becoming ethnically and socioeconomically diverse, with increasing income inequality.[19] The county does not have traditional public housing, which concentrates low-income residents in projects owned and managed by public housing authorities, but rather depends largely on 2 housing programs for low-income residents, which could result in different spatial distributions of units depending on programmatic approach and local conditions.

The Low Income Housing Tax Credit (LIHTC) program is a supply-side program that uses tax credits to raise capital for affordable housing developments. LIHTC development proposals receive points in a competitive process for access to local amenities. Thus, they may be more sensitive to site feasibility considerations and may tend to be located in transportation corridors with lower property values and higher traffic because, in California, the LIHTC program considers access to public transportation in the evaluation of applications.[20,21]

The Housing Choice Voucher Program is not place based and instead promotes poverty deconcentration and dispersal by allowing participants to locate a housing unit in the private rental market; the unit must be affordable within program guidelines (according to fair market rent as established by the US Department of Housing and Urban Development) and must pass a housing authority inspection.

Furthermore, the landlord must be willing to participate in the program. Previous research identified some health, accessibility, and employment implications of relocating poor residents to nonpoor areas,[22–24] but we know very little about the built environment of neighborhoods chosen by voucher holders. Because many voucher households that move relocate to other poor communities,[25,26] we suspect that their new neighborhoods may be older, dense, and walkable and that they differ spatially from areas prioritized by developers leveraging capital through the LIHTC program.

METHODS

We evaluated the spatial distribution of subsidized housing units provided through 2 affordable housing programs in Orange County according to their proximity to health-related built environment amenities and hazards. As previously described,[25] our voucher program data were collected in spring 2002 from a random sample of voucher households (housing units) provided to us by the 2 largest housing authorities in the county, the Orange County Housing Authority (OCHA) and the Santa Ana Housing Authority (SAHA). The OCHA sample comprised 1219 units, representing about 12% of OCHA voucher units, and the SAHA sample comprised 432 housing units, representing about 17% of SAHA voucher units. The OCHA data oversampled family households, and the SAHA data oversampled households that had moved in the previous 3 years.

We obtained data on the location of residential development projects that received LIHTC assistance from the US Department of Housing and Urban Development.[27] These data pertained to 11 413 affordable housing units in 99 housing projects that were “placed in service” in the county between 1987 and 2007; about half were placed in service after 2000. We geocoded the housing unit locations with ArcGIS 9.3 (ESRI, Redlands, CA) and Census 2005 Topologically Integrated Geographic Encoding and Referencing line and address data,[28] and we used Google Maps to identify the locations of addresses that could not be found in the census data.

Our unit of analysis was the housing project for the LIHTC program and the housing unit for voucher programs, because our goal was to understand the implications of siting processes and locations in relation to neighborhood walkability, transit access, and traffic exposure. Although the LIHTC projects contained about 115 units on average, the decision of where to site LIHTC units was made at a project level by housing developers, according to market conditions, local incentives, and related factors. Therefore, examining the spatial implications of the LIHTC program at a project level provided the most direct and informative comparison with the spatial implications of voucher programs, because the location of voucher units is decided at a unit level by recipients finding a potential residence in the rental market. For simplicity, we refer to both voucher and LIHTC subsidized housing as units.

We approximated a unit’s neighborhood demographic and socioeconomic composition by the characteristics of its census block group tabulation area. We obtained racial and ethnic composition information from Census 2010 block group data and estimated changes in composition from 2000 to 2010 by translating 2000 Census block group tabulations into 2010 block group tabulation areas with census area allocation factors.[29,30] Because block group socioeconomic variables were not available from the 2010 Census, we obtained measures of a unit’s neighborhood socioeconomic composition from Census 2000 block group data.[31]

We analyzed unit locations in relation to nearby built environment amenities, including neighborhood walkability, land-use mix, and transit within walking distance, which we approximated as 0.25 miles. These measures represented the density, diversity, design, and regional accessibility factors that could decrease vehicle travel and encourage walking and more active lifestyles.[5] We estimated nearby walkability with 2 measures: (1) the fraction of street intersections within walking distance that were at least 4 way, to capture the

TABLE 1—Block Group Composition in 2010 and Change From 2000: Subsidized Housing Units in Orange County, CA

Characteristic	Orange County	LIHTC Projects (n = 99)	OCHA Voucher Units (n = 1219)	SAHA Voucher Units (n = 432)
Total population, No. (% growth rate 2000–2010)	1647 (4)	2189 (18)	2038 (6)	2225 (-3)
Racial composition (single race), % (% change)				
White	64 (-4)	54 (-4)	44 (-7)	41 (-1)
Black	2 (0)	3 (0)	2 (0)	2 (0)
Asian/Pacific Islander	17 (3)	19 (5)	31 (6)	25 (3)
Other	14 (1)	20 (-1)	19 (2)	29 (-2)
Hispanic composition, % (% change)				
Hispanic	31 (5)	42 (2)	37 (4)	59 (3)
Non-Hispanic White	48 (-8)	34 (-7)	28 (-10)	13 (-6)
Hispanic area[a]	23	37	26	68
Socioeconomic factors				
Foreign-born persons, 2000, %	27	37	41	51
Mean household income, 1999, $	78 508	57 232	52 137	50 322
Households receiving public assistance, 1999, %	3	4	7	7
Persons in poverty, 1999, %	9	16	17	18
Poor area, 2000[b]	12	27	31	39
Housing, 2000, %				
Renter-occupied housing units	37	62	64	56
Persons residing in structures with ≥ 20 units	14	29	26	29

Note. LIHTC = Low Income Housing Tax Credit; OCHA = Orange County Housing Authority; SAHA = Santa Ana Housing Authority.
[a]> 50% Hispanic.
[b]> 20% living in poverty.

degree of street connectivity, and (2) the walk score of a unit's location, derived from Walk Score in August 2010,[32] which measures a unit's proximity to neighborhood amenities according to Google Maps and has been associated with subjective and objective measures of the built environment such as residential density, street connectivity, and public transit availability.[33]

We estimated nearby land-use composition with 2005 land-use data from the Southern California Association of Governments to account for proximity to nearby commercial uses or a mix of commercial and residential uses, which may be associated with higher rates of walking. We also estimated a unit's transit accessibility with 2006 transit stop location data from the association.[34]

We analyzed built environment hazards near affordable units by examining traffic exposure through established proximity-based metrics to approximate exposure to near-roadway air pollution by classifying whether units were within 200 meters (650 ft) of low-, medium- or high-traffic roadways.[16,35,36] We derived this measure from 2005 Highway Performance and Monitoring System data maintained by the California Department of Transportation, which includes estimates of annual average daily traffic on freeways, highways, and major arterial roads. Consistent with previous studies,[16,36] we classified units near at least 1 major roadway with 50 000 or more vehicles per day as being located in high-traffic areas and units near roadways with between 25 000 and 49 999 vehicles per day as being located in medium-traffic areas. We based traffic exposures on a distance of 200 meters (650 ft) because this distance corresponds closely with the distance at which near-roadway vehicle-related air pollutants drop to near-background concentration levels.[10,11]

We examined patterns of neighborhood demographic and socioeconomic characteristics, built environment amenities, and hazards near subsidized units and assessed whether unit locations varied across voucher and LIHTC programs because of differences in underlying regulations and objectives. We then conducted multinomial logistic regression analyses to assess the influence of built environment amenities such as walkability, land-use mix, and transit access on the likelihood of a facility being located in a high- or medium-traffic area. Our results were derived from our full model, with continuous variables, as well as a model with dichotomous area classifications that yielded policy-relevant insights on the types of areas and development patterns associated with exposures.

RESULTS

Between 2000 and 2010, Orange County experienced an 8% reduction in non-Hispanic White residents, a 5% increase in Hispanic residents, and a 3% increase in Asian/Pacific Islander residents (Table 1). In 2010 the county population was 48% non-Hispanic White, 31% Hispanic, and 17% Asian/Pacific Islander.

Nearby Population Characteristics

LIHTC units tended to be located in block groups with substantially higher population growth than in the county as a whole (18% vs 4%), which may reflect that this program is geared toward areas of new development. LIHTC units tended to be in areas with a lower proportion of non-Hispanic Whites and a higher proportion of Hispanics than in the county as a whole; about 37% were in block groups in which at least 50% of residents were Hispanic, and only 23% of the block groups in the county were at least 50% Hispanic. LIHTC units tended to be located in areas with more foreign-born residents and higher poverty rates than the county in 2000, about 27% were in areas in which 20% of residents lived in households with incomes below the federal poverty level,[31] and only 12% of county residents overall lived in such areas. LIHTC units also tended to be located in block groups with higher rates of renter-occupied housing and persons residing in multifamily structures with 20 or more units.

Units subsidized through voucher programs were located in block groups with less population growth than were LIHTC units and, like LIHTC units, tended to be located in areas with a higher percentage of Hispanic residents than in the county overall. This pattern was particularly distinct for the SAHA program, for which 68% of units were located in block groups with at least 50% Hispanic residents (Table 1). More voucher than LIHTC units were located in areas with a high percentage of foreign-born persons and in areas in which 20% of residents lived in poor households.

TABLE 2—Built Environment Surrounding Subsidized Housing Units in Orange County, CA

Variable	LIHTC Projects, No. or %	OCHA Voucher Units, No. or %	SAHA Voucher Units, No. or %
Intersections within 0.25 miles			
Total	36.35	40.59	41.10
Large[a]	0.13	0.14	0.17
Walk score[b]	68.07	68.32	66.36
Land use within 0.25 miles			
Residential	0.35	0.64	0.65
Commercial	0.26	0.15	0.16
Industrial	0.05	0.04	0.05
Open space	0.06	0.03	0.02
Transportation/utilities/vacant	0.29	0.14	0.12
Mixed[c]	0.09	0.09	0.10
Transit access within 0.25 miles			
≥ 1 transit stop	0.87	0.89	0.94
Unique stops for all routes	12.79	9.63	13.01
Traffic volume within 200 m			
High-traffic roadway	0.08	0.13	0.08
Medium-traffic roadway	0.44	0.32	0.55

Note. LIHTC = Low Income Housing Tax Credit; OCHA = Orange County Housing Authority; SAHA = Santa Ana Housing Authority.
[a]≥ 4 directions.
[b]Measures a unit's proximity to neighborhood amenities.[32]
[c]At least one third residential and one third commercial.

Walkability, Transit Access, and Traffic Exposure

Although the walk scores of areas near units differed only slightly across housing programs, voucher units tended to be located in areas with more street intersections and slightly more 4-way intersections than were LIHTC units (Table 2). Voucher units had a higher percentage of nearby residential uses than did LIHTC units (64%–65% vs 35%), and LIHTC units had a higher percentage of nearby commercial and transportation–utilities–vacant uses than did voucher units (26% vs 15%–16% and 29% vs 12%–14%, respectively). More than 85% of units for both program types had at least 1 transit stop and had on average at least 9 unique route stops within walking distance.

Units provided through both program types had relatively high traffic exposure. About 8% of LIHTC units and SAHA voucher units and about 13% of OCHA voucher units were within 200 meters (650 ft) of a high-traffic roadway. About 52% of LIHTC units, 46% of SAHA voucher units, and 63% of OCHA voucher units were within 200 meters (650 ft) of a medium- or high-traffic roadway.

The multinomial logistic regression analysis showed that neighborhood demographic, socioeconomic, nearby built environment, and programmatic factors were associated with location of a facility in a medium-traffic area versus a low-traffic area and in a high-traffic area versus a low-traffic area (Table 3). After controlling for other factors, we found a positive association between the percentage of Hispanic residents in 2010 in a unit's census block group and the probability of being in a high-traffic area, but not with the probability of being in a medium-traffic area. Block group population density and racial characteristics were not significantly associated with a subsidized unit's traffic exposure, and we excluded them from the analysis. The percentage of block group residents receiving public assistance in 1999 had a positive association and the percentage of block group residents in households below the federal poverty level in 1999 had a negative association with location of a unit in a medium-traffic area. These socioeconomic variables were not significantly related to the likelihood of being in a high-traffic area. The percentage of persons residing in structures with more than 20 units was associated with being in a medium- but not a high-traffic area.

TABLE 3—Multinomial Logistic Regression of Medium- or High-Traffic Areas Versus Low-Traffic Areas: Subsidized Housing Units in Orange County, CA

Variable	Medium-Traffic Area, Coefficient	High-Traffic Area, Coefficient
Intercept	–3.67**	–6.35**
Census block group, %		
Hispanic, 2010	–0.04	0.98*
Households receiving public assistance, 2000	4.38**	3.09
Living in poverty, 2000	–2.49**	–1.70
Residing in structures with ≥ 20 units, 2000	1.02**	–0.42
Large intersections within 0.25 miles,[a] %	–1.81**	–3.60**
Land use within 0.25 miles, %		
Commercial	4.89**	8.79**
Industrial	–0.52	–5.97**
Transportation/utilities/vacant	0.49	3.66**
≥ 1 transit stop within 0.25 miles	2.62**	1.54**
Program type[b]		
OCHA voucher program	0.05	1.94**
SAHA voucher program	1.05**	1.85**

Note. OCHA = Orange County Housing Authority; SAHA = Santa Ana Housing Authority.
[a]≥ 4 directions.
[b]The Low Income Housing Tax Credit program was the excluded category.
*$P < .01$; **$P < .001$

The percentage of 4-way intersections near a unit was negatively associated with being in medium- and high-traffic areas, but a unit location's walk score was not significant, so we excluded this factor from the analysis. As expected, the percentage of nearby commercial land uses was positively related to being in medium- and high-traffic areas, and nearby transportation–utility–vacant land uses were associated with higher traffic exposures. Nearby industrial uses were associated with less exposure to high-traffic areas. Having at least 1 transit stop within walking distance was positively associated with exposure to medium- and high-traffic areas. After adjustment for built environment factors, the likelihood of high traffic exposure for OCHA voucher units was statistically different than for LIHTC units (the excluded category). SAHA voucher units were significantly more likely than LIHTC units to be in medium- and high-traffic areas.

Table 4 presents the results of our multinomial logistic regression model with area classifications as independent variables to assess the relationship of the highest or lowest prevalence of key demographic, socioeconomic, and built environment characteristics on the likelihood of traffic exposure. Units in areas with more than 50% Hispanic residents were more likely to be in a high-traffic area, and units in poor areas were less likely to be in medium- and high-traffic areas. Units with greatest nearby walkability were less likely to be in medium- and high-traffic areas, and units in mixed-use areas (at least one third residential and one third commercial uses) had a higher likelihood of traffic exposure. As expected, units with the lowest level of nearby transit service had a lower likelihood of exposure to medium- and high-traffic levels, and those with the highest level of nearby transit service had a higher likelihood of exposure to medium levels of traffic. The probability of exposure for OCHA and SAHA voucher units was not significantly different than for LIHTC units in our model that used area classifications.

DISCUSSION

Although some research sheds light on the neighborhood walkability and physical activity implications of converting distressed public housing projects into mixed-income developments through the federal HOPE VI

TABLE 4—Multinomial Logistic Regression of Medium- or High-Traffic Areas Versus Low-Traffic Areas by Demographic, Walkability, and Transit Characteristics: Low-Income Housing Programs in Orange County, CA

Variable	Medium-Traffic Area, Coefficient	High-Traffic Area, Coefficient
Intercept	0.30	-1.32**
Census block group, %		
Hispanic area,[a] 2010	0.18	0.53**
Poor area,[b] 2000	-0.34**	-0.49**
Walkability[c]		
Highest	-0.68**	-0.80**
Lowest	0.09	-0.07
Mixed land use within 0.25 miles[d]	0.77**	1.49**
Unique transit route stops within 0.25 mile		
Highest quartile	0.59**	-0.03
Lowest quartile	-1.40**	-1.81**
Program type[e]		
OCHA voucher program	-0.32	0.57
SAHA voucher program	0.37	0.11

Note. OCHA = Orange County Housing Authority; SAHA = Santa Ana Housing Authority.
[a]> 50% Hispanic.
[b]≥ 20% living in poverty.
[c]Percentage large intersections within 0.25 miles; ≥ 18.8% = highest quartile of walkability; ≤ 6.1% = lowest quartile.
[d]At least one third residential and one third commercial.
[e]The Low Income Housing Tax Credit program was the excluded category.
***P* < .001

program,[37] our study was the first to our knowledge to assess the spatial implications of the LIHTC program, which incentivizes housing developers to provide low-rent units in new and redeveloped residential buildings, and the voucher program, which enables residents to obtain subsidized housing in the wider rental market, in relation to walkability, transit access, and traffic exposure. We found that low-income residents in subsidized units provided through both programs tended to live in areas with a higher percentage of residents who were renters, Hispanic, foreign-born, or poor than in Orange County as a whole. Despite these similarities, our results suggest that the design of these programs affects the distribution of subsidized units in relation to health-related built environment amenities and hazards.

LIHTC units tended to be located in areas with higher population growth than were units provided through voucher programs, perhaps because the LIHTC program is oriented toward areas of new development. LIHTC units also were located in areas with fewer overall residential uses and more commercial and transportation–utilities–vacant uses than were voucher units. This pattern supports our hypothesis that the orientation of the LIHTC program is more sensitive to local market and site-specific factors and results in more units being located in commercial and transportation corridors. Units subsidized through both program types had high overall traffic exposure, but contrary to our expectations and previous distributional analysis of traffic exposure,[16] those in poor areas had lower overall traffic exposure, after adjustment for other factors. Consistent with the literature, however, units in predominately Hispanic areas had higher traffic exposure.

We found some evidence that low-income residents with vouchers to use in the wider rental market lived in areas with more traffic than was found near sites where developers built units subsidized through the LIHTC program. This pattern raises concerns that voucher holders may be locating in high-traffic areas to benefit from higher transit accessibility in these areas, but our previous research indicated that transit proximity is most likely not a significant factor in their residential choices. Survey results for our sample indicated that the supply of units and personal characteristics are more important factors in voucher holders' location choices.[22,25] Consistent with previous studies,[38,39] our participants reported traveling by passenger vehicle as their dominant commuting mode; fewer than 10% said they got to work by walking or riding transit.

Units in areas with mixed land use and more transit service had a higher likelihood of traffic exposure, but, contrary to expectations, those in more walkable areas with a higher percentage of 4-way intersections had a lower likelihood of traffic exposure, after adjustment for other factors.

Limitations

Although our LIHTC data represented all developments placed in service, the voucher data were derived from a sample and included oversampling. We have no reason to believe, however, that this sample was biased in relation to proximity to the amenities and hazards analyzed. Although we used block group demographic and racial/ethnic data from the recent 2010 census, our block group socioeconomic measures were derived from 2000 census data and may have inadequately represented comparable patterns and recent changes.

Our estimates of traffic exposure may have underestimated potential exposure of low-income residents to near-roadway vehicle-related pollution because pollution concentrations could extend beyond the 200-meter threshold we used to more than 1000 meters from major roadways under different atmospheric conditions.[40] Future research is also needed to understand how the activity patterns of residents relate to nearby built environment amenities and hazards and air pollution exposure.

Conclusions

Our results provide valuable insights into the distributional implications of housing subsidy programs in a suburban county in Southern California experiencing increasing diversity, but further research is needed to understand the implications of these programs in older cities with different social and built environments. Programs that embrace smart growth development goals could provide convenient access to amenities and encourage active travel and physical activity, and we found only limited evidence that these factors were associated with higher traffic exposures.

Research is needed to better understand the dynamics of site choices for subsidized housing and the cost–benefit and locational considerations of LIHTC developers and voucher holders and how their decisions are related to differential exposures across program types. Such research should also examine programmatic factors related to differential outcomes, especially because affordable housing programs have begun to provide incentives for locating close to built environment amenities.[20] ■

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Contributors

D. Houston was primarily responsible for the study conceptualization and design, analysis, and writing the article. V. Basolo contributed to the study conceptualization and design, interpretation of results, and writing. D. Yang contributed to the study conceptualization and data assembly and analysis.

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Note. We are solely responsible for the accuracy of our statements and interpretations, which do not necessarily reflect the views of the US government.

Human Participant Protection

No protocol approval was needed for this study because it relied on secondary data containing no personal identifying information.

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