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# Enhancing Fire Department Home Visiting Programs: Results of a Community Intervention Trial

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## Abstract

**Background—**This study evaluates the impact of an enhanced fire department home visiting program on community participation and installation of smoke alarms and describes the rate of fire and burn hazards observed in homes.

**Methods—**Communities were randomly assigned to receive either a standard or enhanced home visiting program. Prior to implementing the program, 603 household surveys were completed to determine comparability between the communities. During a one year intervention period, 171 home visit events took place with 8,080 homes.

**Results—**At baseline, 60% of homes did not have working smoke alarms on every level; 44% had unsafe water temperatures; and 72% did not have CO alarms. Residents in the enhanced community relative to those in the standard community were significantly more likely to let the fire fighters into their homes (75% vs 62%). Among entered homes, those in the enhanced community were significantly more likely to agree to have smoke alarms installed (95% vs 92%), to be left with a working smoke alarm on every level of the home (84% vs 78%) and to have more smoke alarms installed per home visited (1.89 vs 1.74).

**Conclusions—**The high baseline rates of home hazards suggest that fire department home visiting programs should take an "all hazards" approach. CHWs and other community partnerships can be effective in promoting fire departments' fire and life safety goals. Public health academic centers should partner with the fire service to help generate evidence on program effectiveness that can inform decision making about resource allocation for prevention.

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**Keywords**

injury prevention; smoke alarms; fires and burns; home visits; community health workers; community intervention

## INTRODUCTION

Fire departments in the United States respond to approximately 374,000 residential fires each year.[1] There are more than 2,000 deaths due to residential fires every year, and in 2009, fire and other burns led to 381,012 medical visits.[2,3] The lifetime costs generated in a single year by hospitalizations due to fires and burns is an estimated $1.2 billion.[4] Injuries due to fire disproportionately affect those with lower incomes and living in poor urban environments.[5,6]

Smoke alarms substantially reduce the risk of death in the event of a fire, and increasing their use is a national health objective in the United States.[7] Almost two-thirds (63%) of all residential fire deaths occur in homes without working smoke alarms.[8] Rates of working smoke alarms on every level of a home, the recommended standard, range between 22%-40% in high risk urban communities.[8,9,10]

The CDC-sponsored Smoke Alarm Installation and Fire Safety Education (SAIFE) program has been found to increase smoke alarm coverage in high-risk communities.[11] The program recommends installing 10-year lithium battery smoke alarms on each level of a home, educating the resident about smoke alarm maintenance and fire safety, and community promotion. How to implement such a program to maximize community participation remains uncertain.

Community health workers (CHWs) are often turned to for community promotion. However, a recent systematic review found mixed evidence of their effectiveness,[12] and only two studies involving home injury prevention.[13,14] Almost two decades ago, Schwartz et al[13] found that a CHW intervention addressing multiple home safety behaviors increased smoke alarm coverage by 14%. Gielen et al[14] found that a single CHW home visit after a pediatric health care visit had no effect on smoke alarm use. Thus, the contribution of CHWs to promoting smoke alarm canvassing programs is unclear.

To date, there have been no studies comparing different methods of accessing homes to provide smoke alarms at the community level. With strong evidence supporting their effectiveness and community wide installation programs, and the availability of 10-year lithium battery alarms, it is timely to explore how to maximize participation in these programs.

The Johns Hopkins Center for Injury Research and Policy (JHCIRP) addressed this question in partnership with the Baltimore City Fire Department (BCFD), the Maryland Department of Health and Mental Hygiene's (DHMH) SAIFE program, the Environmental Justice Partnership's (EJP) community outreach program, and the Urban Health Institute's (UHI) community health worker program. Together, we conducted the Johns Hopkins Home

Safety Study to evaluate strategies to maximize participation in the BCFD's smoke alarm home visiting program.

The primary aim of this paper is to evaluate the impact of an enhanced BCFD home visiting program on community participation and installation of smoke alarms when compared to their standard program. We hypothesized that enhancing the BCFD's standard home visiting program with a community promotion component would increase the number of residents who participated in the program and thus an increase in the number of homes properly protected.

To determine comparability of the communities that were to receive the home visiting programs, we conducted baseline household surveys. Thus, a secondary aim of this paper is to describe the rates of fire and burn hazards in a large urban area. The study was approved by the Johns Hopkins Institutional Review Board.

## METHODS

### Standard Study Condition

The BCFD home visiting program has provided home safety education and installed smoke alarms free of charge to any Baltimore City resident for three decades. At the outset of our study and partly in response to focus groups conducted as part of our formative research,[15] the Office of the Fire Marshal developed a new department-wide Manual of Procedures (MOP) for the program and conducted trainings with personnel responsible for making home visits. It required that all existing alarms be tested and firefighters were to install a new 10-year lithium battery alarm on every level unless it was already protected with a working lithium battery or hard-wired alarm. One firefighter was designated to provide fire safety education in the home, but there was no community promotion.

### Enhanced Study Condition

The enhanced intervention included the same services as the standard condition, with several additional components. The enhancements were developed in response to focus groups[15] and with input from the previously listed partners (JHCIRP, BCFD, EJP, UHI) and new partners we engaged during the planning process (community agencies, organizations, and residents). The enhancements were designed to address three issues: 1) residents did not know when the fire department was going to be in their neighborhood so they were often not home or not prepared to let them in; 2) some firefighters were uncomfortable with providing resident education; and 3) there were missed opportunities to address other important fire and life safety education issues once inside the home.

The enhancements included: 1) community promotion of the home visiting event in advance by EJP, project staff and CHWs; 2) tailored home safety education provided by a health educator who accompanied the firefighter into the home; and 3) when available, the CARES (Children ARE Safe) Mobile Safety Center, a 40-foot "house on wheels" with interactive educational exhibits parked in the neighborhood; families were encouraged by the CHWs to visit for additional safety education and low cost safety products.[16] The community promotion component included having neighborhood associations "spread the word" (e.g.,

through listserves or newsletters), posting lawn signs and posters, and having a team of two CHWs go door-to-door encouraging residents to be home for the event and delivering a scripted educational message or leaving a door hang tag if no one was home. On the day of the event, the CHWs again went door-to-door in advance of the firefighters letting residents know they were coming. During the home visit, a study health educator delivered tailored safety messages reinforcing the firefighter's fire safety messages and addressing CO poisoning and scald burns.

## Neighborhood Selection and Random Assignment

To create two comparable study communities, we used census tracts because of the size of the population and the availability of data on relevant indicators: 1) housing vacancy rate; 2) number of previously attempted BCFD home visits; 3) percent of successful BCFD home visits (defined as BCFD gained entry into the home); 4) residential fire rate; 5) percent of dwellings built after 1984; and 6) percent of dwellings that were owner-occupied properties.

Six census tracts were needed in each study community for an adequate number of households to test our hypotheses. To select the tracts, we first formed 10,000 random pairs of census tract sets (six in each set) out of all 49 census tracts in East Baltimore. Using data from the BCFD and the 2000 U.S. Census Bureau,[17] we computed a summary statistic for each set based on its un-weighted average of the 6 indicators listed above. The quality of matching in each pair of sets was assessed as the difference between the two sets of the raw sum of the indicators.

The 10,000 matched sets were sorted by the quality of the matching, and the top one percentile of matched scores was selected for further consideration. The study team physically drove through the top candidate locations to ensure that the areas had residential properties as expected and would be suitable for the intervention. Two appropriate sets of census tracts were identified, and at a partnership meeting a coin toss was used to assign one as the standard and one as the enhanced community.

The final selection of 12 census tracks included a total of 10,879 residences (5,467 in the standard and 5,412 in the enhanced). Public housing and city managed properties were excluded because the BCFD home visiting program does not serve these residences (n = 1,148). Of the 9731 addresses that were potentially eligible for a home visit in the two study areas, 1657 were eliminated because they were vacant or commercial properties or nonexistent addresses or were missed. During the intervention period, an additional 119 addresses were discovered and added; 113 addresses were eliminated because they were missed. Thus, a total of 8,080 homes were eligible for the program and form the sample.

## Census Data

We used census data[17] to assess the extent to which the study areas were comparable on: proportion with income below poverty line; proportion Black or African American; proportion ≥16 years in the labor force; proportion ≥25 years with a high school diploma; proportion receiving public assistance; proportion owner-occupied dwellings; proportion vacant housing; proportion built after 1980. We calculated the proportion for each individual census tract and then calculated the average for the six census tracts in each community.

### Baseline Household Surveys

We conducted household surveys with random samples of residences in each study community to further assess comparability. Between July and December 2009, we completed interviews and home observations with 603 households (311 in the enhanced and 292 in the standard communities). In three waves, a random selection of approximately 1,200 addresses were contacted via mail and then visited by interviewers. A new random selection was done when all previously selected addresses had been resolved (i.e., enrolled, refused, deemed ineligible, or did not respond after 5 attempts). Interviews were conducted with an English-speaking adult. Participants were asked if they had been previously visited by the BCFD; smoke alarms, CO alarms, and hot water temperature were tested.

### Intervention Trial Outcome Data

Home visits were conducted between April 2010 and April 2011. The BCFD attempted to reach every address in the study communities once. A data collector accompanied the firefighters on all home visits and recorded the outcome data: was the resident home (yes/no); did the resident allow the fire department to enter the home (yes/no); and did the resident allow the firefighters to install smoke alarms (yes/no). Based on the number and location of all smoke alarms, we created a variable indicating whether the home had a working smoke alarm on every level at the conclusion of the home visit (9-volt or 10 year lithium battery or hard wired working alarm), and we calculated an average number of alarms installed per home entered.

### Data Analysis

Chi-square and t-tests were used.

## RESULTS

### Comparability of Standard and Enhanced Communities

As seen in Table 1, there were no differences between the study communities on any of the census variables. The study communities relative to the whole of Baltimore City, had a higher percentage of residents living below the poverty line, fewer adults with a high school diploma, fewer owner occupied housing, and more vacant properties.

### Baseline Rates of Prior Program Exposure and Fire and Burn Hazards

As seen in Table 2, there were no differences between study areas in prior exposure to the BCFD home visiting program or in the presence of smoke alarms, CO alarms, and safe hot water temperatures. Although most homes had at least one working smoke alarm, only 38%-42% had one on every level of their home. Roughly one quarter of residents had safe hot water temperatures ($<120^{o}$ F). Slightly more than one-half of the homes had CO alarms.

### Impact of the Enhanced Home Visiting Program

A total of 171 home visit events took place, the results of which are displayed in Table 3. No difference was found between the enhanced and standard communities in the proportion of residents who were home on the day of the event (40%). Residents in the enhanced

community relative to those in the standard community were significantly more likely to let the fire fighters come into their homes (75% vs 62%) and agree to having smoke alarms installed (95% vs 92%). At entry, very few homes did not need smoke alarms (16.0% had working hardwired alarms or 10 year lithium battery alarms on every level), and there was no difference between the enhanced and standard communities (14.7% vs 17.6%, $X^2$= 3.19, p=0.07). In the enhanced area, entered homes were significantly more likely than homes in the standard area to be left with a working smoke alarm on every level (84% vs 78%) and to have more smoke alarms installed per home (1.89 vs 1.74).

## DISCUSSION

The overall aim of this community based intervention trial was to evaluate the impact of an enhanced fire department home visiting program on community participation and installation of smoke alarms. Our baseline survey demonstrated a high need for the program in that the majority of the residents surveyed had been visited previously by the fire department, and yet, 60% of homes did not have working smoke alarms on every level, 72% had unsafe water temperatures, and 44% did not have CO alarms.

The enhanced home visiting program increased access to homes by 21%, from 62% of residents in the standard to 75% in the enhanced area who let the fire department into their homes. Once inside the home, the majority of home visits were successfully completed, and those in the enhanced community relative to those in the standard were significantly more likely to result in having smoke alarms on all levels (84% vs 78%). All of the installed alarms were the 10-year lithium battery alarms with a hush feature. These new alarms offer longer term protection because the batteries do not have to be changed every six months, and the hush feature allows residents to turn off nuisance alarms without removing the batteries or otherwise disabling the smoke alarm. [18]

A recent review of fire and life safety activities in US fire departments revealed that although the vast majority (86%) report conducting prevention education, fewer than 20% report conducting community canvassing programs such as the one evaluated here.[19] Our work shows that such programs are feasible and result in increased protection. Prior smoke alarm distribution programs that have evaluated their impact on fire deaths have had mixed results,[20,21] but programs with 10 year batteries are only just now being evaluated, and we fully expect that increased coverage with these longer lasting batteries will result in fewer fire deaths.

To our knowledge, this is the first time CHWs have joined with a fire department to provide community education and promotion in advance of a canvassing program. Previously reported smoke alarm distribution programs have used various combinations of community volunteers, paid staff, and fire personnel with mixed results[13,14,21,22] Our study is most similar to the earlier work by Schwarz et al,[13] who hired community liaisons to engage community members at the block level in advance of having safety inspectors go door-to-door. Like Schwarz's work, we too found that advance notice provided by a recognized community representative resulted in increased access to homes. We were surprised,

however, that the advance notice did not result in more residents being home on the day of the event; how to address the 60% of residents who were not home remains a challenge.

We were also surprised that more smoke alarms were installed per home in the enhanced community relative to the standard because the fire department protocol was the same in both. It is possible that residents were more receptive in the enhanced community, which encouraged the fire personnel in their efforts to install alarms on all levels. Perhaps the fire personnel were influenced by knowing they were in the enhanced community and by having a health educator with them. It was not possible to "blind" the fire personnel to study condition given the added intervention components in the enhanced area. Because canvassing was assigned based on the firehouse's designated inspection area that did not align with our study areas, some firefighters provided home visits in both areas in which case they may have been more diligent in the standard community, suggesting our results may underestimate the benefit of the enhanced program.

There are limitations to this study. Our findings, while significant, were likely muted by our decision to define the geographic areas using census tracts rather than natural borders that define neighborhoods. Using census tracts allowed us to access existing data to select a comparable set of households. However, we were limited in our ability to create a robust community level campaign because our enhanced community was made up of pieces of several neighborhoods. It was difficult for community partners to fully engage in promoting the program when their organizations encompassed areas that were part of the intervention and other areas that were not. Researchers designing community interventions will need to consider how best to define community in light of the implications for fully engaging community partners. Finally, something other than our intervention may have produced the observed effect. However, we know of no competing ongoing fire safety events in our study areas, and because both study areas were in Baltimore City, any major fire event or fire safety campaign would probably have affected both study areas equally. To maximize the lessons learned from this intervention trial will require follow up of the homes in which alarms were installed to determine their maintenance, and a careful cost-benefit analysis of the interventions would be useful.

Despite these limitations, our large sample size and demonstrated success in gaining access to homes and installing smoke alarms warrants consideration of the implications for fire department canvassing programs more broadly. First, fire departments serving communities such as ours need to take an "all hazards" approach to public education, given the high prevalence of unsafe water temperatures and lack of CO alarms we observed. Second, fire departments should consider ways to better utilize CHWs and other community partners to promote their fire and life safety goals. Although fire department budgets may preclude hiring CHWs, there are likely a number of opportunities for fire departments to partner with other local agencies and organizations that could provide the same function as the CHWs did in this study. Finally, the partnership between the fire service and a public health academic center was important for being able to systematically collect evidence on program effectiveness that can be used to inform decision making about resource allocation for fire and life safety education.

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## Table 1

Neighborhood Characteristics of Selected Census Tracts in East Baltimore and in Baltimore City, MD

| | Standard Study Area | Enhanced Study Area | T-statistic (P-value) | Baltimore City |
|---|---|---|---|---|
| Income below poverty line | 28.2% | 27.8% | 0.042 (0.97) | 20.0% |
| Receiving public assistance | 5.2% | 6.2% | 0.375 (0.72) | 5.1% |
| Black or African American | 57.0% | 54.0% | 0.137 (0.89) | 63.3% |
| 16 years and over in labor force | 65.3% | 60.6% | 0.481 (0.64) | 62.1% |
| ≥25 years with high school diploma | 61.3% | 68.6% | 0.836 (0.42) | 76.9% |
| Owner-occupied dwellings | 46.5% | 44.4% | 0.162 (0.87) | 51.1% |
| Vacant housing | 25.0% | 23.4% | 0.305 (0.77) | 19.3% |
| Dwellings built after 1980 | 6.5% | 17.8% | 1.27 (0.23) | 10.7% |

## Table 2

Baseline Household Survey of a Sample of 603 Homes in Study Areas East Baltimore, MD

| | Standard Study Area (N=292) N (%) | Enhanced Study Area (N=311) N (%) | Chi-square (P-value) |
|---|---|---|---|
| Heard of the BCFD home visiting program[1] | 226(77.4) | 229 (73.6) | 1.18 (0.6) |
| BCFD home visiting program ever came before | 170 (74.9) | 159 (67.8) | 2.85 (0.2) |
| At least one working smoke alarm | 252 (86.3) | 267 (85.9) | 0.02 (0.9) |
| One working smoke alarm on every level | 110 (37.8) | 131 (42.1) | 1.16 (0.3) |
| Any alarms use 9-volt batteries | 202 (89.0) | 220 (91.3) | 0.70 (0.4) |
| Any alarms use lithium batteries | 10 (6.0) | 10 (5.2) | 0.12 (0.7) |
| Hot water temperature ≤ 120° F | 169 (58.1) | 170 (55.4) | 0.44 (0.5) |
| Working CO alarm | 88 (30.1) | 78 (25.1) | 1.93 (0.2) |

[1] BCFD is the Baltimore City Fire Department

## Table 3

Number of Homes Reached and Smoke Alarms Installed in Study Areas East Baltimore, MD

| | Standard Study Area (82 Home Visit Events) N (%) | Enhanced Study Area (89 Home Visit Events)N (%) | Test Statistic (p-value) |
|---|---|---|---|
| **Resident Home** | | | |
| Yes | 1588 (39.2) | 1628 (40.4) | $X^2$=1.11 |
| No | 2460 (60.8) | 2404 (59.6) | (0.3) |
| Total | 4048 (100%) | 4032 (100%) | |
| **Resident Agreed to Entry** | | | |
| Yes | 983 (61.9) | 1214 (74.6) | $X^2$=59.60 |
| No | 605 (38.1) | 414 (25.4) | (<0.0001) |
| Total | 1588 (100%) | 1628 (100%) | |
| **Resident Agreed to Have Alarms Installed** [2] | | | |
| Yes | 883 (92.1) | 1077 (94.6) | $X^2$=5.22 |
| No/Unknown | 76 (7.9) | 62 (5.4) | (0.02) |
| Total | 959 (100%) | 1139 (100%) | |
| **Working Alarms on All Levels at End of Visit** [2] | | | |
| Yes | 767 (78.0) | 960 (84.3) | $X^2$=6.63 |
| No/ Unknown | 192 (20.0) | 179 (15.7) | (0.01) |
| Total | 959 (100%) | 1139 (100%) | |
| **Total # Alarms Installed**[2](Mean per home) | 1663 | 2153 | t=2.79 |
| (Mean per home) | (1.73) | (1.89) | (0.005) |

[2]Excludes 24 homes in the standard area where BCFD was permitted into the home but JHSPH data collectors were not (N=23), and the BCFD could not complete the home visit because they were dispatched on a call (N=1). Excludes 75 homes in the enhanced study area, where the BCFD was permitted into the home but JHSPH data collectors were not (N=18), and the BCFD could not complete the home visit because they were dispatched on a call (N=57).