Influences on Resident's Fire Safety Behaviours: An Evidence Review

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Views expressed in this report are those of the researcher and not necessarily those of the Welsh Government

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Glossary

Acronym/Key word	Definition
Category 1 building	All buildings 18m and above
Category 2 building	All multi-occupied residential buildings below the 18m Category 1 threshold
Meta-analysis methodology	Examination of data from a number of independent studies of the same subject, in order to determine overall trend
Visual acuity	Visual acuity refers to a person's ability to see small details. It is also referred to as clarity of vision or sharpness of vision.
Cognitive ability	The ability of the brain to process, retrieve, and store information.

1.   Introduction/Background

1.1   The Building Safety Team commissioned Sustainable Futures Research Team in the Welsh Government's Knowledge and Analytical Services to undertake an evidence review on available evidence on the human influences in dwelling fires, specifically in multi-occupied buildings. The literature searches were carried out by the Welsh Government Library Services. This review of the results was prepared by using the identified evidence from the literature searches.

Aims and Objectives

1.2   The aim of this literature review was to investigate available evidence on the influences of human behaviour in fire situations. The search was specific to scenarios related to multi-occupied building dwelling fires, however, much of the evidence does relate to dwelling fires more generally, including in ordinary houses The Welsh Government building safety regime differentiates between Category 1 and Category 2 buildings. Category 1 buildings are those which are 18m and over and often referred to as 'high-rise buildings'. Category 2 refers to all multi-occupied buildings below the 18m Category 1 threshold. A multi-occupied building is a residential building where there are two or more dwellings, regardless of whether there is a shared front door to the building. The literature tends to refer to high-rise buildings however this review refers to multi-occupied buildings.

2.   Methodology

2.1   This report is based on a literature search carried out by the Welsh Government Library Services. The searches were carried out between 03/09/2021 and 17/09/2021. The table of results provided from the search is given in Annex A and detail on the specific search strategies is presented in Annex B. The review used a meta-analysis methodology to review the sources and summarise findings. Library services collected research from the following types of sources: Journal articles, theses, and reports. Evidence was included if it was of sufficient quality in line with social research standards and if it was publicly available.

Scope

2.2   The evidence gathered consisted of research reports/papers. Initially only UK evidence was in scope of the review. However, due to the small number of results returned (20), international papers were included in the final review (nineteen). The international papers have been included as they provide a useful insight into the topic but should be applied cautiously to a Welsh context as influences may differ between countries with different social and political context. There were no restrictions on the age of publication; however, the majority (33) of the results found were dated within the previous 5 years at time of collection.

2.3   Seventy results were produced from the search, however only 39 of these have been considered in this review. Those which have not been included did not relate to human behaviour or the multi-occupied buildings context. Of the 39 sources reviewed 26 have focussed on personal risk factors in fire (e.g. influence of personal characteristics and behaviours) whilst 13 cover general risk factors (e.g. building conditions and fire planning). It should be noted that much of the evidence does relate to dwelling fires more generally, as opposed to exclusively multi-occupied buildings.

2.4   Annex C outlines the sources which have not been included and the rationale.

3.   Findings: Summary of the Literature

Personal Risk Factors

3.1   The following sections will outline personal risk factors on fire safety behaviours. These sections will discuss the available evidence on age, impairments, experience of fire, risk perception, condition at the time of fire, priorities in fire and socioeconomic/ demographic background. Gaps in the evidence regarding these topics will also be highlighted. The topics of age and impairments proved most prominent in the literature whilst there are significant gaps in the literature available on the impact of socio-economic/demographic background on resident's fire safety behaviours.

Influences of Age on Fire Safety Behaviours

3.2   One of the most prominent topics to appear in the literature reviewed was the impacts of age on fire safety behaviours, with 12 sources covering the topic in total. The evidence available focused on older people with data on children and young people being limited in scope. Older people can be defined as individuals over the age of 65. Nine sources covered the topic of old age whilst six considered children and young people. The following section will discuss the evidence available on the experiences of older people and children and young people in fire.

3.3   The literature consistently suggests that older people are one of the groups who are at highest risk of home fires. They are also found to have the lowest preparedness and slowest reactions to this (Karemaker et al. 2021; Choi et al. 2020; Geoerg et al. 2019; Social Engine 2019; Thompson et al. 2018; Oswald 2021). It has been found that older people often lacked knowledge on risk behaviours that may start a fire or sources of fire, putting them at risk of having a fire in their home. Determinants that are found to influence fire safe behaviour among older people are risk perception, self-efficacy, habits, and perceived barriers such as physical disabilities. Older individuals perceive the risk of home fires as low while feeling confident in their abilities to act in case of a fire (Karemaker et al. 2021).

3.4   The evidence indicates that numerous factors put older people at risk of fire-related injuries and fatalities including physical aspects, such as a decrease in their

physical health and mobility or vulnerability to injuries, mental aspects such as reduced cognitive capacities or social isolation, and behavioural aspects such as using below-standard or old electrical appliances. Other contributing factors include physiological changes such as thinner skin, decrease in visual acuity or the use of certain medications (Karemaker et al. 2021).

3.5   Older populations are some of the most vulnerable when evacuating a building fire because they are more likely to face issues due to lower mobility, distortion or confusion in situational perception, hearing and visual impairments and problems retaining focus over longer periods of time. The most common cause of complications with older populations includes cognitive disabilities such as dementia, making it difficult to evaluate one's surroundings quickly and accurately and acting in a safe manner, even if one does not have any other impairments (Choi et al. 2020; Karemaker 2021; Oswald 2021; Thompson 2018; Geoerg 2019). Additionally, evidence suggests that following a fire, older age causes restrictions in one's ability to recover from injuries (Thompson et al. 2018).

3.6   The evidence available on children and young people in fire is more limited in scope than the evidence on older people. Nevertheless, six sources did cover the topic of children and young people in fire. Lambie et al. (2018) suggest that younger adults between ages 18 and 24 are one of the most likely groups to participate in unsafe fire behaviours. Moreover, young children are often at higher risk of injury in fire as they lack the experience to recognise the risk posed by fire and often face difficulties being woken by smoke alarms (Thompson et al. 2018).

3.7   Children are also less likely to be able to evacuate a fire unaided; however, studies have also found that households with children are more likely to practice a fire-escape plan (Tannous and Agho 2019). Mytton et al. (2017) contend that children and young people are some of the most vulnerable populations in fire situations. However, they conclude that there is inadequate evidence of the current lived experience of children in accidental dwelling fires to support fire and rescue services in either their fire and rescue training or community fire safety education activities, particularly for non-US countries.

Impacts of Physical and Mental Impairments in Fire Situations

3.8   Fifteen of the sources reviewed focused on the influence that physical and mental impairments can have on the behaviours of people in fire scenarios. The literature highlights that considering the different experiences of people with certain impairments is important to ensure safe fire behaviours. The following section will discuss the available evidence on the experiences of individuals with impairments in fire situations, with explanation into the way different impairments can affect residents in different ways.

3.9   Individuals with impairments are vulnerable to conditions of a fire as they may face difficulties responding to warning signals or evacuating buildings, especially in the case of multi-occupied buildings (Wales 2021; Egodage et al. 2020; Glauberman 2020; Geoerg et al. 2019; Tan and Moinuddin 2019; Butler et al. 2017; Oswald 2021; Choi 2020; Gaire et al. 2018; Gerges et al. 2021; Gerges 2020; Social Engine 2019; Karemaker 2021; Suvar et al. 2019; Xiong et al. 2017).

3.10   Those with impairments can face challenges when performing self-rescue activities, understanding announcements, and receiving warnings meaning that access to guidance and support is vital in the event of a fire (Egodage et al. 2020). Therefore, when evacuation is needed the evidence suggests that in order to ensure protection of residents with impairments appropriate evacuation procedures are key to ensuring safe evacuation for all.

3.11   The literature suggests that it is important to consider the way in which various impairments can affect residents on an individual basis, especially in fire situations (Egodage et al. 2020; Choi et al. 2020; Geoerg et al. 2019; Butler et al. 2017; Suvar et al. 2019). Those with mobility impairments will face movement restrictions during the evacuation process of a building, as extra support from another individual or mobility device is often required in these circumstances.

3.12   Individuals with visual impairments require clear guidance to ensure safe evacuation. Evidence highlights those individuals with visual impairments recommend properly designed handrails, appropriate colour contrasting, tactile signs and evacuation plans in braille, large sized or tactile characters as necessary for safe evacuation (Egodage et al. 2020).

3.13   One of the most common forms of impairments discussed in the evidence is hearing, which can also cause difficulties in fire situations, mainly related to communication issues. In emergencies, those who are deaf or have a hearing impairment may have trouble receiving information or signals of a hazard; this can delay reaction times and lead to unsafe evacuation (Egodage et al. 2020; Choi et al. 2020. Those with hearing impairments may often be reliant on others or visual signalling so it is essential these are clear (ibid).

3.14   Speech impairments are also a factor that can influence one's ability to communicate with others in fire situations, potentially meaning information is not received (Egodage et al. 2020).

3.15   Choi et al. (2020) find that limited perception due to visual, auditory, or cognitive impairment can result in a failure to recognise crucial fire-related cues (e.g., smoke, fire alarms, vocal or gesture-based communication, general egress behavior). It can also cause the disruption of an evacuee's attempt to take the necessary steps toward interpreting the situation at hand and forming the appropriate strategies to deal with the risks that they might encounter while vacating the premises (ibid). For example, an individual with a hearing impairment will be aware of a fire situation much later than an individual without, as they cannot respond to alarm signals (ibid). The literature suggests that it is vital to distinguish the respective attribute of each vulnerable group and create evacuations planning to suit the needs of all to enhance performance in fire situations (ibid).

3.16   In interviews with participants with mobility impairments conducted by Butler et al. (2017) those with an impairment expressed their desire not to be the final person out of the building in evacuation whilst using an emergency stair travel device. Another primary concern of respondents in this research is the scenario of leaving behind their mobility devices, particularly those who used power wheelchairs (ibid). Although emergency stair travel devices allow for safe escape, powered wheelchairs are often left behind meaning once evacuated individuals have lost their mobility and independence. This impairs these individuals in the short-term evacuation and the longer-term recovery period until given access to a similar device. The evidence often called for the use of elevators to evacuate differently

abled people from higher floors of a building (ibid). However, it should be noted that this evidence related to the workplace, rather than a residential building.

Knowledge and Experience of Fire

3.17   Within the literature, twelve sources examined the impact occupant's previous knowledge and experience of fire has on their reactions and behaviours in fire. The following section will discuss the way in which resident's previous knowledge and experiences of fire can influence their reactions to a fire situation. It is apparent in the literature reviewed that some form of knowledge or experience of fire safety positively influences responses to fires, as does involvement with the building's community.

3.18   The evidence suggests that having experience of a residential fire has an impact on an individual's fire safety behaviours (Hulse et al. 2020; Nilson and Bonander 2020; Glauberman 2020; Gerges 2020; Tan and Moinuddin 2019; Thompson et al. 2018; Proulx 2001a; Proulx 2001b). Individuals with previous experience of residential fire are more likely to have fire plans in place and a higher probability of having a functioning smoke detector. Having a direct experience with multi-occupied building fires meant that occupants were more likely to invest in improving household fire safety such as purchasing supplies and planning evacuation with more awareness of evacuation routes (Nilson and Bonander 2020; Glauberman 2020).

3.19   There is evidence that fire safety and building community/ leadership are linked. The evidence from Glauberman (2020) suggests that those who are actively involved in the building's community in multi-occupied buildings are more likely to have higher levels of fire preparedness. This includes individuals who attend board meetings, had served on the resident board of directors, or maintained personal connections with their buildings' managers or staff. In addition, residents who lived in buildings with a greater degree of fire safety leadership were more likely to possess fire safety equipment and had greater confidence and trust in building leadership (ibid). Examples of building-level fire safety leadership included fire safety inspections, enforcement of rules, evacuation drills, communication to residents, and establishing linkages with the local emergency preparedness agencies (ibid). In buildings with less evidence of fire safety leadership, residents

felt that building management should take more initiative on fire safety efforts on behalf of residents (ibid).

3.20 It was also evident that those who lived in a household where at least one member had received some form of fire safety training were more confident in their ability to prepare for fires and were more likely to adopt pro fire safety behaviours (Glauberman 2020). For example, participants who had worked in nursing, in the military, or with utility companies maintained a very high level of household fire preparedness.

3.21 School fire safety education has also been proven influential amongst other household members, with parents of children who received fire safety training benefiting from their children's education (Glauberman 2020). School fire safety education was also very influential among participants in generating positive beliefs about self-efficacy for fire preparedness (ibid).

3.22 The literature also found that gender may also play a part, Tannous and Agho (2019) found that males are more likely than females to have an understanding of what to do in the event of a home fire and are more likely to have an evacuation plan in place.

3.23 In contrast to this evidence, Tong and Canter (1985) argued that occupants who have already experienced fire are less likely to evacuate as they believe they have learnt how to tackle the threat themselves, occupants tend to take risks to tackle the fire themselves before evacuating. Whilst this raises an interesting point, it should be noted that this evidence is dated.

Perceptions of Risk and Decision Making

3.24 An important aspect of fire situations was the influence of an individual's perception of risk and reaction to early warning signals influencing their decision-making. This was discussed in fifteen sources reviewed. The following section will expand on this topic, discussing the varying responses of residents to fire situations.

3.25 Research by Glauberman (2020) determined that in the case of multi-occupied buildings, residents on lower floors described a lower perception of risk from fire in comparison to those on the higher floors. This is due to their closer proximity to the

ground and the option to escape from a window or balcony. However, this sense of security means those residents on lower floors are less inclined to prepare for evacuation or initiate evacuation immediately in response to a fire alarm (Glauberman 2020).

3.26 The literature also stated that in the case of fire, residents are likely to take the role of a follower, ignoring signals they perceive themselves and wait for reactions of other residents before taking action. There is often a leader in fire situations whose decisions are followed by the entire group. Gerges (2020) findings show that where there are multiple exit options, household decision makers tend to choose the most crowded exit paths due to seeing others heading towards it (becoming followers themselves) which can lead to overcrowding, queues and subsequent delaying of evacuation. Decision makers and those who follow are likely to base their response off other individuals, as one of their primary concerns is how they are going to be judged by others or how they can best avoid embarrassment (Cuesta et al. 2021; Wales 2021; Gerges 2020).

3.27 The influence of panic on behaviour during a fire is contested in the literature. Proulx (2001a) identified that the first reaction of people involved in a fire situation is to panic. They define panic in a fire situation as being frightened, scared, nervous or anxious but that it usually does not include the application of irrational behaviour. Proulx (2001a) presented a list of factors that have an impact on human behaviour during an evacuation namely: knowledge and experience. The reaction of panic remains a common expectation of residents in multi-occupied building fires. This belief appears, at least in part, to be an outcome of overly exaggerated reporting by media that seem unable to differentiate between fear and panic (Gerges et al. 2018).

3.28 Conversely, further research by Proulx (2001b) found that there is actually little evidence of panic in fire situations, occupants are often fearful but mostly react in a coordinated manner. Whilst the evidence from Proulx (2001a and 2001b) raises an interesting point, it should be noted that this evidence is dated. However, further contemporary research supports this claim, finding that people are likely to help

others before themselves, especially if they are familiar to each other (Wales 2021; Thompson et al. 2018; Gerges et al. 2018).

3.29   Within the literature, it is evident that there are a range of warning signals or cues in a fire situation which alert residents of fire such as fire alarms, smelling or seeing smoke, reactions of others, flames and heat (Glauberman 2020; Choi 2020; Gerges 2020; Thompson et al. 2018; Gerges et al. 2018). Repeated exposure to fire alarms through alarm testing and false alarms has been found to desensitise people meaning they are not perceived as a serious cue (Glauberman 2020; van der Wal 2019; Gerges et al. 2018; Gerges et al. 2017). Cues which are taken more seriously and prompt people to take actions include seeing smoke or fire, hearing people shout, seeing emergency services and being instructed to evacuate. All of this creates a delay in evacuation as residents wait for the reactions of others before deciding to take actions themselves.

Condition/ Activity at time of Emergency

3.30   Within the evidence, eight sources highlighted the impact smoking, alcohol and drugs can have on accidental dwelling fires. This section of the review will discuss the apparent implications of alcohol, smoking and drugs behaviours in fire situations and the way in which they pose as a risk. There is also an exploration of the data available on the way in which activities such as sleeping may impact an individuals' response to fire.

3.31   Discarded cigarettes and smoking materials have consistently been identified as the leading cause of unintentional residential fires within the international based literature (Oswald 2021; Social Engine 2019; Thompson et al. 2018; Xiong et al. 2017). Statistics specific to the United Kingdom highlight that the main source of ignition in accidental dwelling fire fatalities is smokers' materials (such as cigarettes, cigars and pipes) which results in over a third of all fatalities (37%) (Thompson et al. 2018). The three main sources of ignition in cases of accidental dwelling fire injuries are cooking appliances, other electrical appliances and smokers' materials. The literature also suggests that being intoxicated with either drugs or alcohol has significant impacts on the reactions of occupants in fire situations (Oswald 2021; van der Wal 2019; Social Engine 2019; Suvar et al. 2019 Thompson et al. 2018).

3.32   Evidence also suggests that there is an increased risk that children of smokers will have a greater likelihood of obtaining lighters and matches in the house in an unsafe manner (Thompson et al. 2018). Research results have shown that individuals who have died in smoking material fires are more likely to present with multiple impairments in comparison to those who died in non- smoking material fires (ibid). Significant associations have also been identified between mental illness, psychotropic and sedative drug intake and the risk of smoking material fires (Xiong et al. 2017).

3.33   Short-term residents are more likely to break the rules around smoking in multi-occupied buildings such as smoking on the balcony (Oswald 2021). This leads to fire alarms often being set off meaning they were frequently ignored and presumed as a false alarm. A study from Steen-Hansen (2021) showed that the dominating risk factors for experiencing fires, injuries and fatalities all fall under social problems categories in the medical context. Examples of such factors are reduced mobility (discussed previously), impaired cognitive ability, drug abuse and being influenced by alcohol at the time of fire (ibid).

3.34   New Zealand (NZ) fire service has identified that 50% of fatal residential fires involved alcohol (Social Engine 2019). Further, these frequently involved people who attempted to cook whilst intoxicated, often after returning from a night out. This discovery led to the NZ 'Don't Drink and Fry' campaign, which aims at discouraging young people from using cooking appliances after consuming alcohol (Social Engine 2019). According to Romanian statistics, at least 10% of fatalities in residential fires in Romania were affected by alcohol and other types of drugs at the time of death (Suvar et al. 2019).

3.35   The evidence has shown that the activity or condition of an individual at the time of fire is another influence on reaction to fire situations, eight sources covered this topic. Unlike other multi-occupied buildings, residential buildings are spaces where residents are often asleep. This often leads to a delayed response to the fire and subsequently the evacuations (Oswald 2021; Gerges 2020; Thompson et al. 2018). The literature has argued that in these situations those who are most vulnerable are compulsive hoarders, those under 5 and over 64 years old, those with cognitive and

physical impairments, or people intoxicated by drugs or alcohol. In the case of people with hearing problems, people on sleeping pills, an alarm signal should have a sound level of more than 100 dBA so it can be heard (ibid). Additional to the prospect of being asleep at the time of fire, occupants may also be cooking or completing other tasks or may not be dressed, which can delay evacuation speeds (Gerges 2020).

3.36   Additionally, evidence produced by Gerges (2020) shows that wearing cultural or religious clothing could often slow down evacuation speeds, often affecting women needing to lift or carry longer garments. Data from the same source also argues that wearing high-heeled shoes of 7.6cm or above can cause a decrease in walking speed by 10-15% (ibid). It has also been identified that evacuation speeds in the winter periods are often longer due to residents putting on coats/jackets and warmer footwear (ibid).

Priorities and Bonds to People, Pets and Possessions

3.37   The priorities or bonds to people, pets and possessions in dwelling fires have been proven influential within the available evidence, seven pieces of literature covered this topic. These aspects are discussed in the literature as an influence an individual's response to fire, possibly delaying evacuation times or causing danger to themselves. The movement of occupants can depend on various factors, with strong social bonds to others around influencing the exit route/method as occupants try to stay within a group for as long as possible (Oswald 2021).

3.38   Some of the most notable priorities for individuals set out in the literature include avoiding embarrassment, mitigating impact to their property, avoiding the risk of being unable to remain in their home, concern for others, pets and possessions. To pursue these priorities often leads to unsafe actions that are not aided by fire safety professionals and evidence suggests that the public will often ignore professional advice in order to protect these aspects (Wales 2021).

3.39   There is significant evidence showing that residents are likely to attempt to tackle the fire themselves, numerous different aspects can instigate this however, and it is evident in the literature that many people tackle fires themselves to protect key rooms in their homes such as the kitchen to avoid being rehomed. Wales (2021)

argues that the natural instinct to protect things we cherish from harm can lead to self-appointed firefighting when the desire to protect people, pets and possessions from danger is apparent. Selfish behaviour in fire has been identified as rare, whilst the literature shows that the public are not likely to follow 'the myth of panicking'.

3.40   Within a dwelling fire, people are likely to attempt to tackle the fire and re-enter residential buildings, whilst these behaviours are rarely seen in other types of buildings (Lin et al. 2020; Tan and Moinuddin 2019). This is likely due to the stronger attachments residents have to physical belongings as well as stronger social bonds in residential buildings motivating them to protect their relatives and friends via fire-fighting behaviour and returning into buildings to help.

Socioeconomic and Demographic Factors

3.41   Of the data available specific to the United Kingdom there were significant gaps in the evidence relating to the influence of being from a Black, Asian and Minority Ethnic background or an individual's socioeconomic/sociodemographic status. Within the literature only four sources covered this topic (Nilson and Bonander 2020; Thompson et al. 2018; Tannous and Agho 2019).

3.42   Although there is limited data available for a UK context, there are many international examples available for this topic. These examples are valuable as they show possible scenarios but should be used cautiously when applied to a UK context due to societal differences and potential differences in building standards and structures.

3.43   A study completed by Nilson and Bonander (2020) in Sweden showed that a number of socio-demographic risk factors are evident in fire safety behaviours. These included being male, living alone, belonging to a Black, Asian or Minority Ethnic background, having low educational attainment, as well as other deprivation-related factors such as having a low disposable income, receiving social allowance, being unemployed receiving health-related early retirement pensions etc. Additionally, this research has shown that the risk of fire occurring is highest amongst those who are well-educated, high-income households compared to the rest of the population. Therefore, it would seem that in Sweden it is not that

vulnerable socio-demographic groups have a higher risk of fire but rather a reduced ability to hinder fire growth and/or evacuate.

3.44   Specifically, data from Australia has found that safety equipment is significantly less prevalent in the homes of ethnic minorities, single-households, low-income families and families in rented accommodation. In their study on the 16 fatal fires that occurred in 2001 in New South Wales, Australia, Lewis and Lear identified those from non-English speaking backgrounds as being at increased risk (Thompson et al 2018.). However, this was because those who originated from non-English speaking backgrounds were overly represented in other risk groups such as low socio-economic status and living in public sector housing. It also raises an interesting question about whether a lower standard of English impaired their ability to access and interact with government and local authority services – including sources of home fire safety advice. Research by Tannous and Agho (2019) supports this finding suggesting that participants who spoke languages other than English at home were significantly less likely to have a working smoke alarm. They argued this could be because they may be recent migrants, and therefore more likely to live in poorer households, be unemployed, or be unaware of regulatory requirements.

3.45   It has been argued that the quality of housing is closely related to deprivation and the associated risk factors surrounding the incidence of dwelling fires. Other factors associated with poor quality housing are overcrowding (increasing the risk of injury should a fire start), and poor maintenance of communal areas, escape routes, and smoke alarms. Evidence from Thompson et al. (2018) suggests that although in the USA it has been argued that those from Black, Asian and Minority Ethnic communities are at higher risk of experiencing an accidental dwelling fire, within the UK, there appears to be no clear link between ethnicity and fire risk in the literature reviewed for this report.

General Risk Factors

3.46   The following sections will outline general risk factors to fire safety behaviours. These will be focused on the implications that building structures, information and technology can influence human behaviours. These sections will discuss the

available evidence on evacuation routes, evacuation plans, fire equipment, overcrowding at time of fire and communication equipment.

3.47   Gaps in the evidence regarding these topics will also be highlighted. Evacuation routes and evacuation instructions proved most prominent in the literature whilst there are evidently significant gaps in the literature available on the impact of communication equipment. Although limited in number, the information available on communication equipment in fire provides interesting insights in how they can be applied in these situations.

Evacuation Routes Available

3.48   Within the evidence there was an obvious theme of the influence general risk factors have on an individual's behaviours during fire, mostly relating to structural or communication issues. The most prominent topic within this theme was the availability of exit routes and aspects which influenced residents exit choice. It is clear that general risk factors are a highly influential topic.

3.49   The available evacuation routes and methods was a prominent theme within the evidence with 16 sources providing data on the topic. During a fire emergency, the complexity of buildings and layouts, such as in multiple occupancy buildings, can be confusing and adds unnecessary stress to the building residents. It is likely in emergency situations that residents will choose the most familiar or nearest exit choice (Gerges 2020; van der Wal 2019; Kurdi et al. 2018; Gerges et al. 2018). It is noteworthy that, even though people may be familiar with a building in normal conditions, they may still find certain escape routes and emergency exits unfamiliar during emergencies (Oswald 2021; Lin et al. 2020; Gerges 2020; Butler et al. 2017).

3.50   Problems during a fire arise because systems are often put in place with false expectations regarding how occupants behave during fire (Gerges 2020). An adequately short escape time depends on characteristics of the fire such as growth, obstacles in the path, smoke yield, toxicity and heat generated. It also depends on human characteristics such as personality, observational abilities, responsibility for others and familiarity with the layout of the building (Gerges 2020; Suvar 2019). As stated previously, occupants will tend to evacuate utilising familiar routes and usually these routes are via the main entrance to the building. Additionally, as

argued by Gerges (2020) and Tan and Moinuddin (2019) occupant fatigue due to travel distance in multi-occupied buildings often requires stopping to rest.

3.51   The literature also places attention on the topic of elevator use in fire situations (Gerges et al. 2021; Gerges 2020; Tan and Moinuddin 2019; Thompson et al. 2018; Gerges et al. 2018; Egodage et al. 2020; Glauberman 2020; Sheeba and Jayaparvathy 2019; Butler et al. 2017; Ronchi and Nilsson 2013). Occupants have always been trained and warned not to use elevators when evacuating. In the last decade, this theory has started to be challenged due to the challenges occupants face during stairs evacuation. For example, disabled occupants unable to use stairs and crowd size affect the walking speed of occupants (as discussed earlier in this review). However, most lifts in residential buildings in the UK are not designed to be used for evacuation – eg the lift car, lift shaft and power supply are not suitably protected from fire. Those that are so protected tend to be "firefighting lifts", used by firefighters to access upper floors quickly, and again not suitable for evacuation.

3.52   The results of research conducted by Gerges (2020) clearly indicate that a combination in the use of stairs and elevators could speed up the evacuation of a building by 50% compared to just using the stairs. Furthermore, the time it may take to evacuate either by stairs or elevator tends to influence people's choices. Smoke or fire filling the stairs was the main concern of occupants followed by crowded stair evacuation that could cause delays and increase the evacuation time (reaching ground level). Slip or trip on the stairs was another challenge raised in addition to the stairs being dark and difficult to see in Gerges (2020) work. From the research findings, it is clear that occupants have concerns when using either the stairs or the elevators for evacuation. The paper also finds that occupants remain reluctant to use an elevator during evacuation in fire event, irrespective of any signage clearly stating that is appropriate to do so in the context of modern lift technology.

3.53   Additionally, mobility impaired participants described many benefits that would be gained if the option to use elevators were available to them. These include familiarity and ease of use (especially in the case of existing passenger elevators), the ability to move many people quickly, and the safety and independence of remaining in their own mobility devices through the building and get to a safe place.

However, Gerges et al. (2021) suggest that allowing the use of elevators for the benefit of disabled occupants could lead to their misuse by able-bodied occupants.

Evacuation Plans and Instructions

3.54   A common topic suggested in the general risk factor's theme falls under the importance of proper evacuation planning and instructions, 13 pieces of literature covered this topic within the search. The literature on this topic broadly highlights the need for clear evacuation plans and instructions which fit the requirements of all occupants regardless of personal factors which may influence their behaviours, this is important before, during and after an emergency to maintain safety of residents (Arewa et al. 2021; Egodage et al. 2020; Glauberman 2020; Gerges 2020; Tannous and Agho 2019; Kurdi et al; 2018; Gerges et al. 2021; van der Wal 2019; Tan and Moinuddin 2019; Gerges et al. 2018; Gerges et a. 2017; Oswald 2021). The following paragraphs will expand on these ideas.

3.55   Literature produced by Arewa et al. (2021) and Tan and Moinuddin (2019) has highlighted the importance of successful evacuation instructions, following the Grenfell Tower Fire in 2017. The National Fire Protection Association claims that fire incidents are common to high-rise structures; but incorrect emergency services response and poor communication with building occupants often exacerbated the rate of fatalities. Grenfell Tower, like almost all blocks of flats in the UK constructed since the early 1960s, was designed on the basis that residents should "stay put" – unless residents are affected by the fire, heat or smoke, they are advised to stay in their flat. In some cases, residents were advised to stay in their flat as conditions within the flat were deemed safe.

3.56   The Grenfell disaster exemplifies how occupants' behaviour can be affected by their interpretation of the evacuation instructions received when they are in a situation of interpreting such instructions without any 'expert' or authoritative input (such as they may rely on when being 'marshalled' out of a work environment) within their own homes that contain items of both financial and emotional value (LeGood, 2017).

3.57   Historically, fire incidents in multi-occupied buildings reveal that a firefighting response generally reflects the "stay put" approach to building design and construction (i.e., occupants of multi-occupied buildings should remain in their

apartments) during a fire. The National Fire Chiefs Council (NFCC) supports a 'Stay Put' policy wherever possible as it currently reflects the building regulation requirement that each flat should be its own fire-resisting compartment – therefore effective compartmentation is key for this strategy. Recent fire occurrences in multi-occupied buildings reveal that there are two opposing viewpoints on the stay-put tactic. The study by Arewa et al. (2021) contended that the stay-put tactic is obsolete, with the potential to cause catastrophic misjudgement, mostly during destructive fires in multi-occupied buildings. Arewa et al (2021) arguing that there is a need to advance research on the use of artificial intelligence communication systems and infrared image detectors to enhance quick and smooth fire evacuation in multi-occupied buildings. However, this would not overcome the fact that buildings are not designed and constructed to support a simultaneous mass evacuation via a single stairwell while also allowing access for firefighters via the same route.

3.58   A review of contemporary literature regarding fire in multi-occupied buildings reveals flaws in emergency decision-making, ambiguous fire safety regulations and choice of building materials. For example, many multi-occupied building fire reports cite poor evacuation plans, obscure emergency response/decision making, use of inappropriate fire-resistant building materials, lack of clear fire safety regulations or combination of these factors as reasons for high casualties and wanton destruction of properties. Physical vulnerability goes well beyond the flammable cladding, with many other fire safety defects emerging, including defected fire doors, issues with fire-resistant glass, and problems with egress routes (Arewa et al. 2021; Oswald 2021).

Fire Equipment

3.59   The literature reviewed also covered briefly the topic of fire safety equipment, their use in accidental dwelling fires and their availability to occupants. Within this evidence search, nine sources mention the use and availability of fire equipment in emergencies (Wales 2021; Glauberman 2020; Gerges 2020; Karemaker 2021; Tannous and Agho 2019; Thompson et al. 2018; Nilson and Bonander 2020; Social Engine 2019; Tan and Moinuddin 2019).

3.60   Evidence suggests that residents are likely to attempt to tackle fire themselves
        before calling 999 to avoid a sense of embarrassment. Residents also often take
        risks to save property and minimise loss in an emergency (Wales 2021; Gerges
        2020). However, it has been suggested that provision of fire extinguishers is usually
        low (Glauberman 2020; Wales 2021) limiting the ability of residents to tackle the fire
        themselves. When fire extinguishers are available, those with mental or physical
        impairments cannot rely on using fire extinguishers and usually rely on different
        safety interventions.

3.61   There are many different forms of fire equipment and detection tools. The literature
        suggests that smoke detectors/alarms are the most common form of equipment tool
        as they form the basic fire safety standard for many countries. As the top priority will
        always be preserving occupant's lives, detectors are required to make occupants
        aware early of fires. Kennon and Harmon (2018) explained that smoke and toxic
        gases are the main reason for death during a fire emergency, hence some
        detectors 'will be a must' in every multi-occupied building especially if there is not
        enough heat to activate the sprinklers. Gerges (2020) suggested that smoke alarms
        should be placed between sleeping areas and places that are likely for a fire to
        occur, such as living rooms and kitchens for early detection of smoke in early
        stages.

3.62   Several researchers have found that the risk of becoming a fatality in a residential
        fire is higher when smoke alarms are not installed and that this risk can therefore be
        substantially reduced by installing and maintaining a smoke alarm (Nilson and
        Bonander 2020; Gerges 2020; Tan and Moinuddin 2019; Tannous and Agho 2019;
        Gerges et al., 2018). Additionally, participants who spoke languages other than
        English at home were significantly less likely to have a working smoke alarm. This
        finding is consistent with a previous study which showed that certain population
        sub-groups are less likely to own smoke alarms; in particular, households with lower
        incomes (Tannous and Agho 2019). This is perhaps because poorer households
        may not be able to afford a smoke alarm; it might also explain why the unemployed
        are less likely to install alarms or replace flat alarm batteries.

Overcrowding and Queues at Time of Evacuation

3.63   An area which consisted of limited data in the literature but was raised as an area of concern is the aspect of overcrowding and queues in evacuations of multi-occupied buildings, with nine sources briefly highlighting the topic (Gerges et al. 2021; Gerges 2020; Sheeba and Jayaparvathy 2019; Thompson et al. 2018; Kurdi et al. 2018; Butler et al. 2017; Lin et al. 2020; Tan and Moinuddin 2019; Geoerg et al. 2019; Kurdi et al. 2018). The following section of this review will use the data available to discuss the way in which overcrowding can negatively impact responses and action against fire situations, putting residents at risk.

3.64   For instance, fatalities and injuries result from undesired occupant behaviour (e.g., pushing and competing) in many cases, rather than the actual hazards of building emergencies (Lin et al. 2020). In multi-occupied buildings higher occupancy levels are expected with clusters of family member's cohabitating, it has also been suggested that overcrowding and subsequent risk of injury is closely related to poor quality housing (Tan and Moinuddin 2019). Overcrowding in some households can lead to slow evacuation speeds. As the people count increases, the probability of stampede occurrence in the stairwells increase because of increased congestion, resulting in delayed access to the stairwells, hence, pre-evacuation delay increases (Sheeba and Jayaparvathy 2019). This can also lead to issues in the use of elevators as they also can become overcrowded beyond safety levels. In such cases, it is important to consider several factors, including the smooth flow of pedestrians and the positions of obstacles and exits in response to a fire (Kurdi et al. 2018).

Communication Equipment

3.65   An area of the literature that also provided limited data but potentially may be of importance was the consideration of different communication equipment. Seven sources in total provided information on this topic. There is evidence to suggest that advanced communication systems and equipment enhance quick evacuation in high-rise buildings, whilst poor communication with building occupants from outside can exacerbate the rate of fatalities (Arewa et al. 2021; Egodage et al. 2020; Choi et al. 2020; van der Wal 2019; Butler et al. 2017).

3.66   Smart phones have been proven as useful in the event of a fire, not just as a communication device but as a device of all functions, playing an important role during emergencies. An example is the disaster of the Grenfell Tower fire in June 2017, when looking at the LFB (London Fire Brigade) testimony report it is evident that many of the occupants used their mobile phones to communicate with the fire service and many contacted the LFB multiple times in search for updated information or further guidance (Gerges 2020). Conversely, some evidence suggested that there could also be negative connotations linked to smart phone use within fire situations. In some instances, individuals may use their smart phones to record/video the incident or to call loved ones, potentially slowing evacuation and putting others at risk (Gerges et al. 2017; van der Wal 2019)

3.67   Voice communication systems have recently become an important technology used to provide emergency information (Thompson et al. 2018; Gerges 2020; van der Wal 2019; Suvar et al. 2019; Gerges et al. 2017). It was argued by Proulx (2001) that voice communication has rarely used in the past as it was presumed occupants would panic if they were told there was a fire. However, being told the truth in a fire is more likely to result in an appropriate reaction. As each individual is unique, their behaviour in response to voice communication could change depending on their prior experience and knowledge. It has been suggested (van der Wal 2019) that pre-recorded voiceover messages can lead to confusion and are not as suitable for providing residents with instructions, especially those who have impairments that may mean they need further assistance. Using a live message to aid evacuation allows residents to follow the safest evacuation route and maintains the information they have on the developing situation.

3.68   However, voice signals are not suitable for all and residents with hearing impairments will rely on other forms of communication (Egodage et al. 2020). The evidence suggests that communication and information equipment need to capture the attention of all residents; fire exit maps are not clear in the event of fire due to reduced visibility and limited time to stop and read them. Equipment such as announcements, video screens, stewards or staff members showing residents where to go have been suggested.

4.   Conclusions

4.1   This review has discussed the evidence available on the influences on resident's behaviour in high-rise dwelling fires. The Welsh Government building safety regime differentiates between Category 1 and Category 2 buildings. Category 1 buildings are those which are 18m and over and often referred to as 'high-rise buildings'. Category 2 refers to all multi-occupied buildings below the 18m Category 1 threshold. A multi-occupied building is a residential building where there are two or more dwellings, regardless of whether there is a shared front door to the building. The literature tends to refer to high-rise buildings however this review refers to multi-occupied buildings. It should be noted that much of the evidence relates to general safety behaviours of residents rather than specifically for high-rise dwellings.

4.2   The review draws on a thematic review of evidence available on influences of human behaviour in fire situations. The evidence gathered consisted of research reports/papers. Initially only UK evidence was in scope of the review. However, due to the small number of results returned, international papers were included in the final review (nineteen). There were also no restrictions on the age of publication; however, most of the results produced were from the previous five years at time of collection. Overall, the evidence available is varied in context regarding location however, it provides useful insights into the different aspects that may influence human behaviour and reactions to fire situations. Of the evidence examined, international examples are included as they provide useful information on the topic, however caution should be taken when applying to the UK context. Results from the search and the search strategy can be found at Annex A and B.

4.3   Two core themes could be distinguished within the evidence, these being personal risk factors and general risk factors. The core themes were then separated into further sub-topics. Within the theme of personal risk factors the review discussed the available evidence on age, impairments, experience of fire, risk perception, condition at the time of fire, priorities in fire and socioeconomic/ demographic background. Gaps in the evidence regarding these topics were also highlighted. The topics of age and impairments proved most prominent in the literature whilst

there is evidently significant gaps in the literature available on the impact of socio-economic/demographic background on fire safety behaviour.

Personal risk factors: demographics

4.4   The literature available on age focussed heavily on older people, with limited evidence available on children and young people. The literature consistently suggests that older people are one of the groups who are at highest risks of home fires and injury from home fires. Children are also highlighted as vulnerable in fire situations, however there is inadequate evidence on the current lived experience of children in accidental dwelling fires in non-US countries.

4.5   There was strong evidence on the influence of physical and mental impairments and fire safety. The literature highlights that considering the experiences of people with certain impairments is important to ensure safe fire behaviours as individuals with impairments are vulnerable in a fire as they may face difficulties responding to warning signals or evacuating buildings.

4.6   Of the data available specific to the United Kingdom there were significant gaps in the evidence relating to individuals from a Black, Asian, and Minority Ethnic background or an individual's socioeconomic/sociodemographic status. While there is clear variation in the extent that overcrowding affects Black, Asian and Minority Ethnic groups, evidence suggests that ethnic minority groups in the UK are disproportionately affected by housing overcrowding, across all housing tenures, and are also disproportionately more likely to be affected by socio-economic disadvantage.

4.7   It has been argued that the quality of housing is closely related to deprivation and the associated risk factors surrounding the incidence of dwelling fires. Other factors associated with poor quality housing are overcrowding (increasing the risk of injury should a fire start), and poor maintenance of communal areas, escape routes, and smoke alarms.

Personal risk factors: fire safety behaviours

4.8   The literature consistently finds that two factors positively influence responses to fires; some form of knowledge or experience of fire safety or involvement with their

residential community. Individuals with previous experience of fire are more likely to have fire plans in place and a higher probability of having a functioning smoke detector. Bonds to people, pets and possessions also influence behaviours in dwelling fires. There is evidence that these bonds can delay evacuation times or cause individuals to endanger themselves. There is significant evidence showing that residents are likely to attempt to tackle the fire themselves to protect others and possessions.

4.9 The literature identified risk factors for experiencing fires. Discarded cigarettes and smoking materials have consistently been identified as the leading cause of unintentional residential fires within the literature. Other risk factors for experiencing injuries and fatalities in fire include reduced mobility, impaired cognitive ability, drug abuse and being influenced by alcohol at the time of fire.

4.10 The literature also identifies a range of warning signals or cues in a fire situation such as fire alarms, smelling or seeing smoke, reactions of others, flames and heat. Cues which are taken more seriously and prompt people to take actions include seeing smoke or fire, hearing people shout, seeing emergency services and being instructed to evacuate.

General Risk Factors

4.11 The general risk factors theme was focussed on the implications that building structures, information and technology can influence human behaviours. These sections discussed the available evidence on evacuation routes, evacuation plans, fire equipment, overcrowding at time of fire, and communication equipment. This review has identified an evidence gap on the impact of communication equipment. Although limited in number of sources, the information available on communication equipment in fire provides interesting insights in how they can be applied in these situations.

4.12 The importance of evacuation routes and methods was a prominent theme within the evidence reviewed. During a fire emergency, the complexity of buildings and layouts, such as in multiple occupancy buildings, can be confusing and adds unnecessary stress to the building residents. Evidence suggests that in an

emergency situation it is likely that residents will choose the most familiar or nearest exit choice.

4.13   There is strong evidence on the importance of proper evacuation planning and instructions. The literature on this topic broadly highlights the need for clear evacuation plans and instructions which fit the requirements of all occupants regardless of personal factors which may influence their behaviours, this is important before, during and after an emergency to maintain safety of residents.

4.14   The literature suggests that smoke detectors/alarms are the most common form of equipment tool as they form the basic fire safety standard for many countries. As the top priority will always be preserving occupant's lives, detectors are required to make occupants aware early of fires.

4.15   The literature suggests that overcrowding during evacuation can cause more fatalities and injuries resulting from undesired occupant behaviour (e.g., pushing and competing) in many cases, rather than the actual hazards of building emergencies. In high-rise dwellings higher occupancy levels are expected with clusters of family member's cohabitating. It has also been suggested that overcrowding and subsequent risk of injury is closely related to poor quality housing. Overcrowding in some households can lead to slower evacuation speeds.

4.16   Voice communication systems have recently become an important technology used to provide emergency information. As each individual is unique, their behaviour in response to voice communication could change depending on their prior experience and knowledge. It has been suggested that pre-recorded voiceover messages can lead to confusion and are not as suitable for providing residents with instructions, especially those with impairments that may mean they need further assistance (van der Wal 2019). Using a live message to aid evacuation can allow residents to follow the safest evacuation route and maintains the information they have on the developing situation.

4.17   Overall, the evidence on behaviour in high-rise dwelling fires is strong with insights available across the influence of demographic factors and impairment as well as the ways in which building structures, information and technology can influence human behaviours. Future research should be focused on the experiences of Black, Asian

and Minority ethnic communities in fire situations in the UK context. This is a prominent gap in the evidence which neglects a large section of the population. Additionally, it is evident that attention should be placed on available warning signals as a response to fires, the literature suggests that occupants respond to different signals in different ways (sometimes due to impairments) to allow quick evacuation times comprehensive warning signals which cover the needs of all building occupants will need to be implemented.

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Annex A

Title	Author	Citation	Year of Publ.	Publ. type
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Elderly about home fire safety: A qualitative study into home fire safety knowledge and behaviour	Karemaker, Margo et al	Fire Safety Journal, September 2021, Vol. 124	2021	Journal article
Fire safety in high-rise buildings: Is the stay-put tactic a mis-judgement or magnificent strategy?	Oyen Arewa, Andrew	Buildings, August 2021, Vol. 11: 1-16	2021	Journal article
Homeowner vulnerability in residential buildings with flammable cladding	Oswald, David	Safety Science, April 2021, Vol. 136	2021	Journal article
Learning from fire investigations and research – A Norwegian perspective on moving from a reactive to a proactive fire safety management	Steen-Hansen, Anne et al	Fire Safety Journal, March 2021, Vol. 120	2021	Journal article
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A three-part bayesian network for modeling dwelling fires and their impact upon people and property	Matellini, D.B. et al	Liverpool John Moores University, 2018	2018	Thesis
A code-compliance framework for fire safety in student housing facilities	Hassanain, Mohammad A. et al	Facilities, 2018, Vol. 36, Issue: 7/8: 423-436	2018	Journal article

Children and young people's behaviour in accidental dwelling fires: A systematic review of the qualitative literature	Mytton, Julie et al	**Safety Science, July 2017, Vol. 96: 143-149**	**2017**	**Journal article**
Unintentional residential fires caused by smoking-related materials: Who is at risk?	Xiong, Lin et al	**Fire Safety Journal, July 2017, Vol. 90: 148-155**	**2017**	**Journal article**
Human behaviour during evacuation of primary schools: Investigations on pre-evacuation times, movement on stairways and movement on the horizontal plane	Hamilton, Glenn, et al	**Fire Safety Journal, July 2017, Vol. 91: 937-946**	**2017**	**Journal article**
An experimental study of full-scale open floor plan enclosure fires	Hidalgo, J.P. et al	**Fire Safety Journal, April 2017, Vol.**	**2017**	**Journal article**
A ranking system for fire safety performance of student housing facilities	Hassanain, Mohammad A. et al	**Safety Science, February 2017, Vol. 92: 116-127**	**2017**	**Journal article**
Preventing accidental residential fires: The role of human involvement in non-injury house fires	Ball, Michelle et al	**Fire and Materials, January/February 2017, Vol. 41, Issue: 1: 3-16**	**2017**	**Journal article**
Perspectives of occupants with mobility impairments on evacuation methods for use during fire emergencies	Butler, Kathryn et al	**Fire Safety Journal, 2017, Vol. 91: 955=963**	**2017**	**Journal article**
Human-behaviour under fire situations in high rise residential building	Gerges, Michael et al	**International Journal of Building Pathology and Adaptation, 2017, Vol. 35, Issue: 1: 90-106**	**2017**	**Journal article**
Challenges to fre safety management in multi-storey students' hostels	Agyekum, Kofi, et al	**Modern Management Science & Engineering, 2016, Vol.4, Issue: 1**	**2016**	**Journal article**
A decision model for recommending which building occupants should move where during fire emergencies	Groner, Norman	**Fire Safety Journal, 2016, Vol. 80, Issue: 20-29**	**2016**	**Journal article**
Applying building information modeling to support fire safety management	Wang, Shih-Hsu et al	**Automation in Construction, November 2015, Vol. 59: 158-167**	**2015**	**Journal article**
A qualitative study of experiences, actions and motivations during accidental dwelling fires	Thompson, Owain and Wales, David	**Fire and Materials, June 2015, Vol. 39, Issue: 4: 453-465**	**2015**	**Journal article**
Agent-based simulation of building evacuation: Combining human behavior with predictable spatial accessibility in a fire emergency	Tan, Lu et al	**Information Sciences, February 2015, Vol. 295: 53-96**	**2015**	**Journal article**
Human factors in fire safety management and prevention	Mydin, M. A. Othuman	**Analele Universitatii 'Eftimie Murgu', 2015, Vol. 21, Issue: 213-219**	**2015**	**Journal article**

Social and economic characteristics as determinants of residential fire risk in urban neighborhoods: A review of the literature	Jennings, Charles	Fire Safety Journal, November 2013, Vol. 62, Issue: Part A : 13-19	2013	Journal article
Modelling dwelling fire development and occupancy escape using Bayesian network	Wall, A.D. et al	Reliability Engineering & System Safety, June 2013, Vol. 114: 75-91	2013	Journal article
Predicting human behavior during fires	Kuligowski, Erica	Fire Technology, 2013, Vol. 49: 101-120	2013	Journal article
Fire evacuation in high-rise buildings: A review of human behaviour and modelling research	Ronchi, Enrico and Nlsson, Daniel	Fire Science Reviews, 2013, Vol. 2	2013	Jornal article
Occupant interactions with self-closing fire doors in private dwellings	McDermott, Hiliary et al	Safety Science, 2010, Vol. 48, Issue: 10: 1345-1350	2010	Journal article
Building safety and human behaviour in fire: A literature review	Kobes, Margrethe et al	Fire Safety Journal, 2010, Vol. 45, Issue: 1: 1-11	2010	Journal article

Annex B

Source	Search Strategies
[Please provide a very brief description of the resource where appropriate, and also a link to where you've searched	Search terms and search strategies:
Emerald Insight Emerald is a searchable collection of articles, covering a range of subject areas, including Management, HR and Organisation Studies.	''Human behaviour AND fire safety''; ''human behaviour AND dwelling fires''; ''human influences AND fire safety''; ''domestic fire behaviours''; ''influences AND fire behaviours''; ''building fire safety AND race''; ''building fire safety AND disability''; ''building fire safety AND gender''; ''building fire safety AND age''; '' personal emergency evacuation plans (PEEPS) AND fire safety''; ''fire prevention AND building safety''; '' fire safety management AND planning''; '' occupancy escape AND fire''; ''fire evacuation AND strategy''
Fire Service College The Fire Service College is responsible for providing leadership, management and advanced operational training courses for senior fire officers from the United Kingdom and foreign fire authorities.	This was used as a supplementary source to search the catalogue. Phrase searching was used.
PubMed Central PubMed Central is a free digital repository that archives open access full-text scholarly articles that have been published in biomedical and life sciences journals. As one of the major research databases developed by the National Center for Biotechnology Information.	This was used as a supplementary source
ScienceDirect Science Direct offers access to references, abstracts and (selected) full text for over 2,000 journals in the areas of science, technology and medicine. This subscription includes access to the full text of all the journals within the Social Sciences Subject Collection - over 160 titles covering health, education, environmental and social justice issues.	''Human behaviour AND fire safety''; ''human behaviour AND dwelling fires''; ''human influences AND fire safety''; ''domestic fire behaviours''; ''influences AND fire behaviours''; ''building fire safety AND race''; ''building fire safety AND disability''; ''building fire safety AND gender''; ''building fire safety AND age''; '' personal emergency evacuation plans (PEEPS) AND fire safety''; ''fire prevention AND building safety''; '' fire safety management AND planning''; '' occupancy escape AND fire''; ''fire evacuation AND strategy''
Web of Science Web of Science is a website that provides subscription-based access to multiple databases that provide comprehensive citation data for many different academic disciplines. Web of Science consists of three key databases. Science Citation Index a multidisciplinary index to the journal literature of the sciences. It fully indexes over 6,650 major journals across 150 scientific disciplines. Social Sciences Citation Index similarly fully indexes over 1,950 journals across 50 social sciences disciplines, with	''Human behaviour AND fire safety''; ''human behaviour AND dwelling fires''; ''human influences AND fire safety''; ''domestic fire behaviours''; ''influences AND fire behaviours''; ''building fire safety AND race''; ''building fire safety AND disability''; ''building fire safety AND gender''; ''building fire safety AND age''; '' personal emergency evacuation plans (PEEPS) AND fire safety''; ''fire prevention AND building safety''; '' fire safety management AND planning''; '' occupancy escape AND fire''; ''fire evacuation AND strategy''

additional selected inclusion of relevant items from over 3,300 of the world's leading scientific and technical journals. Arts and Humanities Citation Citation Index covers 1,160 of the world's leading arts and humanities journals with selected additional inclusion of relevant materials from the science and social science indexes.	
UK Universities e.g. Liverpool John Moores University and Loughborough University	This source was searched using generic search terms e.g. ''Human behaviour AND fire safety''; ''domestic fire behaviours''
British Library Ethos Service EThOS is the UK's national thesis service which aims to maximise the visibility and availability of the UK's doctoral research theses. It demonstrates the quality of UK research, and supports the UK Government's open access principle.	This was used as a supplementary source
Ingenta Connect The home of scholarly research, Ingenta Connect is your gateway to the world's most comprehensive collection of academic & professional digital conten	Search terms and search strategies: Ingenta was used for more generic searching e.g. ''Human behaviour AND fire safety''; ''human behaviour AND dwelling fires''; ''human influences AND fire safety''; ''domestic fire behaviours''; ''influences AND fire behaviours''