


## RESEARCH PAPER

## Deprivation and fire injury

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## Abstract

The association between deprivation and accidental dwelling fire injuries was examined in Merseyside which has a high proportion of deprived areas. For the years 2006 to 2016, over half of the accidental dwelling fire injuries in Merseyside occurred in deprived areas, and almost three quarters of alcohol and drug related accidental dwelling fire injuries occurred in such areas. In particular, we examine the relationship between the established accidental dwelling fire injury risk factors of old age, disability and alcohol and drug consumption and the level of deprivation. There were strong correlations between deprivation and the overall number of fire injuries, and between deprivation and fire injuries relating to alcohol/drug consumption, disability/mobility related fire injuries, and fire injuries sustained by those aged 65+.

## KEYWORDS

analysis, deprivation, fire, injury

## 1 | INTRODUCTION

Previous research (Halvorsen et al., 2017) has concluded that it is the concentration of individuals vulnerable to dwelling fires in deprived communities that causes such areas to have higher rates of dwelling fires, rather than deprivation itself. Old age, disability, and alcohol / drug misuse can increase vulnerability to accidental dwelling fire injury (Lowton et al., 2010; Palmu et al., 2018), and these factors are also associated with deprivation (ACOUK, 2021; JFR, 2018). In this paper we examine the relationship between fire injuries related to old age, disability, and alcohol/drug misuse and the deprivation level of the areas where fire injuries were recorded in Merseyside, England, between 2006 and 2016. Merseyside contains a high proportion of deprived areas (HCL, 2019; LCC, 2019; MHCLG, 2019), especially in terms of income and employment (IDAOPI, 2021). Deprivation has

previously been associated with accidental dwelling fire injury risk by research undertaken in various countries (Duncanson et al., 2002; Marsden et al., 2016).

Previous research has examined the various socio-economic factors associated with accidental dwelling fire injury risk including old age (Holborn et al., 2003), smoking (Xiong et al., 2017), alcohol and drug consumption (Palmu et al., 2018), disability (Holborn et al., 2003; Lowton et al., 2010) and deprivation (Arch & Thurston, 2013; Duncanson et al., 2002). Other factors relating to accidental dwelling fire injury risk included the types of materials used in household furniture construction, the types of materials used in building construction and maintenance, and the safety standards of electric and electronic household goods (Butry & Thomas, 2017; Charbonnet et al., 2020; Chen et al., 2019).

In terms of the association between the different socio-economic risk factors and accidental dwelling fire

injury, elderly individuals might be more forgetful, leading to increased accidental dwelling fire risk, and less mobile in terms of leaving a burning building, leading to an increased risk of fire injury (Xin & Huang, 2013). Smoker's materials are a common source of ignition in accidental dwelling fires, leading to an increased risk of fire injury for smokers (Xiong et al., 2017). Those under the influence of alcohol and drugs are more likely to be forgetful leading to increased fire risk, and are less likely to be able to quickly evacuate a burning building, and those with a disability might typically be less likely to be able to evacuate a burning building quickly (Xin & Huang, 2013). However, the association between deprivation and fire injury is less clear (Halvorsen et al., 2017). Given the more complex nature of the association between deprivation and the risk of fire injury and that Merseyside contains a high proportion of deprived areas, this research was undertaken in order to better understand the association between deprivation and the risk of fire injury, and thus inform fire prevention strategies. Runefors et al. (2017) stated that the analysis of fire statistics and fire investigations data can be used to inform appropriate fire injury preventive measures. Establishing the nature and distribution of accidental dwelling fires within the area covered by a fire and rescue service can support the effective targeting of fire safety interventions.

This paper examines the relationship between deprivation and fire injury risk during the years January 2006 to December 2016 in Merseyside. This research is necessary because fire injuries cause harm to the individual, and cost to the UK National Health Service (NHS). An examination of the relationship between deprivation and fire injuries can inform community fire prevention strategies. This research examined factors associated with accidental dwelling fire injury that are also factors associated with deprivation such as being elderly, disability, and alcohol and drug misuse. The research questions which the research addressed concerned the relationship between deprivation and accidental dwelling fire injury, in particular with regard to alcohol and drug consumption, old age and disability.

## 2 | LITERATURE REVIEW

Previous research in various countries has identified different factors associated with accidental dwelling injuries including smoking (Xiong et al., 2017), alcohol and drug consumption (Palmu et al., 2018), being elderly (Holborn et al., 2003) and disability (Holborn et al., 2003; Lowton et al., 2010). Being an elderly person may not be a fire risk factor in itself; however, increasing age is associated with other fire risk factors including reduced mobility, reduced sight and reduced hearing.

### 2.1 | Factors associated with deprivation

Education and local labour markets have been identified as factors affecting of deprivation in England (DepGov, 2020; PSE, 2021). The most deprived and segregated communities are typically the areas in which those with the lowest skills are forced to live (Mean et al., 2005). The UK disability rights organisation commented that in the United Kingdom, almost half of those living in poverty are either disabled or living with a disabled person (DRUK, 2020). Being disabled can create barriers to paid employment. In the United Kingdom during 2017/2018, half of working-age people with a disability were not in paid employment, compared to 18% of people without a disability. Disabled people who are in paid employment on average typically work fewer hours per week and are more likely to be in low paid employment. People with a disability with a given level of qualification tend to be paid less than people without a disability having the same level of qualification (JRF, 2018). Although there are typically much higher levels of non-alcohol consumption in more deprived areas (since alcohol affordability is a key driver of consumption), there are typically also higher levels of very heavy drinking. Poorer areas tend to have much higher numbers of people with complex needs, and a lack of services that can support those people (ACOUK, 2021). Deprivation is linked with the problematic use of drugs. In addition, deprivation often means a drug user is less likely to get care and treatment, and lower chances of overcoming drug problems due to fewer positive alternatives and less access to meaningful employment and housing (DOUK, 2021). Although previously pensioner poverty had decreased across the United Kingdom, more recently, this has started to increase again and in 2016/2017 reached 16%. Poverty affects single pensioners more than pensioner couples (JRF, 2018). The Income deprivation affecting older people index in England (IDAOPI, 2021) measures the proportion of those aged 60+ who experience income deprivation. In the United Kingdom, old age is a factor associated with deprivation, since pensions are typically lower than the incomes of working age people. A comparison of state pensions shows the United Kingdom providing a lower level of pension than most other advanced economies relative to average earnings (UKP, 2022).

### 2.2 | Deprivation and fire injury risk

Previous research in numerous countries has identified that deprived areas typically have a higher risk of accidental dwelling fire (Arch & Thurston, 2013; Duncanson et al., 2002). Areas that have a high level of deprivation

tend to have more severe burn injuries compared to less deprived areas (Snelling et al., 2021).

The relationship between deprivation and fire injury risk concerns complex socio-economic needs and the multiple relationships across such needs. An ecological approach (Beer, 1984) can provide a useful framework for understanding the range of socio-economic circumstances associated with deprivation and with fire injury in order to develop conceptual models of both areas. Circumstances in one area can illuminate parallel circumstances in the other area. For example, disability can affect socio-economic circumstances in terms of employment and deprivation, and can affect vulnerability to fire injury. An ecology of mind approach, that is an interdisciplinary approach (Midgley & Reynolds, 2004) to examining the way in which circumstances in different areas form patterns, can be used to help to understand the association between deprivation and fire injury risk, both on a social and individual level (Bateson, 1976). For example, moderate alcohol consumption may not increase the likelihood of deprivation, or fire injury risk; however, frequent binge drinking may.

Understanding of social phenomena such as deprivation and fire injury risk can be supported using concepts such as emergence and interrelatedness which are fundamental within systems thinking (Midgley & Richardson, 2007). An emergent property of a whole is said to arise where a phenomenon cannot be fully comprehended in terms only of properties of constituent parts (Flood, 2010, 1999). For example, a number of factors such as disability, old age and living alone can contribute to fire injury risk level. By exploring the dynamics of the circumstances associated with deprivation and fire injury risk it can be possible to develop insightful ways for informing appropriate preventative actions (Romm, 2002).

Overall, although previous research concerning fire injuries has identified deprivation as being associated with such injuries, few studies have examined the nature of the deprivation factors associated with fire injury. The originality of the research undertaken is the analysis of the relationship between deprivation and fires injuries attended by a fire and rescue service over a 10-year time interval. The research examined factors associated with fire injury that are also associated with deprivation including being elderly, disability and alcohol and drug misuse.

### 3 | RESEARCH METHOD

The association between deprivation and accidental dwelling fire injury was examined using available fire injury data from Merseyside Fire and Rescue Service

(MFRS) between January 2006 and December 2016. The data used regarding accidental dwelling fire injuries was from the UK Fire Incident Recording System. This included all injuries sustained by residents during accidental dwelling fires that were attended by Merseyside Fire and Rescue Service, such as burns, smoke inhalation and breathing difficulties, and other types of injuries such as shock or collapse, and musculoskeletal injuries.

The research project initially utilised previous research from the literature review and the knowledge and experience of fire and rescue service officers in community safety, strategy and performance, and business intelligence within Merseyside Fire and Rescue Service via discussion groups to develop systems diagrams (Bradley et al., 2020; Morrill, 2021) for fire risk and fire injury risk, and deprivation. Statistical analysis of accidental dwelling fire injury data between 2006 and 2016 was then used to examine the relationships between deprivation, old age, alcohol/drug consumption, disability and the risk of accidental dwelling fire injury.

The research questions underpinning the research were the following:

- How does deprivation relate to accidental dwelling fire injury?
- How do alcohol and drug consumption and deprivation relate to accidental dwelling fire injury?
- How do old age and deprivation relate to accidental dwelling fire injury?
- How do disability and deprivation relate to accidental dwelling fire injury?

These research questions are important, given the need to understand the association between deprivation and accidental dwelling fire risk, and the economic and social costs of accidental dwelling fire injuries. Better understanding of the nature of the association between deprivation and accidental dwelling fire injuries can aid targeting of fire prevention activities, especially given the decreasing levels of fire and rescue service budgets in the United Kingdom. The originality of the research presented is the detailed examination of the association between deprivation and accidental dwelling fire injury as a means of supporting community fire prevention initiatives.

The analysis method chosen to answer the research question was frequency analysis and correlation analysis of different sub-categories of accidental dwelling fire injury circumstances and deprivation data over the period 2006 to 2016. The software used for the frequency analysis and correlation analysis was Microsoft Excel. Accidental dwelling fire incident data recorded includes the age band of those injured, along with whether alcohol

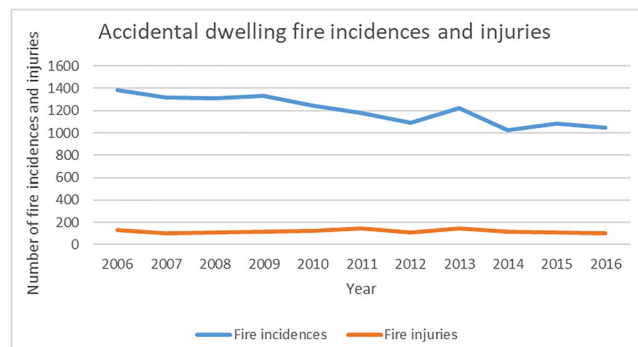
or drugs were involved with the fire injury. In terms of disability related accidental dwelling fire injuries however, only the more severe aspects of disability/mobility are recorded for fire injuries. For example, if the injured individual was a wheelchair user, bed ridden or had mobility problems. Moderate or mild disability or mobility impairments could contribute to the likelihood of accidental dwelling fire injury, but were not recorded for such. For example, those with moderate or mild mobility difficulties such as some elderly individuals would not typically be able to evacuate a burning building as quickly as younger people, which could increase the risk of fire injury due to the extra time taken to leave the building. The level of deprivation measure used in the analysis was the UK National Statistics Indices of Multiple Deprivation decile (IMD, 2021). This is a scale covering areas in England that ranges from one representing the 10% most deprived areas to 10 representing the 10% least deprived areas.

One of the main limitations of the research was data availability, since only certain accidental dwelling fire injury data are typically recorded by UK fire and rescue services, and IMD decile level data are only available at a given level of geographical detail (the Lower Layer Super Output Area level; LSOA, 2022). LSOAs are small areas with an average of approximately 1500 residents or 650 households (MHCLG, 2019). The limitation of the set of data variables recorded regarding fire injuries means that only the recorded data variables are available for research purposes. The limitation of the level of geography of LSOAs implies that there may be variation in the level of deprivation within an LSOA, meaning that the values used are an estimate of deprivation. However, only the level of deprivation at the LSOA is available. A further research limitation related to the potential for generalising the findings of the research for use by other fire and rescue services, since Merseyside is an area containing a large proportion of communities with a high level of deprivation.

## 4 | DEPRIVATION AND FIRE INJURY ANALYSIS

During 2006 to 2016 in Merseyside, the numbers of accidental dwelling fires, and accidental dwelling fire injuries were as shown in Figure 1 and Table 1. Fire injuries during this period mainly resulted from cooking and smoking related fire incidents. The ratio of male fire injuries to female fire injuries was 1.1 to 1 over the period studied.

Merseyside fire and rescue service had previously targeted fire prevention towards the most vulnerable to



**FIGURE 1** Numbers of accidental dwelling fires, and accidental dwelling fire injuries in Merseyside 2006 to 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

fire risk in the community, in particular, elderly individuals living alone with complex health conditions (Taylor et al., 2016). Merseyside fire and rescue service had adopted the UK Home Fire Safety Check programme, which is still currently operational as the main approach to fire prevention within Merseyside. This appeared to have supported the overall reduction in fire incidents and injuries over the period studied. There was a large reduction in the number of accidental dwelling fires (24%), and fire injuries (19%) over the period studied. However, the percentage of fire incidences resulting in injury was fairly constant over the period studied.

### 4.1 | Deprivation and accidental dwelling fire injury

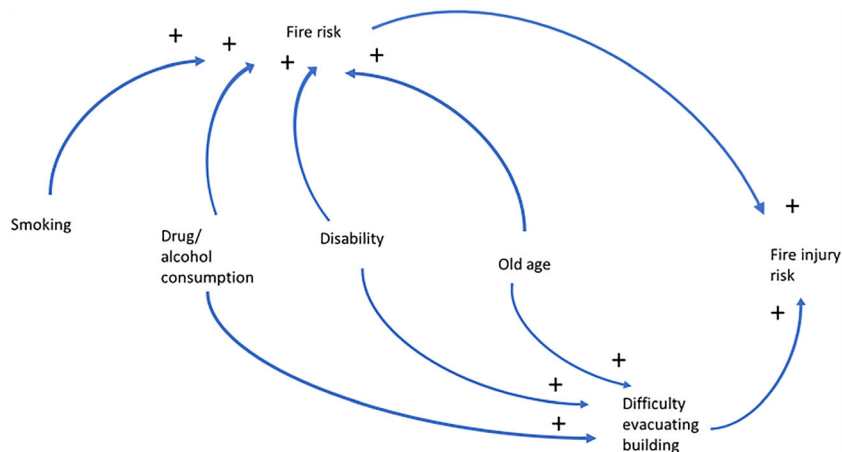
In order to explore the relationship between deprivation and accidental dwelling fire injury, previous research was examined to ascertain the factors associated with such, and was combined with the knowledge and experience of fire and rescue service officers in the fire and rescue service concerned. There can be a number of causal factors relating to fire incidents and injuries as shown in the systems diagram (Bradley et al., 2020; Morrill, 2021) in Figure 2.

Figure 2 shows a systems diagram of the relationship between the main fire incident and fire injury causal factors. The factor at the base of an arrow in the diagram influences the factor at the head of the arrow, in either a positive (or negative) manner. This helps to develop a richer understanding of the situation, the areas of influence and the likely impact of these. Smoking, drug/alcohol consumption, disability and old age are all established causal factors in accidental dwelling fire incidents (Lowton et al., 2010; Xiong et al., 2017), and old age, disability and being under the influence of alcohol/

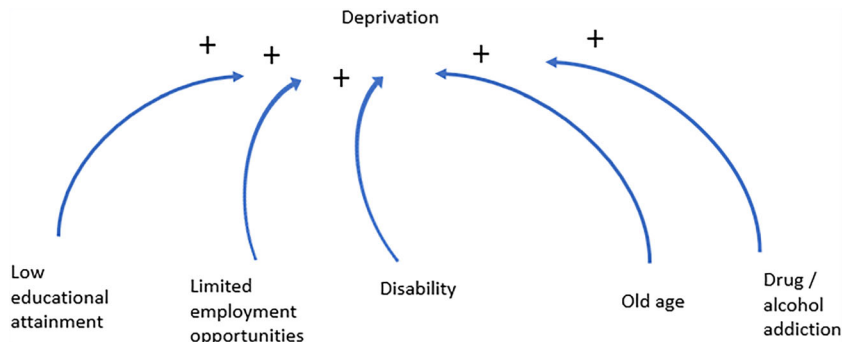
**TABLE 1** Numbers of accidental dwelling fire incidences, accidental dwelling fire injuries, and the percentage of fire incidences resulting in injury in Merseyside 2006 to 2016

	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Fire incidences	1384	1318	1315	1337	1248	1183	1090	1221	1023	1084	1049
Fire injuries	129	100	106	115	126	145	110	146	118	110	104
Percentage of fire incidences resulting in injury	9.3	7.6	8.1	8.6	10.1	12.3	10.1	12.0	11.5	10.1	9.9

**FIGURE 2** Relationship between accidental dwelling fire incident and fire injury causal factors [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



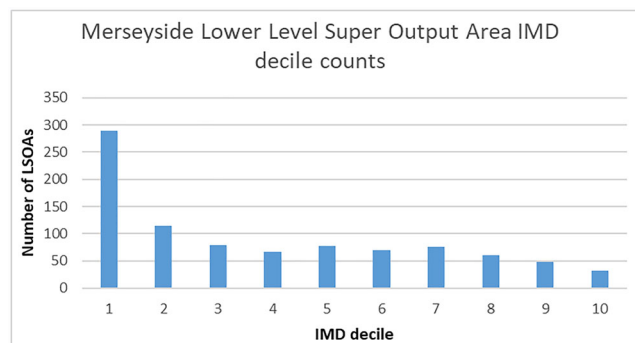
**FIGURE 3** Factors associated with deprivation [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



drugs are established factors relating to the difficulty of escaping a burning building (Cassidy et al., 2021).

Previous research has indicated that there can be numerous factors associated with deprivation. The systems diagram in Figure 3 shows typical factors associated with deprivation.

Low educational attainment and limited employment opportunities are typically viewed as being some of the main factors associated with deprivation (DepGov, 2020), along with disability, old age and drug/alcohol misuse (ACOUK, 2021; DOUK, 2021; JRF, 2018). Merseyside has a high proportion of deprived areas. Figure 4 shows the level of deprivation in Merseyside in terms of how many Lower Level Super Output Areas (LSOAs) within Merseyside are in the highest decile of deprivation (IMD decile 1) to the lowest level of deprivation (IMD decile 10). The IMD deciles are calculated by ranking the 32,844



**FIGURE 4** Levels of deprivation in Merseyside, UK, by IMD decile [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

neighbourhoods in England from most deprived to least deprived and dividing them into 10 equal groups (MHCLG, 2019). Merseyside contains 910 LSOAs.



Figure 4 shows how many of the 910 LSOAs within Merseyside were in the different IMD deciles. The 289 Merseyside LSOAs (32%) were in IMD decile 1 which represents an area being in the 10% most deprived areas in England.

Figure 5 shows the number of accidental dwelling fire injuries that occurred in Merseyside LSOAs within each of the 10 IMD deciles. The majority of the accidental dwelling fire injuries occurred in deprived areas in Merseyside (IMD decile 1). The total number of fire injuries during the period studied was 1309.

In the period studied, it appeared that deprivation was linked to accidental dwelling fire injuries, since 52% of such fire injuries occurred in the most deprived areas (IMD decile 1). The Pearson Product Moment Correlation coefficient for the relationship between the number of accidental dwelling fire injuries and IMD decile was 0.70, which indicates a strong relationship between deprivation and accidental dwelling fire injury.

## 4.2 | Alcohol/drug consumption and deprivation and accidental dwelling fire injury

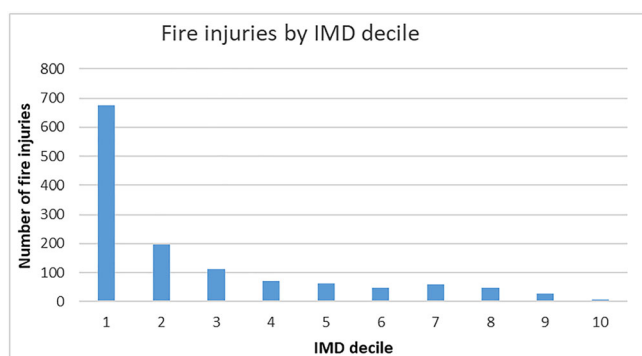
Figure 6 shows the number of alcohol and drug related accidental dwelling fire injuries in Merseyside within areas of different levels of deprivation. The majority of the alcohol and drug related accidental dwelling fire injuries (69.5%) were in the most deprived areas in Merseyside (IMD decile 1). The total number of alcohol/drug related fire injuries during the period was 174.

In the period studied alcohol/drug related fire injury incidents constituted 13% of such injuries. 70% of the alcohol and drug related fire injuries were in the most deprived areas of Merseyside (IMD decile 1). There were approximately twice the number males compared to

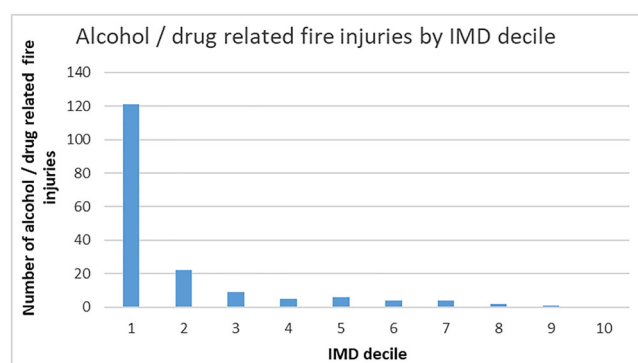
females injured in accidental dwelling fires that involved alcohol or drugs over the period studied. The Pearson Product Moment Correlation coefficient for the relationship between the number of alcohol/drug related accidental dwelling fire injuries and IMD decile was 0.63, which indicates a moderate relationship between deprivation and alcohol/drug related accidental fire injuries. For males the correlation was 0.62, and for females the correlation was 0.66.

## 4.3 | Old age and deprivation and accidental dwelling fire injury

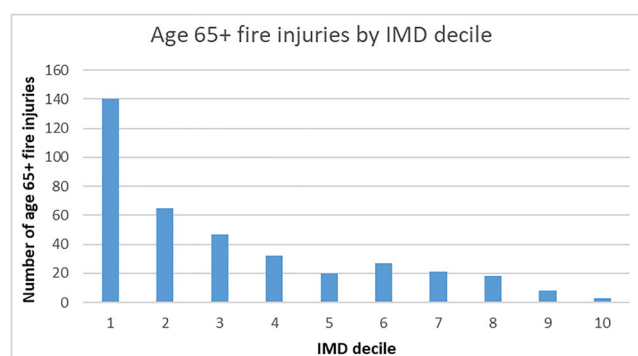
Figure 7 shows the number of age 65+ accidental dwelling fire injuries that occurred in Merseyside areas within each of the 10 IMD deciles. The majority of the age 65+ accidental dwelling fire injuries occurred in the most deprived areas in Merseyside (IMD decile 1). The total number of age 65+ accidental dwelling fire injuries in the period studied was 381.



**FIGURE 5** Fire injuries by IMD decile within Merseyside during the period 2006 to 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 6** Alcohol and drug related fire injuries in Merseyside by IMD decile between 2006 and 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 7** Fire injuries sustained by those aged 65+ by IMD decile in Merseyside 2006 to 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

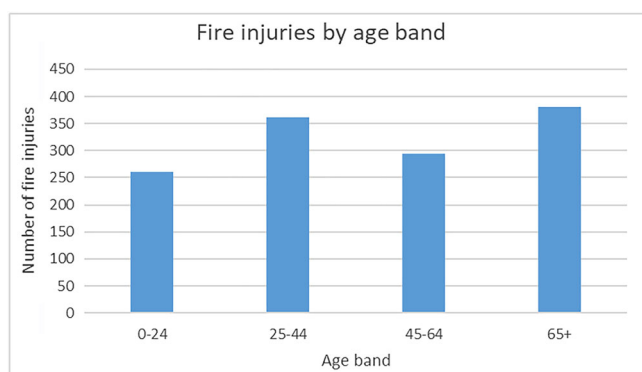
In the period studied, the elderly (those aged 65+) had the largest number of fire injuries. This age group had 29% of the fire injuries in the period studied. The age group 25–44 had 28% of the fire injuries; the age group 45–64 had 23% of the fire injuries. Young people (age 0–24) accounted for 20% of the fire injuries as shown in Figure 8. This equated to fire injury percentage rates of 0.15% (65+ age group), 0.08% (45–64 age group), 0.10% (25–44 age group) and 0.06% (0–24 age group) over the period studied for the different age group populations in Merseyside.

The ratio of female to male age 65+ fire injuries during the period studied was 1.2 to 1. The Pearson Product Moment Correlation coefficient for the relationship between the number of accidental dwelling fire injuries sustained by those aged 65+ and IMD decile was 0.82, which indicated a strong relationship between deprivation and accidental fire injury for those aged 65 and over. For males aged 65+ the correlation was 0.79, and for females the correlation was 0.85.

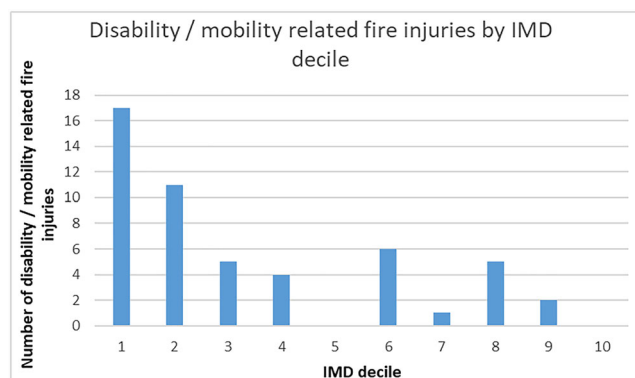
#### 4.4 | Disability and deprivation and accidental dwelling fire injury

Figure 9 shows the number of disability/mobility related accidental dwelling fire injuries that occurred within areas across the 10 IMD deciles in Merseyside. The majority of the disability/mobility related accidental dwelling fire injuries occurred in the most deprived area in Merseyside (IMD deciles 1 and 2). The total number of disability/mobility related accidental dwelling fire injuries in the period studied was 51.

There were roughly twice as many female disability related fire injuries as male disability related fire injuries during the period studied. There were more female disability related fire injuries in the 80+ age category



**FIGURE 8** Fire injuries by age band in Merseyside between 2006 and 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]



**FIGURE 9** Disability/mobility related fire injuries in Merseyside by IMD decile between 2006 and 2016 [Colour figure can be viewed at [wileyonlinelibrary.com](http://wileyonlinelibrary.com)]

compared to males, which mainly accounted for the difference in numbers between the genders. The Pearson Product Moment Correlation coefficient for the relationship between the number of disability/mobility related accidental dwelling fire injuries and IMD decile was 0.75, which indicated a strong relationship between deprivation and disability/mobility related accidental fire injury. For males the correlation was 0.71, and for females the correlation was 0.72. This implies that the level of correlation overall (for both males and females together) between deprivation and disability/mobility related accidental fire injury was greater than that for either gender separately.

## 5 | DISCUSSION

This research presented an original analysis of the relationship between the level of deprivation and fires injuries over a 10 year period (2006 to 2016) within Merseyside in the north west of England. Accidental dwelling fire injuries cause harm to the individual and cost to the UK National Health Service (NHS), and therefore, it is important to understand the how deprivation and fire injuries are related. This is important for supporting targeted fire prevention initiatives. In particular, this research examined fire injury factors that are also associated with deprivation including being elderly, disability and alcohol and drug misuse. In this manner it can be possible to enhance understanding of why accidental dwelling fire injuries are more likely to occur in deprived areas and thus inform fire prevention strategies.

Overall, during the period studied in Merseyside, deprivation appeared to be related to accidental dwelling fire injuries. The 52% of the fire injuries occurred in the most deprived areas in Merseyside. Furthermore, 70% of

alcohol/drug related fire injuries, 39% of fire injuries sustained by those aged 65+, and 33% of disability/mobility related fire injuries occurred in the most deprived areas in Merseyside. There was a strong level of correlation between accidental dwelling fire injuries and deprivation, alcohol/drug related fire injuries and deprivation, fire injuries by those aged 65+ and deprivation and disability/mobility related fire injuries and deprivation. Although there were limitations regarding data availability for the research, the data that were available enabled a detailed examination of the relationships between different factors associated with deprivation and fire injury risk. The different factors overlapped since fire injuries sustained by different age groups and genders were, for example, affected by alcohol and drug misuse. Older people were generally more at risk of fire injury, and those with a disability injured in a fire were mainly in this older group.

## 6 | CONCLUSION

The approach taken for exploring the association between deprivation and accidental dwelling fire injury risk involved examining the commonalities between deprivation and fire injury risk, that is those groups of individuals who are at risk of fire injury and likely to be deprived. These factors were considered in a conceptual systems diagram context before conducting quantitative statistical analysis. Visualising the overall system using systems diagrams can aid changing the structural connections (Bradley et al., 2020) to achieve improved fire prevention outcomes. The research approach used aimed to improve understanding of the problem situation in order to enable appropriate interventions. It is useful and appropriate to use systems diagrams to improve overall understanding of causal factors underlying dwelling fires and their association with deprivation in order to then conduct meaningful statistical analysis using frequency analysis and correlation analysis over an appropriate time period. Merseyside fire and rescue service mainly targeted fire prevention to those most vulnerable to fire injury the community, the elderly, living alone, with complex health conditions. A recommendation from this research would be that deprivation could also be used as a measure for further targeting fire prevention activities within these groups.

The research undertaken into the relationship between deprivation and fire injuries may be of use to other fire and rescue services, in terms of supporting fire prevention initiatives. Targeted fire prevention home visits can help to prevent accidental dwelling fire injuries from occurring. Working collaboratively with other

public sector agencies in health and social care can help to reduce alcohol and drug problems, and appropriately support the elderly and those with a disability, which can aid in reducing both deprivation and fire injury risk for such vulnerable groups.

## DATA AVAILABILITY STATEMENT

Data are available upon request.

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