Published in final edited form as:

J Public Health Manag Pract. 2018 ; 24(5): 444–447. doi:10.1097/PHH.0000000000000757.

The potential for proactive housing inspections to inform public health Interventions

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INTRODUCTION

Expanding healthcare finance options for prevention have created new opportunities to promote public health through improved housing quality.¹ These opportunities increase the need for data about health-relevant housing conditions to target, design, and evaluate services. Data from existing municipal inspection systems are an underutilized source of data for housing related health programs.

Housing infrastructure improvements can reduce risks of lead poisoning, asthma, unintentional injuries, and other health problems.^{2,3} Studies suggest that multi-level housing interventions, such as multi-pronged interventions involving physical, social, or educational programs, have been shown to impact resident health. Examples include lead hazard reduction, home asthma visits, and integrated pest management.^{3,4,5, 6} Housing inspections are the first step to identifying and addressing these hazards.⁷

A growing number of cities proactively inspect all rental housing, including those in privately owned 1- and 2-unit houses, use a periodic cycle (rather than inspection only by complaint or at unit turnover), and conduct both internal and exterior inspections.^{8,9} Rochester, New York has proactively inspected all privately owned rental units for nearly twenty years. City of Rochester housing inspectors receive extensive training to ensure consistent enforcement and use of housing codes citations. Units must pass inspection to receive a Certificate of Occupancy (required to rent a unit), which is valid for three or six years, depending on the type of building. Data on each inspection is recorded and made publicly available.

For municipal inspection data to be useful in informing public health interventions, they must yield systematic and consistent identification of potential health hazards. Our analysis of unit-specific inspection data examines the relationship among housing violations cited, home age, home assessed value, and inspected neighborhood area.

METHODS

Each City of Rochester housing inspector is assigned to one of 26 geographic inspector areas (Supplemental Figure 1). To equalize inspectors' workload, inspector areas encompass similar numbers of properties requiring inspection. The housing stock within these inspector areas varies in terms of size, number of units, age, and value. Inspectors proactively visit all rental units in their area at least once every six years and record any observed housing code violations as part of the Certificate of Occupancy process. Rochester's Property Conservation Code is based on the New York State Uniform Code, with additional local provisions.^{10,11} Violations cited by the inspector are cited in a "Notice and Order" and must be corrected before a Certificate of Occupancy is issued and the unit may be legally rented. The City of Rochester inspections department tracks time elapsed between citation and correction of violations for each house; however, the data used in these analyses contain no details on corrective measures taken.

The City of Rochester provided data on housing violations cited during inspections conducted between 2009 and 2014. Of the nearly 300 possible violations, we consulted with city inspectors to select 136 "healthy home violations" associated with the major housing hazards identified in the 2013 State of Healthy Housing, as well as additional conditions of concern.¹² These violations included window, roof, and siding problems, broken stairs or handrails, leaks, electrical hazards, lack of working smoke detectors (see Supplemental Material for additional detail). We totaled each home's number of violations into a single "Healthy Home Violations Score." Data also included the home's assessed value, year built and building type (single family, duplex, or multi-unit). To maximize comparability by assessed value, we limited our analyses to single family homes inspected once during the 6 year period (n=7623). We converted assessed value and age (year built) into quartiles for analyses.

We constructed a set of linear multilevel regression models (in which violations data were nested within inspector area) to determine whether differences in the healthy home violations could be explained by inspector area, housing age, and assessed value. Housing inspector area was included as a random effect, while housing age and assessed value were included as fixed effects. To investigate whether inspections provide additional information about home health hazards, we created a matrix of housing risk by quartile for age (older housing = higher risk) and assessed value (lower value = higher risk) and compared the mean and standard deviation of housing violations within each cell.

RESULTS

The total number of single family rental homes inspected across the six years ranged from 965 (in 2012) to 1556 (in 2011), and the mean number of all healthy home violations cited per house ranged from 3.6 (in 2010) to 5.4 (in 2012) (Table 1). The number of inspections across all years ranged from 77 to 454 inspections per inspector area, reflecting variance in the proportion of single family rental homes in each area. The number of violations per house ranged from 0 to 32 and distributions were similar across the inspector areas (Supplemental Table 1). Most homes (54.5%) had fewer than four healthy home violations.

However, 10.8% had more than 10 and 1.1% had more than 20 violations. Inclusion (or exclusion) of the properties with 0 violations had no appreciable impact on the analyses, as relatively few properties had 0 violations, and that these “0-violation” properties were not clustered in any one inspector area.

Table 1 shows the mean number of violations by assessment quartile, by year of construction quartile, and by inspector area. There is greater variation in violations within assessment and construction year quartiles 1 and 2 (those with the oldest or lowest value housing). This variation exceeds the differences in mean healthy home violations across inspector areas.

Mixed model analyses showed significant results for inspector area in both the random ($Z=3.35$, $P<.0004$) and fixed effects (Wald’s $Z=3.10$, $P<.001$) models. However, the comparison of the mixed models containing the random effect (inspector area) to one which includes that random effect plus fixed effects (construction year and assessed value) show that the variance structure of the models changed. The variance within inspector area changed slightly (from 20.5 to 19.6), while the variance component between inspector areas decreased markedly (from 1.67 to .60). The ratio of the variance components between the two models (20.5/19.6 to 1.67/.60) suggests that 64% of the variance is attributable to the fixed effects (housing stock).

DISCUSSION

Our results suggest that housing violations are cited consistently across the city of Rochester, since a large portion (64%) of the area-to-area variation in inspection is explained by construction year and assessed value. Thus, inspection outcomes affirm the expectation that older and lower-value housing have more health hazards.

The remaining variation suggests that housing inspection data add significant information about home health hazards beyond what might be predicted based on home age and assessed value alone. Particularly in the highest risk areas, these inspections may identify individual homes or specific areas where residents may be at risk from housing hazards. This also suggests that inspections of high risk rental housing can positively impact housing quality, as violations must be addressed before renting. Additionally, the higher variability in Healthy Home Violations Scores within the higher risk housing quartiles may suggest that some property owners and residents maintain such older, low-value housing in better condition than do others.

This study is limited by the available data on housing risk factors (e.g. age and housing value). Although we found no evidence of systematic differences in healthy home violation patterns between inspectors, a double-blind (side by side) inspection design would be needed to confirm the extent of inter-rater reliability between inspectors.

The next step is to assess inspection data usefulness in predicting health outcomes by housing unit or geographic area, and whether sociodemographic information improves these predictions. Future studies linking these “big data” to address- or neighborhood-specific health information may refine our understanding of the potential for targeted home visiting programs, housing grants, or educational outreach to improve housing-related health

conditions. For example, exploring how well the number of healthy home violations predicts presence of a lead poisoned child could inform lead hazard reduction programs that micro-target high risk blocks. Similarly, models of a subset of violations such as leaking roof, plumbing leaks, and presence of mold might predict asthma emergency department visits at the census block level. Healthy housing violation data might also identify areas with both a high rate of safety-related hazards (broken handrails, stairs, etc.) as well as older adults at risk of falls. Public health professionals should promote expansion of proactive rental housing inspection systems and partner with them to inform, target, and evaluate effective housing-based public health initiatives.

IMPLICATIONS FOR POLICY AND PRACTICE

Public health professionals have long recognized the significant impacts of poor housing on health. However, data to plan, target, and evaluate housing-based health interventions is limited and expensive to collect. Existing housing inspection systems may provide a rich source of data to inform efficient, effective, and sustainable interventions. Unfortunately, little is known about the accuracy, consistency, or predictive value of inspector-collected data. This paper takes a critical first step in establishing the policy-informing potential of this data by showing that inspector-collected data may be particularly valuable in the highest-risk housing (older, low-value rental properties). Future research should explore connections with health outcomes by housing unit, geography, and demographic variables. This analysis is an important foundation for the argument that public health professionals should partner with housing inspectors to plan and evaluate housing-based interventions to promote health and reduce health disparities.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

This work was made possible through core services and support from the University of Rochester Environmental Health Sciences Center (EHSC), an NIH/NIEHS-funded program (P30 ES001247). The authors are extremely grateful to the staff of the City of Rochester for assistance providing and interpreting the inspection data, particularly Gary Kirkmire. The findings of this paper are solely the responsibility of the authors

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Characteristics of and Housing Violations Cited in Certificate of Occupancy Inspections of Single-Family Rental Housing in the City of Rochester, NY 2009–2014.

Table 1

	Grouped By	Number of Inspections	Healthy Home Violations *		Assessed Value		Year Constructed	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Assessed Value	Q1	1903	5.9	5.4	\$ 22,142	\$ 3,497	1904.5	19.1
	Q2	1916	5.1	4.9	\$ 32,742	\$ 3,420	1910.6	19.3
	Q3	1897	3.9	4.1	\$ 47,972	\$ 5,418	1920.6	21.5
	Q4	1907	2.5	3.4	\$ 86,262	\$ 46,729	1929.2	32.4
Year Constructed	Q1	2354	5.4	5.2	\$ 37,310	\$ 27,443	1891.8	13.1
	Q2	1525	4.8	4.7	\$ 43,679	\$ 31,629	1910.3	3.0
	Q3	1758	4.2	4.6	\$ 46,489	\$ 27,468	1920.2	1.3
	Q4	1985	2.9	3.6	\$ 62,556	\$ 41,573	1946.3	25.2
Inspector Area	A1	375	2.6	3.2	\$ 49,117	\$ 12,803	1929.2	18.6
	A2	279	4.1	4.8	\$ 59,200	\$ 39,586	1917.6	19.0
	A3	114	2.1	3.4	\$ 120,422	\$ 117,537	1915.2	28.0
	A4	187	3.3	4.3	\$ 87,463	\$ 41,238	1902.9	25.1
	A5	362	2.2	2.7	\$ 105,337	\$ 34,046	1919.7	27.5
	A6	252	5.2	5.2	\$ 29,970	\$ 8,357	1912.3	13.6
	A7	217	5.9	6.2	\$ 29,083	\$ 15,498	1917.8	34.8
	A8	454	3.6	4.2	\$ 34,339	\$ 9,532	1916.4	15.9
	A9	318	4.3	5.0	\$ 35,720	\$ 15,115	1923.0	36.1
	A10	159	5.2	4.7	\$ 23,548	\$ 10,298	1913.7	32.6
	A11	410	3.5	3.9	\$ 45,352	\$ 16,549	1922.4	20.6
	A12	186	4.3	4.7	\$ 30,842	\$ 11,840	1923.8	37.6
	A13	314	5.4	4.7	\$ 38,829	\$ 15,564	1911.1	14.9
	A14	335	3.3	3.7	\$ 63,153	\$ 22,035	1927.5	21.7
	A15	352	4.0	3.9	\$ 54,050	\$ 16,846	1917.4	11.8
	A16	282	7.1	6.6	\$ 33,250	\$ 12,575	1912.2	29.9

	Grouped By	Number of inspections	Healthy Home Violations*		Assessed Value		Year Constructed	
			Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
	A17	367	4.0	4.2	\$ 30,031	\$ 13,010	1913.2	35.0
	A18	77	2.2	3.4	\$ 113,579	\$ 112,860	1915.6	48.4
	A19	285	4.4	4.3	\$ 55,396	\$ 21,306	1920.9	19.1
	A20	298	5.2	4.5	\$ 39,109	\$ 11,705	1910.8	24.0
	A21	422	5.0	4.8	\$ 35,225	\$ 13,950	1913.4	20.4
	A22	164	5.8	5.0	\$ 27,646	\$ 9,456	1901.4	20.8
	A23	379	5.4	4.9	\$ 32,977	\$ 17,951	1909.8	31.6
	A24	309	6.9	6.0	\$ 26,148	\$ 11,642	1901.8	31.3
	A25	338	4.4	4.6	\$ 45,191	\$ 12,612	1912.5	12.7
	A26	384	3.4	3.5	\$ 61,729	\$ 12,747	1923.4	10.2

* Homes with no violations (zeros) are included in these calculations.