An Investigation into the Circumstances Surrounding Elderly Dwelling Fire Fatalities and the Barriers to Implementing Fire Safety Strategies among this Group

AMY P. HARPUR, KAREN E. BOYCE, NIGEL C. MCCONNELL
School of the Built Environment (FireSERT),
University of Ulster
Shore Road, Newtownabbey, Co. Antrim, BT37 0QB, Northern Ireland, U.K.

ABSTRACT

Examination of real-fire data has indicated that, globally, the *elderly*, particularly *elderly* males are those most at risk of becoming a dwelling fire fatality. This paper presents an analysis of the circumstances surrounding *elderly* dwelling fire fatalities gleaned from coronial reports. The analysis indicated that many *elderly* fatalities were involved in ignition and had existing health conditions that played a role in the fire. The most common fire scenario (which started in home furnishing located in the living room by carelessly discarded smokers' materials) accounted for a quarter of *elderly* fatalities. The risk factors associated with *elderly* fatalities were similar to *other adult* fatalities. However, there were some statistically significant differences. The *elderly* were less likely to have alcohol play a role in their death, more likely to be involved in fires where their clothing was the seat of the fire, have physical illness play a role, and have burn injuries as their primary cause of death. The fire risk to *elderly* householders was frequently identified by members of the community; however, many felt it was inappropriate to intervene to negate the risk although there were some examples of fatalities that occurred even where fire safety measures had subsequently been adopted. The most concerning result from this study is the minimal attention given to how *elderly* householders, especially those with poor mobility, would escape in the event of a fire.

KEYWORDS: human behaviour, human factors, response patterns, egress, fire investigation

INTRODUCTION

Dwelling fires are the leading cause of fire deaths [1,2]. The risk of being involved in a fatal dwelling fire has been linked with several occupant characteristics including demographic factors such as age and sex, health issues such as illness and mobility and lifestyle choices such as smoking or alcohol consumption [3-6]. One of the most commonly reported risk factors is age [1-7]. The elderly, most commonly defined as those aged over 65 years, are, across the lifespan, recognised as the age group most susceptible to suffering a fatal accidental injury in the home [8,9], a sizeable proportion of which are caused by fire. Indeed within the fire statistics the elderly are the age group most at risk of becoming a dwelling fire fatality [3,10-12].

Globally, data gathered on real-fires indicates that, although the elderly are not the group who experience the largest number of fire deaths, they are the most over-represented group in the fire death statistics compared to their share in the population [2,13]. In the US those aged 65 or over, 75 and over and 85 and over were found to have 2 times, 2.8 times and 3.7 times the relative risk of becoming a fire fatality compared to the general population [13]. Similarly, in Great Britain the 60-64's, 65-79's and 80's+ age groups have consistently been the top ranking age groups for fire deaths per million population (pmp), with rates of 8, 10 and 25 deaths pmp respectively in 2010/2011 [2]. Narrowing the focus further, a steep increase in the number of fire deaths among the elderly community was experienced in the year 2012 in Northern Ireland. Within a six week period in spring 2012, seven elderly fire fatalities occurred; this number is equivalent to the total number of accidental dwelling fire deaths in Northern Ireland for all of 2011 [14]. This series of fatalities prompted the authors to investigate the circumstances surrounding the deaths of elderly people from fires in their homes using data collected from coronial reports.

This study is by no means the first investigation into the circumstances surrounding elderly fire fatalities. The increased fire risk to elderly householders was identified some time ago [11,15,16]. However, there has been a recent surge of interest in the subject, spurred on by the impending rapid growth of the proportion of elderly people in society, particularly as the post war *baby-boomer* generation are nearing retirement age [12,17,18]. Additionally, concerns are being raised over the potential consequences of the adoption of *age-in-place* strategies at government level in the UK and US [18,19]. These strategies enable householders to remain in their own home as they age and may have an effect on the number of elderly people exposed to fire risk in the home.

Existing research on the subject indicates that the reasons *why* the elderly are vulnerable are multiple, interlinked and can vary greatly from one individual to another [10-12,18]. While age-related decline in health can vary dramatically from person to person, it is generally accepted that the fire risk to the elderly increases with age, with those over 85 years understood as those most at risk [2,3,10,11]. Previous research has discussed how a decline in physical health associated with ageing can lead to reduced mobility and an increase in the prevalence of disabilities such as vision or hearing impairments, both of which potentially inhibit a person's awareness of their surroundings and ability to escape a fire independently [12]. Elderly people are also widely recognised to be physiologically more vulnerable to burn injuries than adults in the 18-59 years group; studies have shown that elderly patients are less likely to recover fully from burns and the frequent existence of age-related co-morbidities are understood to complicate treatment and reduce the probability of recovery [20-22]. Mental health conditions are also frequently observed; in addition to alcoholism, which is the most commonly identified mental health issue across all adult fire fatalities [3], conditions resulting from age-related cognitive decline such as forgetfulness, dementia and Alzheimer's disease have been identified as important risk factors for this age group [23]. Compulsive hoarding behaviour has also been described as a risk factor for this age group (and others to a lesser extent) with the excessive collection and storage of items by householders posing a fire risk by forming a large fire load and impeding on possible escape routes [18].

Alongside the health conditions there are other knock-on effects that can play a role such as the effect medications can have on alertness or responsiveness to potential fire cues [23,24]. The incidence of social isolation and loneliness among this group can also make them more difficult to reach and this effect often co-exists alongside, and can be exacerbated by, mobility limitations or mental illness [23]. Finally, financial restrictions can make elderly householders reluctant or financially incapable of adopting fire safety measures to make their homes safer [23].

The cumulative effect of all these factors is that, in comparison to the general adult population, the elderly are less likely to be capable of identifying or addressing fire risks in the home, less likely to be alerted to a fire and be fully capable of removing themselves from danger in a timely fashion and ultimately less likely to fully recover from fire injuries. Studies to-date have focussed on identifying these risk factors for elderly dwelling fire fatalities [7,10-12], typically feeding into community fire safety efforts which aim to identify the people most at risk and address the risks [25]. Implementing community fire safety strategies for the elderly is deeply complex as there are many variations, combinations and intensities of risk factors to overcome; barriers created by health issues such as auditory and vision decline and the difficulty of communicating fire risk strategies to elderly householders have been explored by at least one author [26].

This paper aims to build on what has been reported by other researchers by identifying risk factors for a cohort of elderly dwelling fire fatalities, and gaining an understanding of why elderly householders became involved in a fatal dwelling fire. This study will also take advantage of the rich data source detailing the circumstances surrounding the fire and explore the attitudes to fire safety within the home by fatalities, or their associates, which left them vulnerable. Furthermore data on other adult fatalities will be included to compare and contrast the two groups, highlighting differences that can be used to tailor the fire safety message specifically for elderly householders. It is anticipated that this information will aid in the identification of those elderly people most at risk and the types of (possibly modifiable) behaviours and attitudes that undermine the effectiveness of community fire safety strategies for the elderly.

METHODOLOGY

The data presented in this paper forms part of a larger body of research investigating the circumstances surrounding fatal dwelling fires and this paper is the second in a series of papers focused on high risk groups [27]. The wider research covers all fatal dwelling fires that occurred in Northern Ireland during the period 1999-2009 and is the first time such a detailed study has been conducted in this region. Following on from the lead of others within the field of human behaviour in fire [4,28], coronial reports were employed as the principal source of data for the study as they represent a rich source of information on, not only the fire, but also on the people involved, as well as their medical, behavioural and lifestyle history both prior to and during the fire. Compared to the data routinely collected by the fire services alone they give a much more detailed insight into the entire incident, as they typically include documentation such as fire investigation reports, pathology reports, fire service/police reports, character witness statements and accounts from escaped occupants.

In order to access the useful records for this study permission was sought from, and subsequently granted by, the head coroner for Northern Ireland. Additionally ethical approval from the University of Ulster was obtained. The coronial reports on fatal dwelling fires are held for a period of approximately 10 years and, as a result, this research is based on information extracted for the period 1999-2009. This data was extracted, coded and compiled into an SPSS database containing over 200 fields for analysis. Where coronial records were not available for a fatality (e.g. where there was no coronial investigation into the death or where a record could not be located within the archives), data was gleaned from Northern Ireland Fire & Rescue Service's archived *Fire Damage Report*s. The database was developed using the Victoria University Coronial Database as a blueprint (with the permission of the owners) with a view to future comparison of data. Additional fields and codes were added to the database where supplemental information was available. Data extraction involved distilling useful information from the documents within the coroner's report, cross-referencing where possible to improve reliability and inputting directly into the database. The fields within the database fall into four general categories:

- fire incident e.g. source of ignition, date/time of fire, how alarm was raised, smoke alarm details, description of building and its use, occupant numbers, injuries and levels of smoke or fire damage;
- fatalities e.g. age, sex, significant medical history, lifestyle details, actions taken, location during fire, behaviour, injuries and toxicology data;
- escaped occupants e.g. actions taken, cues received and relationships with others; and
- witnesses involved e.g. sex and actions taken.

This paper takes a mixed methods approach to analysis, the preferred method of analysis for this study was quantitative in so far as possible. However, this was not always practical. The source material used for this study was not designed specifically for the purpose of this research and the quantity and quality of data varied greatly from case to case. In instances where data was missing for a database field an unknown code was recorded i.e. no assumptions were made and a code was only recorded when it was explicitly stated in, or was obvious from, the documentation. The inclusion of supplemental information in the coronial reports outside of that outlined in the introduction section offered a unique opportunity to gather insight into the deceased's life including past experiences or attitudes. However, the sporadic inclusion of this type of information in the coronial reports point to any quantification of the prevalence of this data being unreliable at best with a real risk that some factors may be vastly under-represented by the data. Nevertheless, this information may lend itself to an increased understanding of these fatal fire incidents and is therefore not excluded entirely and but reported upon in a qualitative fashion.

The sample

To qualify as an *elderly* dwelling fire fatality in this study, the person must have been aged 60 years or over on the date of their death and must have come to their death as the result of an accidental dwelling fire i.e. excluding suicides, arson and murder. Sixty years of age was chosen as the starting point at which fatalities were considered *elderly* since, until recently, it was the age at which UK residents could retire and qualify for a government pension and thus were more likely to spend time in the home. The complete dwelling fire fatality database for Northern Ireland contains information on all 141 accidental fatalities that occurred from 1999-2009, 125 (88.7%) of which were adults; i.e. aged 18 years or over. Sixty-five (52.0%) adult fatalities (46.1% of all fatalities) were considered *elderly*. Across the period studied the proportion of fatalities in the database that were considered elderly fluctuated, however the proportions year on year were relatively similar. Elderly fatalities constituted average of 43.8% of the fatalities over the period studied with a standard deviation of 15.1%. Throughout this paper the terms *elderly* and *other adults* are used to distinguish the two groups i.e. *elderly* refers to the group of fatalities aged 60 years or over whereas the term *other adult* refers to fatalities aged 18 years to 59 years only i.e. excluding the *elderly*.

RESULTS

For ease of discussion the results section has been divided into four parts. The first section summarises the demographic data associated with the *elderly* fatalities studied. The second section is devoted to the types of incidents where the fatalities occurred. The third section focuses on the fatalities' involvement in the fire and the factors that influenced this involvement. Corresponding data for *other adults* has been included in these sections to compare and contrast the circumstances surrounding *elderly* and *other adult* fatalities. The final section is devoted entirely to the *elderly* fatalities and consists of a discussion of the attitudes and barriers to implementing fire safety strategies among the *elderly* population that were encountered during the study.

Demographic data

As noted earlier, 65 (46.1%) of the dwelling fire fatalities that occurred during the 11 year period studied were considered *elderly*. The *elderly* fatalities were aged between 60 and 97 years with a mean age of 74.3 years. The *other adult* group consisted of 60 fatalities (42.6% of all fatalities) aged between 20 and 59 years with a mean age of 42.9 years. The distribution of fatality age and sex for *elderly* and *other adults* compared to their share in the Northern Ireland population is shown in Table 1. The number of fatalities in each age category is shown in the first column, the figure in the brackets is the number of fatalities in that age/sex category expressed as a percentage of all dwelling fire fatalities (n=141). The second column indicates the percentage of people that fall into that age category in the Northern Ireland (NI) population [29]. The final column is a relative risk score that was calculated by dividing the percentage figure in the first column by the percentage figure in the second column; a relative risk score greater than one indicates that that age/sex category experienced a higher proportion of deaths than their share in the population suggesting that this group is at an increased risk of experiencing a dwelling fire death.

Table 1. Comparison of fatality age and sex to corresponding share in population.

Age Group (years)	Sex of fatality					
	Male			Female		
	% all fire fatalities (no. of fatalities)	% NI population	Relative risk	% all fire fatalities (no. of fatalities)	% NI population	Relative risk
18-29	5.7 (8)	8.4	0.7	1.4 (2)	8.2	0.2
30-39	7.8 (11)	7.1	1.1	2.8 (4)	7.4	0.4
40-49	7.8 (11)	6.7	1.2	2.8 (4)	6.9	0.4
50-59	10.6 (15)	5.6	1.9	3.5 (5)	5.7	0.6
Total adults	31.9 (45)	27.8	1.1	10.6 (15)	28.2	0.4
60-69	11.3 (16)	4.2	2.7	4.3 (6)	4.6	0.9
70-79	10.6 (15)	2.7	3.9	7.8 (11)	3.6	2.2
80+	5.7 (8)	1.1	5.2	6.4 (9)	2.3	2.8
Total Elderly	27.7(39)	8.0	3.5	18.4 (26)	10.5	1.8

The relative risk scores shown in Table 1 indicate that, compared to their share in the population, the *elderly* group in this sample were over-represented with average scores of 3.5 for males and 1.8 for females. The highest relative risk scores belong to the 80+ years category; 5.2 for males and 2.8 for females. The relative risk experienced by males is consistently higher than that experienced by females across the lifespan; ranging from 1.8 (70-79 years) to 3.9 (18-29 years) times higher than that experienced by females. Overall, the risk of becoming a dwelling fire fatality increases with age and males experience a higher risk than females throughout the lifespan. These findings are similar to those reported elsewhere [7].

Table 2 contains information on the lifestyle and health conditions experienced by the *elderly* fatalities with the corresponding figures for the *other adult* group included for comparison. As noted earlier, data was occasionally missing from the coronial reports and this has been accounted for in the following tables by reporting results as the percentage of the fatalities where a factor was known, not as a percentage of all fatalities. For example, in relation to the smoking variable, Table 2, the figures in Column 2 (Elderly) show that information on smoking habits was determined for 61 fatalities, of which 45 were known smokers, i.e. 73.8% of known cases were smokers. Pearson Chi-square tests were performed on the results in Table 2 (only when the data met the test requirements) to determine if there were statistically significant differences between the age groups with respect to the prevalence of each factor. Significant relationships have been denoted alongside the name of the factor in table 2 with the presence of a single asterisk (*) signifying $p<0.05$ and a double asterisk (**) signifying $p<0.01$. This convention of reporting data is also used in Tables 3, 4, 5 and 6.

Table 2. Lifestyle and health conditions for fatalities.

Factor (*) p<0.05, (**) p<0.01		% of fatalities (no. of fatalities/no. of fatalities where factor known)	
		Elderly	**Other adults**
Smoker (**)		73.8 (45/61)	96.4 (53/55)
Problem drinker (**)		63.6 (28/44)	88.0 (44/50)
Health conditions that influenced fire outcome		78.1 (50/64)	63.2 (36/57)
Had a carer/assistant (**)		25.0 (16/64)	7.1(4/56)
Lived alone		80.0 (52/65)	71.2 (42/59)
Marital status	**Married**	14.1 (9/64)	6.8 (4/59)
	Single (**)	48.4 (31/64)	83.1 (49/59)
	Widowed (**)	37.5 (24/64)	10.3 (6/58)
Smoke alarm installed (**)		68.4 (26/38)	95.6 (43/45)
Alarm(s) operated		65.0 (13/20)	44.4 (12/27)

Within the literature two of the most frequently reported risk factors for fatal dwelling fires are smoking and alcohol consumption [30,31]. Table 2 indicates that 73.8% (n=45) of *elderly* fatalities were smokers and 63.6% (n=28) were problem drinkers; a person was considered a problem drinker if they were classified by their GP as an alcoholic or identified by family members or associates as a habitual abuser of alcohol. Twenty-four (54.5%) of the *elderly* fatalities were known to be both smokers and problem drinkers and a closer inspection of the *elderly* problem drinkers indicated that 85.7% (n=24) of them were also smokers, suggesting that smoking frequently goes hand in hand with problem drinking. Although a high proportion of *elderly* fatalities were known to be smokers or problem drinkers they were significantly less likely (for smoking $X^2(1, n=116)=11.262$, $p<0.01$; for drinking $X^2(1, n=94)=7.750$ $p<0.01$) to be so than *other adult* fatalities. *Other adult* problem drinkers were also more likely to be smokers with 100% (n=44) known to have a smoking habit.

Table 2 indicates that 78.1% (n=50) of the *elderly* fatalities had a pre-existing health condition that had an effect on the outcome of the fire i.e. health conditions that had a role in ignition, propagation or outcome of the fire. The literature indicates that pre-existing illnesses, particularly those associated with advancing age, are a risk factor for *elderly* fire fatalities [10-12]. The *elderly* fatalities within this sample were more likely than the *other adults* (63.2%, n=36) to have a pre-existing health condition that influenced the outcome of the fire; however, this difference was not significant. This is perhaps surprising, however, Table 2 indicates only whether the *elderly* fatality had a pre-existing health condition that played a role in their death and does not specify the nature of the condition. Of those that had a pre-existing health condition that played a role in their death, 73.5% (n=36) had a physical health condition and 42.0% (n=21) had a mental health condition; correspondingly 37.1% (n=13) of *other adults* had a physical health condition and 91.7% (n=33) had a mental health condition. Figure 1 shows a further breakdown of the health conditions categorised into mental and physical and shows their prevalence among the two age groupings.

The overall trends in Fig. 1 indicate that, perhaps unsurprisingly, the proportion of fatalities with physical health conditions that played a role in the person becoming a fire fatality increased with age. However, contrary to the trend in physical illness, the proportion of fatalities with a mental illness that played a role in them becoming a fire fatality peaked between 30 and 60 years and then decreased into old age. This result suggests that the health issues experienced by *elderly* and *other adult* fire fatalities differ i.e. mental health conditions are most prominent among *other adult* fatalities, and physical health conditions are most prominent among *elderly* fatalities; this association is confirmed with a Pearson Chi-Squared test, $X^2(1, n=121)=7.675$, $p<0.01$ for mental illness and $X^2(1, n=120)=13.492$, $p<0.01$ for physical illnesses.

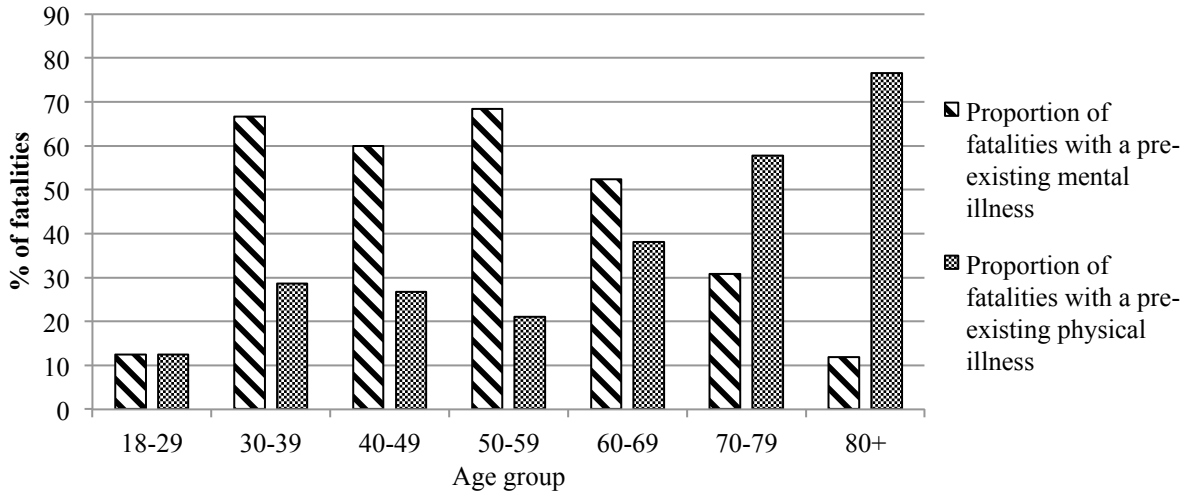

Fig. 1. Proportion of fatalities, by age group, with physical and mental illnesses that played a role in the fire.

A further analysis of the nature of the mental health conditions experienced by the fatalities indicated that, overwhelmingly, alcohol related disorders were the most influential mental health condition experienced by both *elderly* and *other adults*; affecting 20.0% (n=13) of *elderly* fatalities and 54.5% (n=31) of other *adult* fatalities. Compared to *other adult* fatalities, *elderly* fatalities were significantly less likely to have an alcohol related disorder play a role in their death ($X^2(1, n=112)=15.573$, $p<0.01$). This is consistent with the results shown in Table 2, which indicate that *elderly* fatalities were significantly less likely ($X^2(1, n=94)=7.750$ $p<0.01$) to be problem drinkers. Other than alcohol related disorders, depression was the second most common mental health condition for *elderly* fatalities. It was noted to play a role in 4.6% (n=3) of *elderly* fatalities and 17.5% (n=10) of *other adult* fatalities. Previous research has suggested a casual link between depression and alcohol related disorders [32]. Within this sample 80.0% (n=8) of the *elderly* and one of the 3 *other adult* sufferers of depression also had an alcohol related disorder. Age-related cognitive decline was discussed in the introductory section of this paper as a cause for concern with regard to the risk experienced by *elderly* householders; however, there is little evidence that this played a prominent role in these fire deaths. Confusion/delusion was described by the coroner as a factor in a small proportion (6.2%, n=4) of the *elderly* deaths, however, there were no examples of *elderly* fatalities where dementia or Alzheimer's disease played a role in the person becoming a fire fatality.

As noted previously, almost three quarters (73.5%, n=36) of the *elderly* fatalities who had a health condition that played a role in the fire (or 56.0% of all *elderly* fatalities) had a physical health condition; note the sum of the percentages of physical and mental health conditions for the *elderly* fatalities is greater than 100.0% since fatalities often had both physical and mental health conditions. Heart disease was the most common ailment for the *elderly* affecting 25.0% (n=16) of *elderly* fatalities. *Elderly* fatalities were almost twice as likely to experience a physical illness that played a role in the fire than the *other adults*; 37.1% (n=13) of those *other adults* with a pre-existing health condition (or 23.2% of all *other adults*) had a physical illness. There were 12 different physical health conditions that affected *other adult* fatalities; the most commonly occurring physical illness was broken bones which affected 5.4% (n=3) *other adult* fatalities.

As frailty was identified as a factor in 14.1% (n=9) of *elderly* fatalities, information was also collected on the number of fatalities who were known to regularly have the assistance of a qualified carer or assistant. Returning again to the data presented in Table 2, it is evident that 25.0% (n=16) of the fatalities availed of the assistance of a carer to help them carry out day-to-day activities such as dressing, bathing and cooking. This was a significantly higher percentage ($X^2(1, n=120)=7.694$, $p<0.01$) than for *other adult*s (7.1%, n=4). Closer inspection of the demographics of those with carers indicates that 75.0% (n=15) of the 20 fatalities with carers were aged 70+ years.

Table 2 also indicates that 80.0% (n=52) of *elderly* fatalities lived alone. With reference to marital status, the most common reasons for living alone were being single (52.9%, n=27) followed by being widowed (45.1% (n=23). Many *other adult* fatalities also lived alone (71.2%, n=42), although a lesser proportion than the *elderly*, these differences were not significant. However the *other adults* were most likely to live alone as they

were single (85.4% (n=35) compared to 52.9% (n=27)). This suggests that not living alone and being married may be protective factors for the *elderly* and indeed the *other adult* group.

The final result reported in Table 2 concerns the ownership of smoke alarms It is important to note that information on smoke alarms was often absent from the source material. Taking into account the limited proportion of cases where smoke alarm characteristics are defined the results here can only be regarded as indicative. However, from the cases where this information could be determined (this fluctuated with each variable), it was established that 68.4% (n=26) of *elderly* fatalities had at least one smoke alarm in their home. Furthermore, it was established that *elderly* fatalities often (65.0%, n=13) died in incidents where a smoke alarm operated. *Elderly* fatalities were more likely to die in a fire where an alarm operated than *other adults* (65.0% (n=13) compared to 44.4% (n=12)) but significantly less likely ($X^2(1, n=83)=10.818$, $p<0.01$) to have a smoke alarm installed (68.4% (n=26) compared to 95.6%, n=43) suggesting that smoke alarm installation may be a problem for this population. Although the elderly were more likely to have a smoke alarm that operated during the fire just under a third failed to operate (35.0%, n=7). The operation of the smoke alarm is a function of alarm maintenance, its placement relative to the fire and occupants, the type of fire and the time elapsed since ignition; these relationships will not be explored further here however although the reason that alarm failed to operate will not be established here the results indicating that smoke alarm operation was less than 100.0% for the *elderly* suggests that issues associated with smoke alarms and the *elderly* go further than low ownership rates.

Incident data

Table 3 presents the two most common codes reflecting when, where and how the fire started; again the codes are given as a percentage of fatalities for which this information was available. Literature suggests that dwelling fire fatalities most often result from fires that start during the early hours of the morning i.e. from midnight to 6am, originate in the living room or bedroom, are ignited by smokers' materials, with home furnishings or clothing the most common seats of fire; the results here are in agreement with this [3].

Table 3. Most common fire incident characteristics for *elderly* fatalities.

Factor	Code (Two most common for <u>elderly</u> fatalities) (*) p<0.05, (**) p<0.01	% of fatalities (no. of fatalities/no. of fatalities where factor known)	
		Elderly	Other adults
Time of ignition	00:00-05:59 (*)	36.1 (13/36)	59.0 (23/39)
	18:00-23:59	27.8 (10/36)	23.1 (9/39)
Room of fire origin	Living room	60.3 (38/63)	44.8 (26/58)
	Bedroom	22.2 (14/63)	34.5 (20/58)
First item ignited	Home furnishings	32.7 (16/49)	40.4 (19/47)
	Clothing on person (**)	24.5 (12/49)	4.3 (2/47)
Source of ignition	Smokers' materials (**)	53.2 (33/62)	76.8 (43/56)
	Articles placed too close to heat source	19.4 (12/62)	12.5 (7/56)

The most common period of ignition for fires, as shown in Table 3, was 6pm to 6am accounting for 63.9% (n=23) of *elderly* fatalities. More specifically *elderly* fatalities, similar to *other adult* fatalities, most often resulted from fires that initiated in the early hours of the morning i.e. 12am-6am. Compared to *other adult* fatalities *elderly* fires occurred more regularly throughout the day as unlike the *other adult* group the *elderly* fatalities did not have such a large peak during the 12am-6am period; although the most common time period this accounted for just over one third of *elderly* fatalities compared to almost two thirds of *other adult* fatalities.

Elderly fatalities were most likely to result from fires that originated in the living room (60.3%, n=38) or bedroom (22.2%, n=14). The seat of the fire was most commonly located in home furnishings (32.7%, n=16) and clothing on persons (24.5%, n=12) with the most common sources of ignition being smokers' materials (53.2%, n=33) and articles placed too close to heat source (19.4%, n=12). *Elderly* fatalities were significantly

more likely that *other adult* fatalities (X^2(1, n=96)=7.885, p<0.01) to be involved in fires that originated in clothing on person and were significantly less likely (X^2(1, n=118)= 7.124, p<0.01) to result from fires ignited by smokers' materials.

In order to further investigate the circumstances surrounding the deaths of the *elderly* householders, the room of fire origin, the first item ignited and source of ignition data that was discussed in the previous paragraphs were cross-referenced to determine the most common scenarios. The results are shown in Table 4, together with the number of *other adult* fatalities that resulted from each scenario included for comparison.

Table 4. Most common fire scenarios for *elderly* fatalities.

Scenario (Location, source of ignition, first item ignited) (*) p<0.05, (**) p<0.01	**% of fatalities (no. of fatalities/no. of fatalities where factor known)**	
	Elderly	**Other adults**
Living room, smokers' materials, home furnishings	22.9 (11/48)	29.8 (14/47)
Bedroom, smokers' materials, bedding (**)	12.5 (6/48)	38.3 (18/47)
Living room, smokers' materials/ articles too close to heat source, clothing on person (*)	18.8 (9/48)	4.3 (2/47)
Total	54.2 (26/48)	72.3 (34/47)

Table 4 reveals one prominent scenario for *elderly* fatalities, i.e. fires that originated in the living room, ignited by smokers' materials with home furnishings the first item ignited. This scenario was responsible for 22.9% (n=11) of *elderly* fatalities. Further analysis of the circumstances surrounding this specific scenario suggest that *sleeping* and *alcohol* played prominent roles in these incidents; at ignition 72.7% (n=8) of these fatalities were considered to be *possibly sleeping* and 45.5% (n=5) considered to be *impaired by alcohol*. The second most prevalent fire scenario for *elderly* fatalities were incidents that originated in the bedroom, were ignited by smokers' materials where bedding was the first item ignited; this scenario accounted for 12.5% (n=6) of *elderly* fatalities. The final scenario considered in Table 4 is an amalgamation of two very similar scenarios (both less common that the previous scenarios) and was included to illustrate the increased risk to the *elderly* of being involved in a fatal dwelling fire that started with their clothing igniting. Table 3 indicated that 24.5% (n=12) *elderly* fatalities were a result of a fire that started with a person's clothing igniting; 75.0% (n=9) of these incident occurred in the living room and were usually caused by smokers' materials (44.4%, n=4) or the placing of articles too close to a heat source (44.4%, n=4).

Although the second scenario was the second most common for *elderly* fatalities it was significantly less common (X^2(1, n=95)=8.788, p<0.01) for *elderly* than it was for *other adult* fatalities. On the other hand, *elderly* fatalities were significantly more likely (Fishers Exact Test (2-tailed), p<0.05) to result from fires that initiated in clothing on their person. Fatal dwelling fires involving the ignition of clothing frequently result in burn injuries; the increased risk of *elderly* fatalities of being involved in this type of fire may therefore be a factor in why a large proportion of *elderly* fatalities (see Table 7) result from burn injuries.

Fatality condition and involvement in fire

The condition of fatalities in terms of the presence of alcohol/drugs in their system, their involvement in ignition and their subsequent behaviour are detailed in Table 5.

Post mortem testing indicated that one half of *elderly* fatalities (50.0%, n=26) tested positive for alcohol. Positive alcohol readings were not restricted to problem drinkers, however, they did make up the majority (86.4%, n=19) of those who tested positive. It should be noted that testing positive for alcohol indicated that the person had consumed alcohol in the hours leading up to their death; however it does not infer that the fatality was intoxicated nor that it influenced their behaviour.

Table 5. Potential behavioural influences.

Potential behavioural influences (*) p<0.05, (**) p<0.01	% of fatalities (no. of fatalities/no. of fatalities where factor known)	
	Elderly	Other adults
Test positive for blood alcohol (**)	50.0 (26/52)	87.9 (51/58)
Test positive for drugs	45.5 (5/11)	69.0 (20/29)
Possibly involved in fire start	89.2 (58/65)	93.3 (56/60)
Moved in reaction to fire	81.5 (44/54)	74.5 (38/51)

Alcohol can play three major roles in the incident: influencing the fire starting, impacting the occupant's ability to escape and impeding the body's ability to recover from fire injuries. Alcohol frequently featured in the ignition of smokers' materials fires; 63.0% (n=17) of the *elderly* fatalities that resulted from these fires tested positive for alcohol. In these incidents the fatality had often carelessly discarded a cigarette or match while under the influence of alcohol. Cooking fires account for a small proportion of *elderly* fatalities (9.7%, n=6) however 80.0% (n=4) *elderly* fatalities from these fires were under the influence of alcohol. Comparison of escape data for fatalities that tested positive for alcohol versus those who tested negative indicates that there was no significant difference between the two groups and whether they managed to escape the building (alive) during the fire ($X^2(1)=0.103$, p=0.749). It is acknowledged that that alcohol can play a role in the physiological recovery from fire injuries however discussion of this subject is beyond the remit of this paper and is recognised as a limitation of this study.

Although one half of *elderly* fatalities (50.0%, n=26) tested positive for alcohol, this was in fact significantly lower ($X^2(1, n=110)=18.875$, $p<0.05$) than the proportion of *other adult*s (87.9%, n=51) that tested positive for alcohol suggesting that alcohol may not play as strong a role in deaths of the *elderly* as it does in deaths of *other adult*s; this will be discussed in further detail with reference to Table 6.

A very small proportion of *elderly* fatalities (16.9%, n=11) were tested for drugs; 45.5% (n=5) tested positive. The drugs detected were all prescription medicines including pain relief such as paracetamol and codeine and drugs from the benzodiazepine class of drugs frequently used to treat depression and anxiety. The medication was considered by the coroner to have played a part in the death of 2 (40.0%) of those who were medicated at the time of the fire. Just one (20.0%) of the *elderly* fatalities that tested positive for drugs also had alcohol in their system at their time of death; in this instance the combination of alcohol and drugs was considered to have played a part in the death. The literature suggests that medications can play a role in *elderly* fatalities [23], but this does not appear to be the case here. However, the results from this study should be approached with caution; the proportion of *elderly* fatalities tested for drugs was small (16.9%, n=11) and the decision to test was influenced by whether the fatalities' medical history suggested they may have been taking prescription medication. Thus, the results are only indicative as it recognised by the researchers that there was a bias in how the fatalities were selected for drug testing.

Table 5 also indicates that, more often than not, *elderly* fatalities (89.2%, n=58) were deemed to possibly have been involved in ignition. Involvement in ignition covers direct involvement such as dropping a cigarette or indirect involvement through acts of omission such as leaving a chip-pan unattended. Additionally, once the fire had ignited 81.5% (n=44) of *elderly* fatalities were determined to have moved in reaction to the fire. This was not a measure of whether the fatality made an escape attempt, but rather an indicator that the fatality was aware of the fire and had been disturbed from their activity previous to the fire. The definition of 'moved in reaction to fire' was broad and encompassed fatalities that made an attempt to get out of bed to those who made successful escape attempts. Slightly more *elderly* fatalities, 81.5% (n=44) compared to 74.5% (n=38) of *other adult* fatalities were observed to have moved in reaction to the fire. This may be a function of the condition and activity of the fatality before and during the fire however this will not be explored further in this paper.

Table 6 focuses on the most common the actions taken by the *elderly* fatalities, their condition during the fire and the conditions that prevented escape. Included in the table are the three most common codes for each category; since each fatality could have up to three codes all three codes given could apply to one fatality. Once again, *other adult* fatality data is included for comparison.

Table 6. Most common actions and conditions for *elderly* fatalities during the fire.

Factor	3 most common codes for elderly fatalities (*) p<0.05, (**) p<0.01	% of fatalities (no. of fatalities/no. of fatalities where factor known)	
		Elderly	Other adults
Actions taken during fire	Escape actions	60.4 (32/53)	53.7 (29/54)
	Fire-fighting actions (*)	37.7 (20/53)	18.5 (10/54)
	Didn't/couldn't/refused to escape (*)	15.1 (8/53)	3.7 (2/54)
Conditions during fire	Impaired by alcohol (**)	36.2 (21/58)	79.7 (47/59)
	Anxious/distressed (**)	34.5 (20/58)	13.6 (8/59)
	Awake, unimpaired (**)	27.6 (16/58)	3.4 (2/59)
Conditions preventing escape	Clothing on casualty burning (*)	36.5 (23/63)	17.2 (10/58)
	Smoke/visibility problems	28.6 (18/63)	36.2 (21/58)
	Disorientation due to intoxication (**)	20.6 (13/63)	58.6 (34/58)

Table 6 indicates that the most common actions taken by *elderly* fatalities during the fire were escape actions (60.4%, n=32) and fire-fighting actions (37.7%, n=20). *Elderly* fatalities were slightly more likely to take escape actions than *other adults* (53.7%, n=29) and, surprisingly, were significantly more likely (X^2(1, n=107)=5.094, p<0.05) to take fire-fighting actions. The prevalence of fire fighting actions among *elderly* fatalities may be a consequence of the type of fires that the *elderly* are involved in. However, it is recognised that fire-fighting actions within the *elderly* group are often focussed on extinguishing flames on clothing which was identified in Table 4 as a prevalent first item for this group and it is recognised this may be skewing this result. A small proportion (15.1%, n=8) of *elderly* fatalities did not make any attempt to escape; this was due to them not being capable due to illness or reportedly refusing to escape. Significantly fewer *other adult* fatalities took no escape actions (3.7%, n=2); this is not surprising as *elderly* fatalities were significantly more likely to have a physical illness i.e. a physical impairment that may impede escape.

The most common condition of *elderly* fatalities during the fire, Table 6, was being impaired by alcohol (36.2%, n=21). However this was significantly lower (X^2(1, n=115)=21.913 p<0.01) than the proportion of *other adult* fatalities (79.7%, n=47) that were understood to be impaired by alcohol during the fire. The second most common condition experienced by *elderly* fatalities was anxiousness/distress (34.5%, n=20) whilst 27.6% (n=16) were deemed to be awake and unimpaired. Anxiousness/ distress was usually characterised by accounts in the coronial reports of the fatality vocally seeking assistance during the fire. Fatalities that were "awake, unimpaired" were considered to have been awake during the fire and not physically or mentally impaired (including intoxication). *Elderly* fatalities were significantly more likely to be either awake and unimpaired (X^2(1, n=117)=12.183, p<0.01) or experience anxiousness/distress (X^2(1, n=117)=7.338, p<0.01) than *other adult* fatalities.

The final subject addressed in Table 6 is the conditions that prevented the fatalities escaping. The leading reason that *elderly* fatalities could not escape the fires was because their clothing was burning (36.5%, n=23), followed by smoke/visibility problems (28.6%, n=18) and disorientation due to intoxication (20.6%, n=13). *Elderly* fatalities were significantly more likely (X^2(1, n=121)=5.652, p<0.05) to be prevented from escaping by their clothing burning than *other adults* (36.5% (n=23) compared to 17.2% (n=10)), slightly less likely to experience smoke/visibility problems (28.6% (n=18) compared to 36.2% (n=21)) and significantly less likely (X^2(1, n=121)=18.343, p<0.01) to experience difficulty escaping due to disorientation caused by intoxication (20.6% (n=13) compared to 58.6% (n=34)).

Table 7 shows the location and condition of the fatalities in the immediate aftermath of the fire. Two thirds (67.2%, n=43) of the *elderly* fatalities were still in the dwelling i.e. they did not successfully escape; 57.1% (n=20) of these fatalities (or 37.0% (n=20) of all *elderly* fatalities) did not escape the room of fire origin.

Table 7. Condition and location of fatality post fire incident.

Condition or location immediately following fire (*) p<0.05, (**) p<0.01		% of fatalities (no. of fatalities/no. of fatalities where factor known)	
		Elderly	Other adults
Remained in room of fire origin throughout fire		37.0 (20/54)	47.9 (23/48)
Did not escape dwelling		67.2 (43/64)	71.7 (43/60)
Primary cause of death	Inhalation injuries only (**)	49.2 (32/65)	81.7 (49/60)
	Burns only (**)	24.6 (16/65)	6.7 (4/60)
	Fire injury complications	15.4 (10/65)	5.0 (3/60)
	Burns and inhalation injuries	10.8 (7/65)	6.7 (4/60)

The primary cause of death given in Table 7 is defined here as the medical cause of death irrespective of the underlying conditions or circumstances that led to the death. The most common primary cause of death for *elderly* fatalities was inhalation injuries (49.2%, n=32) followed by burn injuries (24.6%, n=16). A further 15.4% (n=10) of *elderly* fatalities succumbed to fire injury complications e.g. organ failure in the hours, days or weeks following the fire. *Elderly* fatalities were, compared to *other adult* fatalities, significantly more likely (X^2(1, n=125)=7.479, p<0.01) to have suffered burns as their primary cause of death and significantly less likely (X^2(1, n=125)=14.391, p<0.01) to have succumbed to inhalation injuries. The significantly higher proportion of *elderly* fatalities that die from burn injuries may be related to the significantly larger proportion (X^2(1, n=96)=7.885 p<0.01) of *elderly* fatalities that result from fires involving clothing igniting; Table 3 indicated that 19.4% (n=12) *elderly* fatalities were involved in fires that involved their clothing igniting in the initial moments of the fire. The primary cause of death for 75.0% (n=9) of these *elderly* fatalities was burn injuries, the remaining 25.0% (n=3) of fatalities died from fire injury complications. None of these fatalities had inhalation injuries as their primary cause of death, further corroborating the association between the nature of the fire i.e. clothing and the incidence of fatal burn injuries. Furthermore, as noted earlier, previous research [21,22] has demonstrated that the *elderly* are physiologically more vulnerable to heat and burn injuries and less likely to recover from burn injuries than younger persons which may even further explain why the *elderly* experienced a significantly higher rate (X^2(1, n=125)=7.479, p<0.01) of fatal burn injuries than the *other adult* group.

Attitudes to fire safety in elderly households

A review of the literature and detailed analysis of the fires presented in the previous sections suggest that age-related decline in health was one of the largest influences on the degree of fire risk experienced by the *elderly*. Health conditions associated with cognitive decline such as Alzheimer's disease and dementia are noted in the literature as risk factors for the *elderly*. Indeed these conditions were evident among some *elderly* fatalities in this study and it was established from accounts given in the coronial reports that these illnesses were often deemed to have clouded the fatalities' decision-making processes leading them to engage in potentially dangerous behaviour within their home. However, although many of the fatalities did have these health conditions the in-depth results from this study shown in the previous sections indicate that they actually had a relatively minor role to play in *elderly* persons becoming a dwelling fire fatality. On the other hand, decline in physical health had a much more pivotal role to play. A decline in physical health and mobility frequently resulted in the *elderly* person being housebound or even bed-bound, leaving them especially vulnerable during the fire. The data presented in Table 2 suggests that fatalities were often physically incapable of escaping the fire in a timely fashion (if at all), even with the early warning of a smoke alarm; this lack of physical capability was further evidenced by the necessity of a carer to assist them with daily activities. Evidence within the coroners' reports indicated that, contrary to popular opinion, [6,18,28] the risk to immobile (and frequently isolated) *elderly* occupants was, more often than not, recognised by at least one person connected to the household. Additionally, considerable efforts had been invested by family, health and community workers into preventing these *elderly* persons becoming involved in fires. However, this was largely limited to preventing the actual fire, with comparatively fewer preparations being made to address how the *elderly* person would actually escape in the event of a fire.

Research has suggested that identifying people at risk can be a problem for this age group, with social isolation playing a key role. However, observations made during this study suggest that, more often than not, the fire risk to the *elderly* person had been identified by at least one person, even where the person was considered socially isolated. A somewhat surprising observation was with regard to the types of people who detected the fire risk; this varied from close relatives and neighbours to occasional visitors to the household e.g. health and social care workers, community workers such as meals-on-wheels and even postal workers or delivery persons. Typical indicators of risk were previous fire incidents, cigarette burns on clothing or bedding, excessive storage of personal possessions (hoarding), dangerous cooking habits such as chip pans or using portable cookers and placing furniture too close to heat sources.

Although risk was frequently acknowledged, many of those who had concerns about the safety of an *elderly* person were unable to take pro-active measures to address the risk. Some were unsure how to go about addressing the risk or felt that they did not want to offend the *elderly* person and it was not their place to intervene. Others did attempt to intervene but the fatality was reluctant to adopt fire safety measures. According to relatives and associates, this was often underpinned by the at-risk person's concern that their independence would be undermined or, that by accepting help, they were admitting that they were unable to care for themselves.

In cases where fire safety measures had been adopted, they were ultimately insufficient to prevent the fire starting. There was more than one example of bedbound *elderly* occupants that were enabled to continue smoking by carers or relatives who provided the *elderly* person with the smokers' materials and tried to reduce the fire risk by creating a safer environment for smoking such as placing additional ashtrays or buckets of water to dispose of cigarettes within easy reach of the fatality; others endeavoured to limit the *elderly* persons' smoking to periods when they were not alone. Implemented fire safety strategies were on occasions unwittingly undermined where *elderly* occupants deactivated smoke alarms by removing the battery or removed the alarms entirely, a behaviour that is by no means unique to this age group [33]. Some relatives of *elderly* occupants who were smokers or drinkers resolved to refrain from supplying the *elderly* person with cigarettes or alcohol but this strategy was on more than one occasion unwittingly undermined by another well-meaning relative or associate who provided the fatality with cigarettes and/or alcohol.

DISCUSSION AND CONCLUSIONS

This paper has presented the results of an investigation into the circumstances surrounding *elderly* dwelling fire fatalities in Northern Ireland. This study has pieced together data collected from coronial reports to identify the types of *elderly* people most likely to become a dwelling fire fatality, how and why they are likely to come to their death in a fire and the issues that must be overcome to prevent future dwelling fire deaths within the *elderly* population. In order to inform future fire safety campaigns aimed specifically at the *elderly* it must also be understood how *elderly* fatalities differ from *other adult* fatalities, i.e. the fire safety message should be tailored to specifically address the risks experienced by this group; for this purpose comparisons were made with *other adult* fatalities data.

Overall, the risk factors identified for *elderly* fatalities in this study are comparable to that already expressed in the literature. The demographic data collected indicated that the risk of becoming a dwelling fire fatality increased with age, particularly for females. The most at risk *elderly* fatalities lived alone, were smokers and/or problem drinkers and had health conditions that affected mobility or cognitive function.

Consistent with previous research, fatalities most often died in fires that occurred during the early morning hours; however, the proportion of *elderly* fatalities dying in this time period is less than suggested by other studies across the entire adult population i.e. *elderly* fatalities occur more regularly throughout the day. The most common source of ignition was smokers' materials which were responsible for just over one half of fatalities; a further one fifth of fatalities were due to fires ignited by an item placed too close to a heat source. Fires most often occurred in the living room and bedroom with home furnishings, bedding and clothing the most common items first ignited. Several fire circumstances repeated throughout the time period studied, the most common being smokers' materials' fires that originated in home furnishings in the living room; this was the case for one quarter of all *elderly* fatalities.

The type of fire the fatality was involved in was found to be closely linked to their primary cause of death. It is understood that inhalation injuries are by-far the biggest killer in dwelling fires [1,2]. However the primary cause of death for a quarter of *elderly* fatalities was burns; a higher proportion than is attributed to *other adult* fire deaths in the literature [1,2]. Fatal burns typically occur in fires where the person is very close to the seat

of the fire e.g. clothing on the person. For the cause of death to be burns rather than smoke inhalation, serious burns must be inflicted quickly by direct contact with a fast flaming fire or a hot object such as a heater or cooker. It is not possible to determine from the data whether *elderly* fatalities were more likely to be involved in such a fire or whether they are just less likely to survive this type of fire. Supplemental data on non-fatal fires would be required to complete this comparison, however, what can be concluded from this research is that this is a prevalent type of fire for *elderly* dwelling fire fatalities.

The majority of fatalities were likely to have been involved in ignition and this was often influenced by physical health conditions. In a small proportion of cases the fatalities had reduced cognitive function which impacted their decision-making and resulted in them endangering themselves by engaging in risky behaviours e.g. positioning themselves too close to sources of heat such as cookers, open fires or portable heaters or attempting to use a home appliance for an unintended use e.g. placing an electric kettle on a gas cooker.

The analysis has indicated that approximately four fifths of fatalities moved in reaction to the fire, even though many were mobility impaired or bedbound. Just one third of the fatalities made it out of the house during the fire; of those who did not escape, just over half remained in the room of fire origin throughout the fire. Many of the *elderly* fatalities had mobility problems, difficulty with activities such as dressing and bathing and a quarter availed of the assistance of a carer to complete these activities. Thus, it is not surprising that over a third of the *elderly* fatalities never made it out of the room of fire origin. Further analysis of the cornoners' reports related to the deaths of these individuals indicates that although carers and families often voiced their concerns and took measures to reduce the fire risk, little consideration was given to how the individuals might escape in the event of a fire.

Comparison of the circumstances surrounding the *elderly* and *other adult* fatalities indicated many similarities. The significant results indicate that although the groups shared many of the same characteristics they were experienced in different proportions. *Elderly* fatalities were approximately one and a half times less likely to be smokers and problem drinkers. They were almost four times more likely to have a carer/assistant or be widowed but twice less likely to live alone as they were single. Two thirds of *elderly* fatalities had a smoke alarm installed compared to almost all of *other adults,* suggesting that there may be poorer uptake of the smoke alarm fire safety message among the *elderly* group. *Elderly* fatalities were twice as likely to have a pre-existing physical health condition that played a role in the fire, however two times less likely to have a mental health condition.

With reference to the fire incident, *elderly* fatalities were almost two times less likely to result from fires that ignited during the early hours of the morning, six times more likely to be involved in a fire that started in their clothing and one and half times less likely to result from a fire ignited by smokers' materials. During the fire *elderly* fatalities were twice as likely to take fire-fighting actions (this may be due to the increased proportion of *elderly* fatalities that result from fires involving clothing igniting in the initial moments of the fire) and almost four times more likely to make no escape attempt (usually a consequence of severe mobility impairment). *Elderly* fatalities were twice as likely to experience problems escaping due to their clothing burning but two times less likely to experience problems escaping because of disorientation caused by intoxication. The increased risk to the *elderly* fatalities in this study of being involved in fires that involving their clothing as the seat of the fire is reflected in the primary cause of death results which indicate that *elderly* fatalities are three and half times more likely to have burn injuries as their primary cause of death and one and a half times less likely to have inhalation injuries as their cause of death than *other adult*s.

These results suggest that many of the risk factors that have been suggested for *other adult* fatalities also exist among *elderly* fatalities e.g. smoking and alcohol abuse. However, community fire safety messages aimed at *elderly* could benefit from additional focus on the dangers of clothing igniting, the dangerous practice of placing items too close to heat sources such as heaters or open fires, reinforcement of the message to install and maintain smoke alarms, and the generation and use of evacuation plans via a system of inter-agency risk assessment, particularly for those mobility impaired.

The literature suggests getting the fire safety message to *elderly* householders can be difficult as there are several barriers to overcome such as the difficulty in identifying those at risk due to the prevalence of social isolation among this group. However, this was not apparent from analysis of the coronial reports used in this study; rather, a high number and broad variety of people in the community had noted the fire risk to the persons on at least one occasion before the fire. Although many of the *elderly* fatalities in this group could be considered socially isolated (indeed four fifths lived alone), most fatalities had contact with some members of the wider community, even if they were estranged from their family. The range of people that voiced their

concerns about *elderly* householders varied from family members to neighbours to community and postal workers. Many of these people intervened in an effort to reduce the risk, although others refrained. Those who refrained either felt that they would be interfering, or were deeply conflicted over what was the best measure to take whilst maintaining the quality of life of the individual.

The major shortcoming arising from these investigations is that there is currently, in Northern Ireland, no system in place through which fire-risk concerns held by a family member or associate of an *elderly* person can be raised and addressed. Whilst such a system would signpost those potentially at risk of a fire, it is recognised that intervention strategies to reduce this risk are more complicated and form part of a greater social issue of how *elderly* persons are cared for within an aging society. Additionally the content of the strategies must be tailored for the specific risks experienced by *elderly* householders on a general level (as shown in the results here) and on a personalised level using an individual risk assessment approach recognising the person's abilities and limitations. Clearly, any interventions need to be balanced by the desire to preserve the dignity, independence and quality of life of the individuals. Overall, any efforts to prevent *elderly* dwelling fire fatalities must form part of strategies implemented at an inter-agency level to minimise all risks to *elderly* people that choose to remain in their own homes into later life.

REFERENCES

[1] Ahrens M. "Home Structure Fires" National Fire Protection Agency: Fire Analysis and Research Division, Quincy MA, 2013.

[2] Department of Communities and Local Government. "Fire Statistics Great Britain 2011 to 2012", London, 2012.

[3] Flynn JD. "Characteristics of Home Victims", National Fire Protection Agency: Fire Analysis and Research Division, Quincy MA, 2010.

[4] Holborn P.G., Nolan P.F., Golt J. (2003) An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000, Fire Safety Journal, 38(1):1-42. http://dx.doi.org/10.1016/S0379-7112(02)00049-8

[5] Thomas, I. and Brennan, P , "Occupants, ignition and fire outcomes", *Human Behaviour in Fire-Proceedings of the Third International Symposium*, 2004 pp 45-56.

[6] Miller I. "Human Behaviour Contributing to Unintentional Residential Fire Deaths1997-2003", New Zealand Fire Service Commission, Research Report Number 47, 2005.

[7] Graesser, H., Ball, M. and Bruck, D,,"Risk factors for residential fire fatality across the lifespan: comparing coronial data for children, adults, and elders", *Human Behaviour in Fire-Proceedings of the 4th International Symposium*, 2009, pp.639-644.

[8] Centers for Disease Control and Prevention, "10 Leading Cause of Death By Age Group 2010", 2012; Available at: http://www.cdc.gov/injury/wisqars/pdf/10LCID_All_Deaths_By_Age_Group_2010-a.pdf, accessed 4/27/2013, 2013.

[9] Centers for Disease Control and Prevention, "10 Leading Causes of Injury Deaths by Age Group Highlighting Unintentional Injury Deaths, United States", 2012, available at: http://www.cdc.gov/injury/wisqars/pdf/10LCID_Unintentional_Deaths_2010-a.pdf, accessed 4/27/2013, 2013.

[10] Ball M., Graesser H,, Bruck D. and Thomas I., "Increased fire death risk for the elderly",(1999) Australian Nursing Journal 16(7); 35.

[11] Elder A.T., Squires T. and Busuttil A.,(1996) "Fire Fatalities in Elderly People", Age and Ageing 25(3); 214-6. http://dx.doi.org/10.1093/ageing/25.3.214

[12] U.S. Fire Administration. "Fire Risk to Older Adults in 2007: Topical Fire Report Series (Volume 11, Issue 10)", 2011, available at: http://www.usfa.fema.gov/downloads/pdf/statistics/v11i10.pdf, accessed 05/14/2013.

[13] National Fire Protection Agency-Fire Analysis and Research Division. "Demographic and Other Characteristics Related to Fire Deaths or Injuries", 2010, Quincy MA, available at: http://www.nfpa.org/assets/files/PDF/OS.SocFactors.pdf, accessed 05/14/2013.

[14] Northern Ireland Fire & Rescue Service. Fire Service Urgently Renew Public Appeal - "Help Us Protect the Elderly in Our Community from Fire", News: Archived News, 2012, available at: http://www.nifrs.org/news.php?sec=16&adate=all&news=23803, accessed 05/14/2013.

[15] National Commission on Fire Prevention and Control. "America Burning", U.S. Government Printing Office, Washington D.C., 1973.

[16] Runyan C.W., Bangdiwala S.I., Linzer M.A., Sacks J.J. and Butts J.,(1992) "Risk Factors for Fatal Residential Fires", New.England Journal of Medicine 327(12); 859-63. http://dx.doi.org/10.1056/NEJM199209173271207

[17] Office for National Statistics, "An Executive summary, 2010-based NPP Reference Volume", 2012, available at: http://www.ons.gov.uk/ons/dcp171776_253890.pdf, accessed 05/14/2013.

[18] Miller I., "Behaviour, Fire And Older People: Implications Of The Demographic Growth Of A Vulnerable Population", Human Behaviour in Fire-Proceedings of the Fourth International Symposium 2009, pp.345-354.

[19] Sixsmith A. and Sixsmith J., (2008) Ageing in Place in the United Kingdom, Ageing International 32(3); 219-235. http://dx.doi.org/10.1007/s12126-008-9019-y

[20] Lionelli G.T., Pickus E.J., Beckum O.K., DeCoursey R.L. and Korentager R.A. (2005) "A three decade analysis of factors affecting burn mortality in the elderly", Burns 31(8):958-63. http://dx.doi.org/10.1016/j.burns.2005.06.006

[21] Keck M., Lumenta D.B., Andel H., Kamolz L.P. and Frey M., (2009) "Burn treatment in the elderly" Burns 35(8):1071-9. http://dx.doi.org/10.1016/j.burns.2009.03.004

[22] Khadim M.F., Rashid A., Fogarty B. and Khan K., (2009) "Mortality estimates in the elderly burn patients: The Northern Ireland experience". Burns 35(1):107-13. http://dx.doi.org/10.1016/j.burns.2008.05.004

[23] U.S. Fire Administration, "Fire Risks for the Older Adult", 1999, available at: http://www.usfa.fema.gov/downloads/pdf/publications/older.pdf, accessed 05/14/2013.

[24] Douglas A, Letts L, Richardson J., (2011) A systematic review of accidental injury from fire, wandering and medication self-administration errors for older adults with and without dementia, Archives of Gerontology and Geriatrics, 52(1):1-10. http://dx.doi.org/10.1016/j.archger.2010.02.014

[25] Diekman S.T., Stewart T.A., Teh S.L. and Ballesteros M.F., (2010) A Qualitative Evaluation of Fire Safety Education Programs for Older Adults, Health Promotion Practice 11(2):216-25. http://dx.doi.org/10.1177/1524839908318169

[26] Mayhorn CB. "Warning the Elderly: Understanding and Overcoming Barriers to Risk Communication", 2012, Prepared for SUPDET 2012: National Fire Protection Association Conference in March 2012, available at: http://www.nfpa.org/assets/files/Research%20Foundation/2012%20SUPDET%20presentations/15-Mayhorn_paper.pdf, accessed 05/14/2013.

[27] Harpur A.P., Boyce, K.E., McConnell N.C., An Investigation into Fatal Dwelling Fires Involving Children Aged Five Years and Under, *Human Behaviour in Fire-Proceedings of the Fifth International Symposium,* 2012 pp.230-238.

[28] Brennan P., (1999) Victims and survivors in fatal residential building fires, Fire and Materials, 23(6):305-10. http://dx.doi.org/10.1002/(SICI)1099-1018(199911/12)23:6<305::AID-FAM703>3.0.CO;2-B

[29] Northern Ireland Statistics and Research Agency. "Mid-year population estimates: Home Population by sex & single year of age". 2013, available at: http://www.nisra.gov.uk/archive/demography/population/midyear/NI_Home_Pop_sya_(1961_2011).xls. accessed 05/142013.

[30] Hall J.R., "The Smoking-Material Fire Problem", National Fire Protection Agency; Fire Analysis and Research Division, Quincy, MA, 2010.

[31] Diekman S.T., Ballesteros M.F., Berger L.R., Caraballo R.S. and Kegler S.R., (2008) Ecological level analysis of the relationship between smoking and residential-fire mortality, Injury Prevention 14(4):228-31. http://dx.doi.org/10.1136/ip.2007.017004

[32] Boden J.M., Fergusson D.M., (2011) Alcohol and depression, Addiction 106(5):906-14. http://dx.doi.org/10.1111/j.1360-0443.2010.03351.x

[33] Ahrens M. "Smoke alarms in U.S. home fires". National Fire Protection Agency; Fire Analysis and Research Division, Quincy MA, 2011.