

Healthy Housing: A Structured Review of Published Evaluations of US Interventions to Improve Health by Modifying Housing in the United States, 1990–2001

We sought to characterize and to evaluate the success of current public health interventions related to housing.

Two reviewers content-analyzed 72 articles selected from 12 electronic databases of US interventions from 1990 to 2001. Ninety-two percent of the interventions addressed a single condition, most often lead poisoning, injury, or asthma. Fifty-seven percent targeted children, and 13% targeted seniors. The most common intervention strategies employed a one-time treatment to improve the environment; to change behavior, attitudes, or knowledge; or both. Most studies reported statistically significant improvements, but few (14%) were judged extremely successful.

Current interventions are limited by narrow definitions of housing and health, by brief time spans, and by limited geographic and social scales. An ecological paradigm is recommended as a guide to more effective approaches. (*Am J Public Health*. 2003; 93:1471–1477)

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PUBLIC HEALTH RESEARCHERS

and practitioners have long recognized that housing influences health. Over the last 150 years, housing reformers and public health workers have periodically joined forces to improve health by strengthening housing regulations, advocating for better housing conditions, or reducing hazards such as fire, lead poisoning, injuries, or window falls.^{1–4} A substantial body of literature demonstrates that poor housing can contribute to infectious disease transmission, injuries, asthma symptoms, lead poisoning, and mental health problems^{4,5–7}—both directly (e.g., because of environmental hazards)⁵ and indirectly (e.g., by contributing to psychosocial stress that exacerbates illness).⁸

Renewed interest in housing parallels a growing interest in ecological approaches to the study of complex health problems and an examination of the social determinants of health and the causes of persistent socioeco-

nomie, racial, and ethnic disparities in health.^{9,10} Several recent reports have demonstrated the value of considering multilevel (e.g., individual, family, social network, community, state) determinants of a variety of health outcomes.^{11–14} Public health advocates have emphasized the importance of creating interventions that address these influences on health^{15,16} and of utilizing ecological approaches that seek changes in both the physical and the social environment, at various levels of organization.

Applied to housing, the ecological approach suggests the importance of looking at characteristics of and interactions among residents, housing units, buildings, blocks, and neighborhoods, as well as housing owners, policies, and institutions that provide or regulate housing and health, to understand their contributions to population health. It also suggests that environmental factors interact with psychosocial variables at several levels to produce

different patterns of health and disease.¹⁷

In this report, we assess the extent to which published studies of interventions designed to improve health by modifying housing reflect these new insights. This study differs from another recent review of the effect of improved housing on health¹⁸ in several ways: (1) we focused on a wider range of housing interventions, (2) we used an ecological paradigm that includes behavior at different levels as producers of both housing conditions and health outcomes, and (3) we restricted the database to US studies over 10 years. Our goals were to

1. Describe the objectives, populations, settings, intervention characteristics, and results of these studies
2. Describe and assess the methods used to evaluate these interventions
3. Assess the extent to which intervention studies addressed

- multiple levels of causation or multiple outcomes
- 4. Identify the strengths, limitations, and gaps in the existing literature on housing interventions to improve health
- 5. Identify directions for future research, policy, and practice

IDENTIFYING HOUSING-BASED HEALTH INTERVENTIONS

To identify relevant studies, a computerized search of 12 bibliographic databases (Cinahl, CSA, EBSCO, ERIC, InfoTrac, MEDLINE, ProQuest, PsycINFO, PubMed, Science Direct, Social Science Abstracts, Sociological Abstracts, and Wiley Inter-science) in the health and social sciences was conducted.

The following key words were used, in various combinations, in the search: *asbestos, asthma, allergens (housing-related), cockroaches, child health, dampness, depression, environmental health, falls, formaldehyde, fungi, health, home, housing, infectious disease, intervention, injuries, lead poisoning, mental health, moisture, mold, morbidity, prevention, rodents, stress, and vermin.*

The criteria for inclusion in this study were housing interventions to improve health, conducted in the United States and published in peer-reviewed journals between January 1990 and December 2001. *Housing interventions* were defined as intentional, systematic efforts to improve residential conditions, either directly or indirectly, through 1 or more of the following measures: rehousing (moving to new housing); changes in physical infrastructure; changes in indoor equipment or furniture; changes in participants' knowledge or behavior; changes

in community norms or collective behavior; changes in housing policy and regulatory practices; and changes in health practitioners' behavior related to housing effects on health. To be included, studies had to describe both the intervention and the evaluation.

Interventions involving persons diagnosed with conditions that were not directly related to housing—for example, HIV infection, schizophrenia (but not depression)—were excluded. Interventions directed at homeless populations were also excluded because they have been reviewed elsewhere.^{19–22}

From the database search, a total of 3204 titles were generated. Of these, 258 were deemed to be potentially eligible, based on the title or abstract. The full articles were then retrieved and carefully reviewed to determine whether they fit the inclusion criteria. The bibliographies of these articles were also searched to identify additional relevant articles. This process yielded a total of 72 housing studies designed to improve health or designed for another purpose but including health as a measurable outcome. Of the 72 studies, 3 interventions were included twice but were related to different outcome measures.

Interventions that met the criteria for inclusion were coded, using an instrument adapted from a similar project.¹⁶ At least 2 of the authors carefully reviewed each of the articles identified by the searches. At least 3 authors discussed and resolved disagreements among the 2 primary reviewers. All coding was based on the authors' account. When the article was not clear about a particular coding category, at least 3 reviewers as-

signed the categories based on a close reading of the text.

THE NATURE OF HOUSING-HEALTH INTERVENTIONS

The intervention settings and target populations included in

these studies are summarized in Table 1. Housing interventions were largely carried out in urban settings: more than half the studies took place in large or medium-sized cities. Only 2 studies were carried out in exclusively rural settings. The majority of projects were conducted in either

TABLE 1—Intervention Settings and Target Populations

Characteristic	No. Studies	% of Studies
Geographic region		
Mid-Atlantic	16	22
Midwest/Great Plains	15	21
New England	13	18
South/Southeast/Southwest	9	13
Pacific Coast	7	10
National or > 1 region	6	8
Unspecified/other	6	8
Type of setting		
Large city	31	43
Mid-sized city	9	13
Small town or city	4	6
Rural area	2	3
National or > 1 setting	2	3
Unspecified	24	33
Age of target population		
Children	41	57
Adolescents	3	4
Seniors	9	13
Other adults	3	54
Unspecified	16	22
Predominant race/ethnicity of target population^a		
African American	22	23
Latino	13	14
White, non-Hispanic	15	16
Asian, Pacific Islander	2	2
Other, unspecified	43	45
Gender		
Male	1	1
Female	3	5
Both	68	94
Participants' predominant SES		
Low income	22	31
Middle income	4	6
Multiple/unspecified	46	64

Note. SES = socioeconomic status.

^aMultiple responses permitted; percentages are reported as percentage of total studies (n = 72).

TABLE 2—Intervention Sponsorship, Staffing, and Funding

Characteristic	No. Studies	% of Studies
Lead and co-sponsors^a		
University/college	55	76
Medical center	27	38
Health department	15	21
Other (e.g., corporation, housing or other government agency)	46	64
Unspecified	5	7
Funders		
Federal government	34	47
State or local government	8	11
Private	8	11
Public and private	10	14
Unspecified	12	17
Primary funding category		
Health	42	58
Housing	7	10
Environment	4	6
Unspecified	19	25
Project staff^a		
Health care provider	32	44
Health educator	11	15
Environmental or housing specialist	25	35
Community residents/community health workers	13	18
Unspecified	19	26

^aMultiple responses permitted; percentages are reported as percentage of total studies (n = 72).

mid-Atlantic (22%); Midwest/Great Plains (21%); or New England (18%) states.

A majority of the studies focused on housing-related issues that can affect children’s health (57%). Senior citizens constituted the second largest age category, representing 13% of the studies. Fewer than half of the studies reviewed provided specific information on other key sociodemographic characteristics—such as race/ethnicity and socioeconomic status. When such information was reported, the primary focus was on low-income residents of color.

Sponsorship, staff, and funding characteristics are described in Table 2. Colleges and universi-

ties, medical centers, and health departments were the most frequent lead or co-sponsors. Almost three quarters of the studies reported receiving full or partial funding from governmental sources. Among public funders, the federal government predominated (47%) over state or local sources (11%). Funding was more likely to be health-related (58%) than housing-related (10%) or environmentally related (6%). Many interventions were staffed by multidisciplinary teams, comprising health care providers (44%), housing or environmental specialists (35%), health educators (15%), and community residents or community health workers (18%).

Intervention design characteristics are listed in Table 3. All were targeted toward primary or secondary public health prevention, or both. The primary focus was on addressing environmental hazards. Lead paint hazards (36%), safety hazards (35%), and asthma triggers/air quality hazards (29%) were the predominant areas of concern. More than 92% addressed a single housing condition. Eighty-five percent conducted one-time interventions—such as a single training program, a single cleaning, or remediation of hazards at one point in time. Interventions often targeted vulnerable populations. For example, the majority of lead poisoning interventions were targeted toward children younger than 5 years and their parents, whereas the majority of fall and other injury interventions were targeted toward seniors.

The most common intervention strategies involved making environmental improvements (31%), educating participants (32%), or both (35%). Interventions were predominately aimed at dwelling unit or participant-level change, or both. Accordingly, the objectives of most of the interventions to effect individual-level change—either psychosocial change (e.g., participants’ knowledge, attitudes, and behavior; 24%); environmental change (physical conditions in individual dwelling units; 22%); or a combination of psychosocial, environmental, and health changes (47%). Only 5 interventions (7%) were aimed at communitywide change, all in combination with individual-level change. Only 15% of the articles reviewed mentioned participant or stakeholder involvement in planning or implementing interventions. In a few instances, re-

searchers employed a participatory approach.^{23–25}

Most interventions focused narrowly on a particular health or exposure condition, in part because of the specificity of public policies (as in the case of lead or firearms storage) and funding streams (as indicated in authors’ acknowledgments to funders). Many public health interventions focused on specific technologies or diseases. In comparison, rehousing^{17,26,27} or home visit interventions^{25,28–30} emphasized well-being, broadly defined, suggesting disciplinary and methodological differences in conceptions of how housing affects health. Many authors reported that budgetary and administrative constraints on interventions and analyses also played a part in narrowing the focus of interventions.

EVALUATION CHARACTERISTICS

All interventions reviewed here included an evaluation component. Characteristics of the evaluation are described in Table 4. More than three quarters of the projects were evaluated by persons hired by the agency or organization conducting the intervention. The most common evaluation methods were environmental sampling; surveys and interviews; and physiological measures. More than 80% employed a quantitative evaluation methodology. About half used a randomized design, and about 60% included a comparison group. Eighty-five percent collected information on outcome measures before the intervention (*preintervention measures*), 43% collected information on outcome measures immediately after the interven-

TABLE 3—Intervention Design Characteristics

Characteristic	No. Studies	% of Studies
Prevention level		
Primary prevention	44	61
Secondary prevention	22	31
Both	6	8
Primary intervention focus		
Lead-based paint hazards	25	35
Injury hazards	26	36
Asthma triggers (e.g., vermin, mold) + air quality	21	29
Access to housing	2	3
Number of housing conditions addressed in intervention		
1	59	92
2	5	8
Associated health condition		
Lead poisoning only	25	35
Asthma/respiratory only	15	21
Injury only	20	28
Cancer only	2	3
Multiple health conditions	10	14
Intervention level		
Individual knowledge, attitudes, behavior only	13	18
Dwelling unit only	31	43
Building only	1	1
Community only	4	6
Multiple levels	23	32
Intervention objectives		
Individual level change		
Psychosocial change only (participant knowledge/attitudes/behavior)	17	24
Environmental change only (physical conditions in dwelling unit)	16	22
Psychosocial, environmental/health status change	34	47
Community- and individual-level change	5	7
Quantitative health-related goals		
Yes	49	68
No	23	32
Number of intervention periods		
1	63	88
≥ 2	9	12
Length of intervention		
< 1 year	42	58
1 year	8	11
> 1 year	11	15
Unspecified	11	15
Intervention strategies		
Education only	23	32
Environmental remediation only	22	31
Education and environmental remediation	25	35
Other	2	3
Stakeholder involvement		
Yes	11	15
None or no information	61	85

TABLE 4—Intervention Evaluation

	No. Studies	% of Studies
Sample and evaluation design ^a		
Sample drawn from larger population	38	53
Randomization to intervention	35	49
Comparison group	44	61
Data-collection periods		
Preintervention	61	85
Postintervention (immediately after intervention)	31	43
Follow-up (several months after intervention)	56	78
Data-collection methods ^a		
Environmental sampling	29	40
Survey/interview/observation	40	56
Physiological measures	11	15
Document review	21	29
Evaluator		
Internal evaluator	56	78
External evaluator	16	22
Baseline disease incidence or prevalence in the community reported		
Yes	32	45
No	40	56
Documented improvements in outcome measures		
Yes	58	81
No (intervention was ineffective)	8	11
Not evaluated	6	8
Results		
Statistically significant	49	68
Not statistically significant	6	8
Statistical significance not tested	17	24
Improvements sustained over time		
Yes	37	51
No (conditions remained the same or worsened)	14	19
Not tested	21	29
Author's assessment of effectiveness		
Very successful	10	14
Moderately successful	53	74
Unsuccessful	9	13
Barriers to success ^a		
Participants' knowledge/awareness	18	25
Housing/environmental characteristics	18	25
Implementation/technological/resource problems	11	17
Participant characteristics (e.g., SES, health status)	17	24
Political/legal constraints	8	12
Inadequate resources	18	25
Attitudinal (e.g., stigma/discrimination)	5	7
No barriers mentioned	9	13

Note. SES = socioeconomic status.

^aMultiple responses permitted; percentages are reported as percentage of total studies (n = 72).

tion (*postintervention measures*), and 78% collected information on outcome measures several months after the intervention was completed (*follow-up measures*). Eighty-three percent of the studies reported tests of statistical significance. Sixty-eight percent reported statistically significant results. More than 80% documented improvements in the main outcome measures; 11% showed that outcomes either remained the same or worsened. Only about half the studies demonstrated that effectiveness could be sustained over time. Although findings reached statistical significance, relatively few authors (14%) rated the interventions as highly successful. However, the vast majority of authors (73%) concluded that their projects were at least somewhat successful. More than three quarters of the authors discussed barriers to successful implementation/maintenance. A wide range of factors were cited, including those related to participant characteristics and environmental, structural, technical, and larger economic and social factors.

QUALITIES OF SUCCESSFUL INTERVENTIONS

Looking across all the intervention studies, several factors seem generally related to success. First, only 2 studies examined policy interventions, but these seemed to be relatively cost-effective.^{31,32} Second, technological interventions appear most successful when the technology is effective, cheap, and durable and requires little effort to maintain or use. Such interventions are especially effective if accompanied by behavioral or

knowledge training, and if hazard amelioration can be successfully accomplished through individual-level efforts alone, for example, fire detectors³³ and scald-prevention devices.³⁴ Information and counseling may increase the presence of inexpensive, readily available improvements, but not those requiring larger investments.^{23,24,35} Third, involving people more deeply in the solution of health problems, especially by home visits, appears to be especially effective and can improve multiple health outcomes,^{28,29,36,37} promote fuller human development, improve social functioning,^{25,28–30} and potentially increase psychological well-being as well.

LIMITATIONS OF RESEARCH

Our study had several limitations. It is based only on articles published in peer-reviewed journals and thus represents a limited portion of interventions actually carried out. It is restricted to those studies that intended to improve health by modifying housing, excluding interventions that might have had this unintended consequence, for example, income support policies that provide resources that can be used to improve housing conditions. Given the limitations of search engines and electronic databases, it is possible that our criteria missed some articles that would have met our inclusion criteria. In addition, we did not correspond with authors of the studies to collect additional information. Because the studies examined different housing exposures and health outcomes at different levels of organization (e.g., individual, housing unit, building, and block) and used different re-

search methods, it was not possible to conduct a meta-analysis using pooled data. Despite these limitations, the interventions we did review met 2 important criteria: they succeeded in obtaining funding from public or private sources to carry out the interventions, and the reports were accepted by peer-reviewed journals. Thus, the articles represent what key stakeholders (e.g., funders, reviewers, and editors) deemed to be important findings on US housing interventions to improve health.

STRENGTHS AND WEAKNESSES OF INTERVENTION LITERATURE

Our review of evaluation methods suggests some strengths and several weaknesses. Most studies met the basic standards of identifying measurable objectives, collecting systematic data on specific housing conditions and health outcomes, and using acceptable methods to assess success in achieving outcomes. In part, the ability to meet these standards was facilitated by a narrow conceptualization of the research.

Few studies provided detailed information on the content of interventions or provided adequate contextual information (e.g., race/ethnicity and socioeconomic status of the target population were unspecified in more than half the studies), limiting generalizability. Most studies measured only the outcomes of interventions, not the processes that led to them, thus limiting their utility for designing other interventions or replication. As noted in another recent review, although several studies showed gains in individual health out-

comes, confidence in findings is limited by small study populations and lack of controlling for confounders.¹⁸

TOWARD ECOLOGICAL INTERVENTIONS

The published housing interventions primarily sought to improve a single health condition by ameliorating environmental conditions, changing individual behavior or knowledge, or both. Only a few studies incorporated ecological paradigms, as many researchers now advocate.³⁸ In the ecological paradigm, behavior, the physical and social environment, and health dynamically connect the individuals, households, buildings, and communities.^{39,40} An ecologically sensitive intervention takes into account the nested structure of the environment in which different scales influence each other. Physically, this includes housing conditions (e.g., vermin, lead dust),⁴¹ homes within multifamily buildings,⁴² all located in neighborhoods within particular settlement forms.¹⁷ Socially, target individuals are situated in households, communities, and political units.⁴³

This principle is illustrated in several of the successful home visit interventions, in which the home was seen as an important setting in which multiple health-related behaviors occur and that potentially contains both health-promoting and hazardous elements. These interventions^{25,28–30} support changes in the physical environment and the recipient's behavior within the context of the habits, abilities, and life goals of the individual and the family. For example, the Department of Housing and Urban Development's Moving to Opportunity

demonstration project showed that families who moved away from public housing found better dwelling conditions and safer neighborhoods, leading to less crime victimization, injury, and asthma attacks among children.^{17,26,27} These findings suggest that interventions could lead to more significant environmental and health effects if they were directed toward the broader goals of decent and affordable housing for all households and better opportunities for human development.

Ecological interventions are conceived as functional relationships among professionals, household members, communities, and political units. Some successful injury-reduction interventions illustrate this approach by connecting elderly participants more closely with supportive friends and family who reinforced the training and provided social rewards.^{25,30} Only a few interventions incorporated participatory approaches, in which various stakeholders join in identifying goals, implementing research, and interpreting findings.^{44–46}

Apart from these examples, most studies intervened on single, individual-level factors, in isolation; examined only 1 or 2 levels of social organization; and failed to use the more sophisticated analytic techniques such as multilevel modeling to understand the separate influences of different levels of analysis and interactions among levels.⁴⁷ These omissions may account, in part, for the lack of sustained improvements in, for example, interventions to eliminate cockroaches and rodents. Because many studies failed to examine the effectiveness of interventions over time, ecological constraints

on the long-term efficacy of other interventions may have gone undetected.

By and large, the studies do not evaluate the multiple pathways by which housing influences health, comparing, for example, the relative roles of the physical and social environment in housing-related health problems. Consequently, there is now no way of assessing the value of, say, individual-level-only versus policy-only versus multilevel interventions. Nor is it possible to compare the effectiveness of housing versus other health-promoting interventions (e.g., dietary changes, alcohol and tobacco reduction). Such comparative studies might help policymakers decide how best to invest limited resources.

FROM EFFICACY TO EFFECTIVENESS

Finally, few interventions moved from efficacy to effectiveness studies. The greatest public health benefits are likely to result from interventions that can be applied in many settings, overcome common institutional and political obstacles, and reach significant portions of the vulnerable populations. The broad-based health improvements found in studies that had the primary goal of, for example, improving the life chances of poor, at-risk families⁴⁸ suggest that we need to know more about the public health implications of housing ecologies that include educational opportunities and support for child rearing, and so forth, that go beyond the usual definition of housing-based public health initiatives. Future studies on housing and health need to address these questions more systematically.

CONCLUSIONS AND RECOMMENDATIONS

The studies reviewed here have shown that changes in residents' knowledge, attitudes, and behavior; the household environment; public policy; and community norms can all contribute to improvements in housing-related health outcomes. The successes and the limitations of the interventions reviewed suggest some new directions that might prove fruitful. It is likely that interventions that combine activities to make changes at several of these levels and examine multiple health outcomes will be more effective than those working at single levels. Unfortunately, this hypothesis has yet to be tested systematically. Most interventions we reviewed could benefit from greater attention to acknowledged basic principles of health promotion such as the use of multiple strategies, the inclusion of participants in planning and implementation, and the importance of intervention intensity and duration.^{16,38,49,50} The promising results from the few policy-change studies provide a rationale for increased attention to this strategy and support recent calls for more attention to this arena, especially as it relates to enforcement of housing codes.⁴

More ecologically grounded interventions should be tested to increase efficacy and overcome the limitations identified in this review and in the epidemiological literature.^{16,42,49–51} The interdisciplinary nature of the ecological paradigm⁵² requires understanding the cultural and socioeconomic dynamics of housing markets and housing production that affect housing access, quality, costs, ownership forms, and settlement patterns and have

implications for physical health, psychosocial well-being, and the interaction of physical and psychosocial health.^{17,53} Intervention and evaluation strategies developed in other fields may have useful applications for public health in addressing multilevel phenomena.^{54,55} At the same time, it must be acknowledged that multilevel interventions can be difficult to implement, be more costly in the short run, and require more time to address the concerns of the multiple stakeholders. Public health leadership may be needed to gain support for this approach.

In conclusion, this review of the literature demonstrates that it is possible to design and carry out interventions that can lead to improved health by making changes in housing-related conditions. The successes and limitations of these efforts provide a foundation for designing a more systematic and coordinated research agenda that can inform the next generation of studies. By incorporating ecological approaches and health-promotion principles, future studies may be able to make additional improvements in housing conditions that lead to better health. ■

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Contributors

S. Saegert conceptualized the project; oversaw the coding, analysis, and housing journal database search; wrote the Discussion; and was responsible for the final draft. S. Klitzman conceptualized the project; oversaw the database search, coding, and analysis; wrote the Results; made tables; and edited the final draft. N. Freudenberg conceptualized the project, oversaw the coding and analyses, and wrote the Introduction. J. Cooperman-Mroczek searched databases, screened articles, coded data, performed analyses, wrote the Methods, and participated in discussions of the findings and interpretation. S. Nassar searched databases, screened articles, coded data, performed analyses, worked with S. Klitzman on the Results and tables, and participated in discussions of the findings and interpretation.

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