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Deprivation and Accidental Dwelling Fires in the Greater Manchester Area Between 2013–2014 and 2023–2024

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ABSTRACT

In this article, the relationship between the level of deprivation, measured by the Indices of Multiple Deprivation decile (IMD decile) determined by the UK Ministry of Housing, Communities and Local Government, and the number of different types of accidental dwelling fires (ADFs) in populations across the different IMD deciles is examined. Data concerning the different types of ADFs categorised by the source of ignition of the fire from Greater Manchester between 2013–2014 and 2023–2024 were used for the analysis. Overall, there was a strong and statistically significant level of correlation (0.97, $p < 0.001$) between the level of deprivation and the overall number of ADFs per 10 000 population in the 2019 IMD deciles and across all the different types of ADFs (e.g., cooking, smoking-related and heating fires). In particular, the ratio of accidental dwelling smoking-related fires per 100 000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 8.4–1.

1 | Introduction

Previous research had indicated that deprived areas tend to have higher concentrations of individuals and households vulnerable to accidental dwelling fires (ADFs) [1, 2]. A measure of deprivation commonly used within England is the IMD (Indices of Multiple Deprivation) deciles, which is a scale ranging from 1, which denotes the 10% most deprived areas (lower level super output areas [3]) in England, to 10, which denotes the 10% least deprived areas. The IMD deciles are calculated by ranking the 32 844 neighbourhoods in England from the most deprived to the least deprived and dividing them into 10 equal groups [4]. IMD scores are determined from seven weighted domains of deprivation that include income, employment, education, health, crime, barriers to housing and services and living environment. For example, the health domain concerns the risk of premature death and reduced quality of life relating to poor physical or mental health and measures morbidity, disability and premature mortality. Lower super output areas [3] are small areas in England with an average of approximately 1500 residents or 650 households [4]. In the United Kingdom, deprivation is defined as a lack of access to resources, services or opportunities that are considered necessary for a decent standard of living and full participation in society. Deprivation goes beyond income and includes multiple dimensions, including employment. Education, health, disability and housing [5].

In England, fire and rescue services are funded by a combination of central government grants from the Ministry of Housing, Communities and Local Government, which form a core part of fire and rescue authority budgets, and local revenue from council tax and business rates. Fire and rescue service authorities in more deprived areas often have lower tax bases, which can limit their ability to raise local funds. Historically, UK fire and rescue service funding formulas included deprivation indices to ensure more support for areas with higher social and economic challenges. However, this has been diluted over time [6, 7]. Both the UK Fire Brigades Union and the UK National Fire Chiefs

Council have warned that continued underfunding, especially in deprived areas, could jeopardise public safety [6, 7].

Although previous research has highlighted an association between deprivation and ADFs [1, 2], the research presented in this article specifically examines the correlation between deprivation (as measured by the IMD decile) and the numbers of different types of ADFs (categorised by the source of ignition of the fire) in populations across the deciles in a detailed study in Greater Manchester in the North West of England over the period 2013–2014 to 2023–2024. This extends knowledge of the circumstances of ADFs in relation to the effects of deprivation on the likelihood of fire. This can then inform fire prevention activities used by Fire and Rescue Services, and particularly those with areas of coverage that incorporate higher levels of deprivation.

2 | Literature Review

2.1 | Deprivation and ADFs

Deprivation can be viewed as consisting of more than just poverty. In the United Kingdom, poverty is commonly defined using income-based measures, whereas deprivation refers to a general lack of resources and opportunities. In the United Kingdom, relative poverty is considered to reflect household income below 60% of the median household income after taxes and benefits. This is the most widely used measure in the United Kingdom and reflects inequality as well as hardship. Absolute poverty refers to households whose income is below a fixed threshold, adjusted for inflation, which reflects a basic standard of living over time [8]. The Joseph Rowntree Foundation defines poverty as the situation where people lack the resources to meet their basic needs and participate fully in society [9]. Pay inequality, poorer health outcomes [10] and unemployment [11] are good indicators of the level of risk of fire in the home [12]. Previous research had indicated that deprived areas typically have a greater likelihood of ADF [13, 14]. In some counties in England, the 10% most deprived areas have rates of fire nearly six times higher than those in the least deprived areas [15]. A study of ADF injury in Merseyside from 2006 to 2016 found that over half of ADF injuries occurred in deprived areas, and nearly three-quarters of alcohol- and drug-related fire injuries were in these same areas. The study also explored how factors like old age, disability and substance use intersect with deprivation to elevate fire risk [16]. A study in Liverpool in 2002 used spatial and temporal pattern analysis to show that ADFs are not random but clustered in areas with shared social, economic and environmental characteristics and highlighted the role of deprivation in shaping fire risk distribution [17]. The Kent Public Health Observatory framed ADF risk as a public health issue, emphasising the social determinants of fire vulnerability, including deprivation [18].

2.2 | Deprivation and Fire Prevention

Some English Fire and Rescue Services prioritise deprived areas for targeting fire prevention [12], typically as part of a broader risk-based fire prevention approach. The Fire Standards Board [19] and the Fire and Rescue National Framework for England [20] require Fire and Rescue Services to identify those most at risk of fire and deliver targeted fire prevention activities that are accessible and inclusive. These standards emphasise reducing community-related risks through evidence-based planning, which often includes socioeconomic factors like deprivation. Each of the 44 Fire and Rescue Services in England is required to develop a Community Risk Management Plan (CRMP). These plans assess local risks, including age and infirmity, mental health, housing conditions and socioeconomic deprivation [20]. Runefors et al. [21] highlighted the need for specific fire prevention measures for different population groups. English Fire and Rescue Services that currently target deprived areas for fire prevention include: Merseyside Fire and Rescue Service, which uses a proactive approach in identifying and supporting at-risk groups in deprived communities [22]; Greater Manchester Fire and Rescue Service, which uses data-driven strategies to prioritise fire safety visits in areas with high deprivation and vulnerability [23]; London Fire Brigade, which targets vulnerable households across boroughs with high deprivation indices [24]; and West Midlands Fire Service, which implements community outreach programmes in deprived neighbourhoods [25]. The MHCLG reported that 85% of all Home Fire Safety Visits in England in the year ending March 2025 were directed at households with at least one vulnerability, often overlapping with deprivation [26].

The novelty of the research presented in this article concerns the detailed analysis of the relationship between deprivation and different types of ADFs categorised by the source of the fire over the period 2013–2014 to 2023–2024 in Greater Manchester.

3 | Research Method

This research analysed previous research studies to determine the most common types of ADFs and the effects of deprivation upon ADF incidence. Analyses were performed on the overall number of ADFs and specific types of ADFs across IMD deciles in terms of the average number of fires in LSOAs in the different IMD decile areas, the number of fires per 10 000 households in the different IMD deciles, and the numbers of fires per 100 000 population in the different IMD deciles to determine the most appropriate basis for assessing the relationship between ADF incidence and deprivation. The data used for the analysis were obtained from Greater Manchester Fire and Rescue Service from the Fire and Rescue Service Incident Recording System and included only ADFs attended by Greater Manchester Fire and Rescue Service during the period 2013–2014 to 2023–2024. The types of ADFs were categorised by the source of ignition of the fire (e.g., cooking fires, heating fires, candle fires, electrical fires and smoking-related fires). The occupancy type of the dwellings at which the fire incidents occurred was included in the dataset obtained from Greater Manchester Fire and Rescue Service (e.g., lone person under pensionable age, lone parent with dependent child/children).

The Pearson product–moment correlation coefficient was used to assess the strength of relationships between deprivation based upon the ordinal scale of IMD decile and the number of different types of ADFs per 100 000 population in the different IMD deciles based upon a case study in Greater Manchester

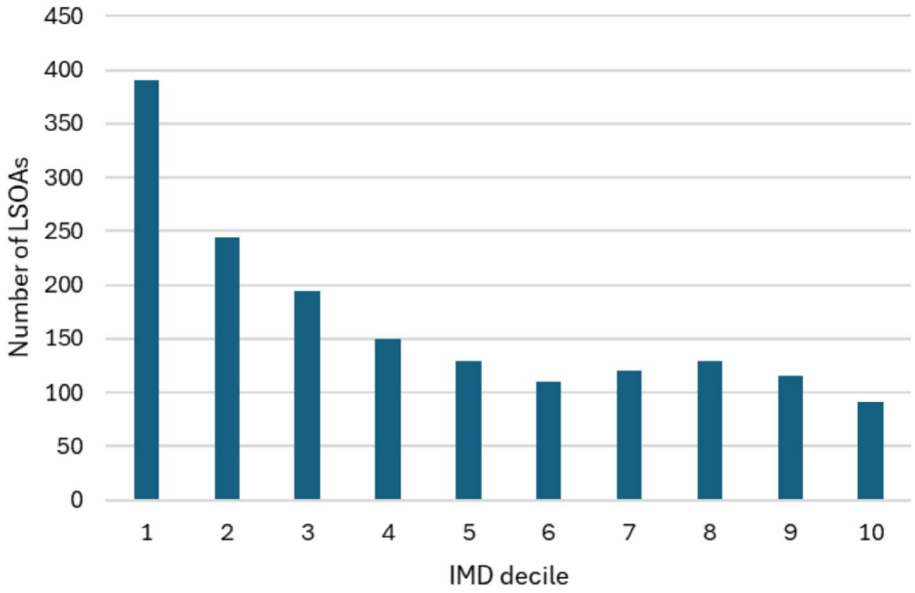

FIGURE 1 | Number of LSOAs in the different IMD deciles in Greater Manchester.

using data from 2013–2014 to 2023–2024. The ratios of the types of ADFs per 100 000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) were then calculated to add context to the correlations.

The research questions addressed by the research were:

- How does deprivation relate to overall ADF incidence?
- How does deprivation relate to specific types of ADFs?
- How do ADF rates vary across levels of deprivation?

These are important research questions, since further knowledge of the relationship between deprivation and ADFs can support appropriate targeting of fire prevention activities by fire and rescue services. This is especially important in a climate of reduced funding for English fire and rescue Services, particularly in areas with high levels of deprivation [6, 7]. The level of deprivation measure used in the analysis was the IMD decile [27] from the UK Ministry of Housing, Communities and Local Government. The IMD decile is a scale ranging from 1, which denotes the 10% most deprived areas in England, to 10, which denotes the 10% least deprived areas. Microsoft Excel was used for the analysis of the data since it was used by Greater Manchester Fire and Rescue Service and is commonly used by other UK Fire and Rescue Services.

4 | Deprivation and ADFs

Figure 1 shows the number of LSOAs in the different IMD deciles in the Greater Manchester area and indicates the predominance of high levels of deprivation (IMD decile 1) within the area.

Table 1 shows the IMD deciles and ADFs in IMD decile areas in Greater Manchester over the period 2013–2014 to 2023–2024 in terms of the average number of ADFs in the different IMD deciles, the number of ADFs per 10 000 households in IMD deciles, and the number of ADFs per 10 000 population in the IMD deciles.

TABLE 1 | IMD deciles and accidental dwelling fires in IMD decile areas in Greater Manchester.

IMD decile	Average ADFs in IMD decile	ADFs per 10 000 households in IMD decile	ADFs per 10 000 population in IMD decile
1	20.50	282.50	112.90
2	14.60	217.60	86.70
3	13.60	195.60	80.40
4	18.40	192.30	79.80
5	10.20	154.30	67.10
6	8.50	128.00	55.40
7	7.60	115.90	49.30
8	6.80	102.80	43.00
9	5.80	91.00	37.60
10	5.70	93.40	37.30

In terms of the Pearson Product Moment Correlations between IMD decile and different measures of ADFs across the IMD decile areas, the correlation between IMD decile and average number of ADFs in IMD decile LSOAs in Greater Manchester was 0.91 ($p < 0.001$), the correlation between IMD decile and ADFs per 10 000 households in IMD deciles in Greater Manchester was 0.96 ($p < 0.001$); the correlation between IMD decile and ADFs per 10 000 population in IMD deciles in Greater Manchester was 0.97 ($p < 0.001$). The number of ADFs per 10 000 population in IMD deciles was then used for assessment of the strength of the relationship between deprivation and different types of ADFs (categorised by the source of ignition of the fire).

Figure 2 graphically shows the relationship between IMD deciles and ADFs per 10 000 population in IMD deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD decile and ADFs per 10 000 population in IMD deciles in Greater Manchester was very strong at 0.97 and was significant at the 0.001 level ($p < 0.001$). The ratio of ADFs per 100 000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 3.0–1. This indicates that ADF risk is higher in more deprived areas, and that fire prevention activities should be targeted more to such areas. Previous research in the United Kingdom and internationally had indicated the association between deprivation and increased domestic fire risk [2, 28].

The health deprivation and disability domain within the IMD is a measure of the risk of premature death and impairment to quality of life through poor physical or mental health. The health deprivation and disability domain measures morbidity, disability and premature mortality. Figure 3 shows the relationship between IMD health deciles and ADFs per 10 000 population in IMD health deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD health decile and ADFs per 10 000 population in IMD health deciles in Greater Manchester was 0.87 and was significant at the 0.001 level ($p < 0.001$). The ratio of ADFs per 100 000 population in IMD 1 health deciles (most deprived in terms of health) to IMD 10 health deciles (least deprived in terms of health) in Greater Manchester over the period studied was 3.0–1. This indicates that ADF risk is higher in deprived areas with poorer levels of health, similar to previous research in the United Kingdom [10], and that fire prevention activities should address those vulnerable to ADFs due to poor physical or mental health.

Figure 4 graphically shows the relationship between IMD deciles and accidental dwelling cooking fires per 10 000 population in IMD deciles in Greater Manchester over the period 2013–2014

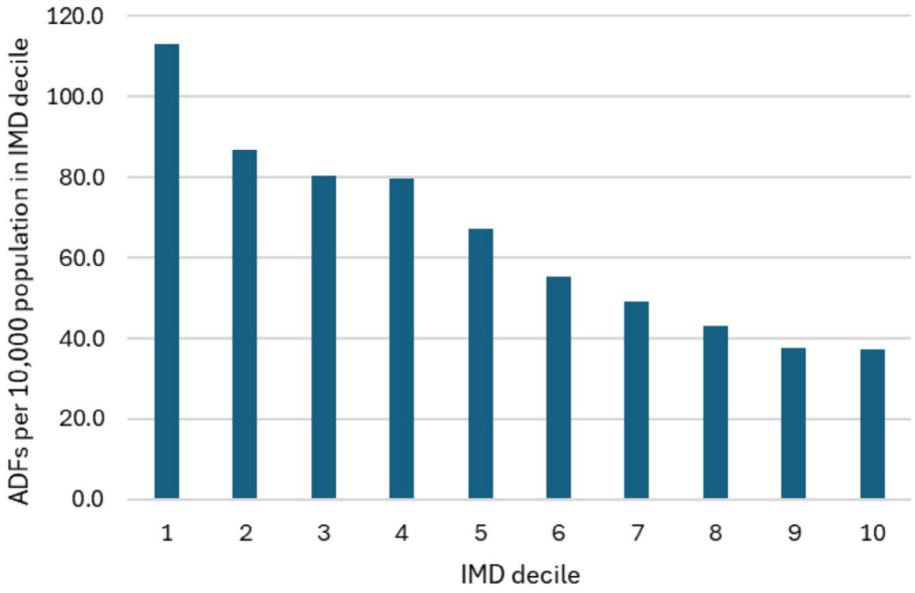

FIGURE 2 | Accidental dwelling fires per 10 000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

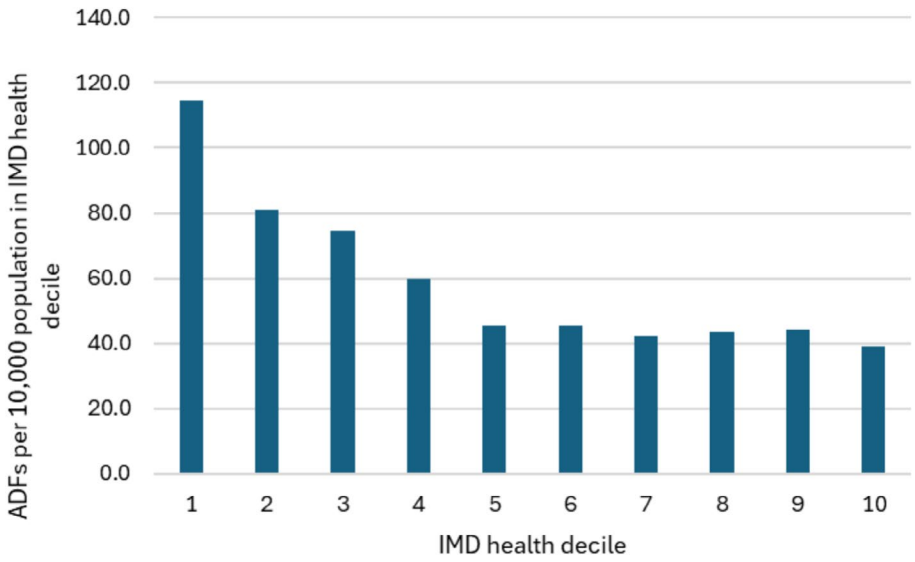

FIGURE 3 | Accidental dwelling fires per 10 000 population in IMD health deciles in Greater Manchester from 2013–2014 to 2023–2024.

to 2023–2024. The correlation between IMD decile and cooking ADFs per 10000 households in IMD deciles in Greater Manchester was 0.96 ($p < 0.001$), which showed a similarly high level of correlation and was also significant at the 0.001 level ($p < 0.001$) compared to the overall numbers of ADFs. The ratio of accidental dwelling cooking fires per 100000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 4.3–1. This indicates that cooking fire risk is higher in deprived areas, as indicated by previous research [29], and shows a greater disparity between deprived and affluent areas than ADFs overall.

Figure 5 graphically shows the relationship between IMD deciles and accidental dwelling smoking-related fires per 10000 population in IMD deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD decile and smoking-related ADFs per 10000 households in IMD deciles in Greater Manchester was 0.95 ($p < 0.001$), which showed a similarly high level of correlation and was also significant at the 0.001 level ($p < 0.001$) compared to the overall numbers of ADFs. The ratio of accidental dwelling smoking-related fires per 100000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 8.4–1. This indicates that smoking-related fire risk is higher in deprived areas and shows a higher level of disparity between deprived and affluent areas compared to overall ADF numbers.

Figure 6 graphically shows the relationship between IMD deciles and accidental dwelling heating fires per 10000 population in IMD deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD decile and

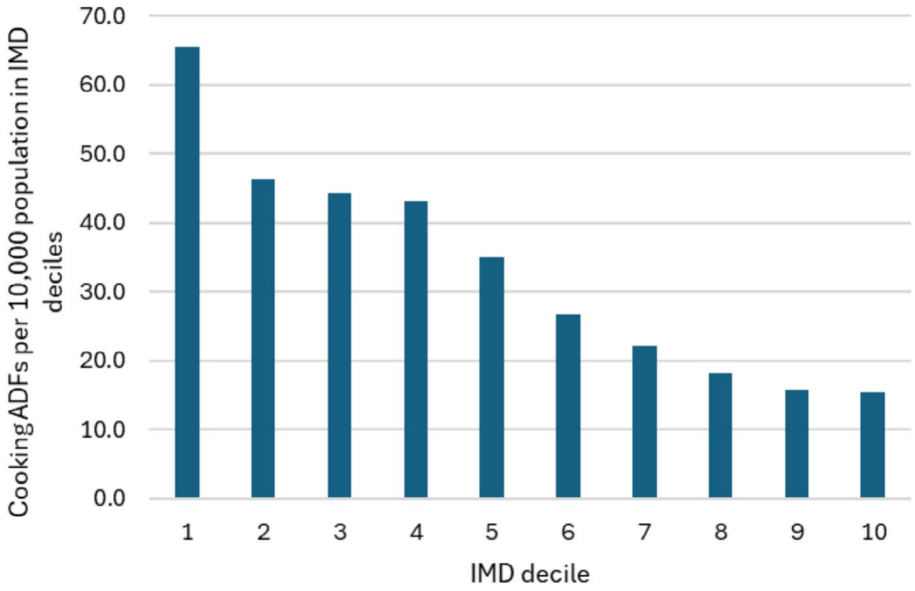

FIGURE 4 | Accidental dwelling cooking fires per 10000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

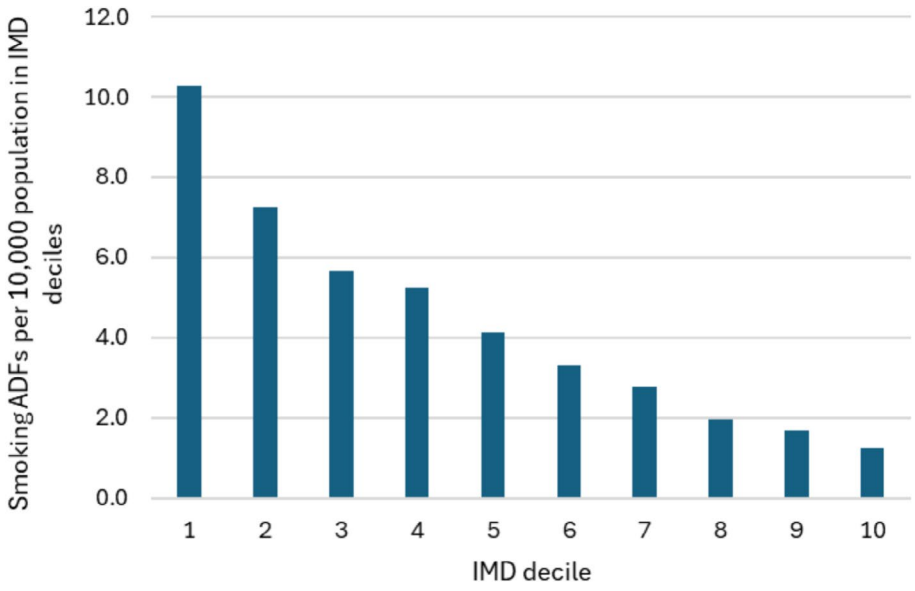

FIGURE 5 | Accidental dwelling smoking-related fires per 10000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

heating ADFs per 10000 households in IMD decile in Greater Manchester was 0.73 ($p < 0.018$), which showed a lower level of correlation compared to the overall numbers of ADFs over the time period studied. In the United Kingdom, some households may resort to using less safe means of heating the home, such as portable heaters, in response to large increases in domestic energy costs [30]. The ratio of accidental dwelling heating fires per 100000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 1.7–1. This indicates that heating fire risk is not as strongly correlated with deprivation compared to the other types of ADFs.

Figure 7 graphically shows the relationship between IMD deciles and accidental dwelling candle fires per 10000 population in IMD deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD decile and candle ADFs per 10000 households in IMD decile in Greater Manchester was 0.89 ($p < 0.001$), which showed a high level of correlation and was significant at the 0.001 level ($p < 0.001$), although the level of correlation was slightly lower compared to the overall numbers of ADFs. Typically, in the United Kingdom, candles are mainly used for mood and ambience purposes; however, candles may sometimes be used as a means of cost-saving due to large increases in energy costs in less affluent households in the United Kingdom [31]. The ratio of accidental dwelling candle fires per 100000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 1.9–1. This indicates that candle fire risk is higher in deprived areas, but does not show as great a level of disparity between deprived and affluent areas compared to other types of ADFs.

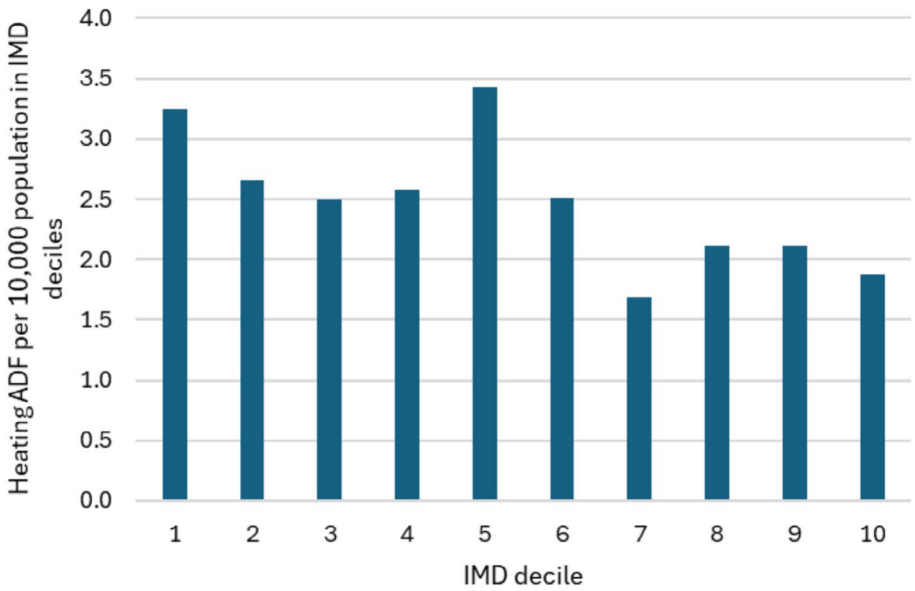

FIGURE 6 | Accidental dwelling heating fires per 10000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

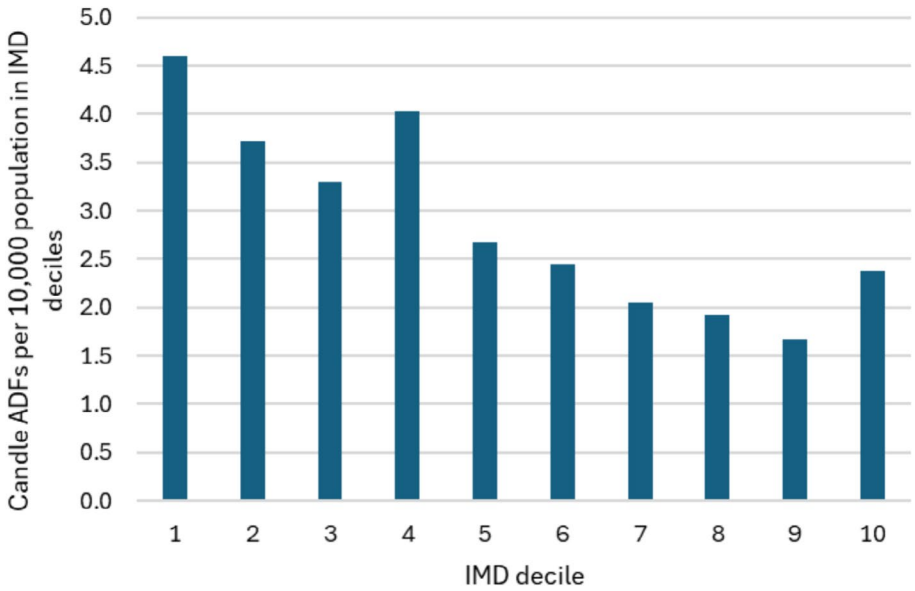

FIGURE 7 | Accidental dwelling candle fires per 10000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

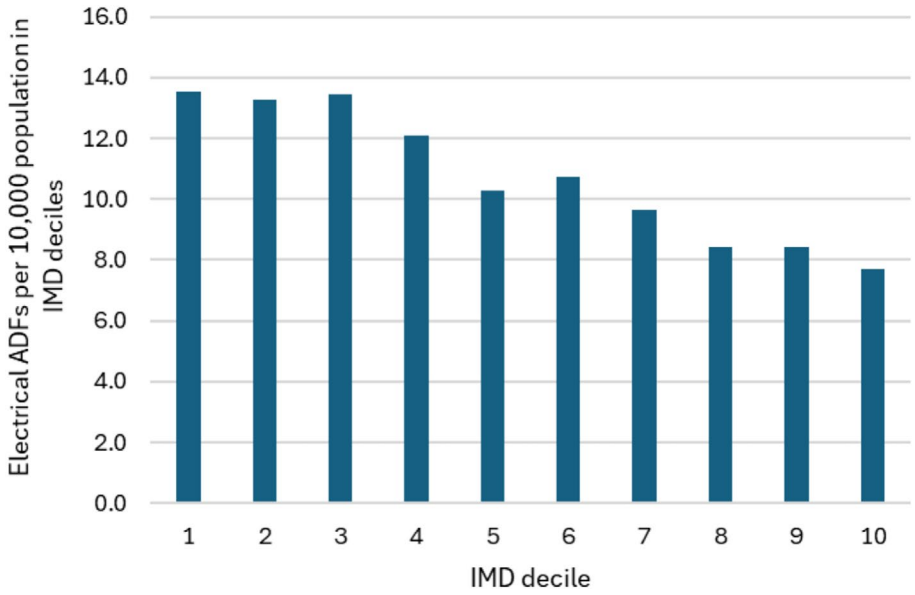

FIGURE 8 | Accidental dwelling electrical fires per 10 000 population in IMD deciles in Greater Manchester from 2013–2014 to 2023–2024.

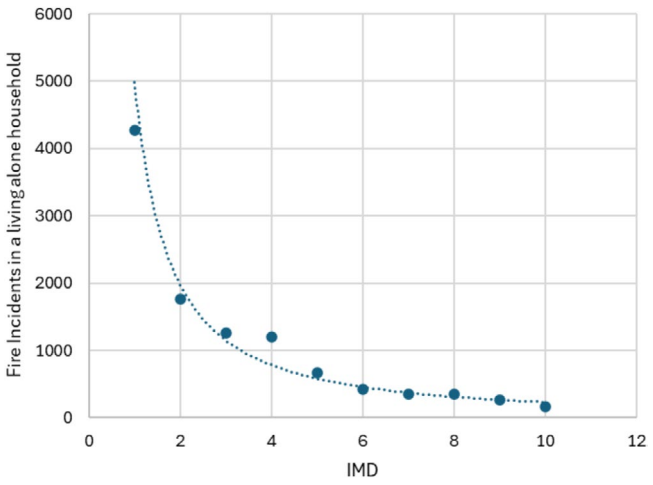

FIGURE 9 | Accidental dwelling fire incidents in living-alone properties by IMD decile in Greater Manchester from 2013–2014 to 2023–2024.

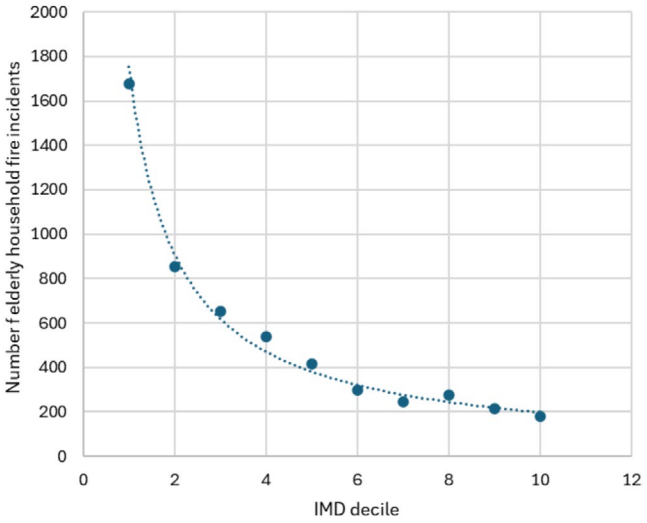

FIGURE 10 | Accidental dwelling fire incidents in elderly households by IMD decile in Greater Manchester from 2013–2014 to 2023–2024.

Figure 8 graphically shows the relationship between IMD deciles and accidental dwelling electrical fires per 10 000 population in IMD deciles in Greater Manchester over the period 2013–2014 to 2023–2024. The correlation between IMD decile and electrical ADFs per 10 000 households in IMD decile in Greater Manchester was 0.97 ($p < 0.001$), which showed a similarly high level of correlation and was also significant at the 0.001 level ($p < 0.001$) compared to the overall numbers of ADFs. In more deprived areas in England, households may keep older domestic appliances for longer and may not keep them appropriately maintained [15], which may present more of an ADF risk. The ratio of accidental dwelling electrical fires per 100 000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 1.8–1. This indicates that electrical fire risk is higher in deprived areas, but does not show as great a level of disparity between deprived and affluent areas compared to other types of ADFs.

Overall, the correlations between the average number of ADFs and specific fire types in the different IMD decile LSOAs and the IMD decile were quite strong. However, for a number of types of ADFs, IMD decile 4 LSOAs showed a deviation from the overall patterns. The IMD decile 4 values were not outliers, since the largest standardised residual for IMD decile 4 values was for candle fires, where the IMD decile 4 value had a standardised residual of +1.57. Typically, standardised residuals greater than ±2 (or ±3 for stricter criteria) may be considered an outlier. In terms of understanding why the variation in the IMD decile 4 values may have occurred, further analyses were undertaken.

Figure 9 shows the ADF incidents in living-alone properties by IMD decile in Greater Manchester, 2013–2014 to 2023–2024. This appears to indicate that there is a relatively higher incidence of ADF incidents in properties where individuals live alone in IMD decile 4 areas compared to the overall pattern of

such fires. This might therefore be an underlying factor in the differences in the pattern of IMD decile values when looking at the overall number and types of ADFs. Previous research had identified living alone as a causal factor in ADFs [32, 33].

Figure 10 shows the ADF incidents in elderly households by IMD decile in Greater Manchester, 2013–2014 to 2023–2024. This appears to indicate that there is a relatively higher incidence of ADF incidents in elderly households in IMD decile 4 areas compared to the overall pattern of such fires. This might therefore be an underlying factor in the differences in the pattern of IMD decile figures when looking at the overall numbers and types of ADFs. Previous research in the United Kingdom and Europe had identified the elderly as being more at risk of ADFs [18, 34].

5 | Conclusion

One of the main limitations of the research undertaken into the association between deprivation and ADF incidence was data availability. Data were only available for ADFs that were reported to the UK Fire and Rescue Services and officially recorded. UK Office for National Statistics IMD decile level data were only available at the lower super output area [3] level of geography or higher. LSOAs are small areas with an average of approximately 1500 residents or 650 households [4]. There would typically be some variation in the level of deprivation among the residents and households within each LSOA. IMD deciles are determined by creating IMD scores where each small area (called a lower-layer super output area or LSOA) is assigned an IMD score based on seven weighted domains of income, employment, education, health, crime, barriers to housing and services and living environment. All 32 844 LSOAs in England are then ranked from most to least deprived. These ranks are then split into 10 equal groups (deciles), with Decile 1 = the most deprived 10% and Decile 10 = the least deprived 10%.

The novelty of the research reported in this paper concerns the detailed analysis of the relationship between deprivation measured by the IMD decile, which is determined by the UK Ministry of Housing, Communities and Local Government and different types of ADFs categorised by the source of the fire over the period 2013–2014 to 2023–2024 in Greater Manchester. Overall, there were strong and statistically significant levels of correlation between the level of deprivation measured by the IMD decile and the number of different types of ADFs per 10 000 population across the IMD deciles. The lowest levels of correlation were 0.73 for heating fires and 0.89 for candle fires, with all the other correlations being 0.95 or above. This indicates that deprivation is a strong indicator of the level of ADF risk and should be considered when targeting fire prevention. The overall ratio of ADFs per 100 000 population in IMD 1 deciles (most deprived) to IMD 10 deciles (least deprived) in Greater Manchester over the period studied was 3.0–1. This ratio varied between the different types of ADFs, from 1.7:1 for heating fires, 1.8:1 for electrical fires, 1.9:1 for candle fires, to 4.3:1 for cooking fires and 8.4:1 for smoking-related fires. This appeared to indicate that smoking was strongly associated with deprivation in terms of its effects on the level of ADF risk. Overall, the disparities in the level of ADF risk between deprived and affluent areas indicate that deprived communities are more vulnerable to fire across all the main types of ADF categorised by the source of ignition of the fire. Overall, the correlations between the average number of ADFs and specific fire types in the different IMD decile LSOAs and the IMD decile were quite strong. However, across some types of ADFs, IMD decile 4 LSOAs showed a deviation from the overall patterns. There appeared to be a higher relative incidence of ADF incidents in properties where individuals lived alone and had elderly residents in IMD decile 4 areas compared to the overall pattern of such fires. These might therefore be underlying factors in the differences in the pattern of IMD decile figures when looking at overall ADFs and types of ADFs.

The high levels of correlation between the level of deprivation (measured by IMD decile) and the numbers of the different types of ADFs in populations across the IMD deciles would appear to indicate that fire prevention strategies should incorporate an element of targeting based upon the level of deprivation. Future research could further investigate the aspects of deprivation that are most strongly linked with increased ADF risk, for example, income deprivation, employment deprivation and the living environment. It is hoped that the research presented in this article may be of relevance to Fire and Rescue Services, especially those that incorporate areas of higher levels of deprivation.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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