

By Ellen E. Kersten, Kaja Z. LeWinn, Laura Gottlieb, Douglas P. Jutte, and Nancy E. Adler

# San Francisco Children Living In Redeveloped Public Housing Used Acute Services Less Than Children In Older Public Housing

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**ABSTRACT** Understanding the links between housing and health is increasingly important. Poor housing quality is a predictor of poor health and developmental problems in low-income children. We examined associations between public housing type and recurrent pediatric emergency and urgent care hospital visits. Children ages 0–18 with public insurance who sought emergency care from any of three large medical systems in San Francisco were categorized by whether they lived in public housing redeveloped through the federal HOPE VI program, nonredeveloped public housing, or nonpublic housing in a census tract that also contained public housing. After we adjusted for potential confounding characteristics, we found that children living in nonredeveloped public housing were 39 percent more likely to have one or more repeat visits within one year for acute health care services unrelated to the initial visit, compared to children who lived in redeveloped HOPE VI housing. We observed no differences in repeat visits between children in redeveloped HOPE VI housing and those in nonpublic housing. These findings support the continued redevelopment of public housing as a means of both improving the health of vulnerable high-risk children from low-income neighborhoods and reducing health care costs.

**Ellen E. Kersten** (ekersten@berkeley.edu) is a PhD candidate in environmental science, policy, and management at the University of California, Berkeley.

**Kaja Z. LeWinn** is an assistant adjunct professor of psychiatry at the University of California, San Francisco.

**Laura Gottlieb** is an assistant professor of family and community medicine at the University of California, San Francisco.

**Douglas P. Jutte** is an associate professor at the School of Public Health, University of California, Berkeley, and executive director of the Build Healthy Places Network, in San Francisco.

**Nancy E. Adler** is a professor of psychiatry and pediatrics at the University of California, San Francisco.

**L**iving conditions during childhood affect health outcomes at the time and across the life course, contributing to socioeconomic and racial/ethnic health disparities for children and adults.<sup>1</sup> Policies that focus on improving “upstream” environmental and economic factors such as housing may therefore improve population health, while also reducing medical costs and health disparities.<sup>2</sup>

Understanding the links between housing and health is increasingly important. Poor housing quality is a predictor of poor health<sup>3</sup> and developmental problems in low-income children,<sup>4</sup> yet research on the health effects of housing policies is limited.<sup>5</sup> Meanwhile, many children

visit emergency departments (EDs) for potentially preventable reasons.<sup>6,7</sup> This utilization is costly: The average ED visit costs two to five times more than an office visit.<sup>8</sup>

ED visits are associated with a number of medical and social factors, such as community household income<sup>9–11</sup> and insurance status.<sup>12,13</sup> There is a need to better understand the full range of social and economic factors that can lead to higher ED visit rates for specific populations.

Housing is a major challenge for low-income families, and various programs seek to address these needs. Approximately seven million households, which include more than four million children, live in housing that is made affordable

through federal rental assistance programs or the Low Income Housing Tax Credit program.<sup>14,15</sup> One of the nation's main rental assistance programs is public housing, which includes 1.12 million public housing units administered by 3,100 local housing authorities.<sup>16</sup> Forty percent of households that live in public housing have children under eighteen.<sup>16</sup>

Over the past two decades, 56,800 public housing units were redeveloped through the federal Housing Opportunities for People Everywhere (HOPE VI) program.<sup>17</sup> Initiated by Congress in 1992, the HOPE VI program was one of the most ambitious urban redevelopment strategies in US history.<sup>18,19</sup> More than \$6.1 billion in federal funds were invested with the aim of rebuilding the most severely distressed and dilapidated urban public housing.<sup>18,19</sup> The program transformed notorious housing projects across the country into lower density, townhome-style communities designed to also attract higher-income families and create mixed-income neighborhoods.

HOPE VI differed from previous housing policies because it did not just focus on improving the physical conditions of particular housing developments. It also explicitly included goals to support individual- and neighborhood-level changes, such as improved resident well-being and self-sufficiency and community institutions and infrastructure.<sup>18</sup> Funded sites were required to use a portion of their resources to provide community supportive services, which in most cases focused on programs related to employment and education.<sup>18</sup>

Much of the research that has examined the impact of public housing—most prominently, the Gautreaux Assisted Housing Program<sup>20</sup> and the Moving to Opportunity for Fair Housing demonstration program<sup>21,22</sup>—has focused on the use of housing vouchers to allow families and individuals to move away from poor-quality public housing. Health was not a primary target for either program.

However, the Moving to Opportunity for Fair Housing program did have some positive impacts on adults' physical health and subjective well-being.<sup>23–25</sup> Evidence of the impacts on youth has been limited to mental health, with unexpectedly mixed outcomes by sex: lower rates of depression and conduct disorders among adolescent girls, but higher rates of depression, post-traumatic stress disorder, and conduct disorders among boys.<sup>26,27</sup> Meanwhile, studies following former residents of HOPE VI sites who were relocated as part of the redevelopment process have generally noted worsening of the residents' already very poor health, even in cases where they moved to better-quality hous-

ing in safer neighborhoods with lower poverty rates.<sup>28,29</sup>

Subsidized housing programs have been shown to have salutary effects for children by preventing homelessness and increasing household disposable income for food and other essentials.<sup>30–32</sup> Nonetheless, public housing is generally located in poor neighborhoods with high levels of crime, low-performing schools, and high levels of harmful exposures to environmental toxins such as lead and mold.<sup>3,30,33</sup>

Little research has evaluated the effects of public housing on child health.<sup>3</sup> Furthermore, existing studies often are weakened by potential confounding as a result of selection bias and limited data availability.<sup>30</sup>

This study advances work that bridges housing and health by combining two data sources—health system utilization records and citywide public housing records. We used technologies for data linkage and spatial analysis to assess the relationship between housing type and child health care utilization. We merged ED and urgent care department electronic medical record data across six hospitals that represented three medical systems. This created a database that included more than 80 percent of emergency pediatric health care visits in the City and County of San Francisco during the period 2007–11.

Our primary aim was to evaluate whether housing type—HOPE VI public housing, non-redeveloped public housing, or nearby non-public housing—was associated with recurrent acute care medical visits in this citywide population of children. The implications of this analysis are relevant for the design, implementation, and evaluation of public housing policies as well as for efforts to reduce health care spending among high-risk children.

This retrospective cohort study was approved by the Institutional Review Boards of Sutter Health and the University of California, San Francisco and Berkeley.

## Study Data And Methods

**POPULATION AND DATA** The study population consists of children younger than age eighteen at their first visit with a valid residential address in San Francisco who met the following three conditions: They sought emergency or urgent care at one of six hospital sites between January 1, 2007, and December 31, 2011; they lived either in public housing or in the same census tract as public housing (which reduced variability in neighborhood-level characteristics); and they had public insurance at their first visit (which reduced confounding by socioeconomic status).

Data were merged within and across hospitals

using Link King software, version 7.1.22.<sup>34</sup> The San Francisco Housing Authority provided addresses of public housing locations, including five properties redeveloped through HOPE VI. All public housing locations were successfully geocoded using ArcGIS, version 10.1. The public housing and patient data were merged by matching standardized addresses. We used 2010 US census boundaries to identify census tracts that contained public housing addresses.

Complete selection criteria are reported in online Appendix Exhibit 1.<sup>35</sup> Visit records that had an invalid patient address (3 percent) were excluded; 98 percent of the remaining addresses were successfully geocoded in ArcGIS. Patients who had a repeat visit and an address in a different neighborhood or public housing development from their first visit (2 percent) were excluded. We also omitted patients who had any visit with a diagnosis code for a complex chronic condition, such as congenital anomalies<sup>36,37</sup> (1 percent), since these conditions are unlikely to be affected by housing quality. The final sample contained 5,711 patients.

**DEPENDENT VARIABLE** Our dependent variable was frequency of emergency and urgent care visits in the year following a patient's first such visit. Return visits within seventy-two hours, which are generally related to the initial presenting complaint,<sup>38,39</sup> were excluded. Visit frequency was coded dichotomously: zero return visits versus one or more return visits.

**INDEPENDENT VARIABLE** Patients were assigned one of three housing types: nonpublic housing ( $n = 3,266$ ), HOPE VI public housing ( $n = 368$ ), and nonredeveloped public housing ( $n = 2,077$ ).

**COVARIATES** We included covariates likely to affect pediatric emergency services utilization.<sup>7,40,41</sup> Individual-level covariates were age (less than 1 year; 1–4 years; 5–9 years; 10–14 years; and 15–17 years), sex, and race/ethnicity (white, Asian, Hispanic, black, and other or unknown or mixed). We also included two indicators of diagnosis severity: the maximum severity score of all diagnosis codes (ranging from 1 to 5, based on the Severity Classification System);<sup>42</sup> and whether the condition was chronic (but not complex), based on *International Classification of Diseases*, Ninth Revision, Clinical Modification (ICD-9-CM), codes.<sup>43</sup>

At the hospital level, we adjusted for whether the initial visit was to the ED or urgent care department and for hospital site. Neighborhood-level covariates were the percentage of the population in the patient's census tract with a household income of less than 200 percent of the federal poverty level and an indicator of whether HOPE VI public housing was located

in the tract (for explanations of these measures, see online Appendix Exhibit 2).<sup>35</sup>

**STATISTICAL ANALYSES** Bivariate analyses compared study population characteristics by housing type; we used chi-square tests for categorical variables and *t* tests for continuous variables. Adjusted odds ratios and confidence intervals were estimated using generalized estimating equations to generate population average coefficient estimates<sup>44</sup> and to control for potential hospital-level clustering.<sup>40</sup> The final model specifications and sensitivity tests are reported in online Appendix Exhibit 3.<sup>35</sup>

**LIMITATIONS** Our study had several limitations. First, the unavailability of total counts of children living in public housing (for details on data availability, see online Appendix Exhibit 2)<sup>35</sup> precluded reporting acute care visit rates for all children in public housing in San Francisco.

Second, we did not have data on unit- or building-level housing quality (for example, data on air quality, mold, and crime), so we were not able to investigate mechanisms that might link housing quality to health. Although the City and County of San Francisco collect data on housing code violations, public housing residents do not regularly report violations, and enforcement is inconsistent.<sup>45</sup>

Third, HOPE VI properties have a mixed-income population. To distinguish children in relatively higher-income households from those in low-income households, we used public insurance as a proxy and excluded uninsured children and those with private health insurance. However, this did not fully control for differences in income and wealth<sup>46</sup> and other household characteristics, such as family structure.<sup>47</sup>

Fourth, 5 percent of visits were by patients with invalid addresses. Although this was unlikely to bias our results, the analysis excluded visits by children who were homeless; were living in transitional care, in juvenile detention, or outside of San Francisco; or who had incomplete or inaccurately recorded addresses.

Fifth, our data set did not include all health care facilities in San Francisco. From 2007 to 2011 the hospitals in our sample treated 80 percent of all children who lived in and sought emergency care in San Francisco and 87 percent of such children who were publicly insured.<sup>48</sup>

Sixth, the residents of HOPE VI public housing accounted for only 6 percent of our study population. This reflects the small proportion of public housing units redeveloped through HOPE VI (5 percent).<sup>17</sup>

Finally, the unique characteristics of our study area, including higher housing costs and median household income and a lower proportion of

children in the city's population and of children without health insurance, compared to other US cities, may limit the generalizability of our findings.

## Study Results

**SUMMARY STATISTICS** The demographic characteristics of the residents of the two public housing types were largely comparable (Exhibit 1). However, compared to residents of public housing, residents of nonpublic housing were significantly less likely to be black (19 percent versus more than 50 percent) and more likely to be Hispanic (52 percent versus less than 25 percent). Additionally, residents of public housing were more likely to be seen for a noncomplex chronic condition, compared to residents of nonpublic housing (more than 17 percent versus 14 percent).

The mean percentage of census-tract population with incomes of less than 200 percent of poverty also varied by housing type (Exhibit 1).

It was greatest for children living in nonredeveloped public housing and lowest for children in HOPE VI public housing.

**UNADJUSTED RESULTS** Children living in nonredeveloped public housing had a significantly greater mean number of emergency and urgent care visits than children who did not live in public housing (2.21 versus 2.06,  $p = 0.002$ ) (Exhibit 2). The number of return visits ranged from zero to eighteen. Among children who were seen for care, 50 percent did not have a return visit within 3–365 days, 24 percent had one return visit, 12 percent had two return visits, and 14 percent had three or more return visits (Exhibit 3).

Children living in HOPE VI public housing had an intermediate mean number of visits (2.16) that did not differ significantly from children in either nonpublic housing ( $p = 0.26$ ) or nonredeveloped public housing ( $p = 0.65$ ) (Exhibit 2). We found the same pattern when we used a dichotomous variable of no return visits versus one or more return visits. Children

### EXHIBIT 1

#### Characteristics Of The Study Population Of Children In San Francisco, By Housing Type

	Full population (N=5,711)		In nonpublic housing (n=3,266)		In HOPE VI public housing (n=368)		In nonredeveloped public housing (n=2,077)	
	Number	% or mean	Number	% or mean	Number	% or mean	Number	% or mean
<b>DEMOGRAPHIC CHARACTERISTICS</b>								
Age (years)								
Less than 1 <sup>abc</sup>	1,332	23%	808	25%	64	17%	460	22%
1–4	1,430	25	841	26	83	23	506	24
5–9	1,205	21	666	20	90	24	449	22
10–14 <sup>a</sup>	1,025	18	548	17	70	19	407	20
15–17 <sup>bc</sup>	719	13	403	12	61	17	255	12
Female	2,752	48	1,559	48	175	48	1,018	49
Race/ethnicity								
White	331	6%	201	6%	23	6%	107	5%
Asian <sup>b</sup>	705	12	432	13	32	9	241	12
Hispanic <sup>abc</sup>	2,172	38	1,713	52	90	24	369	18
Black <sup>ab</sup>	1,963	34	623	19	192	52	1,148	55
Other/unknown/mixed	540	9	297	9	31	8	212	10
<b>HEALTH FACTORS</b>								
Noncomplex chronic condition <sup>abd</sup>	905	16%	446	14%	78	21%	381	18%
Maximum severity score <sup>be</sup>	5,711	2.60	3,266	2.59	368	2.68	2,077	2.61
<b>NEIGHBORHOOD CHARACTERISTICS</b>								
Percent of poverty <sup>abcf</sup>	5,711	46.34	3,266	42.51	368	37.88	2,077	53.88
HOPE VI housing in tract	1,428	25%	1,060	32%	368	100%	0	0%
<b>HOSPITAL VISIT CHARACTERISTICS</b>								
First visit was for urgent care <sup>ab</sup>	2,922	51%	1,717	53%	173	47%	1,032	50%
Visit to more than 1 medical system <sup>ab</sup>	314	5%	145	4%	27	7%	142	7%

**SOURCE** Authors' analysis of hospital emergency department and urgent care department data from three medical systems in San Francisco, 2007–11. <sup>a</sup>Test of association significant at  $\alpha = 0.05$  between nonpublic housing and nonredeveloped public housing groups (by  $t$  test or chi-square test). <sup>b</sup>Test of association significant at  $\alpha = 0.05$  between nonpublic housing and HOPE VI public housing groups (by  $t$  test or chi-square test). <sup>c</sup>Test of association significant at  $\alpha = 0.05$  between nonredeveloped housing and HOPE VI public housing groups (by  $t$  test or chi-square test). <sup>d</sup>Based on *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM), codes (see Note 43 in text). <sup>e</sup>Average maximum severity score (range 1–5) of all diagnosis codes across all visits on the Severity Classification System (see Note 42 in text). <sup>f</sup>Percentage of the population with household income of less than 200 percent of the federal poverty level.

**EXHIBIT 2**
**Total Emergency And Urgent Care Department Visits In 2007–11 By The Study Population Of Children In San Francisco, By Housing Type**

	Full sample	Nonpublic housing	HOPE VI public housing	Nonredeveloped public housing
Number of children	5,711	3,266	368	2,077
Number of visits				
Mean <sup>a</sup>	2.12	2.06	2.16	2.21
Median	1	1	2	2
Range	1–18	1–14	1–11	1–18
Standard deviation	1.70	1.63	1.70	1.81

**SOURCE** Authors' analysis of hospital emergency department and urgent care department data from three medical system in San Francisco, 2007–11. <sup>a</sup>Test of association significant at  $\alpha = 0.05$  between nonpublic housing and other public housing groups (by t test or chi-square test).

in nonredeveloped public housing were more likely than children not living in public housing to have at least one repeat visit (52 percent vs. 48 percent,  $p = 0.004$ ) (Exhibit 3). The percentage of children in HOPE VI housing with any number of return visits (51 percent) did not differ significantly from either the percentage of children not in public housing or that of children in nonredeveloped public housing ( $p = 0.30$  and  $0.67$ , respectively).

**ADJUSTED RESULTS** Living in nonredeveloped public housing remained a significant predictor of recurrent use of emergency health care in models that adjusted for demographic, health, neighborhood, and hospital characteristics. When we made those adjustments, we found that children who lived in nonredeveloped public housing were 37 percent more likely than children who did not live in public housing to have at least one repeat visit to an emergency or urgent care department (odds ratio: 1.37; 95% confidence interval: 1.31, 1.42;  $p < 0.001$ ), and 39 percent more likely than children who lived in HOPE VI public housing to have such a repeat

visit (OR: 1.39; 95% CI: 1.12, 1.71;  $p = 0.002$ ). There was no significant difference in the likelihood of at least one repeat visit for children who lived in HOPE VI public housing compared to those who did not live in public housing (OR: 0.98; 95% CI: 0.082, 1.18;  $p = 0.849$ ).

### Discussion

Our results suggest that housing conditions play a role in disparities in emergency health care utilization patterns. We found that low-income children living in redeveloped HOPE VI public housing were less likely to have one or more repeat acute care visits than children living in older, more traditional public housing. This finding suggests that investments in both improving the physical infrastructure and providing enhanced community supportive services—as mandated in the HOPE VI program—for low-income families may do more than simply provide better housing: Such investments may also foster better health among children and reduce spending for acute care services.

**EXHIBIT 3**
**Hospital Emergency And Urgent Care Department Revisits In 3–365 Days By The Study Population Of Children In San Francisco, By Housing Type**

Revisits	Full sample		Nonpublic housing		HOPE VI public housing		Nonredeveloped public housing	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Any <sup>a</sup>	2,850	50	1,576	48	188	51	1,086	52
Number of revisits								
0 <sup>a</sup>	2,861	50	1,690	52	180	49	991	48
1	1,352	24	766	23	88	24	498	24
2	672	12	371	11	42	11	259	12
3 or more <sup>a</sup>	826	14	439	13	58	16	329	16

**SOURCE** Authors' analysis of hospital emergency department and urgent care department data from three medical systems in San Francisco. <sup>a</sup>Test of association significant at  $\alpha = 0.05$  between nonpublic housing and other public housing groups (by t test or chi-square test).

These findings are especially salient for tax-exempt hospitals as they conduct community health needs assessments and adopt implementation strategies in line with requirements of the Affordable Care Act and for local health departments, many of which spearhead community health improvement processes. Although some community health assessments and implementation strategies address housing and other social and environmental determinants of health,<sup>49</sup> this is not yet the norm.

For example, the most recent community health improvement plan for San Francisco states that socioeconomic conditions are not directly addressed “because these factors are broad social issues that require systematic, institutional change reaching beyond a local public health system’s scope of impact.”<sup>50</sup> Evidence from our study suggests that the issue of housing might indeed be considered to fall within a health system’s scope, given the connections we found between housing type and health care utilization patterns. For organizations that want to reduce health care spending, the finding that investments in good-quality public housing could reduce the expensive use of acute health care facilities by children might encourage their involvement in redevelopment efforts.

This study also supports the inclusion of health and health care factors in decision making about housing policies and programs. Only one in four eligible US households receive federal housing assistance,<sup>15</sup> which suggests a need for expanded housing opportunities for low-income families. The Department of Housing and Urban Development has adopted a “health in all policies” approach that promotes collaborations with health organizations, the use of health metrics, and the inclusion of health and social services into its goals and programs.<sup>51</sup> Local housing authorities and housing developers could benefit by following suit.

In San Francisco and many other cities, housing authorities face budgetary challenges that limit their capacity to conduct essential inspections and maintenance to ensure that all public housing units are fit and available for habitation. By framing safe and affordable housing as an essential driver of community health, housing agencies could join forces with health services organizations to ensure that scarce resources, including those from community benefit funds, are invested in ways that maximize public health benefits for children and other vulnerable populations.

More concrete evidence documenting relationships between public housing redevelopment and children’s health may emerge in evaluations of health outcomes before and after

## Public housing redevelopment policies may play an important role in reducing the use of pediatric acute care services.

redevelopment at particular public housing sites. Several of San Francisco’s remaining public housing properties have begun redevelopment through HOPE SF, a city-sponsored program initiated in response to lessons learned from HOPE VI revitalization projects.<sup>52</sup>

The housing and hospital visit data we assembled for the period 2007–11 provide a baseline of the pediatric health and health care characteristics of this population. These historical data can be compared to data collected after redevelopment to evaluate and monitor changes in children’s health and inform the ongoing redevelopment processes at HOPE SF and other public housing locations.

Both the process and outcomes of this work have implications for organizations beyond health systems and housing institutions, such as schools and social services providers. This study and previous work<sup>53,54</sup> confirm that integrating data across health care systems provides novel insights about population-level, as opposed to simply site-specific, health care utilization patterns.

Efforts to combine data across government agencies, private-sector institutions, or both are likely to be equally valuable for other sectors. Integrated data analysis can help identify the impacts on service utilization of specific programs or policies and inform resource allocation decisions. For example, hospital visit and housing data could be linked with education data to evaluate the relationships between health outcomes, housing type, and school performance and inform the development of school-based health centers and after-school programs.

Future research will require integrating data from additional hospitals and clinics to create a more complete population-level database of health care utilization in San Francisco and beyond, as well as collecting more detailed data on

housing quality and the populations served by housing programs. The nation is embarking on a “new era in housing policy,” with the HOPE VI program being replaced by Choice Neighborhoods, an initiative that—in contrast to the limited public housing focus of HOPE VI—seeks to transform entire low-income neighborhoods into sustainable communities.<sup>19</sup> As more low-income families are affected by housing redevelopment efforts, there is an ongoing need to evaluate and communicate the health impacts of those efforts, especially for children.

## Conclusion

Through the linkage of individual-level health

care and housing data on a citywide scale, this study identified unique health care utilization characteristics of low-income children who lived in different types of public housing. Our results suggest that public housing redevelopment policies may play an important role in reducing the use of pediatric acute care services. Previous research demonstrates that acute care services consume substantial health care resources. It is both possible and necessary for health care providers and other institutions to expand collaborations beyond their own sectors to better identify, address, and monitor the health and health care needs of children and other vulnerable populations. ■

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## Queries

1. Final paragraph, at the last stage you added the sentence beginning “Previous research.” Please now add at least one citation to that previous research.