principle and to produce results permitting strong inferences about treatment effects.

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Contributors: See bmj.com

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Incidence of fires and related injuries after giving out free smoke alarms: cluster randomised controlled trial

ELPS

This is an abridged version; the full version is on bmj.com

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Abstract

Objective To measure the effect of giving out free smoke alarms on rates of fires and rates of fire related injury in a deprived multiethnic urban population.
Design Cluster randomised controlled trial.
Setting Forty electoral wards in two boroughs of inner London, United Kingdom.
Participants Primarily households including elderly people or children and households that are in housing rented from the borough council.
Intervention 20 050 smoke alarms, fittings, and educational brochures distributed free and installed on request.
Main outcome measures Rates of fires and related injuries during two years after the distribution; alarm ownership, installation, and function.
Results Giving out free smoke alarms did not reduce injuries related to fire (rate ratio 1.3; 95% confidence interval 0.9 to 1.9), admissions to hospital and deaths (1.3; 0.7 to 2.3), or fires attended by the fire brigade (1.1; 0.96 to 1.3). Similar proportions of intervention and control households had installed alarms (36/119 (30%) *v* 35/109 (32%); odds ratio 0.9; 95% confidence interval 0.5 to 1.7) and working alarms (19/118 (16%) *v* 18/108 (17%); 0.9; 0.4 to 1.8).
Conclusions Giving out free smoke alarms in a deprived, multiethnic, urban community did not reduce injuries related to fire, mostly because few alarms had been installed or were maintained.

Introduction

Residential fires caused 466 deaths and 14 600 non-fatal injuries in the United Kingdom in 1999.[1] The risk of death from fire is associated with socioeconomic class,[2] partly because of social differences in the risk factors for fires and in ownership of smoke alarms. The risk of death in a house fire is three times higher in homes without smoke alarms.[3] A controlled study before and after distribution of free smoke alarms to households in one area at high risk in Oklahoma City, United States, showed an 80% drop in hospitalisations and deaths related to fire, while morbidity and mortality related to fire in the rest of the city did not change,[4] but these findings may not apply in other settings.

To quantify the effect of giving out free smoke alarms on fires and related injuries, we conducted a cluster randomised controlled trial, in a deprived multiethnic urban population.

Methods

The study took place in two inner London boroughs with a total of 330 000 residents, of whom 51% (168 300) lived in council or other social housing and 18% were from a minority ethnic group. The mean Jarman score, a measure of material deprivation and increased healthcare needs,[5 6] was more than two standard deviations greater than the national mean.

Study design and randomisation

We pair matched 40 electoral wards by Jarman score and randomly allocated wards in pairs to intervention and control groups. The 40 studied wards contained between 2179 and 5586 (mean 3686) households and between 5205 and 12 661 (8191) residents.

Intervention

In coordination with the local health authority, the programme distributed 20 050 smoke alarms, with

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batteries, fittings, and fire safety brochures (in English, Bengali, and other local languages), to 19 950 households, door to door, between July 1997 and January 1998, targeted to households at high risk.[7] Free installation was offered. One year later, postcards reminding that the battery should be changed were sent. Control wards received no intervention.

Outcome measures

The primary outcome was the incidence of injury related to fire resulting in attendance at an emergency department, hospitalisation, or death during the follow up period.[8] We included any injury that resulted from fire in an occupied dwelling of a study ward. We also assessed the incidence of fires in dwellings that were attended by the fire brigade. We collected data for 13 months before and 24 months after we gave the alarms away. We planned a subgroup analysis of injuries that were potentially preventable, had a working alarm been present—for example, smoke inhalation while the resident was asleep.

We examined the prevalence of owned, installed, and working smoke alarms, 12-18 months after distribution, in a random sample of homes rented from the borough council.[9]

Statistical analysis

We based analyses on the original random allocation of the ward where the fire or injury occurred, regardless of whether households had received an alarm. Intracluster correlation coefficients, and between and within components of variance, were estimated from baseline data.[10] The incidence rates of each outcome were analysed using a multilevel Poisson model (see bmj.com). For alarm outcomes, we analysed logistic binomial models, matching on ward and controlling for Jarman score.

Results

Of 20 050 alarms distributed, we estimate 98% went to intervention households. We estimate a total of 85% of recipients lived in council or other rental homes or households including elderly people or children. Installation was provided for 8% (1640) of recipients. Baseline characteristics of the two groups were comparable (see bmj.com).

Injuries related to fire

We identified 384 injuries related to fire, of which 90 (23%) resulted in hospitalisation and eight (2%) in death. Rate ratios show no benefit to all injuries or to hospitalisations and deaths (table). Adjustment for baseline injury rates had little effect on results.

Potentially preventable injuries related to fire

We judged 78% of injuries to be potentially preventable by smoke alarms. There was no evidence of a beneficial effect on preventable injuries or on preventable hospitalisations and deaths, with or without adjustment of the rate ratios for baseline rates (table).

Fires

The fire brigade attended 1603 residential fires in the study area. The intervention did not show a beneficial effect of intervention on attended fires before or after adjustment for baseline rates (table).

Smoke alarm ownership, installation, and function

Of 315 eligible homes, similar proportions of intervention and control households were contacted (82% *v* 79%), surveyed (77% *v* 72%), and inspected (75% *v* 70%).

Groups did not differ in terms of alarms present (odds ratio 1.0; 95% confidence interval 0.6 to 1.9), installed (0.9; 0.5 to 1.7), or correctly installed (0.9; 0.4 to 1.7). Similar proportions of households had at least one installed and working alarm (0.9; 0.4 to 1.8) and at least one correctly installed and working alarm (1.0; 0.4 to 2.4) (see bmj.com).

Discussion

Our programme mirrored the Oklahoma City programme.[4] We distributed similar alarms to the same proportion of target households (27%) and installed a similar proportion (8% *v* 9% in Oklahoma City). In Oklahoma City, however, serious injuries declined by 80% in the intervention area while they increased 8% in the control area. In our study, serious injuries declined by only 13% in intervention wards, compared with a 50% decline in control wards. The confidence intervals of our rate ratios exclude all but a modest effect on total injuries and attended fires. While we cannot exclude a clinically important, beneficial effect on serious injuries, the absence of an increase in the prevalence of installed, working alarms suggests that the apparent lack of benefit in our population is real.

The benefit in Oklahoma City may partially reflect regression to the mean, based on study design; another likely explanation for the different results is that population differences affect the likelihood of alarms being installed and maintained. Recipients may have not understood installation instructions or brochures about the benefits of alarms because of illiteracy or poor command of English. Tenants may have lacked installation skills or tools or may have worried about landlords objecting to installation. Because of the small size of some flats, incorrect installation near sources of

Rates of injuries related to fire, admissions to hospital, and deaths and of fires attended by the fire department in homes supplied with smoke alarms or not

	No of events per total person years (per 100 000 person years)				Rate ratio (95% CI)*	
	Intervention		Control			
	Baseline	Follow up	Baseline	Follow-up	Crude	Adjusted for baseline rates
All injuries	66/181 667 (36.3)	137/340 275 (40.3)	77/173 285 (44.4)	104/319 710 (32.5)	1.3 (0.9 to 1.8)	1.3 (0.9 to 1.9)
Hospitalisations and deaths†	19/181 667 (10.5)	31/340 275 (9.1)	25/173 285 (14.4)	23/319 710 (7.2)	1.3 (0.7 to 2.4)	1.3 (0.7 to 2.3)
Preventable injuries	51/181 667 (28.1)	100/340 275 (29.4)	65/173 285 (37.5)	84/319 710 (26.3)	1.1 (0.8 to 1.7)	1.2 (0.8 to 1.8)
Preventable hospitalisations and deaths	15/181 667 (8.3)	19/340 275 (5.6)	20/173 285 (11.5)	18/319 710 (5.6)	1.0 (0.5 to 1.9)	1.0 (0.5 to 2.0)
Attended fires‡	270/79 516 (339.6)	524/147 080 (356.3)	322/80 215 (401.4)	487/147 558 (330.0)	1.0 (0.9 to 1.2)	1.1 (0.96 to 1.3)

*Rate ratios obtained from Poisson model, taking into account clustering by ward and matching by Jarman score (see bmj.com).
†Intervention group includes one death at baseline and three during follow up; control group includes two deaths at baseline and two during follow up.
‡Incidence rate of attended fires is measured in number of events per total household years (per 100 000 household years).

steam or cooking smoke may have increased false or nuisance alarms, leading to removal of the battery or disconnection.[9 11] We attempted to tackle these barriers in our programme, through use of foreign language brochures and local ethnic minority recruiters, offers of free installation, provision of pictorial information on installation, and postcards reminding recipients to change the battery.[7] Nevertheless, few alarms were installed or working at follow up.

Conclusions

Widespread implementation of programmes giving away smoke alarms may waste resources and be of little benefit unless alarm installation and maintenance is assured.[12] Our results suggest that simply giving alarms to poor, urban households is unlikely to reduce injuries related to fire. We did not assess reasons that alarms were not installed or maintained in this population. We have recently identified differences in long term function according to type of alarm and characteristics of the household.[13] We are currently evaluating attitudes towards fire safety and smoke alarms and how these might affect the installation and maintenance of alarms, to help learn how best to increase installed and working alarms in populations at high risk.

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Competing interests: None declared.

What is already known on this topic

In the United Kingdom, residential fires caused 466 deaths and 14 600 non-fatal injuries in 1999

The risk of death from fire is associated with socioeconomic class

One study reported an 80% decline in hospitalisations and deaths from residential fires after free smoke alarms were distributed in an area at high risk, but these results may not apply in other settings, and evidence from randomised controlled trials is lacking

What this study adds

Giving out free smoke alarms in a multiethnic poor urban population did not reduce injuries related to fire or fires

Giving smoke alarms away may be a waste of resources and of little benefit unless alarm installation and maintenance is assured

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