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TECHNICAL NOTES

# Cooking Practices and Fires

Final Report by:

**Jack Salem**
**Alex Smith**
**Dr. Martina Manes**
University of Liverpool
Liverpool, UK

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1 Batterymarch Park, Quincy, MA 02169, USA | Web: www.nfpa.org/foundation | Email: foundation@nfpa.org

# Foreword

Cooking fires have been a persistent fire problem over the last few decades. According to the NFPA Report (Ahrens, 2020) "During 2014–2018, cooking was the leading cause of reported home fires and home fire injuries and the second leading cause of home fire deaths. Unattended cooking was the leading cause of cooking fires and casualties. Clothing was the item first ignited in less than one percent of these fires." Most home cooking fires start with the ignition of foods or other cooking materials and most involve unattended frying on a range top. Understanding contemporary home cooking practices and building a profile of reasons to understand why cooking is not actively attended would inform fire safety public education messaging strategies.

The project goal is to conduct a comprehensive review of both technical and popular literature to understand contemporary home cooking practices in the USA and review a broad sample of home cooking fires to identify the reasons for unattended cooking. The project tasks included a literature review, identification of parameters, analysis of the information collected from the literature review and the development of a final report.

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## About the Fire Protection Research Foundation

The Fire Protection Research Foundation plans, manages, and communicates research on a broad range of fire safety issues in collaboration with scientists and laboratories around the world. The Foundation is an affiliate of NFPA.

## About the National Fire Protection Association (NFPA)

Founded in 1896, NFPA is a global, nonprofit organization devoted to eliminating death, injury, property and economic loss due to fire, electrical and related hazards. The association delivers information and knowledge through more than 300 consensus codes and standards, research, training, education, outreach and advocacy; and by partnering with others who share an interest in furthering the NFPA mission.

All NFPA codes and standards can be viewed online for free.

NFPA's membership totals more than 65,000 individuals around the world.

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Project Manager: Jacqueline R. Wilmot, PE

## Project Technical Panel

Meri-K Appy, Appy & Associates, Portland, OR

Randy Cooper, AHAM, Rockville, MD

Bobby DellaVale, UL Solutions, Northbrook, IL

Josh Dinaburg, CSA Group, Cleveland, OH

Anthony Hamins, NIST, Gaithersburg, MD

Birgitte Messerschmidt, NFPA, Quincy, MA

Zoe Susice, UL FSRI, Columbia, MD

Andrea Vastis, NFPA, Quincy, MA

## Project Sponsors

# Cooking Practices and Fires

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Students: Jack Salem, Alex Smith

Supervisor: Dr Martina Manes

Department of Civil and Environmental Engineering

School of Engineering | University of Liverpool

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# Abstract

Unattended cooking appears a relevant and pressing issue within the USA representing the number one cause of home fires in the USA each year. Fire statistical datasets could be adopted to effectively analyse this problem while investigating data on real fire incidents in kitchens of residential buildings. The main purpose of this research is to identify the reasons for cooking fires, evaluate the impact on lives and properties, and propose recommendations based on the investigation of real fires affecting residential buildings.

An extensive literature covering a range of topics is developed in this research starting with a discussion on cooking practices in the USA and how they have changed over time across the nation. Consequently, a literature review of previous studies focused on unattended cooking is developed including personal circumstances, such as sleep, alcohol impairment or disability, as well as family circumstances, such as the number of residents in a house, whether a house is rented or owned and the ages of the residents. Finally, a literature review of the fire safety information and warnings on cooking fires is determined including a discussion on the cooktops and ranges sold in the USA, as well as the fire safety information provided in the user manuals. Current fire prevention campaigns in the USA are discussed in relation to their effectiveness in influencing the public.

The research is then focused on the analysis of US fire statistical data from 2012 to 2021 related to kitchen fires in residential buildings by investigating the Fire incidents and Civilian Casualty datasets and producing graphs and trends for the examined period. The fire statistical variables available in each dataset are subdivided according to fire incident description, and personal and family circumstances. Furthermore, the outcomes obtained in the data analyses are compared with the findings derived from the literature review.

Several conclusions are determined based on the developed research. Some main considerations could be attributable to the fact that sleeping was found to be a relevant contributing factor to both fire incident and civilian casualties. Moreover, there is a pressing issue surrounding kitchen equipment and its proper use. This can include not being aware of proper fire safety measures, or equipment not being regularly checked. Therefore, there is a need for continuous research on fire incidents related to cooking fires and this is also supported by the variations found in the trends for the examined period. Another important aspect is related to an education on fire safety, ensuring that fire prevention campaigns are reaching a wider audience potentially considering a future use of social media.

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# Chapter 1. Introduction

## 1.1. Research background

According to the US Fire administration: “Cooking is, by far, the leading cause of home fires and home fire injuries” (US Fire Administration, 2023). In the USA, in 2021, national estimates for residential cooking fires and losses present 170,000 fires, 135 deaths, 3,000 injuries and $494,200,000 leading to a critical fire safety issue that needs to be investigated in detail. This is also in line with the research developed by the NFPA considering the period from 2014 to 2018 for residential buildings when cooking was found to be the leading cause of reported fires and fire injuries and the second leading cause of fire deaths (Ahrens, 2020).

If the variation in residential building cooking fires is plotted from 2012 to 2021, it can be seen that in 2020, there was a peak of 192,600 fires (US Fire Administration, 2022a). The above consideration needs to be contextualized with broader evaluations potentially including the effects of the COVID-19 pandemic and the lockdown measures. Therefore, questions arise on how cooking practices can influence cooking fires in residential buildings and the differences in cooking amongst demographic groups. Moreover, personal circumstances such as distraction, alcohol, medications, disabilities or lack of supervision, as well as family circumstances such as single or multiple occupancy and presence of children, could potentially influence the likelihood of unattended or unsupervised cooking fires.

Another aspect that needs to be considered is the improvement in technology for cooking devices. Mitigation technologies for cooktops currently exist as consumer products or patents, standards are needed on how to test the effectiveness of retrofit safety features, and limited research has been developed on how their safety features could reduce the frequency of cooking-related fires (Lushaka and Zalok, 2014). An analysis of the ranges of cooktops sold in the USA and an investigation of the fire safety guidelines present in their manuals could support the optimization of cooking products and fire safety strategies. Moreover, to increase awareness of cooking fires, the United States Consumer Product Safety Commission provided fire prevention measures and methods to extinguish cooking fires based on practical guidelines for prevention, such as emphasis on child safety and teaching safe cooking practices (U.S. Consumer Product Safety Commission, 2023). Furthermore, the NFPA Fire Prevention Week 2023 is focused on “Cooking safety starts with YOU. Pay attention to fire prevention” (NFPA, 2023).

Considering the complexity of the social and technological factors influencing cooking fires as well as the identification of fire scenarios in kitchens, the research developed in this study appears relevant to

contribute toward a pressing issue that affects not only people working in the fire safety field but also local and national authorities as well as communities and families.

## 1.2. Aim:

The research aims to conduct technical and popular literature to understand contemporary home cooking practices, determine the reasons for unattended cooking, and investigate fire statistical data on home cooking fires in the USA.

## 1.3. Objectives

The following are the objectives of the research to achieve the aim of this study:

1. Conduct a technical and popular literature review on the
    a. changes in cooking practices over the years and among demographic groups
    b. reasons for unattended cooking fires based on personal and family circumstances
    c. ranges of cooktops sold in the USA and information on cooking fires in relations to manual of cooktops and public campaigns
2. Investigation of home cooking fires to analyse contemporary cooking practices associated with cooking fires, and cooking fire injuries and fatalities.

# Chapter 2. Literature Review

In this chapter, the numerous changes that have occurred within the USA in cooking practices are analysed. In particular, the changes in cooking techniques to fulfil the needs of various demographic groups, emphasising the specific methods and preferences within the different cultures are explored. Additionally, the reasons behind unattended cooking fires, looking at personal and family circumstances that might have contributed to these incidents are investigated. A variety of cooktops sold within the USA are also discussed where the specific types preferred by consumers are highlighted. In terms of safety, the relevance of fire prevention campaigns in promoting protection and minimising the potential dangers with unattended cooking is examined and the critical role of fire safety information and warning in the product manuals. Within this chapter, the goal is to provide a thorough literature review of these subjects while highlighting their significance.

## 2.1. Changes in cooking practices

Home cooking practices in the USA have changed significantly over the years, influenced by various factors, including developments in technology, such as cooking equipment, changing eating habits and recent occurrences like the COVID-19 pandemic. To better understand the current situation in home cooking practices in the USA, this section aims to examine the relationships between these factors and their influence on cooking practices, providing insights into how the changes have impacted the way people in the US cook at home.

A study by Marie Plessz and Fabrice Étilé, investigated if cooking is still a daily practice in our lives and identified the trends in the period 1985 to 2010 (Plessz & Étilé, 2019). The study indicated that there is a decline in time spent cooking as US households spent 20 minutes less time per day cooking in 2010 (41.7 min) compared to 1985 (61.4 min), while French households spent 15 minutes less (63.8 min) in 2010 (Plessz & Étilé, 2019). In addition to the trend of declining cooking time, people in the USA now eat less frequently at home compared to in the past. In particular, one-third of the reduction in time spent cooking can be attributed to the weakening correlation between eating at home and cooking in the USA (Plessz & Étilé, 2019).

Despite the reduced cooking time (Plessz & Étilé, 2019), during 2013-2017, cooking was the most common cause of reported fires and fire injuries within households (Ahrens, 2018). The study by Ahrens (Ahrens, 2019) found that during 2013-2017, 49% of home fires were caused by cooking, recording 550 deaths in the US (22% of home fire deaths) and 5,020 injuries (45% of home fire injuries). These results

indicate that despite the decline in time spent cooking at home and the less time spent eating at home, cooking is still the cause of a large portion of household fires in the US (Ahrens, 2019). Furthermore, cooking still caused a considerably larger portion of home fire deaths during 2013-2017, recording 550 deaths, compared to 500 during 1980-1984, with unattended cooking being the leading cause of the fires 31% and thus, the leading cause of deaths (48%) (Ahrens, 2019). Another study by Ahrens (Ahrens, 2009), reaffirmed unattended equipment as the leading cause of fires (38%), consistent with her later study in 2018 (31%) (Ahrens, 2019), followed by heat sources too close to combustibles (12%), unintentional activation or failure to turn off (10%) and abandoned or discarded materials (8%) (Ahrens, 2009). Electric cooking appliances were found to present a greater risk of fires and losses compared to gas (Ahrens, 2009). The latest estimates of cooking fires are published by the NFPA affirming that the during 2017–2021, an estimated average of 158,400 home cooking fires per year were attended by the fire brigades causing an average of 470 civilian deaths, 4,150 civilian injuries, and $1.15 billion in direct property damage annually (Hall & McGree, 2023).

Decreased time spent cooking at home paired with the advancements in cooking technology has shown a decrease in US household fires caused by cooking equipment. A study carried out in 2006 by John R. Hall, Jr. (Hall, 2003) affirmed that cooking equipment was involved in 118,700 reported home structure fires resulting in resulted in 250 civilian deaths, 3,880 civilian injuries, and $512 million in direct property damage.

Investigating further into cooking equipment, more than 28% (more than a quarter) 2014-2018 fatal home cooking incidents involved people who were asleep, according to a 2020 NFPA report (Ahrens, 2020). This raises the suggestion that further safety technologies should potentially be implemented to minimise fires due to unattended cooking equipment. Electric stoves recorded 43% more fires, which had 1,165 fires per million households, compared to 445 fires per million households from gas stoves (Ahrens, 2020). This is likely due to occupants not noticing electric stoves switched on, compared to gas stoves. Another factor could be likely attributable to electric stoves retaining their heat for longer than gas when switched off. The retained heat poses a higher risk if flammable materials meet the hot surface compared to gas stoves, which have a visible flame.

Cooking fires appear to be a major fire hazard event in other countries. Based on a study by Manes and Rush (Manes & Rush, 2017), evaluating English, US and New Zealand fire statistics, faulty appliances and leads was the main cause in non-residential buildings in England, cooking was the main cause in both dwellings and other buildings in the USA, while in New Zealand, fire or heat sources reported the highest values. A common trend in this study appears to be the misuse of equipment or failure of the equipment performing as intended. A detailed comparison between countries can be developed based on the analysis of specific variables to provide an accurate evaluation.

A study by Suzuki and Manzello (Suzuki & Manzello, 2022) found that there was a varied fluctuation in fires during the COVID-19 period (March 2020 to May 2020). The study analysed the data of stay-at-home workers with residential and cooking fires. Area of focus were New York, San Francisco, Tokyo and London from January to June 2020 (Suzuki & Manzello, 2022). Tokyo and San Francisco saw an increase in cooking and residential fires, whereas in New York cooking fires remained the same and there was no data found in London (Suzuki & Manzello, 2022). San Francisco and Tokyo found an increase in both residential and cooking fires, New York found an increase in just residential fires compared to the average evaluated between 205 and 2019 (Suzuki & Manzello, 2022). The study affirms that hesitation to call fire services, due to high demand for emergency services during the pandemic, was the reason for the findings and that data from more countries are required to create a more accurate theory (Suzuki & Manzello, 2022). The main reasoning for Tokyo and San Francisco experiencing an increase in cooking and residential fires during the COVID period, is likely due to the increased cooking activities. The evidence which found US households spent 20 minutes less time per day, cooking in 2010 compared to 1985 (Plessz & Étilé, 2019), is likely to have risen during COVID due to people spending more time at home. The stay-at-home policies could have led to an increase likelihood of cooking related fires. In addition, the stress the pandemic brought could have led to distractions, fatigue, or emotional distress or other factors potentially reducing focus and thus, increasing household fires.

Another study published in December 2020 by a range of researchers at Queen's University Belfast and St. Angela's College (Murphy et al., 2020), examined the changes in cooking practices during the COVID pandemic across several regions, such as the USA and New Zealand. However, this study cannot be used solely, due to limitations. For instance, the use of an online survey, whilst it was necessary during the pandemic, it may bias the sample towards individuals more comfortable using technology. A key relevant finding was the lack of change in consumers' cooking habits and diet quality in the USA. This could be due to the decentralised nature of the country's COVID measures (Badr et al, 2020). Over four months, the virus had rapidly spread to all states, with stay-at-home measures issued by state and local authorities, with varying degrees of enforcement (Badr et al, 2020). Regions with lower levels of stay-at-home measures may have not made much change to their meal preparation, and so may have spent less time cooking in the kitchen (Murphy et al., 2020). Overall, factors such as the varying level of stay-at-home measures, hesitancy to call emergency services, and increased cooking activities have contributed to these variations. Despite the decentralised nature of the COVID measures in the USA, the consideration from the study by Plessz and Étilé (Plessz & Étilé, 2019) that more time was likely spent cooking during the pandemic is supported by a statistical survey on 'statista' by Nils-Gerrit Wunsch (Wunsch, 2022). The survey found that since April 2020, approximately 60% of participants in the US affirm they cook at home more frequently than prior to the pandemic (Wunsch, 2022).

National Institute of Standards and Technology (NIST) developed a series of experiments to identify the effectiveness of cooktop ignition prevention technologies considering several types of commercially available full-scale residential cooktops with integrated ignition prevention technologies gas and electric cooktops, including four propane gas powered cooktops sold in Asia and one stove with electric coil heating elements sold in the USA. The experiments provided data on the character of the ignition prevention technologies and their performance in terms of prevention of cooking oil ignition (NIST Technical Note 1986, 2018).

To conclude, home cooking practices in the USA have gone through a considerable number of changes influenced by various factors, including developments in technology, changing eating habits and the recent COVID pandemic. Studying multiple sources, a decline in the time spent cooking at home and how often people spend eating at home was easily identifiable. Despite the decreased time in preparing meals, cooking is still an area of concern regarding household fires. With the outbreak of the COVID-19 virus, fluctuations in cooking related fire data are evident. Different regions had different levels of stay-at-home measures, lower levels may have not made much change to their meal preparation, and so people may have spent less time cooking in the kitchen. Regions with stricter restrictions, are likely to be the reasoning people spent more time cooking, thus resulting in a greater likelihood of cooking fires. In addition, access to emergency services is probable to be another contributing factor of the fluctuations in the data. Nevertheless, evidence suggests that more people in the USA have been cooking at home since the pandemic. In summary, promoting safety and adjusting to the changing needs in cooking are necessary to understand the complexities of home cooking practices and their relationship with the many different factors.

## 2.2. Cooking practices in demographic groups

To fully understand the issue of cooking fires within the USA, it is first important to discuss common cooking practices among different demographic groups. This section will discuss how the ethnicity, age and region of a group can have an effect on the way they cook, which will ultimately impact the likelihood of a cooking fire.

According to the United States Census Bureau, the population of the USA is split up into seven major ethnic groups: White; Black; Latino; Asian; Native American/Alaska Native; Native Hawaiian and people of two or more races (United States Census Bureau, 2021). The diversity of the nation means that home cooking varies drastically, and each of these distinctive cuisines introduce varied cooking styles and techniques.

The largest ethnic group in the USA is White American, accounting for 59.3% of the total population (United States Census Bureau, 2021). In Paul Freedman's book 'American Cuisine: And How It Got This Way', the identity of 'White American' cooking is extensively discussed. Freedman tackles the common misconception that White Americans do not have a distinctive cuisine, but instead defines it as an amalgamation of cuisines from all over the world. It comprises mostly of European influences as a result of decades of immigration from countries such as Germany, Italy and Ireland in the 20th Century (Freedman, 2019). Common elements of this cuisine include baking, for example well-known dishes such as pies, cakes and cookies; classic meat and potato variations such as stews, roasts and grilled meats; as well as casseroles and other slow-cooked dishes. Freedman then goes on to discuss the practices behind these elements of White American cooking, highlighting the use of ovens and stove tops for a range of dishes, electric slow cookers, as well as charcoal or gas burners for outdoor cookouts (Freedman, 2019). In summary, White American cooking practices encompass a range of techniques and equipment due to their broad cuisine that has taken influence from various parts of the world.

With Central and South America neighbouring the United States, it is no surprise that the second largest ethnic group in the USA is Hispanic and Latino Americans, accounting for 18.9% of the nation's population (United States Census Bureau, 2021). This cuisine has had a large influence on the USA in recent decades, due to immigration from southern countries to the United States (Abasto, 2017). The Hispanic and Latino demographic commonly cook with a range of grains such as rice and corn, as well as proteins such as beef, pork and various pulses. Hispanic and Latino cooking is focused on big flavour with fresh and seasonal ingredients, native to Southern and Central American countries (Abasto, 2017). There is also a huge element of tradition among this demographic, especially regarding technique and equipment. For example, the Cazuela – a traditional clay pot – is used in a lot of Central American cooking within the United States. This pot is commonly used in the oven (Gregory, 2023). Another traditional cooking technique used within this demographic is meat smoking. Asado is a ritualistic method of smoking meat outdoors over a long period of time until it reaches its optimal tenderness. Similar to White American cooking techniques, Hispanic and Latino cooking mostly makes use of ovens and outdoor flames for barbecuing. In Odem and Lacy's book, the idea of immigration of Latino America to the USA is discussed, in which a "vibrant cultural life based on homeland foodways" was created (Lacy & Odem, 2009). This suggests that the common cooking practices within the Hispanic and Latino American community are prevalent in the USA, as the importance of tradition has been carried through immigration over the decades. A separate study has found that at home, most Latino American families "had more traditional Mexican foods available than American foods" also implying that this demographic group utilises more native cooking practices at home (Evans et al., 2011).

The third largest demographic group within the USA is African American, accounting for 12.6% of the population (United States Census Bureau, 2021). African American food, more commonly known as soul food, consists of comfort foods such as macaroni and cheese and fried chicken (Smith Obi, 2019). With fried chicken being a key dish within traditional African American cuisine, it implies the use of domestic deep fat fryers or the use of large quantities of oil in heavy crock pots for home cooks. This technique of deep frying is a key feature of domestic African American cooking (Miller, 2020). This is supported by Harris and Lukas's food research that was done in association with the National Museum of African American History and Culture. Their book draws upon the USA's "long culinary history and on the many significant contributions made to it by African Americans" within domestic homes as well as public establishments. The book defines techniques such as deep fat frying as 'classic' to this demographic (Harris & Lukas, 2018).

Asian Americans make up 5.9% of the North American population, making it the fourth largest demographic group in the USA (United States Census Bureau, 2021). Again, immigration from the East to America brought with it a popular rise of Asian cuisines, with Chinese food being one of the most consumed cuisines in the USA (Mitchell, 2022). Asian American households commonly consume traditional Asian dishes, that include fried rice, noodle, stir-fried meat and seafood with rice flavoursome sauces (Rao, 2021). This is supported by a study conducted in 1989, in which it was found that Southeast Asian families have "maintained strong ties to their native foods and traditional diets" (Harris & Story, 1989), implying that the dishes and techniques explored are relevant to some Asian American families. A huge element of Asian American cooking is the use of a wok – a traditional, deep rounded-bottom cooking pan – as most Southeast Asian dishes are cooked in a wok (Cuisinenet, 2023). Traditional wok cooking requires high temperatures for fast frying, which is why most Asian households will have a gas burner, as woks are not nearly as effective on electric burners (Randall, 2023). This idea of having a gas burner is a vital part of Asian American cooking practices.

In summary, the four main ethnic groups within the US – accounting for over 96% of the American population – utilise a range of cooking techniques and equipment in domestic kitchens. Despite there being common ground among all four groups, there are some disparities that can be inferred. For example, White, Latino and Hispanic Americans are likely to use their ovens the most when cooking, due to the dishes that are commonly cooked within their households. On the other hand, African Americans could be more likely to make use of deep fat fryers considering the food that is commonly cooked within their households. Moreover, Asian Americans could adopt more gas burners than other ethnicities due to the common cooking techniques among their households. It is important to note that these conclusions have been drawn purely from the assumption that each ethnicity only cooks what is common for their group, which is not necessarily true. In fact, due to the sizeable number of resources

across America, as well as its widely diverse society, it is more likely that a large majority of Americans are utilising a wide range of cooking practices, regardless of their ethnic background.

Another important demographic group that should be considered when analysing the cooking practices throughout the US is age group. The age groups to focus on will be 18-29; 30-44; 45-59 and 60+.

A survey conducted in over a thousand US households found that 95% of adults aged 18-29 cook weekly at home, compared to the 92% of adults aged 30-44, 93% of those aged 45-59 and 92% of those aged 60+ (Wolf, 2017). This is likely due to the rising cost of dining out at restaurants, compared with the newfound popularity of home cooking and home delivery services such as Blue Apron (Taylor, 2017). Despite a slightly higher percentage of the younger generation cooking at home, they do so less often than the three other age groups (Wolf, 2017). It was reported that 60% of people aged 60+ cook five or more times at home, while that was only 47% among 18–29-year-olds. For adults aged 30-44 and 45-59, around 52-55% of them cooked five or more times at home. These values are likely due to the older age group (60+) having more time in the day to cook, as a cause of retirement, compared to the other three groups, who are likely in full time work. The higher number of adults aged 18-29 could be due to the pressing issue of obesity in the USA, and the increasing education surrounding healthy eating around the topic (Yaniv et al., 2009). As well as this, it is much cheaper to cook at home, which is an aspect that could appeal to the younger age group. The study also explores the different type of equipment that is used by each age group, which is mainly ovens, stove tops and microwaves across all four groups. People under 30 are more likely to use a toaster over, due to the convenience, ease of use and time-saving aspect (Wolf, 2017).

Regionally, cooking practices can greatly vary. Food writer, Maeve O'Meara, explores these different cooking styles in her show 'Food Safari'. One American cuisine that is explored in the show is barbecue, which originated in the South. A recipe for barbecued ribs at home is given in the show in which an oven, a blender, a stove top and an outdoor grill were used (USA Food Safari, 2009). All four of this equipment would commonly be used in a Southern American kitchen for a variety of dishes, especially the use of the outdoor grill for barbecue (USA Food Safari, 2009). Despite barbecue originating from the South, it is very popular all over the USA and it is reasonable to assume that these cooking practices are not just specific to the South. A Southeast American cuisine that is discussed is soul food, which is most popular in Alabama – its origin. Soul food makes use a lot of lard or butter in recipes like cornbread (USA Food Safari, 2009). One of the most popular Southern American foods is fried chicken (USA Food Safari, 2009), which uses plenty of oil in deep pans on the stove or electric deep fat fryers. The documentary also explores some common theme across the whole of the United States. For example, thanksgiving is a nationally celebrated holiday, that involves a lot of techniques and equipment. These can include ovens, pressure cookers, blenders and stoves (Flowers, 2013). A new technique of deep

frying the thanksgiving turkey is also becoming quite popular due to the guaranteed juicy meat and much quicker outcome (USA Food Safari, 2009).

In the Northeast of America, commonly stews are eaten, which makes use of slow cookers and ovens. As well as this, there is a lot of baking in the Northeast as sweet pies are typically consumed, which are also prepared in ovens (Menyes, 2018). This is supported in Nenes's book, 'American Regional Cuisine', a range of recipes are discussed that are home to the Northeast. Nenes links the abundant seafood and fruit orchards to common dishes like clam chowder and cobbler. Many of the recipes in the book typically require stovetops and ovens (Nenes, 2015). One notable aspect of the Northeast of America is its diversified population, due to immigration from the East, in which "its historical food culture is overlaid by and enriched with food cultures introduced by modern immigrants." (Albala, 2011). This diversity could imply that the home cooking practices are quite varied and are in fact an amalgamation of cooking practices. The Midwest of America has a fruitful grain production, and actually accounts for one of the most intense agriculture areas in the world (Hatfield, 2012). Baking is very popular in the Midwest, and, therefore, ovens are used frequently in the home kitchen (Server, 2019). The Midwest and Central Planes are known as the "breadbasket" of the USA due to their grain production (Nenes, 2015) which supports the idea of frequent baking in this region. The West of America presents a melting pot when it comes to cooking practices, due to influences from Pacific, Mediterranean and South American countries (Nenes, 2015). Commonly, fish is eaten in the West – mainly California. This type of cooking is a combination of various cooking practices, mainly comprised of grilling (Bennett, 2019).

In summary, the USA exhibits a wide range of home cooking practices that vary by ethnicity, age and region. Most Americans, regardless of demographic group, make use of common cooking appliances like ovens and stove tops. Notably, different ethnicities are likely to use a wider range of cook appliances, such as a gas burner in Asian American communities for wok cooking. It is important to note that this a generalised assumption. With regards to age, people aged 60 or above tend to cook more frequently per week than other age groups, while people aged 18-29 are starting to cook more at home, likely due to financial and health reasons. All age groups made use of the common kitchen appliances. However, it was found that the younger age group is more likely to use appliances such as the toaster oven, for its time saving capabilities. In terms of region, food practices can greatly vary. For example, the Southern American states are much more likely to use deep fat fryers due to the popular foods they consume. Overall, the USA use a range of cooking practices that will be further investigated in the data analysis.

## 2.3. Reasons for unattended cooking fires

The critical subject of unattended cooking fires will be investigated, including the causes of the fire being unattended. Therefore, to minimise the occurrence of cooking fires, it is important to understand the factors contributing to unattended cooking fires in terms of personal and family circumstances to create effective prevention measures, raise awareness and educate the public.

### 2.3.1. Personal circumstances

In this section, an investigation on the personal circumstances potentially leading to unattended cooking fires are reviewed based on previous studies. The personal circumstances investigated are focused on distraction, alcohol, medications, drugs, illness, disabilities, lack of supervision, and falling asleep. These are summarized in Table 1 according to the reviewed sources.

*Table 1: Sources investigating personal circumstances as contributing factors to unattended cooking fires*

| **Personal Circumstances** | **Sources** |
|---|---|
| Distraction | Ahrens, M. (2020). *Home cooking fires*. National Fire Protection Association. |
| Alcohol | Ahrens, M. (2020). *Home cooking fires*. National Fire Protection Association.<br><br>Holborn, P.G., Nolan, P.F. and Golt, J. (2003). *An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal, 38(1), pp.1-42.<br><br>Runyan, C.W., Bangdiwala, S.I., Linzer, M.A., Sacks, J.J. and Butts, J. (1993). *Risk factors for fatal residential fires*. Fire Technology, 29, pp.183-193.<br><br>U.S. Fire Administration/National Fire Data Center. (2003). *Establishing a relationship between alcohol and casualties of Fire* . Available at: https://apps.usfa.fema.gov/downloads/pdf/statistics/v3i3.pdf (Accessed: 06 July 2023). |
| Medications, drugs | Ahrens, M. (2020). *Home cooking fires. National Fire Protection Association*.<br><br>Ballard, J.E., Koepsell, T.D. and Rivara, F. (1992). *Association of smoking and alcohol drinking with residential fire injuries*. American journal of epidemiology, 135(1), pp.26-34.<br><br>Holborn, P.G., Nolan, P.F. and Golt, J. (2003). *An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal, 38(1), pp.1-42.<br><br>Runyan, C.W., Bangdiwala, S.I., Linzer, M.A., Sacks, J.J. and Butts, J. (1993). *Risk factors for fatal residential fires*. Fire Technology, 29, pp.183-193. |

| Personal Circumstances | Sources |
|---|---|
| Illness, disabilities | Holborn, P.G., Nolan, P.F. and Golt, J. (2003). *An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal, 38(1), pp.1-42.<br><br>Runyan, C.W., Bangdiwala, S.I., Linzer, M.A., Sacks, J.J. and Butts, J. (1993). *Risk factors for fatal residential fires*. Fire Technology, 29, pp.183-193. |
| Lack of supervision | Ahrens, M. (2020). *Home cooking fires*. National Fire Protection Association.<br><br>Ballard, J.E., Koepsell, T.D. and Rivara, F. (1992). *Association of smoking and alcohol drinking with residential fire injuries*. American journal of epidemiology, 135(1), pp.26-34.<br><br>Holborn, P.G., Nolan, P.F. and Golt, J. (2003). *An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal, 38(1), pp.1-42. |
| Falling asleep | Ahrens, M. (2020). *Home cooking fires*. National Fire Protection Association.<br><br>Holborn, P.G., Nolan, P.F. and Golt, J. (2003). *An analysis of fatal unintentional dwelling fires investigated by London Fire Brigade between 1996 and 2000*. Fire Safety Journal, 38(1), pp.1-42.<br><br>U.S. Fire Administration. (2021). *High-frequency smoke alarms not effective in waking sleeping pre-teenage children*. Available at: https://www.usfa.fema.gov/blog/ci-093021.html (Accessed: 06 July 2023).<br><br>Nationwide Children's Hospital. (2020). *Sound the alarm: Researchers determine more effective ways to awaken children and their families during a house fire*. Available at: https://www.nationwidechildrens.org/newsroom/news-releases/2020/10/cirp-comprehensive-smoke-alarm (Accessed: 07 July 2023).<br><br>U.S. Fire Administration. (2022b). *Civilian fire fatalities in residential buildings (2017-2019)*. Available at: https://www.usfa.fema.gov/statistics/reports/who-fire-impacts/civilian-fire-fatalities-residential-buildings-v21i3.html (Accessed: 06 July 2023). |

As discovered in section 2.1, according to a 2020 NFPA report (Ahrens, 2020), more than 28% of fatal home cooking incidents from 2014-2018 occurred when residents were asleep, raising questions about the fundamental reasons of unattended cooking fires.

In the same study conducted by Ahrens (Ahrens, 2020), human factors are also examined in terms of their contribution to fire ignitions. Notably, the leading human contributing factor to both home cooking fires and deaths between 11 pm and 7 am is "Asleep", recording 23% of fires and 40% of deaths (Ahrens, 2020). This finding highlights the vulnerability of individuals who leave cooking unattended whilst they are asleep, it emphasises the need for safety implementations to cooking technology, such as auto shutdown timers and temperature limiting control highlighted (ANSI/UL 858, 2014). In addition, it highlights the need for fire campaigns to be promoted further to educate residents about fire safety.

During the night, the second highest listed contributing factor for home cooking fires is “Unattended or unsupervised person” which amount for the 14% of recorded fires during 11 pm to 7 am (Ahrens, 2020) potentially attributable to several reasons, such as distractions, multitasking or carelessness. This aspect is closely related to "Asleep", since both circumstances include no responsible adult being nearby to supervise. This analysis sheds light on the importance of supervision in the kitchen. This fact reminds us that leaving cooking unattended, specifically at night or when asleep, significantly increases the chance of fires and again highlights the need for preventative measures. Without full focus, potential hazards and early warning signs are likely to go unnoticed, maximising the likelihood of fires to occur and the damage caused. From 2017 to 2019, the leading cause of fires was unattended equipment, recording 37% (U.S. Fire Administration, 2022b).

Regarding civilian deaths, the second highest factor is listed as “Possibly impaired by alcohol or drugs”, logging 23% of civilian deaths during 11 pm to 7 am (Ahrens, 2020). Alcohol or drugs can weaken an individual’s cognitive judgement and coordination and paired with hazards in the kitchen can lead to the worst-case scenario, as supported by the statistic stated by Ahrens (Ahrens, 2020). Excessive alcohol consumption can result in drowsiness, leading to the individual falling asleep, thus failing to respond in the event of a fire outbreak. Therefore, there could be some overlap with “Asleep” and “Possibly impaired by alcohol or drugs”. Within fire prevention campaigns, it is important to highlight the importance of staying alert whilst cooking and when cooktops are still hot. Moreover, promoting preventative measures, such as smoke alarms, can help alert an individual of early fire warning signs, even if they are drowsy or asleep. A study supporting the theory of smoke alarms by Runyan et al. (Runyan et al, 1993) investigated 151 fatal cases in single family homes in North Carolina, USA during a period of 13 months and also examined non-fatal fires (Runyan et al, 1993). A smoke detector was found to be five times more likely to be missing in fatal fires compared to non-fatal fires where no one was intoxicated or using drugs, odds ratio, 4.5 vs 0.8 (Runyan et al, 1993). In other words, fatal fires are 4.5 times more likely to happen in the absence of a smoke detector when no one is impaired by alcohol or drugs, compared to non-fatal fires. On the contrary, the odds of a smoke detector being absent in fatal fires when someone is impaired by alcohol or drugs are 0.8 times lower compared to non-fatal fires.

To support the claim of excessive alcohol consumption and fires, in another study by Ballard et al. (Ballard et al, 1992), they investigated the relationship between tobacco, alcohol and their combined use as a risk for fire injuries. The study conducted a population-based case control study in King County, Washington, between 1986 and 1987 (Ballard et al, 1992). An odds ratio was calculated where the ratio measured the likelihood of fire injuries in households with different levels of tobacco use compared to households with no smokers. The findings depicted that compared to families without smokers, households with members who collectively smoked one to nine cigarettes per day had a slightly higher

odds ratio (1.5) for fire injuries (Ballard et al, 1992). However, the lack of statistical significance, suggests the possibility that the observed rise in probabilities could be by chance alone. On the other hand, the odds ratio for fire injuries was considerably higher in households with members who smoked between ten and nineteen cigarettes daily (6.6) (Ballard et al, 1992), this was higher than in households with members who smokes between 20 and or more daily (3.6) (Ballard et al, 1992). Regarding alcohol consumption, consumers who regularly drank five drinks or more were at a greater chance of suffering injuries from a house fire (Ballard et al, 1992). However, the authors depicted that the increased risk was partly due to drinkers living in homes with higher smoking levels (Ballard et al, 1992). As a result, the study concluded that smoking was the more significant underlying risk factor for fire injuries, despite the increased risk in houses where alcohol drinkers drank five or more drinks (Ballard et al, 1992). In summary, the study found that smoking greatly increased the likelihood of home fire injuries, with higher levels of smoking resulting in a higher odds ratio. At a glance, alcohol consumption appears to be a risk factor; however, it cannot be claimed definite, since people consuming alcohol usually live in homes with increased smoking rates. At the same time, to strengthen the point about alcohol consumption being a risk factor, a study by Holborn, Nolan and Golt (Holborn et al, 2003), found that 6% of victims (17 deaths) were found to have an alcohol problem (Holborn et al, 2003). Moreover, a study by the U.S. Fire Administration/ National Fire Data Centre in 2003 (U.S. Fire Administration/National Fire Data Center,2003), found that in the USA fires are the fourth most common unintentional injury cause and showed that up to 40% of fatalities from domestic fires may be related to alcohol usage (U.S. Fire Administration/National Fire Data Center, 2003).

An article posted by the U.S Fire Administration evaluated the impact of smoke alarms on waking Sleeping pre-teenage children (U.S. Fire Administration, 2021). The article states that high-frequency tone alarms awaken only 56% of children and prompt 55% to “escape” from the bedroom of house fires in the USA. In another study by Nationwide Children’s Hospital (Nationwide Children’s Hospital, 2020), published in Columbus, Ohio, the researchers found that of 188 children, all aged between five and twelve years old, only 56% awakened and only 55% escaped when a high-frequency tone alarm was used (Nationwide Children’s Hospital, 2020). Children must wake up quickly to evacuate a burning building during a genuine fire as the first minutes after ignition are critical in the fire development. Serious injuries or even fatalities could result from waiting too long to wake up and evacuate. Another article published by the U.S Fire Administration (U.S. Fire Administration, 2022b), reveals that 1,900 fatal fires in residential buildings caused an estimated 2,770 civilian fire fatalities between 2017 and 2019. At the time of the victims’ death 31% were sleeping. The studies mentioned above (U.S. Fire Administration 2021a) (Nationwide Children’s Hospital, 2020) (U.S. Fire Administration, 2022b) provide evidence of the importance of addressing the risks associated with unattended cooking fires and being asleep during a fire. They highlight the need for reliable alarm systems and the shortcomings of

high-frequency tone alarms for waking and encouraging kids to leave the house. The consequences of delayed awakening and evacuation, such as serious injuries, emphasise the importance of responding and acting quickly during a fire and the urgency of implementing preventive measures and safety protocols to mitigate these risks.

In a study by Leistikow, Martin and Milano, (Leistiko et al, 2000), the researchers compiled and studied data to determine the impact of smoking related fires in various countries. The smoking related fires were compared with number of fires, injuries and fire-related deaths per billion cigarettes. Based on the developed research, smoking was determined to be the main cause of house and overall fire related deaths in the USA and seven other countries (Leistiko et al, 2000). Overall, the study concludes smoking to be a main factor contributing to fire incidents, globally. It also highlights the relationship between decreased smoking rates and decreased number of fires in the USA (Leistiko et al, 2000). However, it is crucial to note that this study is from the year 2000 and the conclusions are made by extrapolation and estimation, raising questions about uncertainty (Leistiko et al, 2000).

In addition, the study estimated the percentage of fires, burns and deaths caused by children using cigarette lighters and matches (Leistiko et al, 2000). The number of fires ignited by children with lighters and matches is approximated to reach 100,000 in the USA and potentially globally (Leistiko et al, 2000). This highlights the risk of children being unsupervised and having access to lighters and matches, resulting in devastating fire incidents. Therefore, promoting the need for measures to prevent children from accessing fire hazards, such as lighters, and paying attention to supervising them can reduce the number of fires, injuries and fatalities caused by children igniting fires.

Regarding illnesses, Holborn, Nolan and Golt (as cited earlier about the relationship between alcohol and fires) (Holborn et al, 2003), investigated unintentional home fires recorded by London Fire Brigade between 1996 and 2000. At least 21% of unintentional home fire victims (58 deaths) had physical disabilities including, arthritis, strokes, infirmity, frailty, blindness or partial site (Holborn et al, 2003). The conditions these victims suffered are likely to have limited mobility to react quickly, stop or escape the fire. Moreover, 5% of victims (15 deaths) from unintentional home fires had mental illnesses or other disability including, depression, schizophrenia, Alzheimer's and other types of dementia (Holborn et al, 2003). Finally, 6% of the victims (17 deaths) were suffering from other health conditions, such as heart conditions, epilepsy, diabetes and others (Holborn et al, 2003). These health conditions are likely to have impacted the individuals' ability to recognise and respond to fire hazards and to escape the fire.

Furthermore, regarding homes without any disabled people, it was found that it was seven times more likely for a smoke detector to be absent in fatal fires compared to non-fatal fires (4.4 vs 0.6) (Runyan et

al, 1993). On the contrary, the absence of a smoke detector did not provide statically convincing evidence, with the likelihood of fire related deaths when a person had a disability (Runyan et al, 1993).

To further strengthen the relationship of personal circumstances to unattended fires, 61% of victims were found adjacent to the fire, due to a number of cited reasons (Holborn et al, 2003). The most relevant reasons were due to disability (28 deaths) (Holborn et al, 2003), being intoxicated from alcohol or drugs (19 deaths) (Holborn et al, 2003) and the victim being "Asleep" (15 deaths). Only four deaths were recorded due to the person battling the fire (Holborn et al, 2003).

In conclusion, this section has examined and highlighted the great impact personal circumstances such as distractions, alcohol and a lack of supervision contributes to the frequency of unattended cooking fires and are summarized in Table 1. The studies covered how vulnerable those who are asleep during a fire are, as well as how important it is to have reliable alarm systems to wake up children and adults. The strong correlation between alcohol and smoking increases the importance of fire safety campaigns and implementing effective preventative measures. It is important to emphasize the need for technology solutions as well as education to provide methods that can compensate for human error. The section also stresses the risk that people with disabilities, mental illnesses and other health issues have, underscoring the need to include their needs when developing fire safety procedures. In general, preventing unattended cooking fires and minimising fatalities will depend on having a good understanding of the causes and applying preventing measures.

### 2.3.2. Family circumstances

Conversely, not all reasons for unattended cooking are personal circumstances. This section will explore the range of family-related circumstances that may contribute to unattended cooking. These circumstances can include age of residents, number of parents or responsible adults present, income and type of home (apartment, single-family, dormitories, etc.). A comprehensive literature review on these family-related circumstances will be reviewed and discussed. Table 2 is a summary of all the family-related circumstances that could lead to unattended cooking and any relevant sources associated with that circumstance.

*Table 2: Sources investigating family circumstances as contributing factors to unattended cooking fires*

| Family circumstances | Sources |
|---|---|
| Building Type | Greene, M.A. and Andres, C. (2009) *2004-2005 National sample survey of unreported residential fires*. The Commission.<br><br>U.S. Congress (2013) *Federal fire prevention and control act of 1974*. Public Law, pp.93-498 |
| Households with children (under 18 years old) | Greene, M.A. and Andres, C. (2009) *2004-2005 National sample survey of unreported residential fires*. The Commission.<br><br>Chhetri, P., Corcoran, J., Stimson, R.J. and Inbakaran, R. (2010) *Modelling potential Socio-economic determinants of building fires in south east Queensland*. Geographical Research, 48(1), pp.75-85.<br><br>Lushaka, B. and Zalok, E. (2014) *Development of a sensing device to reduce the risk from kitchen fires*. Fire technology, 50, pp.791-803. |
| Households with members over the age of 65 | Greene, M.A. and Andres, C. (2009) *2004-2005 National sample survey of unreported residential fires*. The Commission.<br><br>Jurdi-Hage, R., Giblett, C. and Prawzick, A. (2017) *Incidence, Circumstances and Risk Factors of Residential Careless Cooking Fires in the City of Regina*.<br><br>Hastie, C. and Searle, R. (2016) *Socio-economic and demographic predictors of accidental dwelling fire rates*. Fire Safety Journal, 84, pp.50-56. |
| Number of residents within a household | Greene, M.A. and Andres, C. (2009) *2004-2005 National sample survey of unreported residential fires*. The Commission.<br><br>Chhetri, P., Corcoran, J., Stimson, R.J. and Inbakaran, R., (2010) *Modelling potential Socio-economic determinants of building fires in south east Queensland*. Geographical Research, 48(1), pp.75-85.<br><br>Turner, S.L., Johnson, R.D., Weightman, A.L., Rodgers, S.E., Arthur, G., Bailey, R. and Lyons, R.A. (2017) *Risk factors associated with unintentional house fire incidents, injuries and deaths in high-income countries: a systematic review*. Injury prevention, 23(2), pp.131-137.<br><br>Nilson, F., Bonander, C. (2020). *Household Fire Protection Practices in Relation to Socio-demographic Characteristics: Evidence from a Swedish National Survey*. Fire Technol 56, 1077–1098. |

| Family circumstances | Sources |
|---|---|
| Privately owned or rented property | Gerritson, E. (2018) *Evaluating strategies to reduce the incidence of residential cooking fires in the city of Fond Du Lac, Wisconsin*. City of Fond Du Lac Fire Rescue.<br><br>Greene, M.A. and Andres, C. (2009) *2004-2005 National sample survey of unreported residential fires*. The Commission.<br><br>Turner, S.L., Johnson, R.D., Weightman, A.L., Rodgers, S.E., Arthur, G., Bailey, R. and Lyons, R.A. (2017) *Risk factors associated with unintentional house fire incidents, injuries and deaths in high-income countries: a systematic review*. Injury prevention, 23(2), pp.131-137.<br><br>Waters, T. and Wernham, T. (2023) *Housing quality and affordability for lower-income households*. IFS<br><br>Jennings, C.R. (1996) *Urban residential fires: an empirical analysis of building stock and socioeconomic characteristics for Memphis*. Tennessee, City University of New York, New York.<br><br>Shai, D. (2006) *Income, housing, and fire injuries: a census tract analys*is. Public health reports, 121(2), pp.149-154.<br><br>Menyes, C. (2018). *Dishes You'll Only Find in the Northeast.* Available at: https://www.thedailymeal.com/cook/dishes-only-found-northeast/. (Accessed: 16 June 2023). |
| Single-parent homes | Gerritson, E. (2018) *Evaluating strategies to reduce the incidence of residential cooking fires in the city of Fond Du Lac, Wisconsin*. City of Fond Du Lac Fire Rescue.<br><br>Chhetri, P., Corcoran, J., Stimson, R.J. and Inbakaran, R. (2010) *Modelling potential Socio-economic determinants of building fires in south east Queensland*. Geographical Research, 48(1), pp.75-85.<br><br>Jonsson, A. and Jaldell, H. (2020) *Identifying sociodemographic risk factors associated with residential fire fatalities: a matched case control study*. Injury prevention, 26(2), pp.147-152. |

Some of the following popular literatures are not related to cooking fires directly, and instead related to residential fires as a whole. However, it is reasonable to assume that the majority of residential fires discussed can be linked to cooking fires.

The 2004-2005 National Sample Survey of Unreported Residential Fires in the USA provides a range of information provided by the American public on residential fires, specifically those that are not attended by the fire department. The report presents a range of factors contributing to residential fires

and how family-related circumstances can affect a fire. Firstly, it was found that around two-thirds (4.6 million) of fires in 2004-05 were caused in single family residences, while the remaining third (2.6 million) were caused in other residences (Greene & Andres, 2009). The reason for this statistic is likely due to the fact that other residences – such as apartments, multifamily dwellings and dormitories – require regulations to ensure fire safety for the inhabitants (U.S Congress, 2013). This can include fire safety information sheets provided in kitchens, as well as fire prevention devices such as smoke detectors and sprinklers, all of which aid in deterring users from leaving their cooking unattended. On the other hand, in single family residences, this type of regulation is likely to be less frequent, and therefore there are limited reminders and safety measures in place to ensure residents attend their cooking at all times. Moreover, according to the new UL858 (60A) standard published by Underwriters Laboratories, when the safety shut-off device detects a pan temperature near the limit, the burner will shut off automatically until a and safe pan temperature is reached (ANSI/UL 858, 2014).

The 2004-05 report also found that there were 9.4 fires per 100 households in households with at least one member under the age of 18 and only 4.9 fires per 100 households in households with no members under the age of 18 (Greene & Andres, 2009). This means that having at least one child in the home increased the risk of a fire by almost double. This is likely due to the fact that children require supervision from parents or guardians, which could take a person's attention away from cooking and contribute to an unattended cooking fire. Similarly, children are less likely to be educated in the dangers of unattended cooking than adults, and could unknowingly contribute to an unattended cooking fire hazard. This is supported by a similar study conducted in South East Queensland, Australia, in which it was found that there was elevated residential fire occurrence in families with children under the age of 15 (Chhetri et al., 2009). In a similar sense, a study conducted in Ontario in 2005-2006 found that the root cause of residential stovetop cooking was unattended cooking due to distractions such as attending to a child (Lushaka & Zalok, 2014).

Another characteristic that was found in the 2004-05 report was that households with all members under the age of 64 were six times more likely to be involved in a residential fire than households with at least one member who is aged 64 or above (Greene & Andres, 2009). The full benefit age is 66 years and 2 months for people born in 1955, and it will gradually rise to 67 for those born in 1960 or later in the USA (National Academy of Socia Insurance, 2023). During retirement, it is likely that a resident will have more time and less responsibilities (in terms of supervision of young children). This is supported by a study conducted in the city of Regina, Canada, in which it was found that only 14.6% of residential cooking fires were caused by people aged 65+ (Jurdi-Hage et al., 2017). Similarly, Hastie and Searle found no link between persons over the age of 65 and the increased risk of fire in their 2016 study 'Socio-economic and demographic predictors of accidental dwelling fire rates' (Hastie & Searle, 2016).

The USA National Survey of Unreported Residential Fires also found a connection between the number of residents in a household and the prevailing risk of a residential fire. It was found that on average, homes with a single resident had 3.2 fires per 100 households. In a similar respect, two-member homes had 4.8 fires per 100 households, three-member households had 8.3 fires, four-member homes had 10.0 fires and homes with more than four members had 12.9 fires per 100 households (Greene & Andres, 2009). This relationship could be linked to additional children within expanding families highlighting why the occurrence of fire is increased as household members increase. As previously mentioned, the addition of persons under the age of 18 within a household has seen to increase the likelihood of a residential fire and can lead to unattended cooking. (Greene & Andres, 2009), (Chhetri et al., 2009). The idea that more residents in a household directly effects the risk of a dwelling fire is supported by the systematic review conducted by Turneret al. in 2017 (Turner et al., 2017). Among other factors, the review found that residential fires were more prominent in situations where households had a larger number of residents (Turner et al., 2017).

A Swedish study that analysed a national survey regarding household fire protection in relation to socio-demographic characteristics found a similar trend with age groups dividing the population into different fire-safety clusters (Nilson & Bonander, 2020). A summary table is provided in Table 3.

*Table 3: Subdivision of the population according to fire safety cluster (Nilson & Bonander, 2020)*

| Clusters | Description |
|---|---|
| Cluster 1—Uninterested in fire safety | The individuals in this cluster are often young (18–29 years), have a low level of income and are more often born outside of Sweden. They often live in a single household in a multi-family house |
| Cluster 2—Minimal fire safety | The individuals in this cluster are more often young (18–29 years), unmarried and have a low level of income. Women are more prevalent in this cluster. Individuals in this cluster more often live in multi-family houses, are born outside of Sweden and have children |
| Cluster 3—Reliance on fire detection | The individuals in this cluster are more often older (65 years or above), married or widowed and have a low level of income. They are slightly more often female and born in Scandinavia or Europe |
| Cluster 4—Formally educated in fire safety | The individuals in this cluster more often live in a single-family home, are more often men, middle-aged (50–64 years) or 30–49 years, born in Sweden, married, have children and have a high or medium level of income |
| Cluster 5—Informally educated in fire safety | The individuals in this cluster more often live in a single-family home, are more often middle-aged (50–64 years), born in Sweden and are married |

As seen in Table 3, there is a trend between fire safety involvement and age. Generally, the older groups of adults seem to have more fire safety involvement – which can include knowledge of unattended cooking. This study complements the popular literature that has already been discussed in this section.

A study that evaluated home cooking fires in Fond Du Lac, Wisconsin, found that a significantly large 85% of fires were caused in homes that were being rented and not privately-owned (Gerritson, 2018). The 2004-05 national survey for unreported residential fires also found that renter-occupied properties had more fires than owner-occupied properties per 100 households (Greene & Andres, 2009). Similarly, in another study, it was also concluded that fires were more prominent in households that were non-privately owned (Turner et al., 2017). There are many possible reasons for this correlation of domestic fires and renter-occupied properties. One possibility is that it is common for renters to have a lower income than homeowners (Waters & Wernham, 2023). In several popular literature sources, there is a connection between lower-income homes and the increased risk of domestic fires. For example, a study conducted in Memphis, Tennessee found that fires are more likely to start in low-income homes – as people with lower income are more likely to live in older buildings with less fire safety regulation (Jennings, 1996). A more recent study in Philadelphia also found a similar link between low-income residences and the increased risk of fire injury. In addition, the study also saw significant interaction between low-income homes and older buildings (Shai, 2006). Similarly, it was found that lower income families had the poorest knowledge of identifying household hazards such as unattended cooking (Mayes, et al., 2014).

The Fond Du Lac study also found that social factors contributing to the residential cooking fires revealed that income status was the number one contributing factor, closely followed by educational level and last by family structure (Gerritson, 2018). This is especially understandable in single-parent homes, as, commonly, the parent has the obligation to supervise their child without any support from another parent or guardian. This is supported by Chhetri, et al. in which one of the main characteristics associated with elevated fire incidence was single-parent households (Chhetri et al., 2009). A 2020 study on the sociodemographic risk factors associated with residential fires found that adults living together with a child and adults living with a partner were at lower risk of a fire than adults living alone or single parents (Jonsson & Jaldell, 2020). Again, this reinforces the idea that single parents are at a higher risk of an unattended cooking fire, as they have more responsibility to manage on their own than two-parent households.

In summary, there are many family-related factors that contribute to unattended cooking. The popular literature that was reviewed found that these factors include single-parent households; a lack of fire safety education (as a result of lower-income households); the age of the residents in a household; the number of people and number of children in a household; and the type of dwelling. All of these factors

contribute to unattended cooking and will be considered during the analysis and discussion parts of this report.

## 2.4. Fire safety information and warnings on cooking fires

The overall goal of this section is to highlight the importance of fire safety in the context of cooking fires. Therefore, the types of cooktops available in the USA are researched and the numbers of specific types of cooktops are classified according to the cooktop types. Additionally, fire safety guidelines provided in user manuals investigated in the light of the visibility and clarity of warnings about unattended cooking. It is important to highlight that unattended cooking fires are also linked to unattendance, distractedness, or negligence. Furthermore, the manuals and reference warnings are investigated to understand if they are displayed on the appliance itself. Finally, fire prevention campaigns targeted at reducing cooking-related fires in the USA are researched with the benefits and limitations of each campaign highlighted.

### 2.4.1. Cooktops and ranges sold

A range of cooktop types have been sold in the USA, with the majority being primarily electric and gas according to a 2020 survey from 18,500 households (Buchholz, 2023). According to the survey, a share of 68% of the USA have an electric stove whilst, a share of 38% of the USA have gas one (Buchholz, 2023).

The U.S. Energy Information Administration (EIA, 2022) provides information on source for energy in the USA based on data and analysis on production, consumption and trends (Beall, 2022). Based on Figure 1, it is clear to see ownership of electric stoves reaching 90% in North Carolina (Beall, 2022). Despite electric stoves having the majority share within the USA, gas stoves are still prevalent in states such as California (70%) and New Jersey (69%) (Beall, 2022). This is an area of concern due to the potential health risks, methane, nitrogen dioxide, carbon monoxide, and fine particulate matter, which can cause respiratory conditions and illnesses (Buchholz, 2023). There has been a great deal of research developed on natural gas leaks (greater than 90% methane) over the three million miles of pipeline in the US supply chain (Alvarez, et al. 2018). Despite this, relatively little research has been focused on emissions inside of homes and other structures ("post-meter" emissions) (Lebel et al, 2022). Methane has provided nearly one-fourth of the global radiative forcing since 1750, and its concentration has been rising from then (Etminan et al. 2016). Even considering a shorter lifetime than carbon dioxide, methane is 34–86 times more potent than carbon dioxide over 100 year and 20-year timescales (Lebel et al, 2022).

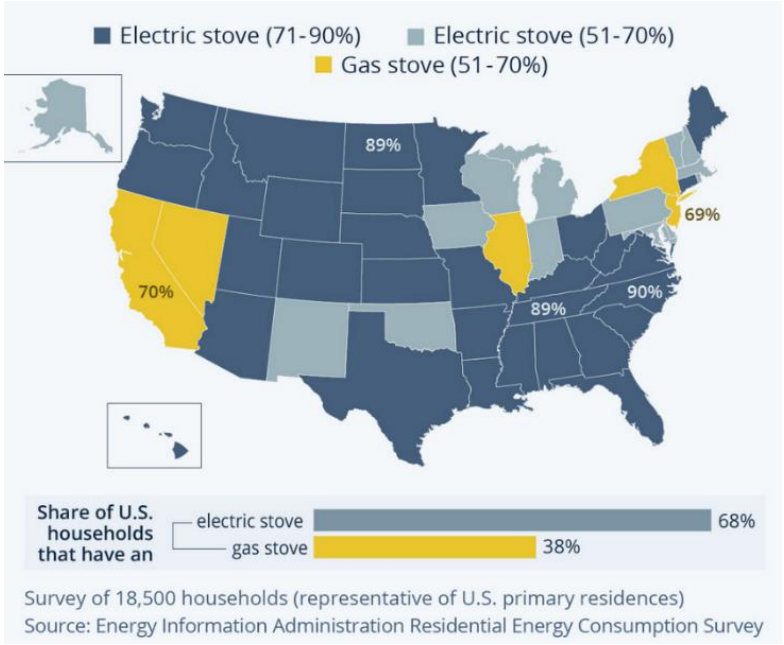



*Figure 1: Most common type of stove in the USA by households in 2020 (Buchholz, 2023).*

In terms of cooktop usage, as of 2020, most residents in the USA (89%) own a cooktop attached to an oven (a range), and are used eight times per week on average, compared to ovens used three times per week on average (Beall, 2022). Nearly all households own at least one microwave, according to the report (Beall, 2022). In addition, 56% of families regularly use an electric coffee maker, 75% using one at least irregularly (Beall, 2022).

Narrowing down to specific appliances, in 2020, rice cookers were used by 13% of homes and instant pots by 16% of households in the USA. The states with the highest utilisation of rice cookers were Hawaii (74%), Louisiana (29%), and California (26%) (Beall, 2022).

In Figure 2, the evolution of unit shipments of electric and gas cooking appliances in the USA from 2007 to 2017 is presented. It is evident that electric ovens record a notable decrease then a steady increase, recording 867,000 units in 2007, 549,000 units in 2009, then the shipments increase to 777,000 units in 2017. The decline during 2007 to 2009 could be attributed to the global financial crisis during this period (Singh, 2023). Moreover, electric surface cooking units slightly decline recording a high of 512,000 units (2007) and a low of 304,000 units in 2012 (Statista, 2014). Similarly, Figure 2 shows 55,000 gas oven shipments were recorded in 2007 and a low of 31,000-unit shipments in 2012, with a steady increase subsequently. The gas oven shipments reiterate the earlier considerations, that despite electric stoves having the majority share within the USA, gas stoves are still prevalent in states such as California (70%) and New Jersey (69%) (Beall, 2022).

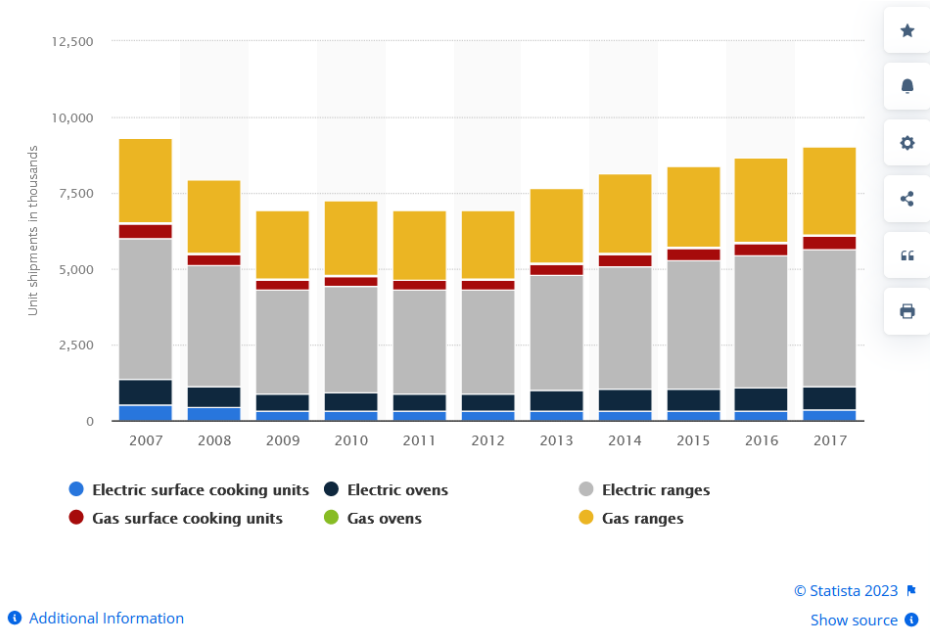



*Figure 2: Unit shipments of electric/gas cooking appliances in the USA. from 2007 to 2017 (in 1,000s) (Statista, 2014)*

The common decrease seen in the period from 2007 to 2012 could correspond to the aftermath of the global financial crisis. The economy of the USA was in a serious recession by the winter of 2008, stock markets worldwide were seeing their steepest decline since the September 11$^{th}$ 2001 terrorist attacks (Singh, 2023). Furthermore, home ownership in the US reached a peak of 69.2% in 2004 thereafter, property values began to decline in early 2006 (Singh, 2023). The decrease in disposable income meant that consumers had less purchasing power and had to prioritise their expenditures on essential items. This could be a contributing factor to the decrease in unit shipments. In addition, the housing market crash could had resulted in a decline in construction and home sales, another potential factor for the decrease in unit shipments. The decrease in unit shipments during 2007- 2009 with a steady increase is a repeated trend with electric ranges, gas surface cooking units and gas ranges, further supporting the hypothesis that the trend is potentially attributable to the global financial crisis (Singh, 2023).

The above considerations are also supported by the dramatical decrease in the consumer spending habits in 2008-2009, causing a decrease in employment, especially the goods-producing sector (Barello, 2014). However, consumer spending and employment steadily increased in 2011 and 2012, although the recovery was slower than it had been following prior recessions (Barello, 2014). Moreover, technological advancements, such as energy efficiency, may mean that appliances are lasting longer resulting in lower shipments compared to prior 2009. To support this hypothesis, induction cooktops were found to boil water 20 to 40% faster than gas and conventional electric cooktops according to Consumer Reports (Farrell & Hope, 2022). The quicker cooking times increase efficiency, performance and durability. Additionally, consumers are likely to be more concerned about the environment so want

to minimise unnecessary purchases resulting in less waste, another potential factor for the slower increase from 2012-2017.

A study by Gruenwald published in the International Journal of Environmental Research and Public Health provides valuable insights into the population implications of using gas stoves and the relation with childhood asthma within the USA (Gruenwald et al. 2022). Despite the study primarily focusing on the health impacts, it indirectly provides useful information on the cooktops sold in the USA, highlighting the popularity of gas stoves (Gruenwald et al. 2022). The study states that gas stoves are used in 35% of households in the USA, with some states having a popularity as high as 68% in some states, such as California and Illinois (Gruenwald et al. 2022). Based on the above considerations, it provides more evidence of the popularity of gas stoves. Earlier, it was found that according to a 2020 survey, a share of 68% of the USA have an electric stove whilst, a share of 38% of the USA have gas one (Buchholz, 2023). However, the study does not provide information on specific types of cooktops, brands or models sold in the USA. Consumer reports stated that half of homes in the USA have gas as an option, as of December 2022 (Hope, 2022). Furthermore, the U.S. Energy Information Administration recorded that two-thirds of USA use electric stoves (EIA, 2023) proving that gas cooktops are not as common to electric cooktops, within the USA.

The new UL858 (60A) standard published by Underwriters Laboratories includes a new test requirement for cooking oil ignition where all new household electric coiled cooktops/ranges must meet the new test requirement by April 2019. This test requires that an electric coil stovetop be turned to its maximum heat setting with a pan of oil on the element and allowed to operate for 30 minutes or until the cooking oil ignites, whichever comes first. If there is ignition, then the product fails and cannot be listed for sale in North America (ANSI/UL 858, 2014). This is also supported by several studies aiming to define temperature-limiting control systems for preventing oil ignition on gas and electric cooktops (Primaira, 2015) and to demonstrate technology able to reduce unattended cooking fires resulting from ignition of food using a variety of cooking operations, pan types, and cooktop types (Primaira, 2011).

In conclusion, this section emphasizes the popularity of electric and gas cooktops in the USA, with 68% of homes owning an electric stove and 38% owning a gas stove (Gruenwald et al. 2022). Gas stoves are still popular in states, such as California and New Jersey (Beall, 2022). Additionally, the decline in shipments during 2007 to 2012, is hypothesised to be attached to the global financial crisis and the decrease in consumers' disposable income (Singh, 2023). The slower increase from 2012 to 2017, may be influenced by improved energy efficiency of cooktops, increasing their longevity. Also, an increase in environmental awareness among consumers may have made them try to minimise waste by keeping their cooktops for longer. The prevalence of gas stoves, as cited by multiple sources, emphases the importance of the health risks associated with their use. The changes introduced by the UL858 (60A)

standard (ANSI/UL 858, 2014) will have a direct impact on cooking fires and it is important to maintain focus on older existing electric stovetops most associated with cooktop fires.

### 2.4.2. Manuals for popular cooktops and ranges

An important aspect that should be considered in the research is the available information on fire safety that is provided in cooktop manuals. Providing adequate fire safety information can massively reduce the risk of a fire and it is important to ensure the public are educated in protocol in the event of a fire. The New York Times has researched over 120 cooktops equally subdivided between gas and electric in order to determine the best one for the consumer (Wells Lynch, 2023a and 2023b). Two articles were published summarising the four best cooktops for gas and electric.

The top pick for electric cooktops was the GE JB735 (Wells Lynch, 2023a). The initial pages of the GE JB735 user manual gives instructions on health and safety, as well as aspects of using the range, in which fire safety and warning is mentioned. The manual informs the user to read all of the health and safety instructions before using the product and there are bullet points containing safety instructions in various categories, including but limited to, general safety instructions such as keeping flammable materials away, how to act in the event of a fire, and oven safety instructions. Each of these boxes contains a bold black and white 'WARNING' sign in the top left corner for customers to read them carefully. The manual also highlights the importance of not leaving any materials such as textiles or oven gloves on the cooktop, or materials such as foil on the surface of the oven, as well as keeping the oven clean to avoid ignition from residual grease. All of these warnings are helpful for the user in understanding how to avoid a fire and what to do in the event of a fire. Importantly, the manual contains a section with 'FIRE HAZARD' written at the top of the page instructing the user to never leave the range unattended when the cooktop is on high or medium, as this can lead to fire, injury or death. It also explains a 'hot cooktop indictor light system' associated with the product. The system will indicate which hob is hot with a red light, even if the hob has been switched off. The light will remain until the associated burner has reached a temperature below 150°F (66°C). Despite this, more information about the danger of leaving a cooktop unattended could be given and made clearer for the user, as the warning within in the manual is very brief. The manual refers to a self-cleaning feature, in which it operates at high temperatures to burn off any residual food soils. This could be considered a type of unattended cooking, as, the oven is still in use without supervision. Detailed instructions and health and safety warnings for the self-cleaning process are provided, which is an aspect where this manual is satisfactory. On the other hand, it does not seem to refer to any symbolic warnings that are present on the range itself, implying that there are none. This could potentially lead to a fire risk, as a number of people may not be aware of the instructions available in the manuals (GE Appliances, 2023a).

The New York Times article also advertises two other GE cooking ranges, the GE JB645 and the PROFILE PB965 in their list of the top four electrical ranges (Wells Lynch, 2023a). GE Appliances uses the same user manual for these two electric ranges, and, therefore, these manuals provide the same safety information as previously mentioned (GE Appliances, 2023b), (GE Appliances, 2023c).

The second most popular electric cook range, according to the New York Times, was the Frigidaire Gallery GCRE3060A (Wells Lynch, 2023a). The Frigidaire Gallery GCRE3060A user manual has a similar layout to that of the GE JB ranges, in which fire safety information is presented at the very beginning of the manual. The manual defines and sets out the difference between their 'WARNING' and 'CAUTION' symbols – both of which are highlighted in bold and black and white. These symbols are present throughout the manual and many of them refer to fire safety and how the avoid a fire. The manual exhibits similar fire safety warnings as the GE JB user manuals, although they do not stand out as much, due to the unboxed format. The manual also explains how to act and what to avoid in the event of an oven fire. It also has a list of safety instructions highlighted in bold font, one of which being to 'Never Leave Surface Units Unattended' and explains the risk of greasy spill overs, and the risk of ignition from dry pans. However, this is seemingly the only warning given about unattended cooking related to the risk of a fire. This manual presents a distinction between an 'Element On' light and a 'Hot Surface' light, which is more detailed than the GE ranges. In the Frigidaire Gallery manual, an extended section is dedicated to explaining what these two lights mean, and even provides a recommendation to check these lights once cooking is complete. There is no indication of any symbolic warnings present on the appliance itself. As with the GE JB manuals, more explanations could be added to ensure a sufficient warning within the manual for the user with regards to leaving the range unattended while in operation. Moreover, a symbolic warning on the cooker could help reduce the risk of a fire, especially for users who do not read the manual. (Frigidaire, 2023a).

Another popular electric range in the USA is the Samsung NE63A6111SS, according to a home improvement blog, The Spruce (Puisis, 2023). The user manual for the Samsung electric range is a comprehensive document that covers a range of aspects. Initially, the manual defines a range of warning symbols that are present throughout the manual, including but not limited to warning, caution, do not attempt, do not touch and unplug the power. These symbols are helpful in categorising the provided safety information, so that the user is able to acknowledge the fire-related warnings. Similar to the other manuals, the Samsung electric range manual begins with a range of fire-related safety instructions. It covers a wide range of aspects regarding fire safety, and warns users to not leave the appliance unattended, specifically in high or medium heat settings, due to the risk of boilovers. In line with the other ranges, the Samsung appliance has a light indication system that illuminates when the cooker is hot and remains until the cooker has reached a temperature below 150°F (66°C). The main issue

surrounding this manual, and the cooktop itself, is any symbolic warning on the cooktop regarding the risk of unattended cooking, which is similar to the other reviewed appliances (Samsung, 2023).

It is also important to consider cooktops, ovens and ranges from earlier years to account for homes without the most modern technology. Considering that the average life expectancy of an electric range is around 13-15 years (DeSiato, 2022), it is only appropriate to review the user manual of a popular kitchen appliance brand from 13 to 15 years ago. A study conducted in 2011 found that the most popular kitchen appliance brand in the USA at the time was Wolf Appliances (Power, 2011). Therefore, the Wolf E Series Oven SO30-2F/S coupled with the Wolf Electric Cooktop CT15E/S user manuals will be reviewed, as both of these products were in production circa 2010. Both product manuals consist of the same initial pages, instructing the user to avoid doing a list of actions. The SO30-2F/S Oven user manual is very limited in its fire safety instructions. While it does mention what not to do in the event of a fire, as well as what can cause a fire, these warnings are very brief and are only across four pages of the manual. There is also no information on leaving the oven unattended while in operation, nor is there any mention of oven fires from sources other than grease (Wolf, 2011a). The CT15E/S Cooktop manual has very similar initial warnings as the other examined ranges, with one additional warning or not leaving cooking unattended on high heat. The Cooktop manual also shows the hot surface indication system on the product. Despite this, the information on fire safety is very limited for this product and there is minimal mention of unattended cooking and the risks surrounding it (Wolf, 2011b). This suggests that popular kitchen appliances from circa 2010 had limited fire safety information on their user manuals. It is reasonable to assume that members of the public would still have these kitchen appliances due to their popularity at the time, as well as their average life expectancy. More fire safety awareness should be publicly available for domestic, electric kitchen appliances.

It is also important to review various gas-powered cooktops, ovens and ranges, as roughly 40% of USA homes own a gas kitchen appliance (Statista, 2020). The current most popular gas stove is the GE JGB735, in accordance with the New York Times (Wells Lynch, 2023b). As with the GE user manuals for electric appliances, the layout and format of this user manual is well organised, with relevant safety information in boxes, and warnings in bold black and white writing. One main difference with this user manual, is that the initial warning page is dedicated to what the user should do if they smell gas. Furthermore, it sufficiently highlights the importance of reading the manual to avoid fire, explosion, damage, and injury. Another important section informs the user about the gas cooktop, how it works and what to do in the event of a fire. The manual also provides warnings for the user to never leave the stovetop unattended in bold writing. Finally, it explains how to safely ignite the stovetop without the risk of fire. The user manual for this appliance seems comprehensive as it has sufficient information on unattended cooking and what to do if the user smells gas. (GE Appliances, 2023d).

The New York Times also advertises another gas-powered kitchen appliance, the GE Profile PGB965 by GE Appliances in their article on the top four gas stoves and ranges. GE Appliances uses the same user manual for this product as they do for the electric GE JGB735. Therefore, the fire safety information provided is the same as the GE JGB735previously mentioned. (GE Appliances, 2023e).

Another popular gas range in the USA, according to the New York Times, is the Frigidaire Gallery GCRG3060A (Wells Lynch, 2023b). This user manual is mostly the same as its electric counterpart, the GCRE3060A, with an additional warning box regarding what the user should do if they smell gas. The manual clearly states that the information provided must be followed exactly, to avoid any fire or injury. It briefly describes how to light the gas stovetop; however, there is not any additional information or warning about cooking with gas. The information on unattended cooking relates mainly to small children, and there is a brief sentence about the danger of leaving cooking unattended on a high heat. Aside from this, no other information is present on the dangers of unattended cooking, and there is no obvious reference to any warnings on the appliance itself. This is a feature that needs to be reviewed, as currently, it could present a danger between the user and the risk of a cooking fire (Frigidaire, 2023b).

The final, most popular, gas-powered stovetop, according to the New York Times, is the Whirlpool WFG320M0BS (Wells Lynch, 2023b). The initial warning page of this user manual successfully alerts users to carefully follow the instructions to avoid the risk of injury or death highlighting important messages written in bold and large safety alert symbols. The manual comprehensively describes what the user should do if they smell gas, and also alerts the user that gas leaks are not always detectable by smell. The section of the manual related to the cooktop use is clear and explains how it works, with accompanying fire warnings and symbols. The manual also provides recommendations for the flame settings on the cooktop to avoid any fire hazard. It has no clear warning on unattended cooking, unlike the other manuals that have been reviewed (Whirlpool, 2023).

As with the electric appliances that have been reviewed, it is important to include a gas-powered stovetop or range from around 13 to 15 years ago, to ensure the analysis is representative. The Wolf R Series Gas Range R304 kitchen appliance will be reviewed as it was in production circa 2010. The user manual for this product has an initial warning page, that instructs to read the manual carefully to avoid the risk of fire, as well as how to act if the users smell gas. Aside from this, the information on fire safety is very limited, and any unattended cooking warnings are not obvious. This is similar to the Wolf electrical appliance that was reviewed, and this approach could be related to the company or the time of production. This is an aspect that should be investigated further to understand how much information is publicly available regarding fire safety.

The information on electric and gas ranges presented in this section are summarised in Table 4.

In summary, a comprehensive review has been conducted of a variety of electric and gas cooktops and ranges. While all the manuals do exhibit some form of fire safety warning, it was found that earlier models are potentially lacking on information. It is reasonable to assume that many members of the public have owned a cooktop or range for over a decade. The newer models had more detailed information regarding fire safety. All the investigated electric appliances have hot surface indicators, which acts as a form of warning when a cooktop is unattended, whereas the flame of a gas cooker is the limited warning for unattended cooking. Further improvements could be applied to all the cooktops and ranges reviewed in terms of expressing the importance of not leaving cooking unattended. Despite most products including unattended cooking warnings in their manuals, very few seemed to reference the warnings present on the product itself. This is a feature that could be considered in future design, as users may not even read the provided manuals, so warnings on the cooktop itself will at least keep users informed.

*Table 4:Summary information on the kitchen appliances reviewed in section 2.4.2*

| Type | Recent or old | Product | Fire safety information available | Obvious warning of unattended cooking provided | Specific warnings about unattended cooking | Warnings about unattended fires appearing on the appliance itself |
|---|---|---|---|---|---|---|
| Electric | Recent | GE JB735<br><br>GE JB645<br><br>GE PROFILE PB965 | General fire safety information* provided at the beginning of the manual<br>Bold, boxed format information easy to read | Provided | Brief, but visible box about unattended cooking and the related dangers<br>Warnings about self-cleaning feature<br>Only warns about unattended cooking on high or medium stovetop settings | Red light indicator for hot surfaces on stove top<br>No symbolic warnings seemingly present |
| | | Frigidaire Gallery GCRE3060A | General fire safety information* provided at the beginning of the manual<br>Unboxed format, making information less apparent<br>Manual defines difference between 'warnings' and 'cautions' | Provided | Bold warning about not leaving surface units unattended and explaining the surrounding risks. However, this is the only mention of unattended cooking | Separate 'unit on' and 'hot surface' indication lights<br>Manual warns user to check lights after each use |
| | | Samsung NE63A6111SS | General fire safety information* provided at the beginning of the manual<br>Wide range of symbols defined at the beginning of the manual | Provided | Bold warning about not leaving the cooktop unattended, especially in high or medium settings due to the risk of boilovers | Red light indicator for hot surfaces on stove top<br>No symbolic warnings seemingly present |
| | Old | Wolf E Series Oven SO30-2F/S and Wolf Electric Cooktop CT15E/S | Only mentions on how to act in the event of a fire and what can cause a fire<br>Limited mention of oven fire safety | Provided, but limited | No mention of unattended oven fires<br><br>One brief mention of not leaving the stovetop in operation on high heat<br>Information generally limited | Light indication system for hot surfaces |

| Type | Recent or old | Product | Fire safety information available | Obvious warning of unattended cooking provided | Specific warnings about unattended cooking | Warnings about unattended fires appearing on the appliance itself |
|---|---|---|---|---|---|---|
| Gas | Recent | GE JGB735<br><br>GE PROFILE PGB965 | General fire safety information* provided at the beginning of the manual<br>Information provided on igniting the cooktop safely and how to act if the user smells gas.<br>Statement affirming user must follow all instructions to avoid fire | Provided | Warns user never to leave the cooktop unattended | No seemingly obviously warnings provided |
| | | Frigidaire Gallery GCRG3060A | General fire safety information* provided at the beginning of the manual<br>Unboxed format, making information less apparent<br>Manual defines difference between 'warnings' and 'cautions'<br>Additional information given regarding how to act if the user smells gas | Provided | Small warning about leaving cooking on a high heat,; however, information mostly relates to unattended cooking in the interest of child safety | No seemingly obviously warnings provided |
| | | Whirlpool WFG320M0BS | General fire safety information* provided at the beginning of the manual<br>Warns user how to act if they smell gas, and that not all gas leaks are detectable by smell<br>Recommends flame settings to avoid a fire | Provided | No obvious warnings presented | No obvious warnings presented |
| | Old | Wolf R Series Gas Range R304 | Warns user how to act if users smell gas<br>Instructs the reader to read the manual carefully | Not obvious | No obvious warnings presented | No obvious warnings presented |

*General fire safety information – Information includes: How to act in the event of a fire; Oven fire safety; Keep flammable materials away from the cooktop; Keep materials such as foil away from the base of the oven

Despite the importance of the information available in manuals, it is difficult to determine the percentage of consumers who read the manuals or if they review the information years after the purchase. The above-mentioned aspects will determine even further the need for continuous fire prevention campaigns to increase awareness on cooking fires.

### 2.4.3. Fire prevention campaigns

Fire prevention campaigns are essential for raising awareness about fire safety and promoting proactive fire prevention measures. The aim of the campaigns is to reduce the number of fires occurring and the effects of fires on people, homes, property and the environment. Cooking education should consider the whole cooking process. These campaigns increase the awareness of people on fire risk enabling a sense of ownership and responsibility to act and thus, reduce the risk of fires by providing important information and fostering a culture of fire safety.

One fire prevention campaign “Recipe for safer cooking”, produced by the United States Consumer Product Safety Commission, listed fire prevention measures and methods to extinguish cooking fires (U.S. Consumer Product Safety Commission, 2023). The campaign focused on common causes, providing practical guidelines for prevention, such as emphasis on child safety and teaching safe cooking practices (U.S. Consumer Product Safety Commission, 2023). Additionally, the campaign highlights the importance of being prepared with fire extinguishers and smoke detectors. On the contrary, the campaign had a limited scope, focusing on kitchen fire prevention. There is not a discussion on alternative fire extinguishing solutions, such as fire blankets. Finally, it does not list evacuation plans or fire drill practices.

A fire prevention campaign “Cooking fire safety” is produced by the U.S Fire Administration (U.S. Fire Administration, 2023) and includes statistics, fire prevention tips, infographics and handouts, accommodating for a diverse range of readers, such as those who are not fluent in English or older people who may have difficulty reading. There is also a Spanish version of a fire prevention handout. Whilst the campaign highlights staying in the kitchen while cooking and using timers, it does not investigate alternative prevention measures, such as smart technology which have automated safety systems, stove knob safety locks and guards, motion sensors and timers that cuts power when the cooktop is unattended, contactless detector, wireless control system designed to cut power before a pan reaches autoignition temperatures, sound detectors - designed to cut cooktop power when a smoke alarm sound, plug and play retrofit electric coil heating elements limiting temperature. Furthermore, the campaign is specific to the USA and does not account for regional differences. For example, people are likely to use much older equipment and different cooking practices, due to the different cultures, such as outdoor cooking.

Fire prevention campaigns are also available internationally as introduced by Burnshield, which is a South African based medical manufacturer of first aid kits and Burnshield emergency burn care (Burnshield, 2021a), focuses on preventing kitchen fires and injuries (Burnshield, 2021b). The campaign highlights the risks of unattended cooking and provides tips. For instance, staying in the kitchen at all times when cooking and keeping flammables away from stovetops (Burnshield, 2021b). As self-promotion, the campaign recommends having first aid kits in the kitchen in case of any burns and statistics are provided to emphasise the importance of preventing cooking fires, such as ranges or cooktops accounting for three-fifths (61%) of cooking fires within households (Ahrens, 2020). The campaign includes statistics to raise awareness about the impact of kitchen fires and like the US Consumer Product Safety Commission campaign, safety guidelines for prevention are covered. However, it provides a general overview to minimise cooking fires that need to be adapted to specific situations that could lead to kitchen fires. Furthermore, there is limited discussion on fire prevention outside the kitchen and the statistics provided are based on annual averages without additional context or further analysis.

The NFPA produced several cooking fire safety campaigns, one being a "Cooking Safety" poster campaign (NFPA, 2019a), as shown in Figure 3, with fire prevention steps, fire extinguishing methods and how to act if the methods fail. The poster raises awareness about the leading cause of home fires (unattended cooking) (NFPA, 2019a). The increased awareness can reduce the occurrence of accidents and minimises the risk of fire occurrence. The poster, with bright colours and cartoon drawings provides useful safety guidelines for the reader to apply at home. On the downside, the poster campaign has limited qualitative information. Due to this, the campaign is limited for more complex emergencies, such as cooking fires in larger homes. Therefore, the guidelines suggested cannot be applied to all scenarios. In more serious situations, the individuals should prioritise their own safety, instead of tackling the fire. On the plus side, the campaign does suggest evacuation if there are any doubts. The poster campaign is in English, which means that there is likely to be language barriers if readers outside the USA try to access the campaign. Publishing the poster in several languages would make the poster more accessible. Publishing in multiple language is not unrealistic because despite the NFPA being focused on the USA, they have published teaching tools for keeping the community cooking safely in various languages (NFPA, 2019b), which leads onto the next campaign published by the NFPA. The NFPA has a comprehensive campaign providing teaching resources to keep the community safe when cooking (NFPA, 2019b). The campaign provides a huge range of resources with checklists, tip sheets, handouts, reports, fact sheets, links to videos and customisable materials, such as pre-written letters to help spread awareness about home cooking safety (NFPA, 2019b). The pre-written news releases and letters widens the population, and the message reaches thus, maximising the fire safety awareness campaign. Moreover, this is the only listed campaign that recognises the importance of making the

campaign applicable to as many communities as possible by providing easy to read handouts in 16 different languages (NFPA, 2019b). The campaign focuses on educating about cooking safety and prevention but changing the behaviour of people and ensuring the changes are difficult. The campaign is published by the National Fire Protection Association mainly targeting US population (NFPA, 2016).

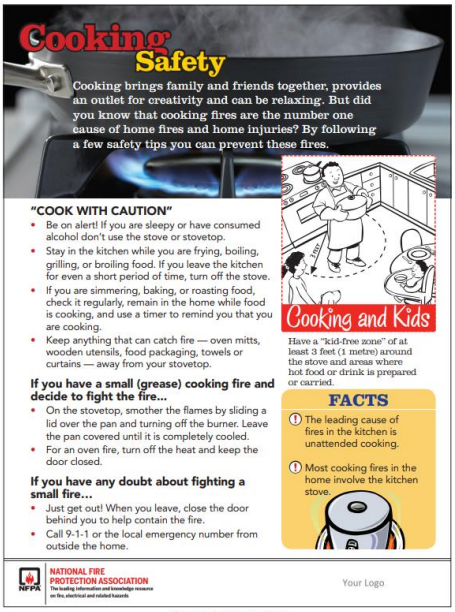



*Figure 3: NFPA Cooking Safety Campaign (NFPA, 2019a).*

Furthermore, the NFPA Fire Prevention Week 2023 is focused on "Cooking safety starts with YOU. Pay attention to fire prevention" (NFPA, 2023). Since 1922, the NFPA has sponsored the public observance of Fire Prevention Week. In 1925, President Calvin Coolidge proclaimed Fire Prevention Week a national observance, making it the longest-running public health observance in our country. During Fire Prevention Week, children, adults, and teachers learn how to stay safe in case of a fire. Firefighters provide lifesaving public education in an effort to drastically decrease casualties caused by fires. Fire Prevention Week is observed each year during the week of the 9$^{th}$ of October in commemoration of the Great Chicago Fire (8$^{th}$ October 1871) killing more than 250 people and destroying more than 17,400 structures.

A blog posted on Proline Range Hoods, merged statistics, and facts into one fire prevention blog (Proline Range Hoods, 2023). The campaign uses comprehensive data on cooking fires by the NFPA, such as a NFPA study published by Ahrens (Ahrens, 2020). The campaign includes causes, common trends and preventative measures. As a result, the campaign raises awareness and educates the public that despite the frightening nature of fires, they can be easily prevented. Through a mixture of messages, engaging pictures and interactive links, the campaign primarily focuses on empowering the reader with fire safety knowledge, to minimise the occurrence of fires (Proline Range Hoods, 2023). The objective of the campaign supports the safety of households and communities by establishing a common culture of fire

prevention and encouraging responsible cooking techniques, hence lowering the frequency and seriousness of cooking-related accidents and their associated dangers.

Overall, the campaigns promote awareness of fire prevention and protection. However, there are several aspects that can be improved for future campaigns such as covering a wide range of fire prevention strategies, including different solutions, and considering cultural and regional differences in all countries. Different campaigns have their strengths and limitations but they all aim to reduce the number of fires and minimize the impact on residents, homes, properties and the environment. From the campaigns, valuable information can be gathered, promoting fire safety. On the contrary, more fire prevention measures are required, such as more solutions to extinguishing fires and evacuation drills. The campaigns should take into consideration the differences in other regions. Overall, the goal is to ensure that people adhere to fire safety procedures and adopt behavioral changes that protect communities from the dangers of fire occurrences.

The literature review developed in this Chapter supported the evaluations related to cooking fire practices, differences in cooking practices among demographic groups, personal and family circumstances influencing cooking fires. Furthermore, an investigation of the ranges of cooktops sold in the USA and their manuals were developed to identify cooking equipment and possible source of ignition. Finally, fire prevention campaigns were studied to evaluate how local and national authorities enhance the awareness on cooking fires for households and communities. All of these aspects will be further defined based on the data analysis developed in the following Chapter.

# Chapter 3. Identification of parameters

In this chapter, a thorough investigation is conducted of home cooking fires in the US from 2012 to 2021. The investigation involves the National Fire Incident Reporting System (NFIRS), a comprehensive database of fire-related information in the USA. The importance of using the NFIRS as a primary data source is highlighted. Additionally, the data reliability and quality are explored, discussing methodologies to ensure accuracy and consistency. Once completed, the US Fire Incident and Civilian Casualty datasets are thoroughly examined to investigate the trends and impacts over the examined period. Finally, links between the outcomes obtained in the literature and fire statistical data are investigated. The major findings are compared to identify possible differences, further developing current understandings of home cooking fires within the USA.

## 3.1. National Fire Incident Reporting System

The National Fire Incident Reporting System (NFIRS) and its reference guide (version five) is used as the recording form for the fire statistical data and as a guide to understand and interpret the datasets effectively. The NFIRS 5.0 has been developed over 25 years on the input of all 50 states and more than 40 metropolitan fire departments (US Fire Administration National Fire Data Center, 2015). This reporting system was developed by the U.S. Fire Administration and composed of 11 different modules. Specifically, the focus of this research was on the Fire Module (module 2), which provides data and information about each fire incident to which the department responds and to the Civilian Fire Casualty Module (module 4), which is intended to record injuries or fatalities suffered by civilians or other emergency personnel (such as police officers) in connection with a fire event (US Fire Administration National Fire Data Center, 2015). The NFIRS states that the Civilian Fire Casualty module is to be used in conjunction with the Fire Module and, where applicable, the Structure Fire Module. This approach ensures a cohesive analysis and enhances the usability of the collected data.

## 3.2. Data quality and data reliability

As with any data analysis, addressing the reliability and quality of the NFIRS dataset is paramount. Having accurate data is what enable organisations to develop their fire protection and deploy strategies for ensuring proficient safety; therefore, it is important to guarantee a high quality of the examined data. The NFIRS provides detailed information about reported fires across the nation to help understand the fire problem and aid in reflecting the effectiveness of fire departments. This reporting system is used across the USA, creating unity among different states. It lives under the umbrella of U.S. Fire

Administration's National Fire Data Centre (NFPA Responder Forum, 2015), which gives the data credibility, as it is a nationally recognised and approved system. In recent years, there have been many improvements to the NFIRS to ensure reliability, including various checks on the data before the publication (U.S. Fire Administration, 2023).

Despite the NFIRS dataset covering a wide range of fire incident variables, a number of obstacles were found during the analysis phase. Firstly, the dataset presents a large number of blank spaces in the spreadsheet. This is likely due to lack of information or variables not considered to be compulsory when filling in the NFIRS. The presence of several missing values constitutes an issue for the data analysis as it is difficult to interpret blank spaces. In conjunction with the previously mentioned considerations, the dataset also presents two classes that assume relevant, and in some cases the majority of values: "O" meaning "Other", and "U" meaning "Undetermined". Similarly, these two classes introduce uncertainties and difficulties in the analyses. The National Association of State Fire Marshals (NASFM) has published a report examining the gaps within the NFIRS data. They provide a comprehensive list of reasons which could all be contributing factors to these gaps. For example, one option is Fire Marshals documenting a variable as "Undetermined" as the fire requires further investigation. Another factor could be the fatigue in the fire fighters after the fire has been extinguished in filling in the form (National Association of State Fire Marshals, 2014).

In the research developed in this project, a transparent approach is adopted for the data analysis. All blank spaces and the values related to the classes of "Others" and "Undetermined" have been disregarded to ensure the data are actually representative of the fire incidents. This reduces the data entries while it eliminates any uncertainty in the data analysis, which is a priority within this project.

## 3.3. US fire statistical data on home cooking fires from 2012 to 2021

A thorough analysis is carried out of the statistical data relating to home cooking fires that occurred in the US from 2012 to 2021. The goal is to reveal trends, patterns and underlying insights over the examined period. Through a deep understanding of the data, key factors that may have contributed to these fires will be stated. It is important to note that the analysis is focused on the latest available datasets covering a period of 10 years. Furthermore, the fire statistical variables present in the examined module of the NFIRS were identified and assigned to personal or family circumstances able to influence the fire incidents.

### 3.3.1. NFIRS Fire Module

Table 5 groups the variables for the NFIRS Fire Incident Module (module 2) according to Incident Description, Personal Circumstances and Family Circumstances. As a result, this systematic approach

enables trends to be identified easily and meaningful conclusions can be drawn thus, improving the efficacy of the analysis and encouraging a greater understanding of the underlying fire occurrences.

*Table 5: Fire Incident Dataset Variables*

| Fire incident dataset – fire statistical variables | | |
|---|---|---|
| **Incident description** | **Personal circumstances** | **Family circumstances** |
| Cause of ignition<br>Number of units<br>Buildings involved<br>Onsite material<br>Heat sources<br>Item first ignited<br>Type of material<br>Fire spread | Factor contributing to ignition | Structure type<br>Structure status<br>Structure damage<br>Presence of detectors<br>Presence of automatic extinguishing systems |

To ensure the selection of data is linked to only residential cooking fires, the variable related to the "NOT_RES" (Not-residential) is filtered so that only residential fires are displayed. In addition, the variable related to the area of origin "AREA_ORIG" is filtered to select only "Cooking area, kitchen".

The data shown has removed blank spaces as well as items labelled "O" Others or "U" Undetermined. This was applied to ensure fires analysed were only to home cooking fires and that any incomplete recorded fires are excluded, minimising the likelihood of anomalies impacting the data analysis.

### 3.3.2. NFIRS Civilian Fire Casualty Module

Table 6 summarises the available variables for Civilian Fire Casualty Module (module 4) of the NFIRS. The variables are divided into three categories: Casualty Description, Personal Circumstances and Family Circumstances. These categories will also allow for the data to be conveniently compared to the literature that was previously discussed in Chapter 1. A range of Casualty Description and Personal Circumstances variables are identified; however, there were no relevant Family Circumstances variables within this module.

*Table 6: Civilian Fire Casualty Dataset Variables*

| Civilian Fire Casualty dataset – fire statistical variables | | |
|---|---|---|
| **Casualty description** | **Personal circumstances** | **Family circumstances** |
| Number of casualties<br>Severity of injury<br>Cause of injury<br>Factor contributing to injury<br>Activity during injury<br>Location of the injury<br>Story of the injury | Gender<br>Race<br>Ethnicity<br>Human factor<br>Age<br>Region | |

To ensure only the relevant data are investigated, the datasets need to be filtered. Within the Civilian Fire Casualty datasets, a variable that summarises the specific location of the incident, identified as

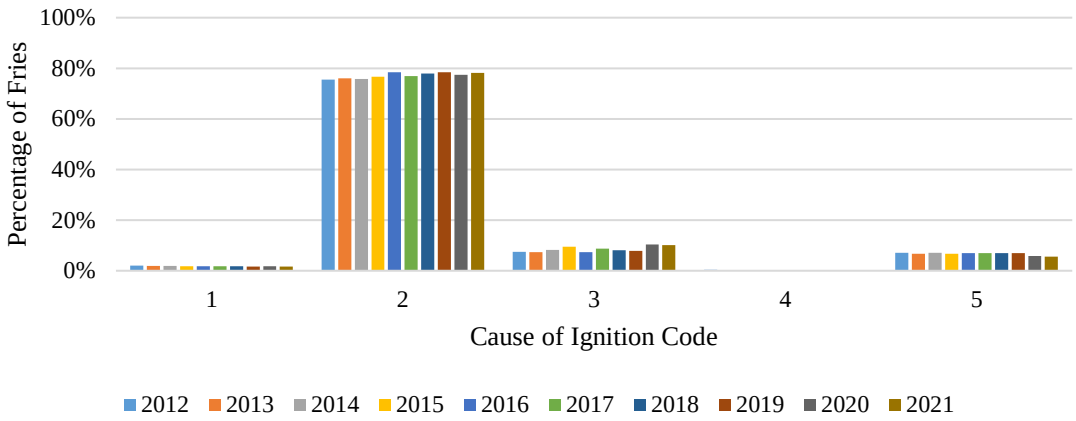
"SPC_LOC_IN" within the Excel spreadsheet, presents a range of possible locations where the casualty happened. In order to ensure the selection of the data related to cooking fires, the location "kitchen/ cooking area" has been used to filter the fire incidents with the aim to cover all the other variables and provide a comprehensive assessment. As previously mentioned, the data that is presented has intentionally excluded blank spaces, as well as entries listed as "O" or "U". This was applied to maintain transparency, and to remain as representative as possible.

## 3.4. Data analysis of the US Fire Incident datasets from 2012 to 2021

As shown in Table 5, the fire statistical variables available in the Fire Incident datasets based on the information recorded according to the NFIRS Fire Module have been subdivided according to three groups (Incident description, Personal circumstances and Family circumstances) and will be examined in detail in the following sections from 2012 to 2021.

### 3.4.1. Incident description

In the group related to the Incident description, the first investigated variable of the Fire Incident datasets relating to cooking fires is the "Cause of Ignition" (Figure 4). Immediately, it is clear that the class "Unintentional. Includes fires caused by careless, reckless, or accidental acts" is the highest reported value for every year since 2012 to 2021, consistently being highest by over 60%. The consistency within this class and the one related to "Intentional. Includes deliberate misuse of heat source or a fire of an incendiary nature" over the years could suggest that human behaviour and awareness has not changed much over the years. Despite being lower than "Unintentional", the second highest class is "Failure of equipment or heat source" values from 7.5% in 2012 to 10.2% in 2021. This suggests that there are hazards in the kitchen that need to be addressed. Moreover, it could indicate a lack of regular inspection and cleaning of the appliances, this point is supported later, as "Failure to Clean" is identified as a contributing factor within the "Factor Contributing to Ignition" (Figure 9). For the class "Failure to clean", there is a fluctuation over the years as 2020 and 2021 both recorded the highest compared to previous years leading towards a value around 10%. Therefore, to prevent or at least reduce the risk of fires caused by equipment, manufacturer's instructions and safety guidelines could examine this aspect in detail. For example, regular inspections of appliances could be carried out and appliances should be cleaned and unplugged when not in use, whilst avoiding overloading extension cords.




**1.** Intentional. Includes deliberate misuse of heat source or a fire of an incendiary nature; **2.** Unintentional. Includes fires caused by careless, reckless, or accidental acts; **3.** Failure of equipment or heat source. Includes mechanical problems; **4.** Act of nature. Includes causes related to weather, earthquakes, floods, and animals; **5.** Cause under investigation.

*Figure 4: Cause of Ignition vs Total Fire Percentage*

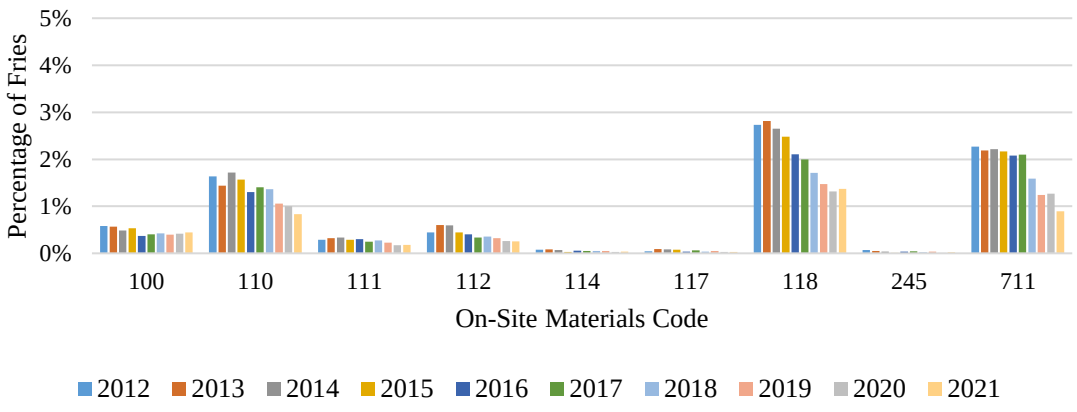
The "Number of Units" represents the number of unit within a building and it is different to the number of buildings involved which will be discussed later in this section. For example, a 100-apartment building will be logged as 100 units and one building. Consistently from 2012, around 90% of recorded fires fall between zero and ten units, with approximately 66% having one unit involved and roughly 7% recording two units involved. This is interesting because, as discussed later in the analysis of "Fire Spread" (Figure 8), the two dominating classes were fires recorded as confined to the floor of origin and object of origin. This could be attributed to the upkeep of fire safety equipment within larger residential buildings, due to stricter regulations and more frequent inspections. Furthermore, it could imply that larger residential buildings have more efficient fire suppression systems or fire prevention measures that keep the fire from spreading beyond the floor but not necessarily beyond the object. This analysis is supported by a study of the U.S. Fire Administration affirming that between 2017 and 2019, the bulk of residential fires (63%) occurred in one- and two-family dwellings (U.S. Fire Administration, 2021b). The analysis within the report is consistent with the one obtained based on the Fire Incident datasets. Multifamily dwellings and other residential buildings are likely subject to more stringent building and fire codes, which require detection and suppression equipment as well as regular fire inspections. Furthermore, multifamily houses and other residential buildings may require additional expert maintenance (U.S. Fire Administration, 2021b).

The variable related to the "Number of buildings involved" identifies the scale of the fire. The analysis showed a decrease of "1" building involved from 73% in 2012 to 66% in 2021. Kitchen fires have become less likely to spread to adjacent buildings over time; even fire incidences involving two buildings have declined from 0.39% of total residential kitchen fires in 2012 to 0.34% in 2021.

Figure 5 represents the trends for "On-site materials", which contains any commercial, industrial, energy or agriculture products or materials on the property involved in the fire. The class related to "Fat/Cooking grease includes lard and animal fat" recorded the highest combined in the examined period with a total of 20.7% with the class of "Appliances. Includes refrigerators, stoves, irons", being closely matched with 18.0%. "Fat/Cooking grease" from Figure 5 has links to Figure 4. From Figure 4, "Failure of equipment or heat source" was hypothesised to be due to a lack of maintenance. It is in this light that deep fryers and grills used in kitchens frequently need regular maintenance, including cleaning and oil removal. Cooking grease may be present in greater amounts if certain maintenance duties are neglected, creating greater fire hazards as fat and grease are incredibly flammable.

Moreover, the class of "Appliances. Includes refrigerators, stoves, irons" for the "On-site materials" records one of the highest values, with 2.3% of total residential kitchen fires in 2012 and a decrease to 0.89% in 2021. Any breakdown or failure in these equipment increases the chance of fire occurrences overall by causing issues such as, overheating, sparks, or electrical fires.

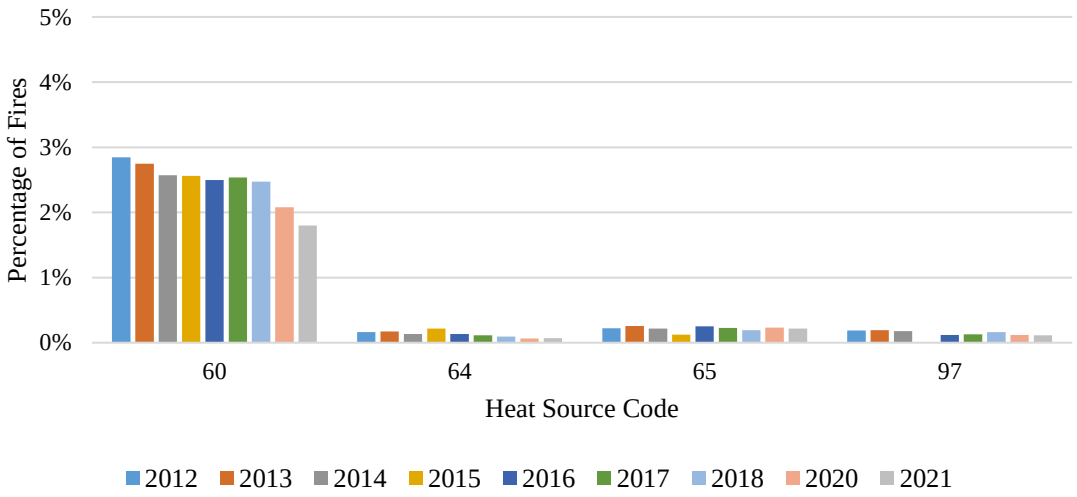
According to Figure 5, the class of "Food, other" is the third highest category. It is important to note that only some of the selected classes have been examined, it is a strategic approach to focus on those with the highest relevance and potential impact on fire incidents. Over time, kitchens can accumulate excess items, including non-food materials, such as kitchen gadgets and containers. As a result, the clutter may obstruct fire exits, create pathways for fires to spread and act as fuel for the fire. On a positive note, the majority of the classes for on-site materials show a clear trend decreasing from 2012 to 2021. This decrease in the percentage of fires could be attributable to the efforts applied to reduce potentially combustible or hazardous materials. This pattern highlights an ongoing dedication to safety and fire avoidance.




**100.** Foods, beverages, agriculture, other; **110.** Food, other; **111.** Baked goods; **112.** Meat products, includes poultry and fish; **114.** Produce, fruit, or vegetables; **117.** Cereals, grains; packaged; **118.** Fat/Cooking grease includes lard and animal fat; **245**. Glass, ceramics, china, pottery, stoneware, earthenware; **711**. Appliances. Includes refrigerators, stoves, irons.

*Figure 5: On-Site Materials vs Percentage of Fires*

When examining the category of “Heat source” (Figure 6), it is important to note that the study focuses on specific selected classes related to analysing residential kitchen fires, this analysis does not diminish the significance of other potential contributing factors, such as heat from candles or fireworks. “Heat from open flame. smoking materials or other” (60) is easily identified as the most frequently recorded heat source, recording 1.80% of residential kitchen fires in 2021, compared to the next most common class, “Lighter: cigarette lighter, cigar lighter” (65), recording only 0.22% in comparison. The data also show an encouraging trend that is worth mentioning. Since 2012, the percentages of fires in this class have steadily decreased from 2.85% in 2012 to 1.80% in 2021. Again, this downward trend implies that public awareness campaigns and improved safety measures have been effective in fire prevention. As discovered in Section 2.4.1, electric and gas stoves are adopted throughout the USA. As a reminder, according to a survey, a share of 68% of the US have an electric stove whilst, a share of 38% of the US have a gas one (Buchholz, 2023). Therefore, if the heat is attributable to open flame, it is likely due to gas stoves. Despite only having a share of 38% of the USA, it is recorded as the highest category for the heat source, emphasising the hazards they possess. Therefore, increasing the attention to safety on these appliances, could potentially reduce these values further to the already decreasing trend. Manufacturers should prioritise the integration of safety features in gas appliances, these could include automatic shutdown timers and audible alarms. According to a report by IBM, approximately 50% of businesses are benefiting from automating IT, business, or network processes with AI, including cost reductions and efficiencies (54%) (IBM Corporation, 2022). With the exponentially increasing popularity of AI, integrating smart technology with the use of AI in gas appliances would be useful and able to alert residents remotely when cooking is left unattended, providing an added layer of safety.




**60.** Heat from open flame or smoking materials, other; **64.** Match; **65.** Lighter, cigarette lighter, cigar lighter; **67.** Multiple heat sources, including multiple ignitions.

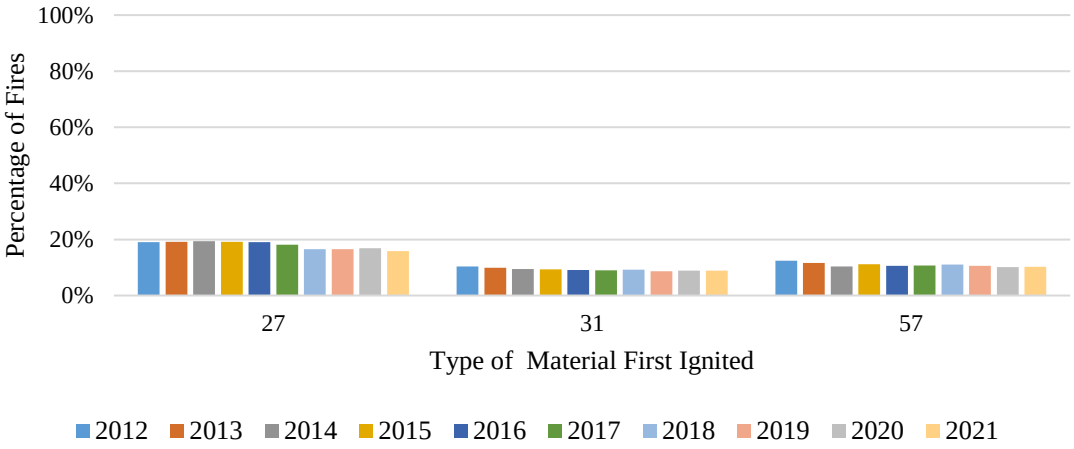
*Figure 6: Heat Source vs Percentage of Fires*

Regarding “Item First Ignited”, the analysis presents only two classes related to kitchen fires: “Household utensils. Includes kitchen and cleaning utensils” and “Cooking materials. Includes edible materials for man or animal. Excludes cooking utensils”. These classes were selected based on the availability of data, the research aims and their relevance to residential kitchen fires. Cooking materials is the highest recorded class, assuming a similar value each year at around 44% and household utensils, recording approximately 4% evenly throughout the years. These values do not seem unreasonable as, from analysing “On-Site Materials” (Figure 5), “Food, other” was outputted as the third highest class after “Fat/Cooking grease” and “Appliances. Includes refrigerators, stoves, irons”. This suggests that cooking materials are a major contributing factor to the cause of residential cooking kitchen fires.

The variable of “Type of Material” (Figure 7) is required for fires only if the “Item First Ignited” is other (00) or a code less than “70”, these could include “Structural Component, Finish”, “Furniture, Utensils”, “Soft Goods, Wearing Apparel”, “Adornment, Recreational Material, Signs”, “Storage Supplies”, “Liquids, Piping, Filters” or “Organic materials”. The class of “Cooking oil, transformer oil, lubricating oil” is higher than “Fat, grease, butter, margarine, lard, tallow” and “Food, starch. Includes flour. Excludes fat or grease”. For instance, in 2021, “Cooking oil, transformer oil, lubricating oil” recorded 15.8% of total residential kitchen fires, “Fat, grease, butter, margarine, lard, tallow” recorded 8.8% and “Food, starch. Includes flour. Excludes fat or grease” recorded 10.3%. This could be attributable to cooking oil, transformer oil and lubricating oil have greater flash points than the other two categories (Chef’s Vision, 2023). The flash point is the temperature that an oil will start to burn (Chef’s Vision, 2023). Fat, grease, butter, margarine, lard, tallow, food and starch have flash points lower than cooking oil, transformer oil and lubricating oil. Therefore, cooking oil can be used for high-heat cooking, including deep-frying or frying. However, these oils can easily exceed their flash points and catch fire if the temperature is not managed or the person in charge leaves the cooking unattended, again emphasising human error.

Additionally, oils (the class of “Cooking oil, transformer oil, lubricating oil”) are typically used for frying, whereas the solid fats (“Fat, grease, butter, margarine, lard, tallow” and “Food, starch. Includes flour. Excludes fat or grease”) are typically adopted for indirect heating, such as in ovens. The use of direct heat sources with the oils, results in a greater probability of fires, since the direct contact with the hot surface creates a greater chance of something catching fire. Furthermore, indirect cooking with “Fat, grease, butter, margarine, lard, tallow” and “Food, starch. Included flour”, typically uses indirect cooking methods, such as ovens. Indirect cooking methods usually have timers that people will adopt with less chances of burning compared to frying with oils. However, values of the solid fats still record a fairly high percentage of fires. The reason could be that people are more aware of the risks with cooking oils, especially when frying and may take precautions accordingly. Contrarily, solid fats and

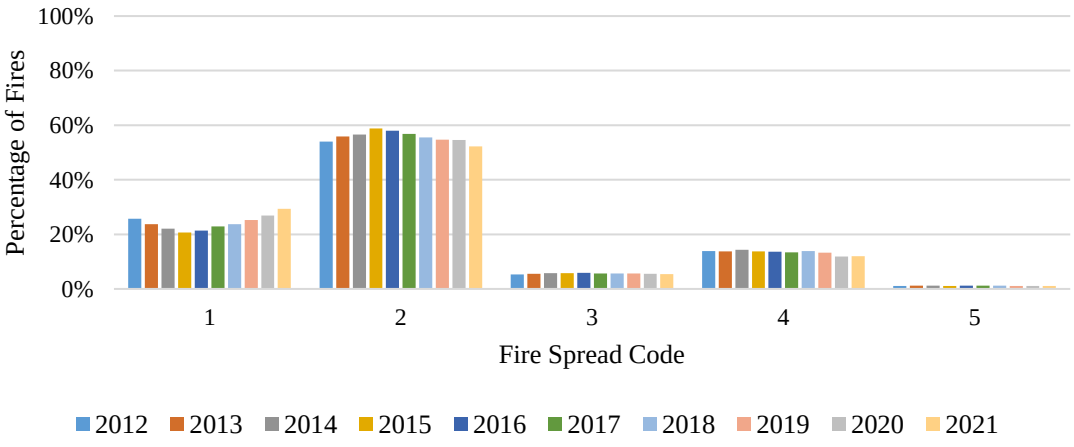
food items are seen as less risky, potentially leading to people being more careless. To support this point, cooking oils has seen a decrease in fires since 2012 and as hypothesised from Figure 6, heat from open flame recorded a downward trend implying that public awareness campaigns and improved safety measures have been effective in fire prevention and in increase the awareness of people to risks, compared to the solid fats, which has seen similar values over the past years.




**27.** Cooking oil, transformer oil, lubricating oil; **31.** Fat, grease, butter, margarine, lard, tallow; **57.** Food, starch. Includes flour. Excludes fat or grease.

*Figure 7: Type of Material Ignited vs Percentage of Fires*

Regarding the "Spread of the fire" (Figure 8), most fires are "Confined to the room of origin", which means that they are not contained by the object of origin, such as the stove or the oven, recording at least 20% more fires than "Confined to object of origin". After 2015, there is a continuous drop of fire spread "Confined to room of origin" and an increase after 2015 of the fire spread "Confined to object to origin". This may be due to people being more educated on how to act swiftly and effective in the event of a fire, to minimize the spread of fires when they do occur.



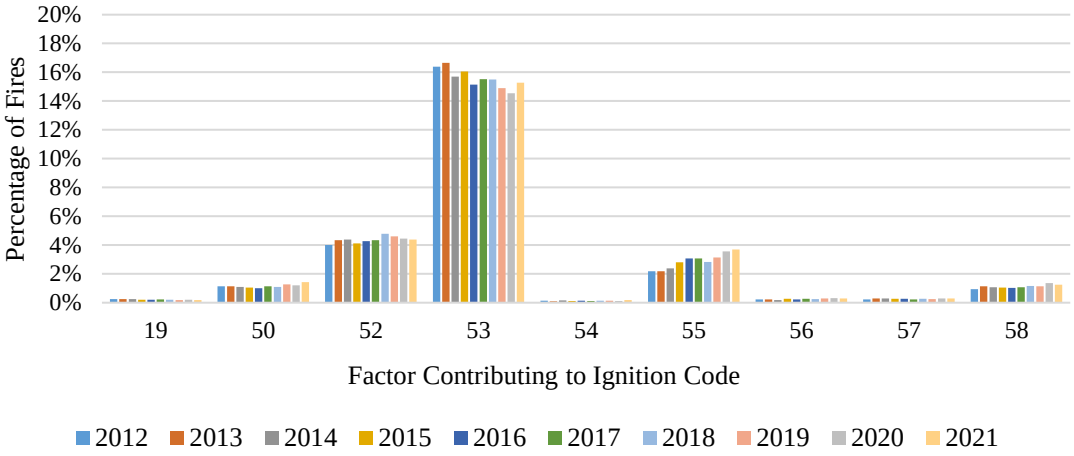

**1.** Confined to object of origin; **2.** Confined to room of origin; **3.** Confined to floor; **4.** Confined to building; **5.** Beyond building

*Figure 8: Degree of Fire Spread vs Percentage of Fires*

### 3.4.2. Personal circumstances

"Factors contributing to ignition" (Figure 9) contributed to the heat source and flammable material combining to ignite the fire. It is the only identified variable within the Fire Incident Dataset related to "Personal Circumstances". Again, it is critical to emphasise that the assessment of residential kitchen fires in this study focuses solely on specific selected classes. This tailored method allows for a more in-depth examination of categories thought to be particularly influential in fire accidents. Clearly, the class of "Equipment unattended" is the dominating category by at least 10%. Cooking is a routine action that many people carry out while multitasking or distracted by other things like phone calls and children. This can cause the cook to forget about the meal on the stove or in the oven and leave it unattended for an extended period of time. With the increasing popularity of technology, like smartphones and tablets, with 4,195 million users recorded worldwide in 2021, compared to 2,594 million in 2013 (Degenhard, 2023). These factors can cause people to forget about food on the stove and oven, leaving it unattended and potentially causing fires. However, there is a staggered decline in percentage of fires from 2012 to 2021 recorded as "Equipment unattended", this again supports the hypothesis that public awareness campaigns and improved safety measures have been effective in fire prevention, as reiterated from Figure 7 and Figure 6.

From Figure 9, "Accidentally turned on, not turned off" is the second highest class, recording 4.4% of total residential kitchen fires, followed by "Failure to clean", logging 3.7% in 2021. Another notable class is "Operational deficiency, other" with similar values over the years of around 1.2%, apart from a slight increase after 2018, likely due to the increased home cooking activate, due to COVID lockdown restrictions and people working from home. Increased cooking during the COVID pandemic is supported from a study evaluated in section 2.1, a statistical survey by Nils-Gerrit Wunsch (Wunsch, 2022). The survey found that since April 2020, approximately 60% of participants in the USA affirm they cook at home more frequently than prior to the pandemic (Wunsch, 2022).




**19.** Playing with heat source. Includes playing with matches, candles, and lighters and bringing combustibles into a heat source; **50.** Operational deficiency, other; **52.** Accidentally turned on, not turned off; **53.** Equipment unattended **54.** Equipment overloaded; **55.** Failure to clean. Includes lint and grease buildups in chimneys, stove pipes; **56.** Improper startup/shutdown procedure; **57.** Equipment not used for purpose intended. Excludes overloaded equipment; **58.** Equipment not operated properly.

*Figure 9: Factors Contributing to Ignition vs Percentage of Fires*

### 3.4.3. Family circumstances

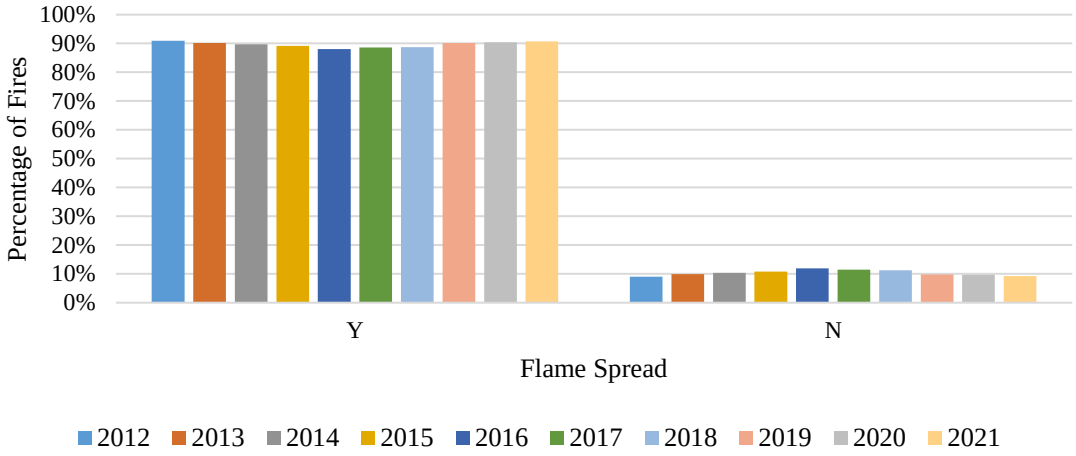
The first variable that falls under "Family Circumstances" is the "Structure Type". There is not much variation in the data, with similar values since 2012 of around 94% of total residential kitchen fires being within enclosed buildings, including subway terminals and underground buildings. This leaves only 6% of the rest of the fires being within other structures, such as within fixed portable or mobile structures, including mobile homes, campers, portable buildings, and the like that are used as permanent fixed structures.

"Structure Status" can be analyses in conjunction with "Structure Type". Over 95% of the recorded fires each year from 2012 to 2021, were recorded under the class "In normal use. Includes properties that are closed or unoccupied for a brief period of time, such as businesses closed for the weekend or a house with no one at home" followed by "Vacant and secured", only recording similarly around 1.6% of fires each year and "Vacant and unsecured" recording around 1% yearly.

Based on the above considerations, it is evident that most fires are within buildings that are in use and within enclosed environments. Once again, this highlights that the main contributing factor is human behaviour paired with enclosed surroundings, providing fuel for the flames to spread. On the plus side, it was discovered from "Flame Spread" that fires have seen a downward trend in fires confined to room of origin thus, an increase in fires confined to object of origin so despite the majority of fires being likely due to human behaviour, it appears residents are more aware of their actions, resulting in a decrease of flame spread.

In addition, “Structural Damage” outputs similar findings. Nearly all the fires recorded have zero or one storey impacted. The class of “Significant structural damage” (25 to 49% of flame damage) and greater damage has the majority since 2012 falling under zero storeys affected. Once more, this shows that the home cooking fires within the US have been mainly limited to the object of origin or the room of origin and did not compromise the integrity of the structure. However, the limited change from 2012 encourages the investigation of the effectiveness of fire suppression equipment and emergency response techniques in reducing the severity of these incidents. Moreover, understanding the factors that contribute to fire spread can help guide preventative measures and technologies, contributing to safer residential environment. Furthermore, it emphasises the importance of early identification and responding quickly in avoiding more significant structural damage, emphasising the vital role of resident fire safety education, readiness and suppression systems.

Investigating the “Flame Spread”, a similar trend is found from 2012 to 2021. However, there is a slight decline, with 2016, 2017 and 2018 seeing a slight decrease of flame spread of around 2% and thus, a slight increase of “No” flame spread during these years. The development of fire safety Standards and regulations on cooking appliances may be the contributing factor for lowering the chances of cooking equipment igniting or malfunctioning. To support this consideration, a source from the 2018 International Fire Code (IFC), which establishes minimum regulations for fire prevention and protection in buildings and premise, states that all cooking equipment and any open-flame shall be separated from combustible material display or storage by a horizontal distance of not less than 5 feet (1524 mm) (International Code Council, 2017). However, the increase of flame spread after 2018 can be attributed to the unprecedented events of the COVID outbreak in 2019. The increased cooking activities, due to the stay-at-home measures in place, increases the likelihood of fires, increasing the chances of flame spread during the period from 2019 to 2021. This analysis sheds light on the relationship of regulatory measures, societal events, and behavioural modifications in determining flame spread trends in the context of home cooking fires across the study period. It emphasises the importance of comprehensive fire safety regulations in mitigating possible threats, while also highlighting the importance of adjusting regulations in response to unexpected events.




**Y.** Yes; **N.** No.

*Figure 10: Flame Spread vs Percentage of Fires*

Establishing if a smoke detector was present in fires from 2012 shows a promising trend. Since 2012, there has been a slight increase in the number of smoke detectors. In 2012, there was about 61% of fires with a smoke detector present but during 2021, there was recorded to be around 67% of fires with a smoke detector. Once again, this is further evidence from the upward trend that improved fire safety regulations and public awareness campaigns have been effective in increasing fire awareness. This also gives further reasoning for trends discussed earlier. For example, the decrease in fires restricted to the room of origin and the accompanying increase in flames contained only to the object of origin could be credited in part to the increased use of smoke detectors. This shows that early detection measures are effective in limiting the spread of fires beyond their initial place of ignition. This encouraging trend emphasises the crucial role of education and promotion in improving household fire safety practises. It also underscores the idea that simple but significant behavioural adjustments, such as installing smoke detectors, can have a substantial impact in decreasing fire-related risks and minimising possible damage.

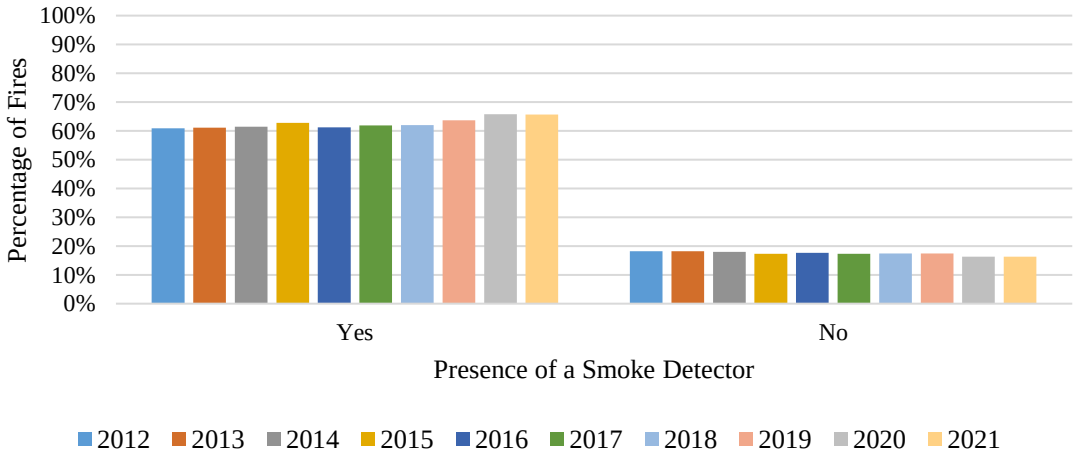
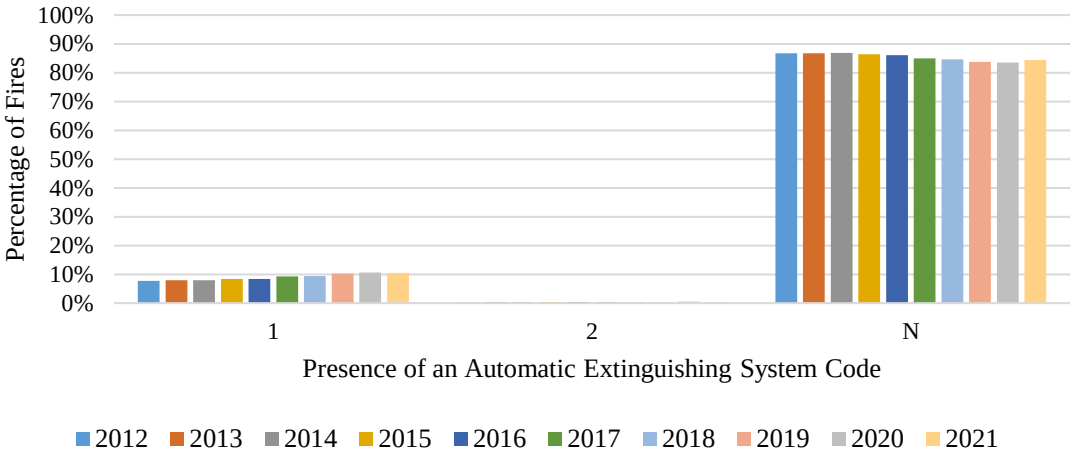



*Figure 11: Presence of a Smoke Detector vs Percentage of Fires*

To accompany Figure 11, Figure 12 shows a similar positive trend, with a larger portion of residential kitchen fires having an automatic extinguishing system present. In 2012, there was 7.7% of fires with an automatic extinguishing system present, increasing to 10.5% in 2021. Once more, this could be another contributing factor for aspects such as the decrease in fires restricted to the room of origin and a corresponding rise in flames contained only to the item of origin.




**1.** Yes; **2.** Partially Present; **N.** No

*Figure 12: Presence of an Automatic Extinguishing System vs Percentage of Fires*

## 3.5. Data analysis of the US Civilian Casualty Datasets from 2012 to 2021

As shown in Table 6, the fire statistical variables available in the Civilian Casualty datasets based on the information recorded according to the NFIRS Civilian Fire Casualty Module have been subdivided according to three groups (Incident description, Personal circumstances, and Family circumstances) and will be examined in detail in the following sections from 2012 to 2021. There were no Family circumstances identified within this module.

### 3.5.1. Civilian casualty description

Firstly, it is important to examine the evolution of kitchen-related civilian causalities across the 10-year period. Figure 13 shows the number of civilian casualties for each year. As seen in the graph, there has generally been a decline in casualties from 2012 to 2021, which gives evidence that fire prevention appears to be effectively. This graph demonstrates the importance of fire incident research and how it can support the nation's effort to improve their fire safety regulations. One notable element of this graph is the slight rise in casualties between the years 2016 and 2018. This presents a similar idea to what was found in the 2020 NFPA report on home cooking fires, in which the fires in 2016-2018 were branded as 'historically high' (Ahrens, 2020). The main conclusion from Figure 13 is that fire incident research is

helping to reduce the number of casualties within cooking fires. This type of research is important and should continue in order to progress this beneficial trend.

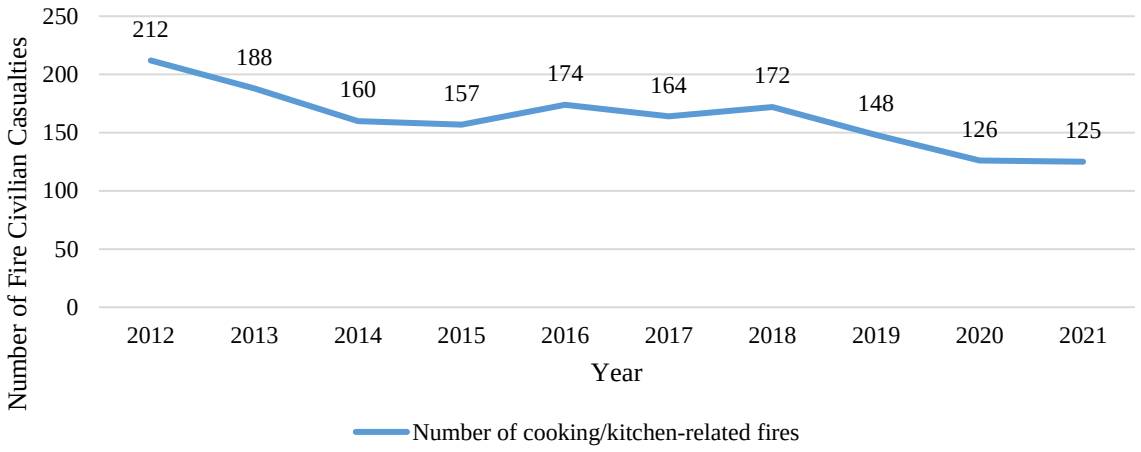
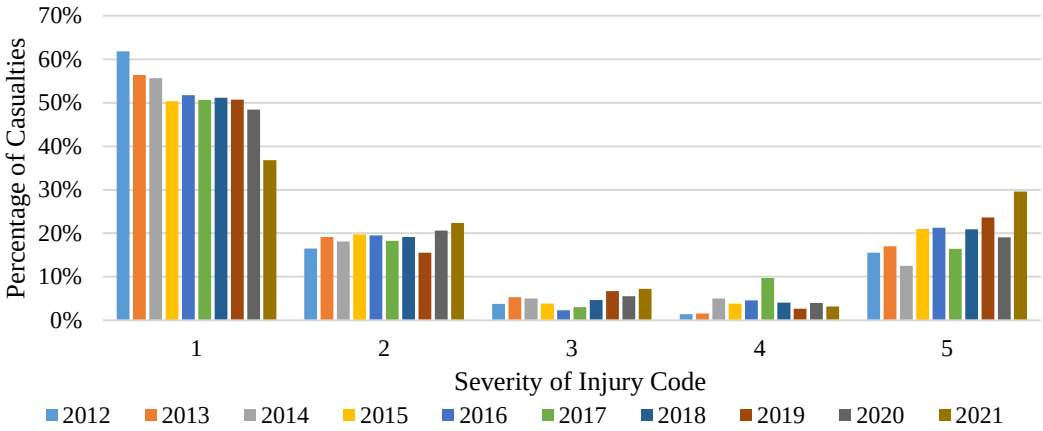



*Figure 13: Number of cooking/kitchen fire related casualties from 2012 to 2021*

Over the 10 years, around 35-65% of the injuries obtained during a cooking-related fire were classed as "Minor" which accounts for the majority of all injuries. "Minor" implies an injury that is sustained but does not require professional medical attention, for example a "Minor" injury could include small burns from hot surfaces or cooking equipment. This suggests that a large portion of cooking fires are maintained and controlled before anything severe can occur, which could be a comment on the performance of extinguishing systems in residential kitchens or a civilian's ability to evacuate a kitchen before a moderate injury can occur.

What is notable about Figure 14 is that there were more deaths in 2021 than any other year and generally, the percentage of deaths increases over the decade. Despite there only being 125 cases in 2021, which is fewer than any other year, 29.6% of injuries were recorded as "Death". Conversely, the percentage of injuries considered as "Minor" seems to decrease over the decade. A 61.8% of the casualties in 2012 were noted as "Minor"; however, in 2021 this figure drops to 36.8%. This suggests that while the fire-related casualties have dropped in number, there could be increasing in severity throughout this time period. This is something that should be further examined to understand why casualties have become less frequent but more severe over time. One suggestion could be the use of new technologies, as well as the adaptation of new trends, in recent years. An example could be the new fashion of deep-frying the thanksgiving turkey that was explored in Maeve O'Meara's food documentary (USA Food Safari, 2009) or the drastic rise of technologies such as air fryers, which saw a 51% increase in sales from 2019 to 2022 (Lucas, 2023), as these appliances may cause less controllable fires due to the potential aspect of users not knowing how to use them safely. The injuries noted as "Moderate" or "Life threatening"

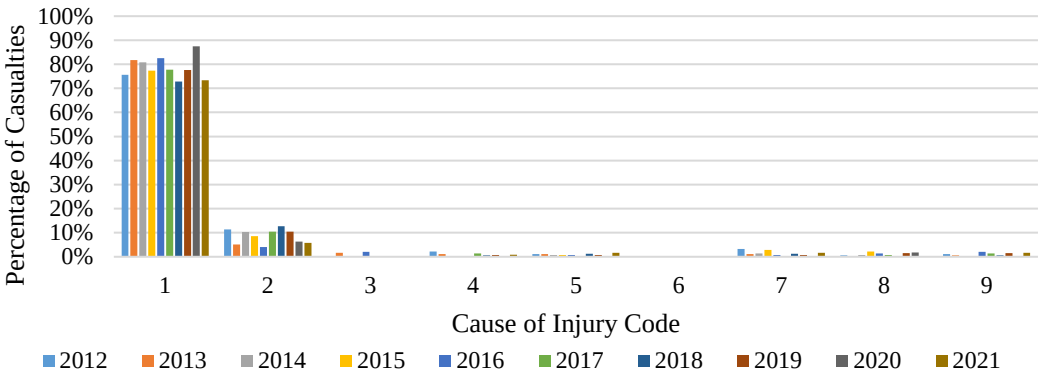
consistently remained below 10% throughout the decade. These categories can be difficult to justify, as it is not within a Fire Marshal's expertise to determine the severity of a civilian's injury. From their perspective, it is much easier to determine if the severity of the injury is either minor, moderate or death, which explains why those three categories are consistently the most frequent, as seen in Figure 14. There is no obvious jump in data during the COVID-19 period, which is surprising, considering the increased number of civilians cooking at home. In summary, Figure 14 presents a trend that shows an increase in the severity of injuries over the years. The rise in injury severity despite there being a fall in total injuries is something that should be further examined.




**1.** Minor; **2.** Moderate; **3.** Servere; **4.** Life Threatening; **5.** Death.

*Figure 14: Severity of the fire-related injuries vs Percentage of Casualties*

During the 10-year period, there were only really two prominent "Causes of injury" (Figure 15). The first, and most frequent, was civilians being exposed to fire products, such as flame, heat, smoke and gas. The second most frequent cause of injury was civilians being exposed to toxic fumes other than smoke. Together, these two categories made up between 85-95% of all casualties across the years. This is a reasonable result, as naturally, most fire-related injuries are likely to be caused by the fire itself rather than another factor. On the other hand, "Structural collapse" accounted for 0% of the cause of injury for any year. This is also reasonable, as in the event of a fire, civilians would be able to evacuate the building much quicker than the time it takes for a structure to collapse from fire, meaning the chances of sustaining an injury from structural collapse is very low. "Exposure to fire products" accounts for around 75-85% of all injuries over the years.




**1.** Exposed to fire products including flame, heat, smoke and gas; **2.** Exposed to toxic fumes other than smoke; **3.** Jumped in escape attempt; **4.** Fell, slipped or tripped; **5.** Caught or trapped; **6.** Structural collapse; **7.** Struck by or contact with object. Includes assaults by persons or animals; **8.** Overexertion or strain; **9.** Multiple causes.

*Figure 15: Cause of injury vs Percentage of Casualties*

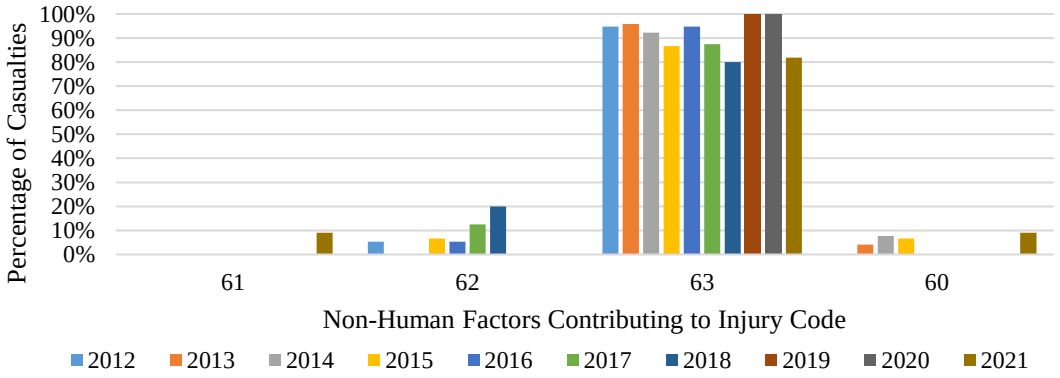
The NFIRS provides many classes for possible non-human factors that contributed to an injury, although not all are relevant to cooking fires. Figure 16 includes only four classes, as it was decided that these four classes were the only ones relevant to cooking fires. The most common non-human factor that contributed to a civilian casualty was the "Improper use of cooking equipment", as it consistently contributed to at least 80% of casualties throughout the examined time period. In fact, in 2019 and 2020, almost the totality of the casualties were caused by this factor. Similarly, the second-most frequent factor contributing to injury was the "Improper use of heating equipment". These two factors are fairly similar in the sense that they both occur due to a lack of understanding and education from civilians. It is important to note that this fire statistical variable is not always available in the NFIRS datasets and they only account for a small portion of the civilian casualties. Nonetheless, Figure 16 represents a deeper, much more pressing issue surrounding cooking fires, or any residential fires for that matter: education in fire safety and fire awareness is the pinnacle of importance in preventing residential fires. As previously discussed, fire prevention campaigns are present within USA society; however, Figure 16 would suggest that these campaigns need to be strengthen among civilians. One way to prevent this is through emphasis on social media, as these platforms allow for information to spread rapidly with ease, for example, via advertisements. Social media is a major part within USA society, and this should be utilised to its fullest potential in order to promote fire safety.

Another consideration that can be derived from Figure 16 is the lack of obvious information available for civilians. Linking back to section 2.4.2, several kitchen appliance manuals, especially older models, have limited fire safety information, and is still assuming users actually read the manual. Giving light to the conclusions made in section 2.4.2, users may benefit from fire warnings displayed on kitchen

appliances themselves, as this eliminates the risk of users not reading the instruction manuals, and also presents a more prominent reminder about fire safety.

It should also be noted that unattended cooking could contribute to the improper use of kitchen equipment, as many user manuals will give instructions on how to use an appliance properly, including not leaving cooking unattended. This ties in with the general issue surrounding this research, being the lack of understanding of the dangers of unattended cooking. Figure 16 presents an idea that reinforces the nature of this research, where education on fire safety is the cornerstone of fire prevention, especially on a residential scale and that campaigns for the wider public should be utilised to their maximum potential to prevent casualties surrounding cooking fires.

Another possibility is that there was inadequate fire safety information was provided in the user manual. As discussed in section 2.4.2, some user manuals were limited in their fire safety information, especially the manuals of older kitchen appliances. Considering this data is from as early as 2012, it is likely that the fire safety information contained in these user manuals was very limited. This is certainly something that should be considered in future design.




**61.** Unvented heating equipment; **62.** Improper use of heating equipment; **63.** Improper use of cooking equipmet; **60.** Equipment-related factors, other

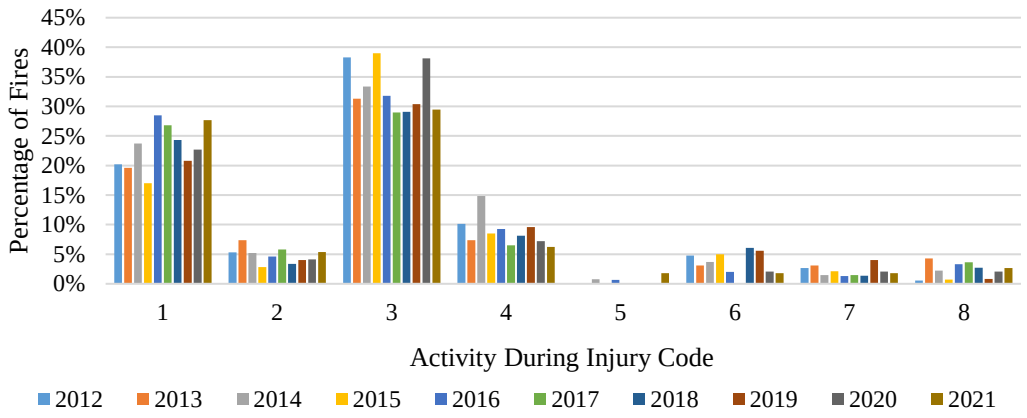
*Figure 16: Non-human factors contributing to injury vs Percentage of casualties*

The most common activity that civilians were doing at the time of their injury was listed as “Fire control”. This class was consistently the highest during the 10-year period, followed closely by “Escaping”. Together, these two categories accounted for over 50% of all kitchen-casualties in the datasets. Fire control could tie-in closely with the idea of proper fire safety education that was explored from Figure 16. Many people may attempt to extinguish a fire without a good knowledge of how to do it safely, for example, by using water on an oil fire. This will cause the fire to spread viciously, which can cause serious injuries. Figure 17 emphasises the importance of educating the public on fire safety, including how to act around a fire safely. Again, extinguishing a fire properly is something that is

explored in some user manuals but not all of them, and should be considered in future design. Ensuring that civilians are aware of how to control a fire will massively reduce the casualty rate.

With regards to "Escaping", it is understandable why this is the second-most common activity while getting injured in the event of a fire, accounting for 17-28.5% of casualties across the 10-year period. Many private homes will not have a fire escape plan in place, so perhaps civilians were unprepared in the event of a fire, causing them to get injured. This suggests that members of the public should have a fire safety plan in place, even if it is within a private home, as it will improve safety and reduce injury. The third most common activity during injury was "Return to fire before control", making up 6.3-14.8% of casualties over the 10 years. This is understandable, as people will want to rescue their possessions or perhaps other family members even when they have evacuated safely. Despite this, the number has decreased over the years. Perhaps this is a sign that sufficient education on fire safety is having a positive impact on the number of casualties, as many fire prevention campaigns will always inform civilians to never return to the scene of a fire once they have safely evacuated.

Interestingly, "Sleeping" does not account for many civilian injuries, making up only 0-6.1% of all injuries. This presents a different trend to what is found in popular literature (Ahrens, 2020). However, the data presented in this section summarises casualties, and it is likely civilians wake up before they are injured by a fire, which explains the difference in trends.

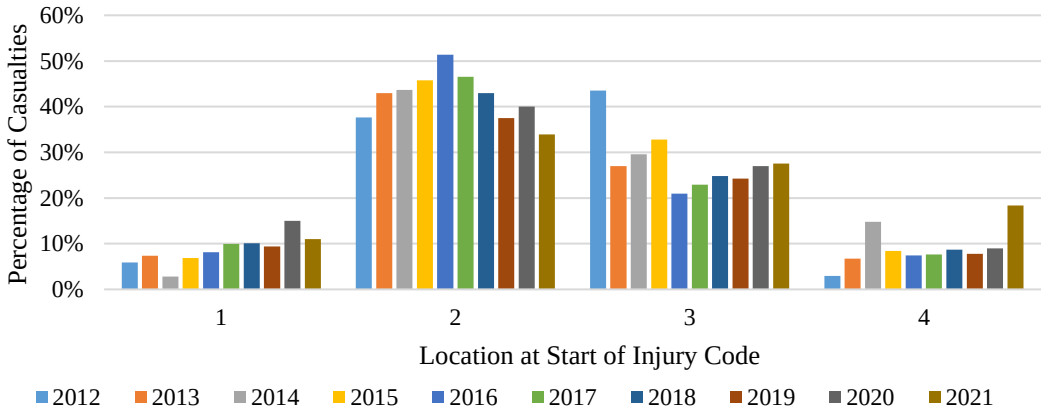



**1.** Escaping; **2.** Rescue attempt; **3.** Fire control; **4.** Return to fire before control; **5.** Return to fire after control; **6.** Sleeping; **7.** Unable to act; **8.** Irrational act

*Figure 17: Activity during the injury vs Percentage of casualties*

With regards to the "Location of civilians at the time of injury", the most frequent location was noted as "Not in the area of origin and not involved" as the highest in 2016, accounting for 51.4% of all casualties for that year. This location could be a comment on how fires have spread in the past, as all these civilians claimed that that they were not in the area of origin when they got injured, implying the

fire must have spread to some degree for them to get injured. If that is the case, the decline from 51.4% to 33.9% in 2021 could be an indicator that fires are spreading less in recent years, which is a sign of improvement in the fire safety measures adopted. The second most frequent location over the years was "Not in area of origin but involved" [in the fire]. This was in fact the highest in 2012, accounting for 43.5% of all casualties for the year implying that the civilian who was involved in the fire attempted to evacuate the location and got injured in the process of evacuation. This stresses the importance of having safe and effective evacuation plans, especially within residential homes, where fire safety might not be discussed enough. Having evacuation plans in the event of a fire will help protect civilians and reduce injury in the future. As seen on Figure 18, "Not in area of origin, but involved" is steadily rising, which implies that the civilians who have been involved in recent years are less educated in fire safety and fire evacuation strategy, which is something that should be considered in future works.




**1.** In area of origin and not involved; **2.** Not in area of origin and not involved; **3.** Not in area of origin, but involved; **4.** In area of origin and involved

*Figure 18: Location at the start of the injury vs Percentage of casualties*

Between 70% and 84.6% of casualties occurred on the first storey of a building across the time period, and the remaining casualties mostly happened either at storey zero (ground floor) or at storey two. This is an expected outcome as buildings with one, two or three storeys account for most standard residential houses. These residential houses are less likely to have fire evacuation plans or regulated fire prevention measures that would typically be found in a block of flats or dormitories. Figure 19 implies that civilians in homes without a regulated fire safety plan are probably more likely to get injured than those who live in taller buildings like flats, due to the different regulation in place. The reason why the first floor is assumes high values might be due to the fact that the injury could also be sustained from jumping from a window to escape. Presumably, most residential homes in the USA have two storeys, the ground floor and the first floor, explaining why most of the data is contained within those two categories. Despite most kitchens likely being on storey zero, the evacuation routes from a ground floor are much more

accessible, reducing the chance of injury. It is important to note that Figure 19 only displays a relevant selection of possible storey with the highest values while the NFIRS records more classes.

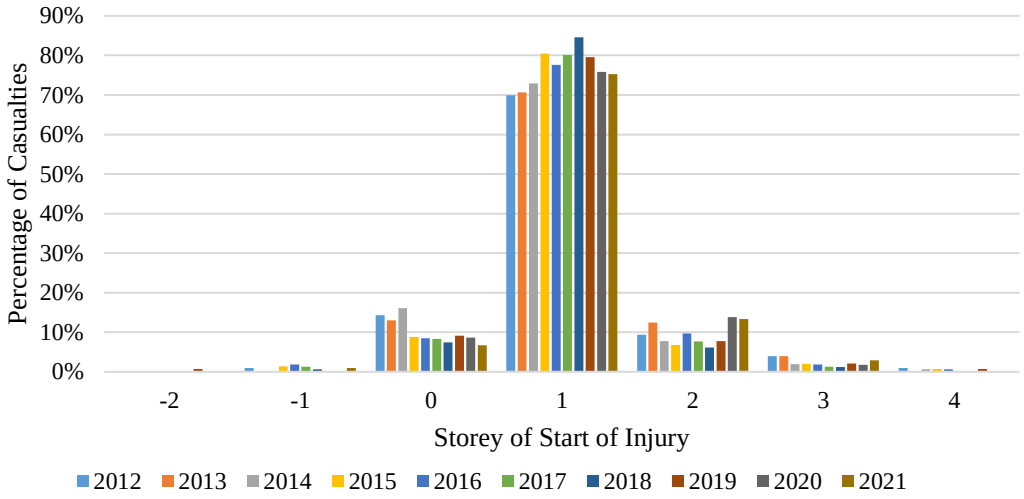
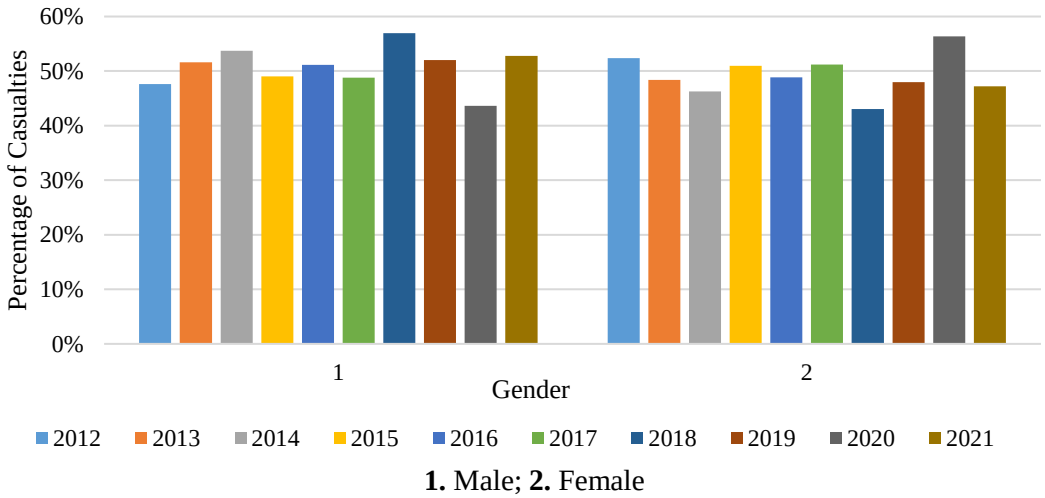



*Figure 19: Storey when the injury occurred vs Percentage of casualties*

### 3.5.2. Personal circumstances

The percentage of casualties divided into gender is a fairly evenly distributed trend (Figure 20). Both genders accounted for around 50% of casualties. Notably, there were more female injuries in 2012, whereas there were more male injuries in 2021; however, this trend is certainly not linear. It is unsurprising that the percentage of kitchen-fire related casualties is approximately evenly split between the two genders. On a general note, men were slightly more likely to be involved in a casualty, having a majority for 60% of the decade. Despite this, it is safe to assume that there is so significant connection between civilian casualties and gender for this time period.

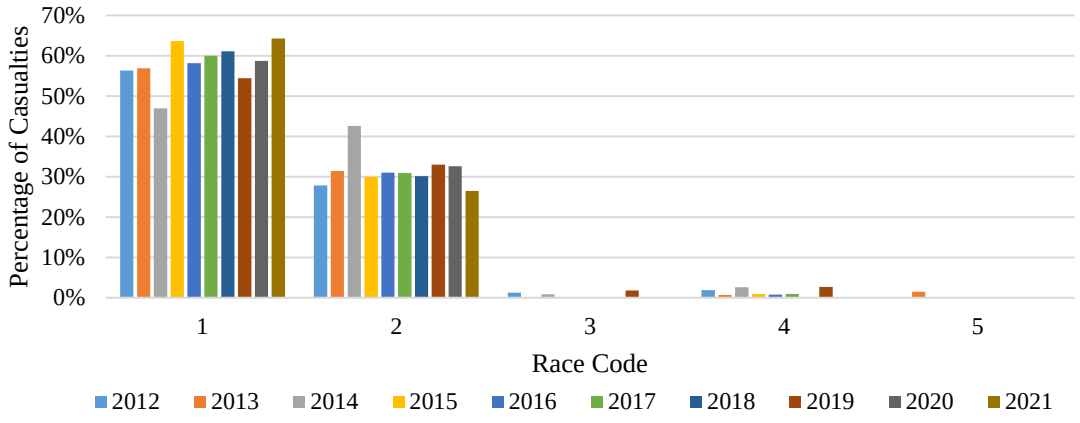



**1.** Male; **2.** Female

*Figure 20: Gender vs Percentage of casualties*

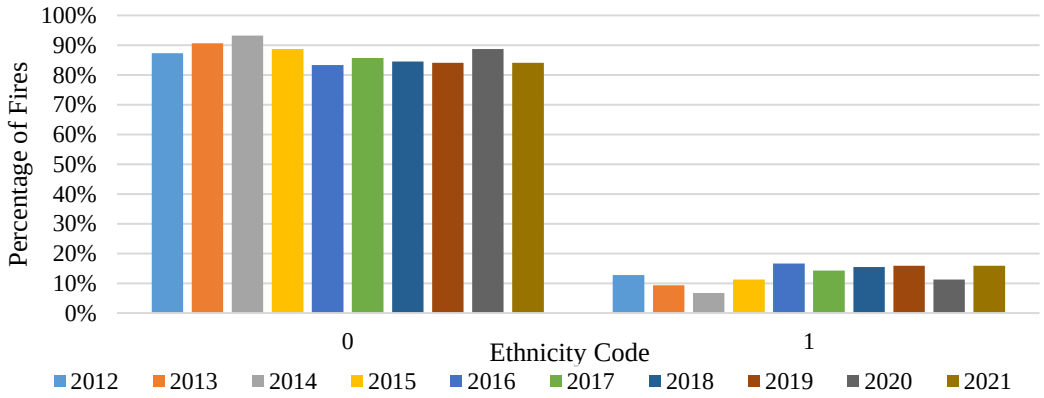
When race is considered, the most casualties occurred within white American kitchens, accounting for 47-64.3% of casualties across the 10-year period (Figure 21). This was followed by black American kitchens, in which 26.5-42.6% of casualties occurred over the decade. These two race groups together determine the majority of the casualties, with other races accounting for only 2%. It is important to note that Figure 18 also follows the population distribution within the USA, as white Americans account for 59.3% of the US population (United States Census Bureau, 2021). When analysing Figure 21, this factor should be considered, as the figure does not necessarily provide an accurate trend between cooking fire casualties and race.

Another important factor to consider, is that the NFIRS has a separate section entitled "Ethnicity", which encompasses two categories: "Hispanic or Latino"; or "Not Hispanic or Latino". Therefore, an entire demographic group is not considered in Figure 21, which will impact the implications of the graph massively, as the Hispanic and Latino community is the second largest racial group in the United States (Unites States Census Bureau, 2021). Due to the complex cultural history that surrounds Latin America, this was removed as a racial group, and is instead considered as an ethnicity (Demby, 2014). Within the NFIRS, there is a question for race as well as one for ethnicity; however, this ambiguity between a race and an ethnicity leaves gaps in the data, in which there are fewer data entries for the ethnicity section. Figure 22 shows the trend from 2012 to 2021 of civilian casualties by ethnicity. The main issue with this figure is that a civilian may identify as Latino, but also associate themselves to a particular race - for example, White Latino - meaning the analysis of this graph may be inaccurate. For the purpose of reliability and to remain conservative, conclusions should only be made about the given race groups from Figure 21, and Figure 22 should be considered with high degree of cautions.




**1.** White; **2.** Black, African American; **3.** Am. Indian, Alaskan Native; **4.** Asian; **5.** Native Hawaiian, Other Pacific Islander.

*Figure 21: Race vs Percentage of casualties*

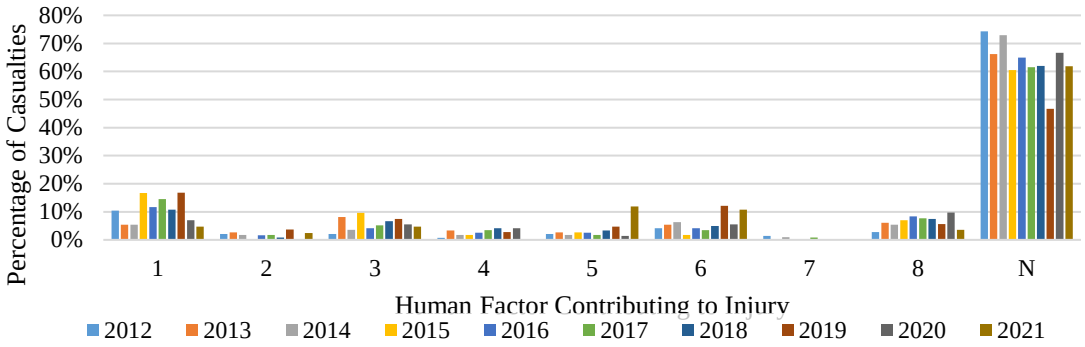



**0.** Hispanic or Latino; **1.** Non Hispanic or Latino

*Figure 22: Ethnicity vs Percentage of casualties*

With regards to the "Human factor that contributed to injury", the NFIRS has nine possible options, which are listed in Figure 23. This variable requires some interpretation, as it could be difficult for a fire fighter to accurately document the human activity, especially in a time of crisis and stress. Moreover, civilians could be distracted or unable to respond when they are being asked this question. Therefore, it is unsurprising that the most frequent class across all the examined 10 years was listed as "None", reaching an average of 63.8% of all data entries for this variable. It is unsurprising that this category is so high, as in a time of emergency and in some cases, life or death, this is one of the questions on the NFIRS that could be seen as irrelevant for ensuring civilian safety. Furthermore, a residential fire does require at least some human activity for ignition, so it is unlikely that these entries are accurate.

The class of "Asleep" is the most common class, accounting for 4.8-16.7% of casualties for the year. This correlates directly with the work done by Ahrens, where it was found that being asleep contributed to 23% of fires and 40% of deaths in residential cooking fires (Ahrens, 2020). This is closely followed by "Physically disabled, includes temporary or overexertion", "Unattended or unsupervised person, includes persons too young/old to act" and "Possibly impaired by alcohol" assuming 3.4%-12.1%, 2.8%–9.7% and 2.1%-9.6%, respectively. This also correlates with previous studies, such as the 2020 report by Ahrens (Ahrens, 2020), as well as the 2003 study done by Holborn and others, where it was found that disabilities and alcohol were big contributors to fatalities within residential fires (Holborn, et al, 2003). Meanwhile the least common option was "Physically restrained", which barely accounted for any of the fires over that time period.




**1.** Asleep; **2.** Unconscious; **3.** Possibly impaired by alcohol; **4.** Possibly impaired by other drug or chemical; **5.** Possibly mentally disabled; **6.** Physically disabled, includes temporary or overexertion; **7.** Physically restrained; **8.** Unattended or unsupervised person, inludes

*Figure 23: Human factor that caused injury vs Percentage of casualties*

Across the years, a general trend is that there are more casualties as the age group increases. On average, the class of age between 0 and 17-year-olds had less casualties, while 60+ year-olds recorded more casualties. It is unsurprising that children were involved in the least casualties as they typically do not cook as much as the other age groups. Similarly, it is understandable that the 60+ age group is most at risk of casualties as they spend more time in the kitchen than any other age group. Moreover, mobility may become an issue for civilians within that age bracket. There was an unusually high spike of casualties in 2021 within the 60+ age group, which could be a nod to the ageing population around the globe. However, 60+ year-olds made up 40% of all casualties for 2021 which seems unproportionally high and is perhaps something that should be studied further. As found in the 2017 study, adults aged 60+ cook more frequently each week (Wolf, 2017); therefore, there is likely a correlation with the frequency of cooking and the likelihood of injury. Interestingly, these results are not in line with similar studies developed in the past. For example, Green and Andres found that households with at least one member aged over 64 years were six times less likely to be involved in a fire (Green and Andres, 2009). Similarly, another study found that only 14.6% of residential cooking fires were caused by people aged over 65 years (Jurdi-Hage, et al, 2017). The data provided in this section refers to civilian casualties, so by pairing the popular literature with this data, it can be implied that while adults aged 60+ are less likely to be involved in a fire, they are more likely to be injured in one. This could perhaps be due to the reduced mobility issues that are associated with an older age group. This also implies that fire safety education among older age groups is not an issue, as they are involved in less fires.

In a similar respect, it was found that homes with members under the age of 18 are more likely to be involved in a fire (Greene and Andres, 2017); however, Figure 24 implies that civilians aged between 0 and 17-years-old are the least likely to be injured. This could perhaps be down to parents or guardians prioritising their child's safety, ensuring they are evacuated before an injury occurs. There is seemingly little disparity between the age groups 30-44 and 45-59, differing by only 0.4% on average for the whole

decade. An important aspect to note for this variable is the provided data presented a large number of uncertainties. Several ages were noted as decimal points, while some ages were noted as highly unlikely – for example, '999' was one of the entries. In order to maintain the transparency within the data analysis, these uncertainties were discarded. Figure 24 is a summary of only the reliable data entries.

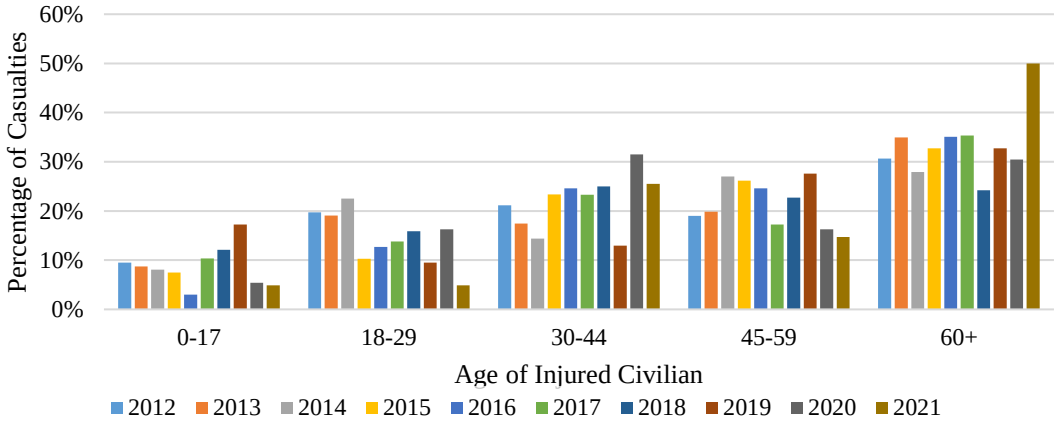
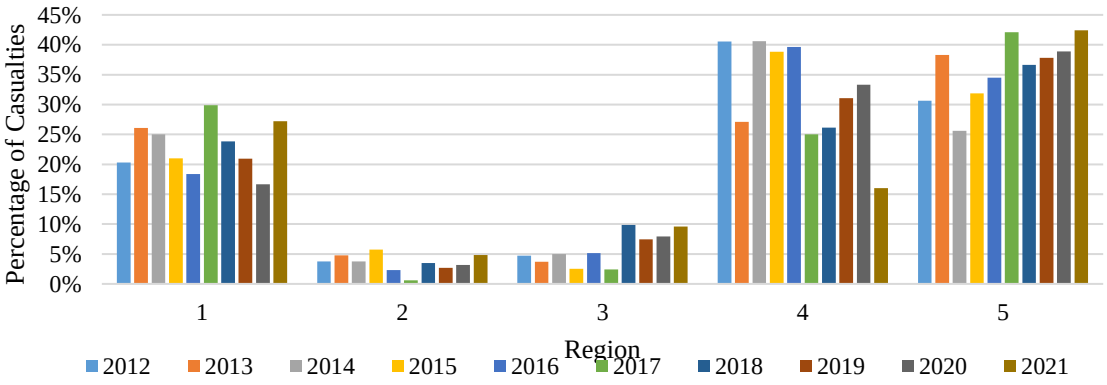



*Figure 24: Age group vs Percentage of casualties*

With regards to the region, the majority of casualties occurred within the Midwest, determining 25.6-42.4% of casualties across the decade. This was followed closely by the Southeast region, which accounted for 16-40.6% of casualties. The fewest casualties occurred in the Southwest, with only 0.6-5.7% of all casualties across the years. From 2018, the percentage of casualties increases each year within the Midwest, which is something that could be further examined. This could be a nod to the melting pot of culture within the Midwest (Nenes, 2015), meaning it is likely that there are a wide range of cooking practices in this region. In a similar respect, the number of casualties in the Northeast rapidly increased in 2021 from the decline in previous years, while there was a significant decrease in casualties in the Southeast in 2021.




**1.** Northeast; **2.** Southwest; **3.** West; **4.** Southeast; **5.** Midwest

*Figure 25: Region vs Percentage of casualties*

In summary, a range of fire incidents and civilian casualty description, personal and family circumstance variables have been analysed from 2012 to 2021. A range of conclusions have been made from the graphs, but the most notable considerations from these sections was firstly, the level of education, both on fire safety and on proper use of kitchen equipment. This was seemingly a recurring theme, and is certainly something that should be explored.

# Chapter 4. Conclusions

A thorough examination of the data regarding cooking fires within the kitchen provides an eye-opening investigation of the trends and contributing factors to these incidents. The occurrence of unintentional causes is consistently high, highlighting the need for ongoing efforts to inform and increase public awareness. The rise in fires attributed to equipment or heat source failures underscores the importance of following regular inspection and maintenance procedures. Moreover, the rise in “Failure to Clean”, particularly in recent years, determines the importance of appliance upkeep. The importance of fat and cooking grease as influencing factors highlights the need for appropriate an frequent cleaning procedures.

The frequent occurrence of smaller residential units in these incidents raises concerns about a potential gap in fire safety measures between smaller and larger buildings. Additionally, the data analysed emphasises the importance of cooking materials as a primary ignition source and the necessity of not leaving cooking unattended. The decreasing trend in fires contained to the room of origin and the rise in fires contained to the source object indicate the improved safety measures and public awareness campaigns having a positive effect on fire prevention. There is a clear dominance of "Equipment Unattended" supported by the prevalence of factors such as "Accidentally Turned On" and "Failure to Clean".

The increased use of automatic extinguishing systems and the sharp decline in fatal fires highlight the life-saving potential of suppression technologies. In addition, addressing the particular difficulties that people face, such as with limited mobility or cognitive impairments is crucial for ensuring their safety in the event of a fire. A crucial area for focused intervention is closing the knowledge gap in fire safety protocol and awareness, especially in lower-income households.

With regards to civilian casualties, there were also some discovered trends. Firstly, fire safety education could play a huge role in reducing the number of casualties associated with cooking fires. “Improper use of kitchen equipment” was by far the most frequent factor contributing to a fire, which can be resolved by fire prevention campaigns, perhaps through popular social media, to appeal to a wider audience. There is also a gap in the fire safety information provided within appliance manuals and on the appliance itself, which contributes to the pressing issue of a lack of knowledge.

The age of a civilian seems to have a strong correlation with the likelihood of injury, increasing with age. This can be prevented potentially through extensive safety measures within residential homes.

"Sleeping" was determined as the most frequent human-activity aside from "None". This is a recurrent trend among previous studies and should certainly be examined further.

Although this research is proving to be effective, a main problem lies within the NFIRS data itself. While extensive, there is a need for a more unanimous approach to fire data collection. By enforcing more scrutiny towards the data, the element of uncertainty is reduced. Overall, this analysis provides a thorough overview of factors affecting residential kitchen fires and offers insightful information for fire prevention measures.

## 4.1. Benefits and Limitations

Undertaking the research on cooking practices and cooking fires has demonstrated a valuable opportunity to enhance our understanding of fire safety concerns. Examining factors influencing cooking practices and fire risks such as, demographic factors, personal circumstances, cooktop types and public campaigns, contributed significantly to the current body of knowledge. These complex topics were effectively investigated by using a variety of quantitative and qualitative sources, such as journal papers, fire prevention campaigns and the USA fire datasets. Quantitative data provide statistical insights into trends and patterns. On the other hand, qualitative data dives deeper into the nuances. For example, quantitative data are adopted to measure the frequency and severity of cooking fires, and qualitative data are used to understand the experiences of people who have been involved in cooking fires. To strengthen the validity and reliability of the obtained conclusions, insights into the variables that affect cooking habits and fire risks, such as uncleaned stovetops contributing to the risk of fires, were determined. Supporting the body of knowledge on cooking practices and fire prevention will shape fire safety campaigns and design safer cooking environments. Despite the complexities, this research is an essential step towards a safer and more informed society.

Collecting and analysing data from diverse sources demonstrated difficulties such as issues with data quality and accessing relevant and reliable literature and cooktop manuals. Additionally, handling such a substantial volume of data within the fire datasets, spanning from 2012 to 2021, showed to be resource intensive and time consuming. There were inconsistent findings such as a significant number of blank spaces and data classified as "Others" or "Undetermined". To draw reliable conclusions from the extensive dataset, it became necessary to carefully examine each data point while accounting for possible variations and discrepancies. This extensive approach was necessary to accurately reflect the nature of home cooking practices and fire incidents over the specified period.

Overall, despite these challenges, the developed research has the potential to significantly advance public fire safety measures and fire prevention techniques. The research has enabled the understanding

of home cooking practices within the USA and fire incidents, helping to design and implement specific measures to significantly reduce the dangers of cooking-related fires, ultimately resulting in safer environments.

## 4.2. Future work

Future studies in this area should investigate particular aspects that have arisen from this research. A comparative study between different states within the USA could reveal geographical differences. As a result, this would allow for the development of region-specific fire safety measures, adapted to the characteristics of each location. In addition, investigating further into the environment would also be beneficial, especially regarding smaller residential units. This could reveal any discrepancies between smaller and larger buildings' fire safety protocols, resulting in necessary adjustments in regulations and inspections. Future research would benefit greatly by expanding the scope to include worldwide datasets and literature studies to compare cooking-related incidents across cultures and identify global patterns and contributing factors. Fire safety community, local and national authorities and the general public could learn how cooking practices, fire prevention measures, and safety protocols vary across different regions and cultures. Reoccurring trends will be identified not only within the USA but also globally. Moreover, innovative fire prevention strategies and technologies that have been successfully implemented in various countries can be transferred, resulting in more robust safety measures.

Furthermore, evaluating deeper into technological advancements could transform fire prevention methods, such as the incorporation of smart house technologies and automatic system devices. A beneficial study would be to assess the effectiveness of these technologies in practical contexts and to analyse their potential for widespread adoption. The feasibility and cost-effectiveness of the measures would also be beneficial to illustrate any economic implications.

Finally, the crucial significance of fire safety awareness in lower income households has been portrayed in this study, thus targeted interventions should be created and evaluated to bridge the knowledge gap in minimising fire incidents and how to tackle them if they occur. Providing accessible resources, such as educational programs, along with smoke detectors and fire extinguishers, could significantly enhance the overall fire safety readiness of vulnerable communities.

Overall, the analysis of these key areas of future research can further refine our understanding of residential kitchen fires and develop customized, evidence-based fire prevention measures that have the potential to save lives and protect communities. This continued effort will undoubtedly contribute to a safer and more secure living environment for individuals across the USA. These methods can also be applied globally to address any reoccurring trends identified worldwide.

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