



## Review

## A review of the literature on human behaviour in dwelling fires

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## ABSTRACT

Most fire-related injuries and fatalities in the UK, and other parts of the world, continue to occur during fires in the home – incidents where it is acknowledged that human factors play a contributing role. Yet the field of fire safety lacks an up-to-date review of the literature on human behaviour during fires in domestic spaces. Given there is now a growing body of work looking at human behaviour in dwelling fires, a review of the literature in this area is timely. Drawing from published studies, this paper sets out what is currently known about human behaviour in dwelling fires and highlights the differences that appear to exist between these spaces and what is known and accepted about human behaviour in public, commercial and industrial spaces. This paper then goes on to consider the nature of “fire risk”, arguing that much of the work in this area continues to conflate, or fails to recognise the existence of, different types of risk profiles, instead considering fire risk as a single type of risk, based mainly on factors related to fatalities. However, research findings point towards fire risk as at least three separate forms: the risk of a fire occurring, the risk of fire injury and the risk of fire fatality. By drawing together the literature on human behaviour in dwelling fires this paper argues that those who survive dwelling fires cannot be considered as “near miss fatalities”, but instead must be treated as a separate and distinct group.

## 1. Introduction

The majority of literature on human behaviour in fires is focussed upon understanding human behaviour in fires occurring within public, commercial and industrial spaces – there is not a comparable body of literature focussing exclusively upon human behaviour in single family/occupant dwellings (Bryan, 1999; Kobes and Helsloot, 2010; Babrauskas, 2013; Thompson and Wales, 2015). Although Wood, Bryan, and Canter et al., incorporated studies of behaviour during dwelling fires in their early research into the area in the 1970s and early 1980s (Wood, 1972; Bryan, 1977; Canter, 1990), since this period it is an environment that has been largely neglected in comparison with non-domestic settings. Moreover, the literature that does exist on human behaviour in domestic settings is focussed upon the identification of occupant risk factors related to fire fatalities within dwellings (Brennan and Thomas, 2001; Sekizawa, 2005; Flynn, 2010; Graesser et al., 2009), or studies of smoke alarm response and evacuation from high-rise occupancies (Proulx, 1998; Sekizawa et al., 1999; Kobes et al., 2008; Barber, 2009; Mansi, 2013). These are of course important areas which need to be examined and understood. However, it is the case that such research has not been accompanied by a commensurate level of focus upon the behaviour and motivations of those who survive fires in single occupancy domestic environments – either with or without injury

(Canter, 1990; Bryan, 2002; Wales and Thompson, 2013). This paper will establish what is currently known about human behaviour in dwelling fires and highlight the differences that appear to exist between these spaces and what is known and accepted about human behaviour in fires that occur in PCI (public, commercial and industrial) spaces – presenting the case for why behaviour in dwelling fires is deserving of a greater research focus. In addition this paper will consider the nature of “fire risk”, arguing that dwelling fire risk cannot be considered as one single type of risk, instead it must be considered as three separate forms of risk: the risk of a fire occurring, the risk of fire injury and the risk of fire fatality. This paper asserts that despite efforts by some researchers to incorporate this distinction into work on dwelling fires, much of the effort in this area continues to conflate the three risk profiles, an approach which leads to an inaccurate and incomplete understanding of dwelling fires.

## 2. Methods

Internet searches of electronic databases (Google Scholar, Web of Science, EBSCOhost Research Databases) were undertaken using the keywords ‘human behaviour in fire’, ‘dwelling fire’, ‘domestic fire’, ‘fire injury’, ‘fire fatality’, ‘fire risk’, ‘fire incidence’, ‘fire mortality’. In addition, hard copy conference proceedings from Human Behaviour in

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Fire, Interflam, Asiaflam, Flame Retardants, and the IAFSS symposia were used along with a CD-based compendium of human behaviour in fire papers (Boyce, 2015). Statistical and government sites in the UK and USA with online publications and reports were accessed along with several online university repositories (the University of Greenwich, the University of Huddersfield, the University of Ulster, and the University of Surrey) and the library catalogue of the UK Fire Service College. The focus of this paper is on accidental dwelling fires (ADFs). Here the distinction has been made between fires that have been deliberately started, perhaps as a result of arson, and fires which occur accidentally within a residential environment. It is noted that in the UK the general assessment made by the attending fire crews is sufficiently broad to always be able to make a determination concerning whether the fire was deliberate or accidental, thus the proportion of undetermined fires in the UK is negligible. Furthermore, while primarily concerned with ADFs occurring in the UK, where relevant, and in order to support any wider points being made, this paper also considers circumstances within the USA, Canada, Australia, New Zealand, Sweden and Japan. The reason for the inclusion of these particular countries is because of their status as leading sources of research into human behaviour in fire and papers published in English on this subject.

### 3. Definition of terms

The terms ‘fatal casualty’ (also referred to as fatality, fire fatality or fire-related death) and ‘non-fatal casualty’ (also referred to as injury) are often used in fire studies and while their definitions may appear self-explanatory, they can have different meanings to various audiences. The Home Office (the UK government department with responsibility for collecting and publishing fire statistics) attaches specific meanings to these terms. Fire fatalities are described as a death which is the direct or indirect result of injuries caused by the fire (Department for Communities and Local Government, 2015). In this case a direct result would be a person being overcome and dying from exposure to the smoke and products of combustion, or through burns from the flames. An example of indirect result would be of a person jumping from a building to escape a fire and subsequently dying of the injuries sustained as a result of the fall – while not injured by the fire itself, the actions the person undertook because there was a fire may be considered to have led to their death. The death could also occur weeks or months later as the timescale extends for 364 days after the date of the fire, thus giving a cut-off date of a year. With ‘non-fatal casualties’ the following four groups are defined by the Home Office for incident reporting standards: those given first aid at the scene of the fire; those taken to hospital with slight injuries; those taken to hospital with serious injuries; and those for whom there does not appear to be any obvious sign of injury or shock, but who are advised to attend hospital or see a doctor as a precaution (Department for Communities and Local Government, 2015). Thus UK fire statistics concerning non-fatal casualties cover a range of injuries, from very minor (not requiring hospitalisation) to very serious (requiring hospitalisation potentially for an extended period) without distinction. This paper also uses the abbreviation FRS when referring to the fire and rescue service (also known as fire brigades or fire departments).

### 4. Fire, fatality and injury trends in the UK

Perhaps the most striking aspect about the numbers of reported fires in the UK is the scale of the decline that has taken place since the millennium. In the space of 15 years, total recorded fires of all types have more than halved, falling from 445,000 in 2000/01 to 200,000 in 2015/16 (the peak of 572,000 fires occurred in 2003/04). Similarly, over the same period, ADFs witnessed a drop of approximately one third from 54,000 to just under 35,000 (Department for Communities and Local Government, 2015; Home Office, 2016; Fire and Service, 2016; Welsh Government, 2016). A similar picture is evident for fire-

**Table 1**

Fatalities and injuries for all fires and ADFs, 2000–2015.

Year	All fire fatalities	ADF fatalities	All fire injuries	ADF injuries
2000/01	554	363	16,542	11,263
2001/02	583	404	16,907	11,348
2002/03	522	341	15,055	10,200
2003/04	576	359	15,228	10,226
2004/05	483	322	13,672	9476
2005/06	470	286	13,578	9323
2006/07	430	249	13,088	8902
2007/08	458	291	12,669	8714
2008/09	404	268	11,533	7987
2009/10	416	275	10,652	7244
2010/11	388	268	11,134	7776
2011/12	380	244	11,300	7729
2012/13	350	217	10,300	7354
2013/14	322	219	9748	6872
2014/15	325	209	9232	6496
2015/16	367	237	9493	6490

Source: DCLG (2010, 2015), Home Office (2016), Scottish Fire and Rescue Service (2016), Welsh Government (2016). NB. From 2008, data collected changed from the UK to Great Britain.

related fatalities and injuries during the period 2000/01–2015/16 (Table 1). The number of fire fatalities have fallen by more than 30% and fatalities occurring in ADFs specifically have declined by 35%. Although, it is worth noting that, as with overall fire fatalities, a few increases in ADF fatalities were recorded during this 15 year period (Department for Communities and Local Government, 2015; Home Office, 2016; Fire and Service, 2016; Welsh Government, 2016). Fire-related injuries also displayed strong downward trends, declining by more than a third albeit, as with fatalities, with some slight increases during this period. This overall downward trend (and the years that saw sporadic increases) was similarly observed for injuries occurring in ADFs, the number of which fell by over a third (Department for Communities and Local Government, 2015; Home Office, 2016; Fire and Service, 2016; Welsh Government, 2016).

However, it has not always been a story of decline. The number of fires in 2015 is around double that experienced in 1950 – a trend that may appear to correlate with the growth in the number of UK dwellings since 1950 (there are now twice as many dwellings – approximately 28 million in 2014 (Department for Communities and Local Government, 2016) – while the population is a third greater – 64 million in 2013 (Jefferies, 2005; Office for National Statistics, 2018) – than in 1950). As Fig. 1 shows, however, there was actually a period of growth that was then halted and reversed. The number of dwelling fires underwent a steady increase since 1950, slowing somewhat through the 1980s and 1990s before beginning to decline at the start of the millennium. The point to note here is that – accepting that the figures represent an amalgam of both deliberate and accidental dwelling fires, the distinction only being made from year 2000 onwards – the fall in reported dwelling fires means that in the space of 15 years the current figure has fallen to approximately the same level as in the late 1960s.

To make international comparison possible, Fig. 2 presents UK dwelling fires per 100,000 people for the same period (1950–2015). It is interesting to note that since the millennium the number of fires per 100,000 people has halved, despite a ten percent increase in the population over the same period.

An overview of dwelling fire fatalities since 1960 shows that their downward trend was first observable at the end of the 1970s, with the number of fatalities declining by 47% in the period 1979–2000 and then by a further 38% in the period since the millennium (Department for Communities and Local Government, 2015; Home Office, 2016; Fire and Service, 2016; Welsh Government, 2016) (Fig. 3). It may be reasonable to assume that these figures will be subject to historical limitations imposed by the varied data collection and reporting standards of different FRSs – and in some countries that may be the case.

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