KENT PUBLIC HEALTH OBSERVATORY

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Kent Fire & Rescue Service

Accidental Dwelling Fires – A Public Health Approach to Risk Factors

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Produced by

Naomi Clemons: Senior Intelligence Analyst
Joshua Stroud: Intelligence Analyst
Laura Hill: Information Officer
Richard Stanford-Beale & Lynsey Mahmood: Kent Fire and Rescue Service
Correspondence to: KPHO@kent.gov.uk

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1. Introduction & Objectives

For over 10 years fire and rescue services have been visiting people's homes, not only to provide advice on how to avoid being the victim of an accidental house fire, but also to carry out other interventions to reduce risk.[1] Since such schemes began, a drop in the demand for fire and rescue services to attend accidental dwelling fires has been noted, although this cannot all be attributed to the introduction of these visits. Safe and Well visits are designed not only to identify and support individuals in relation to the risk of fire, but also to advise on a wider range of issues that impact on their quality of life[2]. Research suggests that the wider determinants of health, both physical and mental can impact on accidental dwelling fire (ADF) risk[3]. Collaborating with public health partners, fire and rescue services have been involved in various initiatives ranging from fall risk assessments, to alcohol and mental health advice. Such collaborative initiatives demonstrate how Safe and Well visits can have an impact on wider public health. Whilst not always quantifiable, such collaborations remain of upmost importance as social prescribing, and more effective use of wider resources become increasingly important to maintaining a healthy population.

1.1.1 Aims

Literature indicates that certain populations are at increased risk of experiencing ADFs, whilst others are at increased risk of fatalities resulting from ADFs. Health conditions, lifestyles, and behaviours, such as poor mobility or smoking are thought to play a role in both the cause and outcome of ADFs, although the extent of the influence of these variables is yet to be fully understood. Therefore, this profile aims to establish concentrations of the population across Kent that may be at increased risk of ADFs, or at increased risk of fatalities resulting from ADFs. Cohorts were built based on health and lifestyle factors drawn from literature that identifies such factors as potentially playing a role in ADFs. The impact of these factors was assessed by overlaying the health-based cohort populations with the already established KFRS ADF risk model. By building cohorts based on health-based factors

[1] National Fire Chiefs council - **http://www.cfoa.org.uk/21422**
[2] National Fire Chiefs council
[3] See Holborn P, Nolan P, Golt J. An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000. Fire Safety Journal. 2003; 38(1):1-42 and Taylor, M., Higgins, E., Lisboa, P., & Kwasnica, V. (2012). An exploration of causal factors in unintentional dwelling fires. Risk Management, 14(2), 109-125.

and overlaying the output with an already established model, it is anticipated that a greater understanding of the relationship between health-based factors and ADF's will be obtained. Identification of relevant health-based factors will also assist with more effective deployment of KFRS resources and targeted Safe and Well visits, and in time, a deeper understanding of the relationship between health and ADFs.

1.1.2 The Impact of Safe and Well visits

Safe and well visits are known by various names across different fire and rescue services but are conducted with similar principles in mind. In England up to 670,000 Safe and Well visits are conducted per year and whilst, undoubtedly, other factors play a part, such visits have contributed to a reduction in recorded accidental dwelling fires[4].

- In the last 10 years there has been a 26% reduction overall in dwelling fires across England. Accidental fires have decreased by 21% and deliberate dwelling fires have decreased by 52%. [5]
- In the last 10 years, there has been a 34% reduction overall in dwelling fires in Kent which is a greater decrease when compared to the average for England. Accidental fires have decreased by 32% which is a much greater decrease compared to the average decrease for England, and deliberate dwelling fires have decreased by 40%.

Deliberate dwelling fires fall out of the scope of this project and therefore will not be discussed further. Accidental dwelling fires (ADFs) will be the focus of the report.

The impact of Safe and Well visits cannot be measured in a way that can directly be linked to a change in health outcomes or even a reduction in fire incidents. A recent review of KFRS Safe and Well visits identified that visits did have an impact on spreading core fire safety messages, raising awareness and had some impact on behavioural change of those who had received a visit.[6] The wider determinants of health and health behaviours influence the outcome and prevalence of ADFs. Therefore, taking a health-led approach to identify risk is a useful and informative process.

[4] NHS England - **https://www.england.nhs.uk/wp-content/uploads/2015/09/safe-well-visit-pinciples.pdf**
[5] National Fire and Rescue incident statistics **https://www.gov.uk/government/statistics/fire-and-rescue-incident-statistics-england-year-ending-september-2019**
[6] Kent Fire and Rescue Service Evaluation of Safe and Well Visits April 2020 **https://www.kent.fire-uk.org/about-us/research/published-research/evaluation-of-safe-and-well-visits-2019-20/**

2. Risk Indicators

2.1 Review of Literature and National ADF Fire Incident Data

A literature review, conducted by KFRS, and recorded fire incident data identified several risk factors that contributed to the increased risk of death or serious injury as the result of an ADF. It is interesting to note that those at risk of dying in an accidental fire, are not at the greatest risk of having an accidental fire, they are often two distinct groups. Preventative strategies therefore need to be different for different groups. Whilst literature has indicated that certain factors can be predictive in terms of the prevalence and outcome of ADFs, not all predictors identified are equally strong, and it can be challenging to adjust for variation in behaviour and human activity.[7] What is clear is that ADFs are not distributed evenly across the socio-economic spectrum, increased deprivation being a strong predictor for ADFs, especially in single person households aged under 65.[8] Public health literature indicates that there is a relationship between health and ADFs, but the nature of this relationship is yet to be fully established. One review indicates that deprivation is a strong predictor of ADFs, and poorer health behaviours and lifestyles are associated with deprivation, therefore the link with health factors is influenced by deprivation.[9]

2.1.1 Risk factors contributing to Fatalities[10]

National fire data indicates that fatalities from ADFs are most common in the over 65 age group and those living in single person households. Table one shows the fatality rate per million population with a gradual increase from aged 25 to 39 with a more marked increase from 65 and even more so from 80 years.

[7] Hastie, C & Searle, R. (2016). Socio-Economic and Demographic Predictors of Accidental Dwelling Fire Rates. Fire Safety Journal. 84. 50–56. 10.1016/j.firesaf.2016.07.002.
[8] Hastie, C & Searle, R. (2016). Socio-Economic and Demographic Predictors of Accidental Dwelling Fire Rates. Fire Safety Journal. 84. 50–56. 10.1016/j.firesaf.2016.07.002.
[9] Hastie, C & Searle, R. (2016). Socio-Economic and Demographic Predictors of Accidental Dwelling Fire Rates. Fire Safety Journal. 84. 50–56. 10.1016/j.firesaf.2016.07.002.
[10] Information supplied by Richard Stanford-Beale KFRS

Age Group	Rate per 1,000,000 pop 2017/18	Rate per 1,000,000 pop 2018/19	Rate per 1,000,000 pop 2019/20
Under 1	4.85	N/A	N/A
1 - 5	2.08	0.30	N/A
6 - 10	1.98	0.85	N/A
11 - 16	1.80	0.26	N/A
17 - 24	1.12	0.94	0.37
25 - 39	3.00	1.06	0.71
40 - 54	3.17	2.36	2.45
55 - 64	5.75	4.13	3.39
65 - 79	7.05	5.85	7.18
80 and over	17.27	15.16	14.80

Table 1: Rate of fatalities in ADFs per 1,000,000 population by age group[11]

	Number of fatalities in ADFs attended by FRSs in England by household type			
Financial Year	**Lone person over Pensionable Age**	**Lone person under Pensionable Age**	**Other household types**	**All AFD fatalities**
2014/15	64	36	67	**167**
2015/16	72	47	70	**189**
2016/17	69	36	81	**186**
2017/18	69	114	59	**242**
2018/19	58	39	68	**165**
2019/20	61	37	69	**167**

Table 2: Number of fatalities in ADFs attended by FRSs in England by household type [12]

Table 2 indicates that lone person households are the most common type of household in which ADF fatalities occur. Except for an anomaly in 2017/18, lone person household where the individual is aged over pensionable age are the most common type of household in which ADF fatalities occur. Therefore, lone person dwellings, especially where the individual is aged over 65 are two key risk factors for fatal ADFs and therefore form the base of one of the cohorts.

In addition to older age and living alone, characteristics that appear to be associated with fatalities as a result of ADFs identified by the KFRS led literature review include age (children under 11 but especially under 5), being male, non-white ethnicity, mental/physical ill-health

[11] Home Office Fire Statistics table FIRE STATISTICS TABLE 0506a: Fatalities1 in accidental2 dwelling fires by age and cause of death, England

[12] National Fire and Rescue Incident statistics – Fire Statistics Table A6 Number of fire-related fatalities1 in accidental2 dwelling fires by type of household, England

or disability, smoking/drug/alcohol use and low social economic status. However, the research shows that these characteristics interact, and it is not possible to identify the significance of each factor on ADF risk from the literature alone.

These risk factors were used to form the basis of two cohorts, firstly a cohort formed of an elderly population and second a cohort formed of households made up of single parents with multiple children. These were separated in to two cohorts because of their likely distinct geographical and health-based differences. Age is often not associated with increased risk of fire but increased risk of casualties resulting from fire.[13] Both groups are at increased risk of ADFs that result in fatalities.

2.1.2 Risk factors contributing to chance of accidental fire resulting in Injury[14]

As established by the literature those, who are at greater risk of experiencing an ADF or being injured as a result are a separate group to those who are more likely to experience a ADF that results in a fatality. Prevalence of ADFs and related injuries are associated with; specific ages, being male, disabilities, social economic status, types of occupancy, smoking, alcohol/drug use and previous experience of fire. The research shows that these factors are more complex and harder to identify than for ADF fatalities, partly due to the lack of accurate and specific data. This is also an area which is hard to research due unreported fires and reliance on self-reporting.

There is little evidence to demonstrate the impact of health-related conditions or behaviours, besides smoking and alcohol consumption combined with high levels of deprivation for the group most likely to suffer injury as a result of an ADF. Therefore, this paper explores if health related behaviours and conditions potentially have an impact in predicting the prevalence of ADFs linked to this cohort as well as the cohort where fatalities are more likely.

2.1.3 Health based cohorts

Health related factors are considered to play a role in the likelihood and outcome of ADFs, but these are not the sole contributors to outcome, with many other social, demographic,

[13] Holborn, Nolan, & Golt, (2013) An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000, Fire Safety Journal. 38 1–42. doi:10.1016/S0379-7112(02)00049-8.
[14] Mahmood & Stanford-Beale (2021) Review of Evidence to support Risk Stratification in Accidental Dwelling Fires. https://www.kent.fire-uk.org/about-us/research/published-research/segmentation-report-2021/

and environmental factors also in play. Recognising the interplay of multiple factors, the focus here is to better understand the impact of an individual's health factors and behaviours in terms of their association or otherwise with ADFs. This was achieved by overlaying the current KFRS model with health-based cohorts and examining their associative correlation with ADFs.

Each cohort was created with either the prevalence of ADFs or the likely outcome of ADFs in mind. The first two cohorts were created based on the outcome of an ADF resulting in a fatality. With so few fatal fires occurring in Kent, testing the validity of such cohorts presents a challenge. However, the distribution of such cohorts across Kent still provides a useful insight to KFRS for potential prevention work. The third cohort was based on predicting ADF prevalence. Various health related factors, such as those that impact on mobility and health behaviours (e.g., smoking) were incorporated into these cohorts in various ways. Further details on the make-up of these cohorts can be found in the next section.

Cohort One: Fatal – Elderly: This risk analysis will focus on identifying clusters of households where individuals over the age of 65 are most at risk of fatal accidental house fires.

Cohort Two: Fatal – Children: This risk analysis will focus on identifying clusters of households where children may be at risk of fatal accidental house fires.

Cohort Three: Injury/Fire: This risk analysis will identify clusters of households where individuals are most likely at risk of non-fatal ADFs that result in injury.

3. Risk Analysis

To identify where populations fitting the cohort criteria were clustered in Kent, various public health databases, both open source and the Kent Integrated Database were interrogated. Data on long term health conditions impacting mobility, socio-economic status, age, gender, smoking and alcohol use, were accessed and combined to identify geographical hotspots. Whilst disability was requested as an indicator, gathering accurate data on physical disabilities is problematic and therefore the decision was taken to focus on conditions that impacted mobility as a similar indicator. It must also be acknowledged that data completeness is variable. For example, smoking status and alcohol use is not recorded for all individuals in Kent. Health related conditions and behaviours are also variable and changeable; therefore, these cohorts are likely to change and adapt overtime.

Analysis was conducted at two geographical levels, local authority and Lower Super Output Area (LSOA). The analysis undertaken at local authority level was designed to give a broad overview of the local context and population makeup relevant to the cohorts. Each cohort was divided into different levels of risk category based on varying combinations of health factors, health behaviours and socio-economic factors to assist with potential future targeting. Analysis was conducted independently of current ADF locations at this stage to ensure that a health led approach remained the priority. After the key at-risk groups were identified, these were then cross referenced with the KFRS risk model to establish any overlap, the results of which can be seen in section 4.

3.1 Cohort 1 – Elderly fatal ADFs

3.1.1 – Local context

According to 2019 Mid-Year population estimates, in Kent and Medway there are a total of 1,860,100 people. 364,200 people equating to 19.6 % of the total population aged 65 or over.[15] Table 2 shows that Folkstone and Hythe, Thanet and Dover have the highest proportion of the total population aged over 65, indicating that coastal towns may feature as key areas for fatal ADF's due to the increased age of the population in these areas.

[15] Population Estimate Unit, ONS Mid-Year population estimates 2019

District	Total aged over 65 years	% of over 65s of total local authority pop.
Folkstone and Hythe	28,100	24.9
Thanet	33,900	23.9
Dover	27,800	23.5
Sevenoaks	26,100	21.6
Canterbury	34,200	20.7
Gravesham	18,600	19.4
Tunbridge Wells	23,000	19.4
Maidstone	33,000	19.2
Swale	28,800	19.2
Tonbridge and Malling	24,900	18.8
Ashford	23,500	18.1
Medway	44,900	16.1
Dartford	15,800	14
Total	**364,200**	**19.6**

Table 2: % of population aged 65 and over by Kent local authorities

There is no single measure for the numbers of individuals with physical disabilities. The ONS estimates that around 40%[16] of the population aged over 65 are living with self-identified disability, although this increases significantly with age. In Kent it is estimated that 17.6 % of the total population are living with a long-term health problem or disability as defined by a self-evaluation questionnaire.[17] Individuals living in the East of Kent in areas such as Thanet, Dover, Shepway, Canterbury but also Swale are more likely to report living with a disability or long-term health problem,[18] suggesting that levels of fatal ADFs may be increased in these areas.

In Kent those aged over 65 are far more likely than any other age group to claim disability benefit. 17.5% of the Kent population aged 65 and over claim disability benefit,[19] supporting the notion that disability increases with age. Older adults who live alone are more likely to have multiple long-term conditions (50% compared to 42% of older adults who live with others)[20]. ONS estimate that 3.2[21] million over 70s live alone in the UK, which equates to

[16] http://www.ons.gov.uk/Annual Population Survey (3-year Pooled dataset)
[17] 2011 Census, Table Ks301EW, Office for National Statistics
[18] As above
[19] Department of work and pensions
[20] (Dreyer et al., 2018). The Association between Living Alone and health care utilisation in older adults
[21] https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/families/adhocs/11446peoplelivingaloneaged65yearsoldandoverbyspecificagegroupandsexuk1996to2019

around 37% of the total population. Cohort analysis at a more granular level exploring some of these key risk factors will identify key areas within Kent where there are high concentrations of individuals with multiple risk factors that could contribute to the likelihood of a fatal ADF.

3.1.2 Elderly – Fatal Kent Specific Cohort

Data was extracted from the Kent Integrated Dataset (KID) to identify the spread of individuals who may be at risk of fatality resulting from an ADF. A cohort of 91,889 individuals aged 65 and over, living in a single person household were identified. 83% of the individuals were aged 70 and over. Being aged 65 and over along with living in a single person household was the starting point for inclusion into this cohort, however three sub-groups, very high risk, high risk and medium risk were then created based on the addition of cumulative risk factors.

3.1.3 Very High Risk

Criteria for the very high - risk group: aged 65 and over with three or more long term health conditions (LTCs), which indicates poor health, residing in an area of IMD decile 1 – 5. A total of 12,258, 13%, of the total cohort fall into this risk category.

Table 3 below demonstrates the proportion of individuals that fall into the very high - risk category across the district that see higher than the 13% average.

District	Total Cohort Count All risk levels	% in Very High- Risk Category
Thanet	9,329	19.41
Gravesham	4,850	16.97
Medway	12,025	16.38
Dover	7,113	16.24
Dartford	3,990	15.26
Shepway	7,031	15.06
Swale	7,156	14.94

Table 3: Cohort 1 – Very high risk by district

Table 3 shows how Thanet, Gravesham, Medway, Dover and Dartford all see concentrations of individuals that fall into the very high-risk category of a potentially fatal ADF. Incident

data for the last 5 years for ADFs involving fatalities where the individual was aged 65 or over was provided by KFRS. Whilst numbers are relatively low, Medway, Shepway and Gravesham are the only three districts that have seen more than one fatal fire fitting this category in the last 5 years.

3.1.4 High Risk

Criteria for the high - risk group: aged 65 and over with 2 long term health conditions (LTC) indicating poor health, residing in an area with a IMD decile of 1 – 5. A total of 10,021, 11% of the total cohort fall into this risk category.

Table 4 below shows the proportion of individual that fall into the high - risk category across the district that see higher than the 11% average.

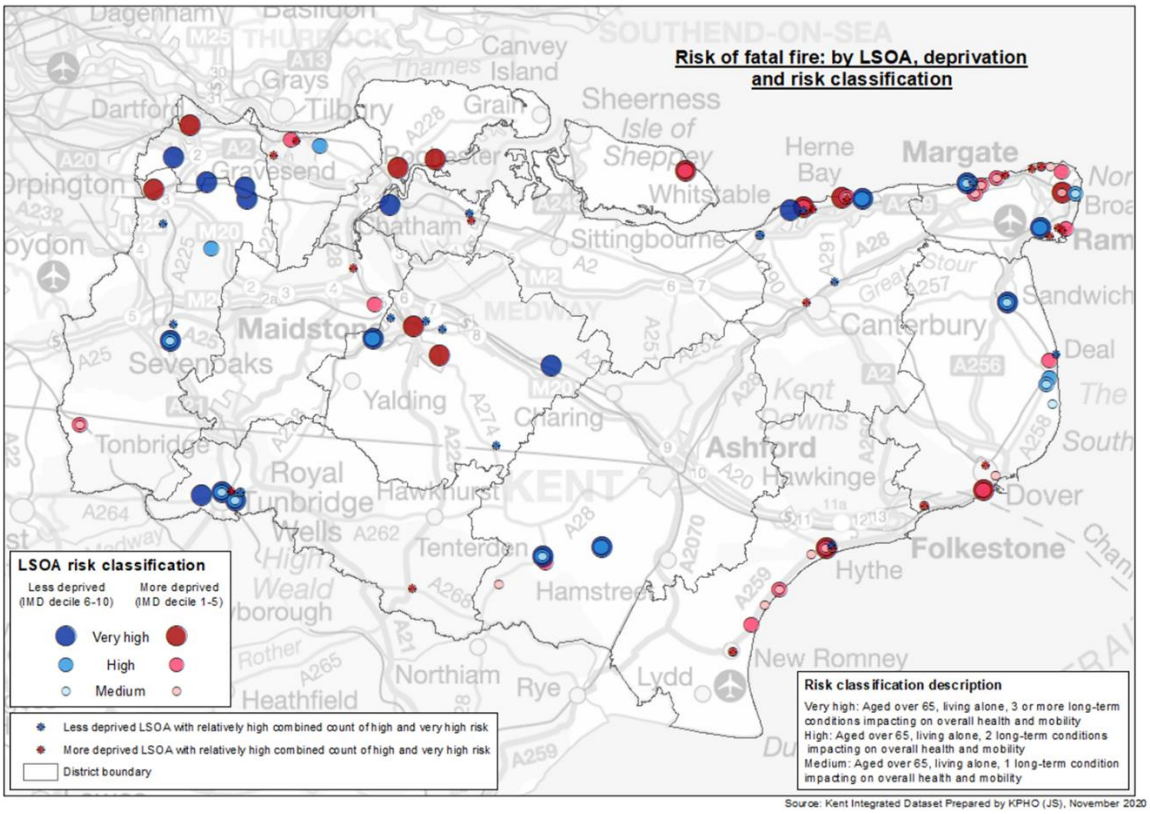
District	Total Cohort Count All risk levels	% in High-Risk Category
Thanet	9,329	16.9
Medway	12,025	13.8
Gravesham	4,850	13.6
Swale	7,156	13.6
Dover	7,113	13.3
Shepway	7,031	12.0
Dartford	3,990	11.7

Table 4 Cohort 1 – High risk by district

The districts highlighted as seeing the highest proportion of individuals falling into the high-risk category are the same as those identified in the very-high risk category suggesting that these two cohort populations are closely aligned geographically.

Similar analysis was also conducted for a group termed as 'medium risk,' however it did not add any additional detail at local authority level, but it has been included in analysis at LSOA level. Medium risk was defined as aged 65 or over, living alone with 1 LTC impacting on overall health and mobility. Whilst analysis of local authority level data gives a good indication of where such populations may be clustered, more granular detail about the distributions of such populations across Kent helps to offer greater insight.

Map 1 below demonstrates the distribution of very high risk, high risk and medium risk populations calculated at LSOA level. The cohort has been split into a more deprived and a less deprived group. Each marker on the map represents one LSOA. The size of the marker and strength of the shading relates to the level of risk: medium, high, very high.



Map 1: Distribution of very high risk, high risk and medium risk populations at LSOA level

3.2 Cohort 2 - Child Fatal ADFs

Very low numbers of ADFs result in fatalities involving children and the factors influencing such situations are hard to predict. Therefore, less emphasis has been placed on this category due to the inability to draw reliable data to inform decision making. Lone parent families have been used as an indicator of risk in other ADF statistical models,[22] and the literature supports the ideas that lone parent household present an increased risk. Children under the age of 11 are considered at increased risk, this risk increases significantly for

[22] Higgins, E., Taylor, M. and Francis, H., (2012) A systemic approach to fire prevention support. Systemic Practice and Action Research, 25(5), pp.393-406 and Higgins, E. and Taylor, M., (2012) Developing a statistical methodology for improved identification of geographical areas at risk of accidental dwelling fires. In Proceedings of Geographical Information Science Research UK Conference.

children under the age of 5 who are not only more likely to engage in fire play, often with unsupervised smoking material that may lead to fire, but they also have a reduced ability to self-rescue[23],[24].

Districts that compromise higher levels of lone parent families include Thanet, Swale, Medway, Dartford and Gravesham. Thanet and Swale also see higher proportions of children living in poverty along with Folkestone and Hythe and Medway[25]. However, alone these are not substantial enough indicators for fatal ADFs involving children. With no child fatalities because of ADFs recorded in Kent in recent years, it is not possible to test the validity of this cohort against KFRS data. However, understanding the geographic spread of this population across Kent could assist with campaigns focussed on prevention.

3.2.2 Kent specific cohort

Due to the nature of the data held on the KID it was not possible to identify the core risk group of multiple children under the age of 11 residing with a lone parent. The data extracted only included the count of children aged under 18 residing in a household with a single parent. With the potential for change in this category being greater than the other categories in terms of the time period covered by the KID, the decision was taken to identify one single group that were considered at greater risk rather than the three risk categories seen in the other two cohorts.

Data extracted identified a cohort of 34,623 households defined as single parent households where the parent was aged between 18 and 50. It was not possible to establish how many of the children in the household were aged 11 or under, therefore the at-risk group was created based on the number of children in the household aged under 18 and if the parent had ever been recorded as a smoker. A total of 1,144 households were identified where 4 or more children aged under 18 were residing, and the parent has ever been recorded as a smoker. This equates to 3.3% of the identified cohort.

[23] Harpur, A.P., Boyce, K.E. and McConnell, N.C., 2013. An investigation into the circumstances surrounding fatal dwelling fires involving very young children. Fire safety journal, 61, pp.72-82.
[24] Gov.UK Fire Safety for parents and child carers https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/475173/Fire-Safety-for-Parents-and-Child-Carers.pdf
[25] Kent district profiles found at https://www.kent.gov.uk/about-the-council/information-and-data/facts-and-figures-about-Kent/area-profiles

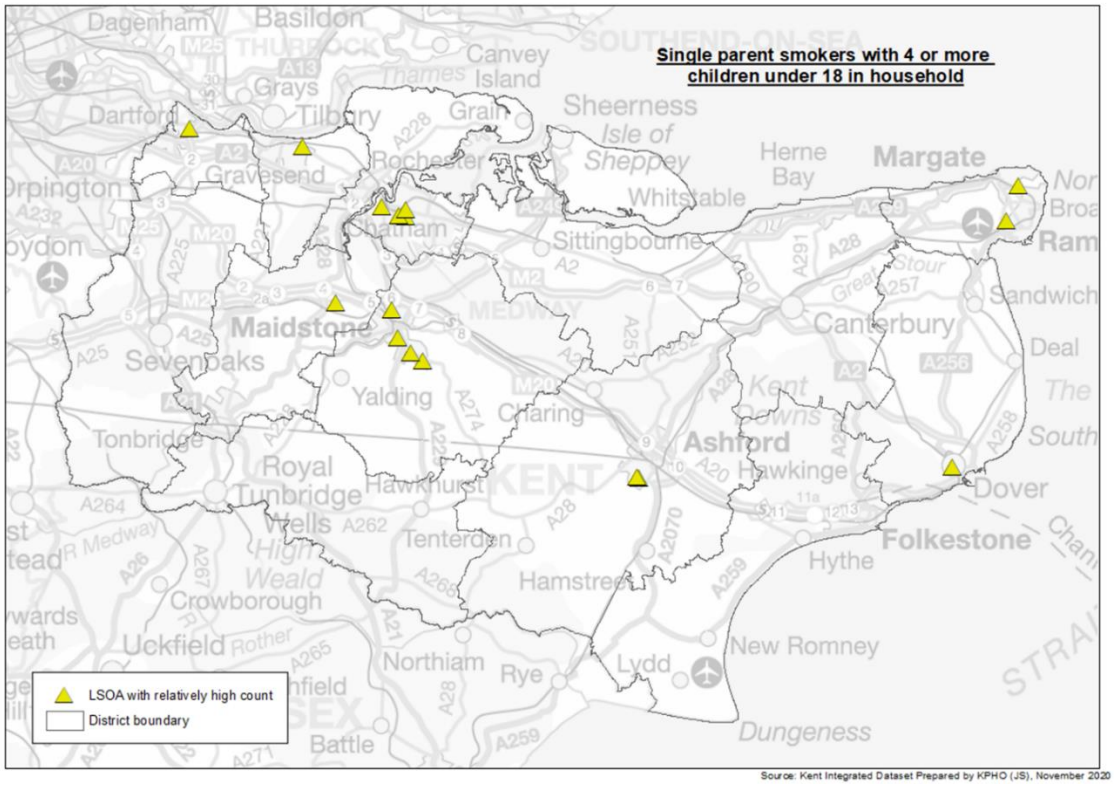
Table 6 below shows the proportion of households that fall into the 'at risk' category across the districts that see higher than the 3.3% average.

District	Total Cohort Count	% in At-Risk Category
Thanet	3,150	4.1
Canterbury	2,244	3.8
Dover	2,297	3.8
Swale	2,916	3.8
Medway	6,221	3.6

Table 5 Cohort 2 – At risk by district

Table 5 shows that Thanet, Canterbury, Dover, Swale and Medway all see higher than average proportions of households that fall into the at-risk category. KFRS report that there have not been any fatal house fires involving children in the last 5 years in Kent, therefore this data cannot be compared to current fire data.

Map 2 below demonstrates the geographical distribution of cohort 2 calculated at LSOA level.



Map 2: Distribution of cohort 2 at LSOA level

3.3 Cohort 3 – ADF and non-fatal casualties

By far the most common outcome for ADFs is non-fatal, yet non-fatal injury can range from minor to severe. There has been no attempt to segment the population in terms of the potential severity of injury. As identified in the literature in section two, males, residing alone aged between 40 and 49 who engage in smoking and harmful drinking behaviours in economically deprived areas are key risk factors for ADF prevalence. There is little evidence exploring the impact that specific health conditions have on this cohort, but to maintain a health-based approach to the selection, data on LTC was included to assess whether a relationship with broader health issues exists. The age range for this cohort was extended to 64 due to the increased risk of ADFs potentially resulting in a fatal outcome for single person households.

Dover, Folkstone and Hythe and Tunbridge Wells are all districts with higher-than-average populations of males aged between 45 and 64 years of age. Ashford, Sevenoaks and Tonbridge and Malling also have moderately elevated levels of these populations. High risk drinking behaviour is estimated to affect around 6%[26] of males in the 45 – 64 years age group. Local Authority smoking prevalence estimates range from 11% through to 16% and indicates that Thanet, Medway, Maidstone, and Swale see higher than average levels of smokers, followed by Canterbury and Dover.

3.3.1 Kent Specific Cohort

Data was extracted from the KID to identify the spread of individuals who may be at risk of injury resulting from an ADF. A cohort of 29,519 males aged between 45 and 64 years, living in a single person household were identified. Being aged between 45 and 64 years along with living in a single person household qualified an individual for inclusion in this cohort, however three sub-groups, very high risk, high risk and medium risk were then created based on the addition of cumulative risk factors.

[26] https://digital.nhs.uk/data-and-information/publications/statistical/statistics-on-alcohol/2020/part-4

3.3.2 Very High Risk

Criteria for the very high - risk group: aged between 45 and 64 with three or more LTC, which indicates poor health, residing in an area with an IMD decile of 1 – 5, with a marker for mental health conditions and being recorded as having ever smoked. A total of 712, 2.4, %, of the total cohort fall into this risk category.

Table 8 below shows that the proportion of individual that fall into the very high - risk category across the districts that see higher than the 2.4% average.

District	Total Cohort Count All risk levels	% in Very High- Risk Category
Thanet	2,885	3.95
Canterbury	2,242	3.48
Dartford	1,712	2.92
Medway	4,607	2.67
Shepway	2,128	2.58

Table 6 Cohort 3 Very high risk by district

Table 6 shows how Thanet, Canterbury, Dartford, Medway, and Shepway all see high concentrations of individuals that fall into the very high-risk category for ADFs. KFRS incident data indicates that Medway, Maidstone and Shepway saw the highest number of accidental fires in the category over the last 5 years., Ashford and Tunbridge Wells also saw a slight increase in the proportions of accidental fires when assessed as a percentage of the cohort population in those areas.

3.3.4 High Risk

Criteria for the high - risk group: Single adult male, aged between 45 - 64, smoker, two LTCs, with a MH marker or three or more LTCs with no MH marker, and being recorded as having ever smoked. A total of 1,727, 5.9 %, of the total cohort fall into this risk category.

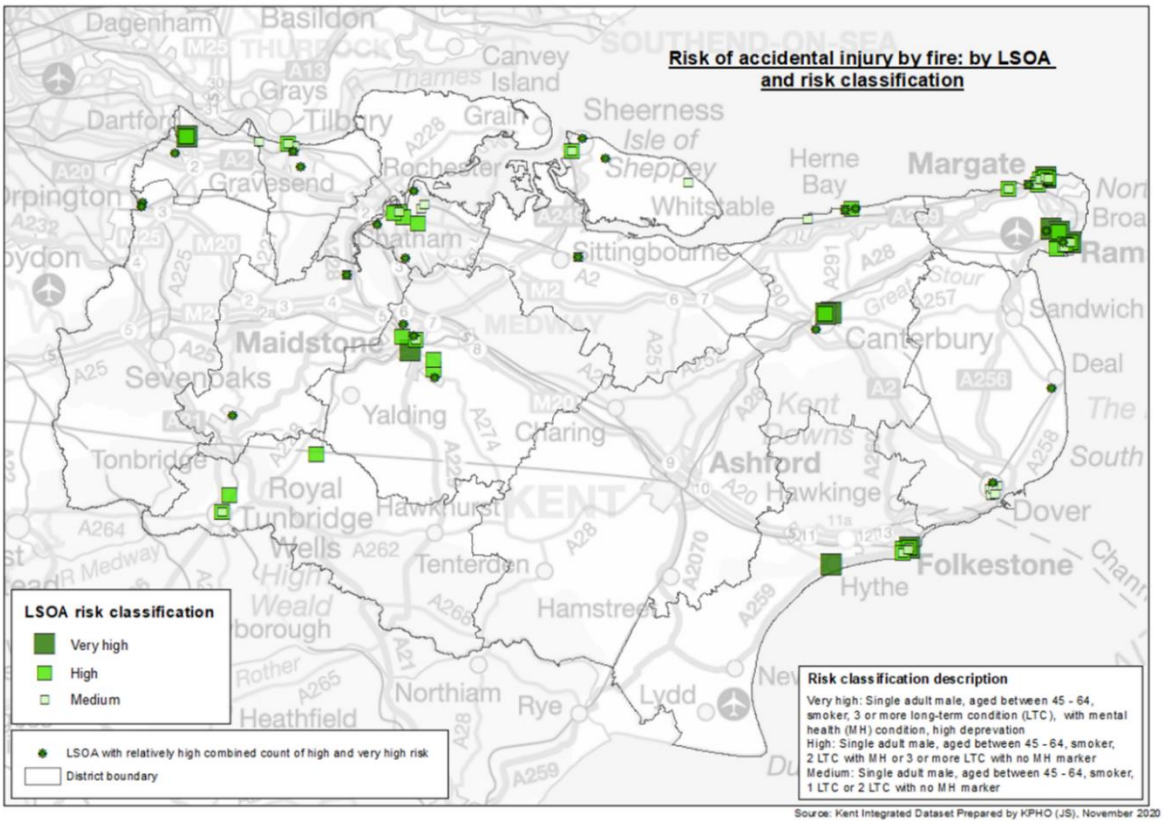
Table 9 below demonstrates the proportion of individual that fall into the very high - risk category across the district that see higher than the 5.9% average.

District	Total Cohort Count All risk levels	% in High-Risk Category
Canterbury	2,242	6.6
Tunbridge Wells	1,883	6.5
Maidstone	2,560	6.3
Sevenoaks	1,658	6.2
Dover	2,211	6.1

Table 7 Cohort 3 – High Risk by district

Table 7 shows how Canterbury, Tunbridge Wells, Maidstone, Sevenoaks, and Dover all see higher than average levels of individuals that fall into the very high-risk category of single men prone to ADFs. A further medium risk category was established, which consisted of a single adult male, aged between 45 and 64, recorded as a smoker with one LTC or two LTCs with no MH marker. Analysis of this cohort at district level did not yield any additional results but this has been included in the mapping at LSOA level below.

Map 3 below demonstrates the geographical distribution of very high risk, high risk and medium risk populations calculated at LSOA level for cohort 3.



Map 3: Distribution of very high risk, high risk and medium risk populations at LSOA level for cohort 3

4. Cohort Comparison with KFRS risk model

4.1 Cohort Overlaps

To test the relationship between health factors and behaviours identified in the literature, and the likelihood of experiencing an ADF and the resulting injury or fatality, the output from the two approaches were geographically compared. The health-based cohorts were geographically overlayed with a risk model developed by KFRS (which is based on Mosaic categories and historic ADF incidents) to see if cohorts based on health-related risk factors fell into the same high-risk areas identified by the KFRS model.

The KFRS model has already been validated to a high degree of accuracy when identifying groups who may be at risk of ADF fatalities or injury. The purpose of comparing the KFRS and health cohort approach was to identify the health makeup of the populations that overlap with the KFRS predictive model, to distinguish which health related conditions may contribute to the likelihood and outcome of ADFs.

Both the correlation and the overlap between the models were calculated based on the outliers from the different risk categories identified by the health cohort approach, which were allocated risk weighted scores, and the outliers in estimated casualty counts from the KFRS model at LSOA level. The correlation coefficient represents statistically the strength of the association between the outliers from the KFRS model and the health-based model at LSOA level based on weighted risk score and estimated casualty counts. The overlap is based on outliers displayed in the form of a percentage showing how many of these outliers identified in both the health cohort and KFRS models overlap. LSOAs were weighted based on the level of risk they contain (see Appendix B for a detailed breakdown of the methodology). Weighting the LSOA to highlight the level of risk they carry to undertake this analysis allows for a degree of robustness in these results. If the overlap and correlation were based on total count alone, this would not allow for the different combination of health-related factors to be taken into consideration.

Table 8 below demonstrated both the correlation and the overlap for each of the health-based cohorts and the KFRS model.

Cohort	Overlap	Correlation coefficient (p value)
1 Elderly Fatal	24%	0.29 (0.000)
2 Child Fatal	15%	0.43 (0.000)
3 Living Alone Injury	39%	0.73 (0.000)

Table 8 – cohort overlap and correlation by LSOA

When health-based cohort 1 weighted outliers were compared to the KFRS model, an overlap at LSOA level of 24% was identified, which indicates that factors such as age over 65, living alone, multiple LTCs may play a part in contributing to the outcome of ADFs. When looking specifically at the characteristics of the health-based cohort that overlapped with the KFRS model the following was revealed. Nearly 80% of the cohort lived in an area with a Kent and Medway IMD decile[27] of 1, further supporting the established notion that deprivation plays a role in ADFs. Interestingly just under 5% were recorded as having dementia or severe mental health issues. However, the recording of MH issues and the early stages of dementia is likely under-recorded and those experiencing more severe symptoms are potentially more likely to have help in the home which may reduce their risk of ADF. 31% had 3 or more long term conditions recorded which indicate poor health and likely impact on mobility, just under 13% were registered as having asthma or COPD. More evidence is needed to determine the strength of these factors and how they work in combination with one another to increase or not the likely outcome of an ADF.

Whilst factors outside of health-related conditions or very specific combinations of health factors need to be identified to strengthen this overlap, it should also be noted that it is still unclear how much health factors contribute to the outcome of ADFs. Further investigation of the degree of association of the presence or absence of health-related conditions with victims of historic fatal ADFs may facilitate a more profound understanding of how these

[27] Deprivation deciles are based on the Index of Multiple Deprivation 2019 (IMD 2019) which is the official measure of relative deprivation. Decile 1 represents the most deprived 10% (or decile) of neighbourhoods in England and Decile 10 represents the least deprived 10% (or decile) of neighbourhoods in England. A Kent and Medway adjusted measure has been calculated, therefore Decile 1 represents the most deprived 10% (or decile) of neighbourhood in Kent and Medway

factors interact and in particular, the extent to which health related conditions relate to the likelihood or outcomes of ADFs.

When health-based cohort 2 was compared to the KFRS model it was found that the outliers overlap at LSOA level 15% of the time. This suggests that taking a health-based approach to predicting ADFs involving children is potentially more complex. When looking specifically at the characteristics of the health-based cohort that overlapped with the KFRS model it was evident that; around 60% of the cohort live in an area with a Kent and Medway IMD decile of 1, 44% were recorded as smokers and 26% have three or more children residing in the house. This indicates that deprivation plays a significant factor. Whilst under half of this cohort are recorded as being a smoker, with smoking decreasing in prevalence, this still represents a large proportion of the overlapped cohort, indicating that it may potentially play a role in predicting ADFs. This low overlap is unsurprising considering the limited availability of health-related data link to this cohort coupled with the extremely low prevalence of ADFs resulting in the fatality of a child. It is unlikely that the health-based elements of this cohort could be further developed at this stage.

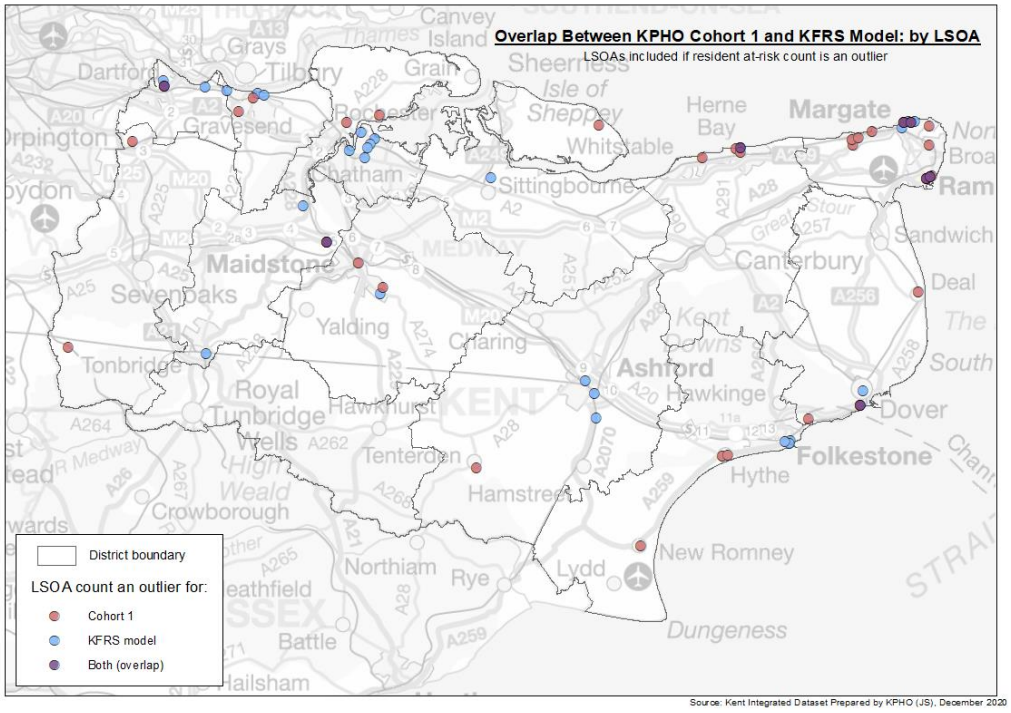
When health-based cohort 3, weighted outliers were compared to the KFRS model, it was found that the outliers overlap at LSOA level 39% of the time with a correlation coefficient 0.73. This represents the strongest degree of association identified between the health-based risk factors and the KFRS risk model. When looking specifically at the characteristics of the health-based cohort that overlapped with the KFRS model the following was revealed. Just over 58% of this cohort were recorded as smokers and 83% were living in an area with a Kent and Medway IMD decile of 1, confirming that smoking and deprivation are two key risk factors for this group. Prevalence of a severe MH condition or depression was recorded for 38% of this cohort, again indicating that this may be a risk factor, however prevalence of individuals with 3 or more LTC was only 11% suggesting the relationship with conditions impacting on overall physical health and mobility were not as important when predicting risk for this group.

In summary, using health-based cohorts which have been designed using existing literature, to predict the locations and outcomes of ADFs has a variable success rate. There is substantial overlap with the health-based cohort identified as being likely to experience ADFs that result in injury. This gives weight to the notion that having access to information

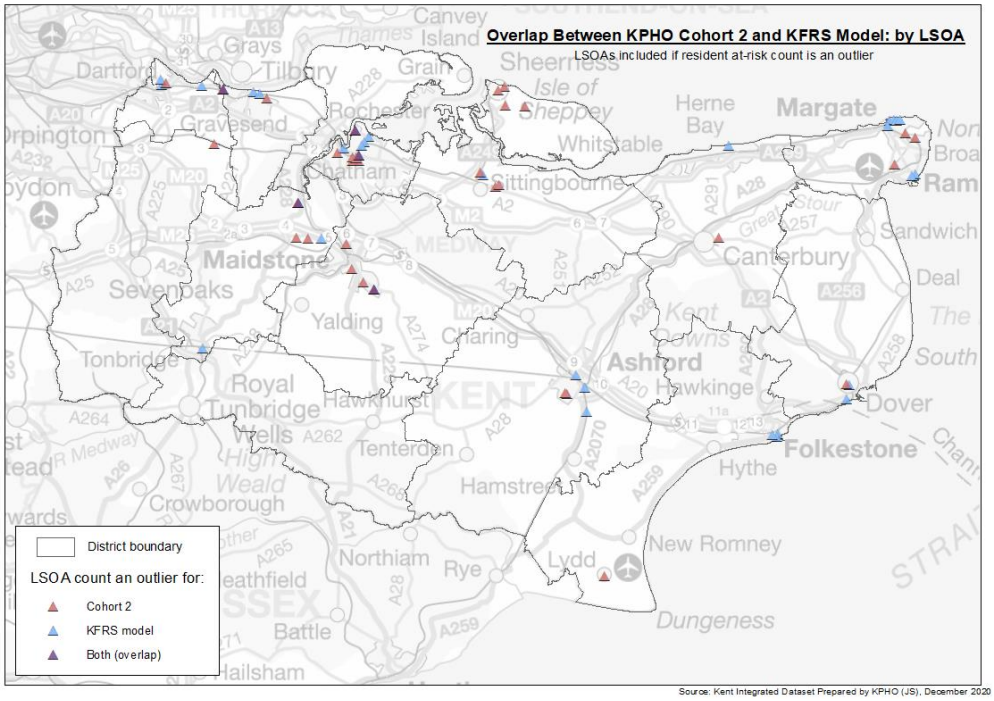
to identify individuals who are male, living alone, aged 45-64, that smoke and have a combination of long-term conditions, a mental health condition and who live in relative deprivation, can help to identify risk segments which may be of interest for targeting preventative interventions. However, the overlap between identifying those at risk of a fatal fire from a purely health-based approach and the KFRS predictive model is not as strong. So, whilst health related factors can be acknowledged as playing a role in the fatal outcome of an ADF, further analysis needs to be undertaken to establish a more specific combination of health, social and environmental factors which can be tested against the well-established KFRS predictive model.

4.2 Overlap Maps

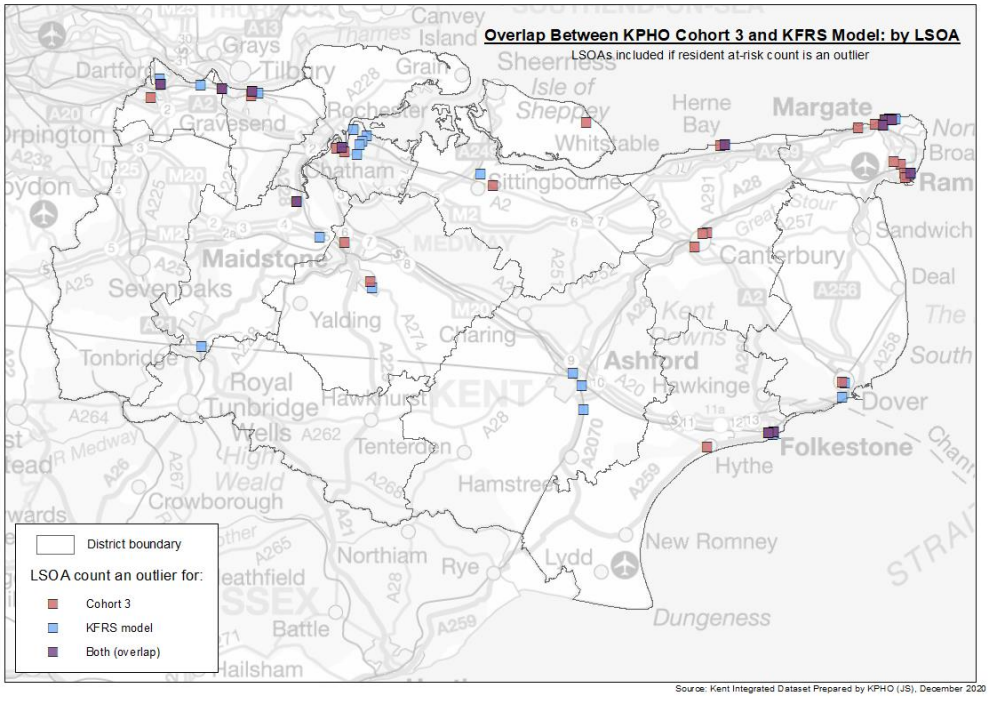
The maps below show LSOAs that have a high estimated casualty count according to the KFRS model, a high risk-weighted cohort count, or both[21]. The maps in this section provide a visual display of the overlap between the current cohorts and the KFRS risk model as discussed above.



Map 4: Cohort 1 overlap



Map 5: Cohort 2 overlap



Map 6: Cohort 3 overlap

5. Conclusion

Literature suggests that health factors play a role in the outcome and potentially the prevalence of accidental dwelling fires, although there is a lack of clarity around the impact of different combinations of health-related factors. This paper highlights that, when identifying those at risk, taking a purely health-based approach to predicting ADFs, certain at-risk cohorts are more easily identified than others. This paper indicates that there is a relationship between cohorts identified based on health-related risk factors and a predictive model developed by KFRS. This further supports the need for closer collaborative work between both health and fire services to not only reduce the risk of ADF but also to develop additional support inputs to those with health concerns living in the community.

The findings also indicate that further research is needed to unpick the interplay between more specific combinations of health-related factors and other socio-demographic and environmental factors.

Appendix A

Long Term conditions can include: Alcoholic liver, Anaemia Anorexia/Bulimia, Anxiety, Asthma, Blindness, Bronchiectasis, Bronchitis, Cancer, Cardiovascular disease, Cerebral Palsy, Chronic back pain, Chronic Kidney disease, Chronic Liver disease, Coronary heart disease, COPD, Dementia, Depression, Diabetes, Diverticula, Endometriosis, Epilepsy, Glaucoma, Hepatitis, Heart failure, Hypertension, Learning Disabilities, Severe mental health condition, MS, Osteoarthritis, Osteoporosis, Parkinson's, Pneumoconiosis, Prostate disorders, Pulmonary Oedema, Rheumatic Heart disease, Rheumatoid Arthritis, Spina bifida, Stroke

Appendix B

Risk-weighted Counts

A risk-weighted count for each cohort in each LSOA was created from the raw LSOA counts of each cohort. Three population cohorts were used to create an LSOA risk-weighted cohort count:

- Cohort 1: Over 65 with at least one long-term condition, living in deprived LSOA (IMD quintile 1-5)
- Cohort 2: Single parent that smokes and has 4 or more children under the age of 18 in the house
- Cohort 3: Single adult male, aged 45-64 that smokes and has some combination of long-term conditions, mental health issue and deprivation

Population cohorts 1, and 3 were further segmented into risk categories:

Cohort 1	
Risk category	**Description**
Very High	Aged over 65, living alone, 3 or more long-term conditions (LTCs) impacting on overall health and mobility and in a more deprived area (IMD quintile 1-5)
High	Aged over 65, living alone, 2 LTCs impacting on overall health and mobility and in a more deprived area (1-5)
Medium	Aged over 65, living alone, 1 LTC impacting on overall health and mobility and in a more deprived area (1-5)
Cohort 3	
Risk category	**Description**
Very High	Single adult male, aged between 45 - 64, smoker 3 or more LTC, with MH condition, high deprivation

High	Single adult male, aged between 45 - 64, smoker, 2 LTC with MH or 3 or more LTC with no MH marker
Medium	Single adult male, aged between 45 - 64, smoker 1 LTC or 2 LTC with no MH marker

For cohorts 1, and 3, the LSOA risk-weighted count was calculated using the following formula:

(Very high risk count * 3) + (high risk count * 2) + medium risk count

The risk-weighted cohort counts for cohorts 1 and 3 were summed and added to the cohort 2 count to give a total risk-weighted cohort count of individuals in each LSOA.

Cohort Maps

For cohorts 1 and 3, an LSOA was marked if its count of medium, high **and/or** very high-risk residents is greater than 1.5 times the interquartile range above quartile 3. The size and strength of shading of the marker reflects the risk level for which the LSOA has a high count.

For example, LSOA E01024471 has a high count of medium, high, and very high-risk residents in cohort 1. This is shown on the map by concentric circles of different shades at the LSOAs location.

The small asterisk markers represent LSOAs that do not have high counts at either the high risk or very high-risk level using the interquartile range method but, when the counts from the two risk levels are combined, the combined count of high risk and very high risk is significant (i.e. higher than the lowest high risk LSOA count already marked on the map).

Overlap Maps

For each cohort, risk-weighted counts greater than 1.5 times the interquartile range above quartile 3 were marked on the map. The KFRS model estimated casualty counts greater than 1.5 times the interquartile range above quartile 3 were also marked on the map. The LSOA population weighted centroid was used to locate the markers on the map. Any overlap in these markers was coloured purple to indicate an LSOA that has a high risk-weighted count of residents and a high estimated casualty count according to the KFRS model.

For all cohorts combined, the LSOA count for the very high-risk category in cohorts 1, 1.5 and 3 was adjusted for the rate of injuries or fatalities. The rate of fatalities (ONS, 2018/19)

was applied to the very high risk counts in cohorts 1 and 1.5 and the rate of injuries (ONS, 2018/19) was applied to very high risk counts in cohort 3. The resulting adjusted counts were summed and added to the cohort 2 count. Counts greater than 1.5 times the interquartile range above quartile 3 were also marked on the map. The LSOA population weighted centroid was used to locate the markers on the map. Any overlap in these markers was coloured purple to indicate an LSOA that has a high rate-adjusted count of very high-risk residents and a high estimated casualty count according to the KFRS model.