An assessment of the impact of Home Safety Assessments on fires and fire-related injuries: a case study of Cheshire Fire and Rescue Service

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Abstract

Background
Deaths and injuries related to fires are largely preventable events. In the UK, a plethora of community-based fire safety initiatives have been introduced over the last 25 years, often led by fire and rescue services, to address this issue. This paper focuses on one such initiative – home safety assessments (HSAs). Cheshire Fire and Rescue Service (in England) implemented a uniquely large-scale HSA intervention. This paper assesses its effectiveness.

Methods
The impact of HSAs was assessed in relation to three outcomes: accidental dwelling fires, accidental dwelling fires contained, and injuries arising from accidental dwelling fires. A two-period comparison in fire-related rates of incidences in Cheshire between 2002 and 2011 was implemented, using Poisson regression and adjusting for the national temporal trend using a control group comprising the 37 other English non-metropolitan fire-services.

Results
Significant reductions were observed in rates of accidental dwelling fires (IRR: 0.79, 95% CI 0.74-0.83, p<0.001, 02/03-07/08 vs 08/09-10/11) and associated injuries (IRR: 0.49, 95% CI 0.39-0.60, p<0.001, 02/03-06/07 vs 07/08-10/11), but not in the proportion of fires contained to room of origin.

Conclusions
There is strong evidence to suggest that the intervention was successful in reducing domestic fires and related injuries.
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Introduction
Fire-related deaths and injuries have become an enduring global public health issue. The majority (95%) of deaths occur in low and middle income countries. However, in high income countries such as England, fire-related casualties from accidental dwelling fires (ADFs) continue to be associated with various forms of disadvantage such as living in rented or mobile accommodation, living in areas of deprivation, having a low income, being a single parent family, with children and the elderly particularly at risk. In England, inequalities in fire-related casualties have become somewhat entrenched during a period in which there has been a long-term downward trend in fire fatalities and fire-related injuries. However, deaths and injuries related to fires are no longer viewed as unavoidable accidents but rather as largely preventable events. Over the last 25 years there has been a plethora of community-based safety initiatives, often led by fire and rescue services (FRS). This paper focuses on one such initiative – home safety assessments (HSAs) – which were an integral part of the statutory duty placed on fire and rescue services in 2004 relating to community fire safety, and were primarily concerned with reducing ADFs. The paper reports on the impact of HSAs on ADFs and fire-related injuries in one FRS area.

The setting for the research was Cheshire Fire and Rescue Service (CFRS), a non-metropolitan fire service in north-west England. At the time the study took place it covered four unitary councils: Halton, Warrington, Cheshire East, and Cheshire West and Chester. This area is similar to many other non-metropolitan areas, containing a mix of rural and urban/suburban areas. HSAs were introduced in April 2002. A low level intervention was maintained until April 2006 (median 3,706 HSAs per year), and increased to a much higher level for the next five years (median 62,725 per year). The exact form HSAs have taken has not been uniform across the 45 FRSs in England. Most involve the fitting/testing of a smoke alarm and the delivery of key fire safety messages – such as the importance of closing doors at night. In Cheshire, CFRS had expanded its HSA model to include a multifaceted fire risk and needs assessment tailored to each specific household. This included, for example, the identification of principal hazards on a room-by-room basis, as well as taking appropriate action and giving specific advice in respect of all identified hazards. An appraisal was made of any smoke detection provision, which included an assessment of the need for additional detectors (and their subsequent fitting) and the fitness-for-purpose of existing provision. A risk-based methodology was developed to identify those households at heightened risk of fire-related events. Data from a variety of sources were used to develop a risk profile of
households: for example, with permission from the Caldicott Guardian, data from the GP
registers in all four local authority areas were used to assess risk and determine those over 65
years of age who might be at heightened risk such as those who are elderly and living alone.
Households where there were people with other vulnerabilities were also identified and
addressed through a system of partner agency referrals. This meant that HSAs could be more
effectively targeted at households judged to be at most risk.

Methods
Since 1994 and the introduction of the Fire Data Report (replaced in 2009 by the Incident
Recording System) all FRSs have been required to collect detailed information on all fires
attended. For the purpose of this study this routinely collected data was used to assess the
impact of HSAs in relation to three outcomes: ADFs; ADFs that were contained (confined to
room of origin); and injuries arising from ADFs. (Definitions of all terms such as ‘accidental’,
‘dwelling’ and ‘non-fatal injury’ can be found in the relevant Fire Statistics publication11.)
The Cheshire results were adjusted for national trends by comparing them with a retrospective
control group comprising the 37 other English non-metropolitan fire-services.

Data were obtained from two sources. We obtained data for Cheshire directly from CFRS and
national statistics from the UK government Department for Communities and Local
Government (DCLG)
(http://www.communities.gov.uk/publications/corporate/statistics/monitorq1q42011). Data
consisted of annual population estimates by fire service region; HSAs carried out; ADFs
recorded; and injuries arising from ADFs. Metropolitan services were excluded (Greater
Manchester, Merseyside, South Yorkshire, Tyne & Wear, West Midlands, West Yorkshire,
and Greater London), as these were less comparable to Cheshire in terms of demography, risk
and approaches needed to implement HSA-type interventions. Two fire-services (Devon and
Somerset) were amalgamated in April 2007 – for the purpose of this analysis, pre-2007 data
for the two counties were combined. The Isles of Scilly data were combined with Cornwall.

National incidence data were available for the period April 2001 to March 2011. CFRS data
were available for April 2002 to March 2011. Population statistics were available for 2001 to
2009. To maximise the available incidence data for analysis, populations for 2010 were
estimated assuming a linear upward trend from the previous 10 years’ data.

All outcomes were measured as an annual rate per 100,000 population. Population was taken
to be the mid-year estimate for each fire-service region. The proportions of ADFs contained
were available from CFRS but not nationally. Fatalities arising from ADFs were not
examined, as the annual incidence in Cheshire was too low (an average of 4 per year) to enable a meaningful analysis.

The rate of HSA intervention carried out by CFRS in the study period was compared with the control group. The impact of the intervention was assessed using a three-stage analysis for each incidence outcome. Stage 1: a year effect was estimated for the control group using Poisson random effects regression, with year fitted as a fixed effect and ‘fire service’ fitted as a random effect. This year effect estimated the underlying trend over time for the control group. Stage 2: the period during which incidence rates were shifted after the high-intervention period began was defined. Stage 3: an HSA effect was estimated for Cheshire by comparing two time-periods using Poisson regression fitted to the CFRS data. This model included an indicator variable for time-period, and an offset to adjust for the year effect estimated in Stage 1. Time-period was defined for each outcome separately to reflect the period of time where a marked change in that outcome had occurred. Effect sizes and 95% confidence intervals (CIs) for both types of model are incidence rate ratios (IRRs), which represent the average factor increase/decrease in rates: over one year for temporal trends, and pre- and post-intervention for HSA effects. Trend in ADFs contained was tested with the Chi-squared test for trend.

**Results**

In 2001/02 the median rate of HSAs (per 100,000 population) was 187.8, rising to a median of 1335.7 in 2010/11 (Figure 1). This reflects the national trend towards increased intervention of this kind. A few fire services implemented a more intensive intervention in the second half of the study period. CFRS was alone in maintaining more than 4,000 HSAs per 100,000 population over a five-year period. Cleveland was the only other fire service to go above this level, and this was for just two years (06/07 and 07/08). We can therefore conclude that CFRS was unusual in approach. Figure 1 also clearly shows that CFRS implemented two distinct levels of intervention: Low (02/03-05/06) and High (06/07-10/11).

There was a marked downward trend in ADFs for both groups. For the control group the median number of ADFs per 100,000 population was 73.2 in 2001/02. This fell steadily by an average rate of 3.1% per year (IRR: 0.969, 95% CI 0.967-0.970) over the study period to 53.0 in 2010/11. Figure 2 shows boxplots and averages for the control group, together with results for Cheshire. This clearly shows that Cheshire rates were higher than the control group averages pre-April 2008, and lower afterwards. Modelling showed that this reduction was significant (IRR: 0.78, 95% CI: 0.74-0.83, p<0.001). The fall occurred two years after the high level HSA intervention had begun.
Injuries also fell over the course of the study period in both groups. In the control group, the median number of injuries per 100,000 population was 9.4 in 2001/02, and 3.8 in 2010/11. This was an average reduction of 10.7% per year (IRR: 0.895, 95% CI 0.891 – 0.900). Figure 3 shows boxplots and averages for the control group, together with results for Cheshire. This clearly shows that Cheshire rates were higher than the control group averages pre-2007/08, and lower afterwards. Modelling showed that this reduction was significant (IRR: 0.48, 95% CI 0.39-0.60, p<0.001). The Cheshire rates fell one year after the beginning of the high level HSA intervention, though rates rose slightly in the final year studied to be level with the control group average.

The percentage of ADFs contained to room of origin for CFRS fluctuated slightly between 89% and 94% (mean (SD): 91.1 (1.4) %). There was no evidence of a trend over the study period (p=0.59, $\chi^2_{\text{trend}}$).

Discussion

Main findings of this study

The results show that CFRS had marked drops in incidence rates for two of the outcome measures: ADFs and injuries arising from ADFs. These falls – which were considerable even after accounting for the downward trend seen nationally – coincided with the introduction of a uniquely large-scale targeted HSA intervention. There was no trend in the proportion of ADFs that were contained, showing that the intervention did not reduce the chance that a fire spread outside its room of origin. The results provide strong evidence to suggest that HSAs lead directly to the improvement in incidence rates, though we cannot discard the possible existence of unknown causal factors peculiar to CFRS coinciding with the timing of the intervention. However, to the best of our knowledge the study period did not coincide with any large scale developments in the study area that would have had a major impact on home fire safety risk.

What is already known on this topic

To date, there has been a dearth of research on the impact of FRSs’ community fire safety work, particularly in relation to HSAs. The majority of published research has explored the impact of educational programmes for children and parents, often delivered through health care professionals or teachers in schools and the promotion of smoke detectors. A systematic review of controlled trials of interventions to promote smoke alarms concluded that whilst fires detected by smoke alarms were likely to lead to more rapid discovery and less fire damage to property there was no beneficial effect on fires or fire-related injuries.
While estimates for smoke alarm ownership indicate an increase from around 9% in 1987 to 86% in 2010\(^{10}\) the presence of a functional alarm is substantially lower in disadvantaged inner city neighbourhoods and those living in rented accommodation where fire risk is greater\(^{1,17}\). Recent research suggests that the inconvenience and annoyance of false alarms is a factor in preventing installation and maintenance of smoke alarms\(^{14,18}\). Nonetheless, because the presence of a functioning smoke alarm has been shown to reduce the risk of death in the event of a house fire\(^{1}\) a recent report by the World Health Organisation\(^{19}\) concluded that smoke alarms had proven or promising evidence of effectiveness. This suggests that smoke alarms are important in improving home safety if maintained adequately. Installing smoke alarms and/or testing functionality may be more effective in the context of a multifaceted fire safety visit that involves a globalised assessment of fire risk and discussion of key fire safety messages, as carried out through the CFRS HSA.

**What this study adds**

This study is one of the first to evidence the impact of HSAs on ADFs, and injuries arising from ADFs, in one FRS. Emergency responses to fire and rescue incidents are costly, not only in terms of time and money, but also through damage to property, major injuries, and loss of lives. HSAs, as a preventive intervention, have the potential to contribute to a broad range of savings. In 2006, the Office of the Deputy Prime Minister\(^{20}\) published estimates of the economic cost of fire to the economy (of England and Wales), which was put at £7.03 bn. In 2010-11 fire and rescue services in England attended 227,000 fires resulting in 321 fatalities and 9,300 non-fatal injuries (including those who had a precautionary check)\(^{10}\). About 75% of fatal and non-fatal injuries occur in ADFs (36,000 in 2010-2011).

Home safety is an important wider determinant of health and wellbeing, and contributes to feelings of security. This study has shown that HSAs can improve home safety by reducing fire-related risk. The significant improvements in ADFs and ADF-related injuries were achieved during the period 06/07-10/11 and 07/08-10/11 respectively, during which time CFRS was delivering more than 4000 HSAs per 100,000 population. This level of intervention penetration seems to be required to achieve the improvements observed. However, at some point most ‘at risk’ households will have been targeted, at least once. This ‘saturation point’ is the point at which it becomes less likely that further HSAs will have as strong a potential to make an impact on incidence rates. Therefore a levelling off of trends would be predicted over time. However, four types of household might still benefit from an HSA: new-comers to the county; new households formed as young people set up home for themselves; those who move from lower to higher risk households through, for example,
ageing; and those for whom repetition of the intervention is needed. The number of such households in an area would determine the scale of any future HSA intervention.

In considering the generalizability of the findings, not only is the level of implementation important so too is the nature of the intervention itself. This study could shed no light on the influence of the particular multifaceted nature of the CFRS HSA relative to other forms of HSA. However, the fact that the intervention had a significant impact on ADFs and injuries but not on the proportion of ADFs contained might indicate that the types of actions and behaviours that were influenced by the intervention were those that reduced the likelihood of fires occurring, rather than those related to fire containment. It must also be acknowledged that the effectiveness of the intervention in Cheshire might have been, at least in part, influenced by the responsiveness of the target group, namely those living in households that have been judged, for a variety of reasons, to be at heightened fire risk. The offer of an HSA is taken up differentially by households and it may be the case that those at high risk are also those more likely to refuse. If the probability of high risk households refusing an HSA could be reduced than there is scope for the intervention to have an even greater impact than is evidenced in this study.

**Limitations of the study**

This study used routinely collected statistics to explore the impact of an intervention designed to improve home fire safety. In a study of this nature, it is difficult to distinguish fire service contributions to improvements from other social changes that lie outside the fire service’s sphere of influence. There may also be questions relating to the accuracy of statistics – namely, definitions of ADF and ADF injury; completeness of injury reporting; and discrepancies between CFRS-sourced statistics and those from DCLG.

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**Acknowledgements**

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**Research ethics**

Anonymous data were used in this study; ethical approval from the relevant university research ethics committee was not required.
References

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Figure Legends:

**Fig. 1** CFRS HSA intervention rates compared with boxplots of rates in the control group: all English non-metropolitan fire services excluding CFRS (April 2001 – March 2011)

**Fig. 2** CFRS ADF rates compared with boxplots of ADF rates in the control group: all English non-metropolitan fire services excluding CFRS (April 2001 – March 2011)

**Fig. 3** CFRS ADF injury rates compared with boxplots of ADF rates in the control group: all English non-metropolitan fire services excluding CFRS (April 2001 – March 2011)

**Table 1** Estimated incidence rate ratios (95% CI) representing the average annual rate reduction for the control group (all English non-metropolitan fire services excluding CFRS); and the estimated effect of the HSA intervention in the CFRS area.
Figure 2
Figure 3
### Table 1

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<th>CFRS</th>
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<td><em>Year effect</em></td>
<td><em>HSA effect</em>(a)</td>
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<td>ADF</td>
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<td>0.78 (0.74 – 0.83)(b)</td>
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<tr>
<td>Injuries</td>
<td>0.895 (0.891 – 0.900)</td>
<td>0.48 (0.39 – 0.60)(c)</td>
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(a) Adjusted for *Year* effect as estimated by control group model; (b) 02/03 to 07/08 vs 08/09 to 10/11; (c) 02/03 to 06/07 vs 07/08 to 10/11.