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European Fire Safety Alliance

Fatal residential fires in Europe

A preliminary assessment of risk profiles in nine European countries

De Brandweeracademie is onderdeel van het Instituut Fysieke Veiligheid.

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Preface

The improvement of fire safety in the living environment can only be effective when we have knowledge about the chances, circumstances and effects of residential fires. Since fire safety and fire safety measures transcend national borders, greater insights into residential fires on a European level is necessary.

For this reason, the European Fire Safety Alliance (EuroFSA) and the Dutch Fire Service Academy (IFV) have conducted a research study into fatal residential fires in Europe. The data of 9 European countries has been collected and analysed and the first results of this research are detailed in this report.

This report is a first step towards a better understanding of fatal residential fires in Europe. However, in the future, more steps need to be taken to create a more reliable image of fatal residential fires in Europe. For example, the data of more countries needs to be collected and analysed to arrive at a more representative selection of European countries.

Furthermore, to have more conformity, this data needs to be reported over similar time periods. This report contains singular data, but future research will also contain crosslinks which will provide more insight into the relationship between the causes and effects of fatal residential fires.

In the past, various differences in definitions have impeded a sound statistical overview. This report therefore tries to overcome these differences and makes a start on building a reliable statistical overview that will make comparisons between countries possible.

René Hagen
Professor of Fire Safety

Introduction

Background

Since 2008, the Fire Service Academy (IFV) has been conducting research into fatal residential fires in the Netherlands. It has focussed on unintentional fires in homes and associated structures where people have died as a result of the fire or as a consequence of injuries the victim has suffered from the fire. Based on research into human behaviour in fire and fire safety engineering, a model has been developed including factors that influence fire safety. The factors can be summarized into those related to human characteristics, building characteristics, fire characteristics, and intervention characteristics. The model has been operationalized in (among other things) a questionnaire for fatal home fires in the Netherlands. After ten years of research, the model has proved robust and provides useful information for fire safety policy.

The European Fire Safety Alliance (EuroFSA) requested the Fire Service Academy to explore whether any information is known at a European level regarding fatal residential fires. So far, there have been few comparisons of fire statistics across Europe. The UK Department for Communities and Local Government (DCLG) (Greenstreet Berman, 2012) has compared European fire statistics and concluded that it is difficult to compare current fire data between European states due to differences in reporting practices. This may be the case if the intention is to develop a joint database for European fire statistics. However, if the goal is to compare risks and policy effects in different countries, the separate databases offer interesting and useful information. Based on this information it is even possible to outline an overall picture for Europe, albeit a preliminary sketch.
In an quick scan of the literature on (fatal) residential fires, we noticed that several European countries collect data to some extent, which might be useful for an international database study. In addition to the Netherlands, eight European countries have been selected for further research, namely Norway, Sweden, Finland, Denmark, Estonia, Poland, Belgium and the United Kingdom (England in particular).

The ultimate goal is to develop a database for fatal residential fires in Europe, preferably in cooperation with Eurostat. However, at the moment, it is only possible to gain an insight into the characteristics of fatal residential fires in European countries based on current national databases and literature. Taking into account the above mentioned limitations, this research aims to indicate (risk) factors that are associated with fatal residential fires in Europe.

Objective and research questions

The objective of this study is to explore the available information on fatal residential fires in the selected European countries. The research question is: *What information is available on fatal residential fires in European countries?* In order to answer this question, the following sub-questions are posed:

1. Which possible risk factors for fatal residential fires are known in the Netherlands and international meta-analyses?

2. Which definitions are used for the collected items and to what extent do they correspond per country?

3. What information about fatal residential fires is collected in the databases in the selected European countries?

4. What are the main characteristics of, and risk factors for, fatal residential fires at country level?

5. Is it possible, based on the available information, to draw up a risk profile at a European level? If not, what is necessary to provide the information required for this risk profile?

1 Methodology

1.1 Approach

In this study, we collected information on fatal residential fires in Europe by analysing the general literature available on fatal residential fires, country specific literature, and by collecting data on fatal residential fires provided by European countries. Firstly, the use of international literature on fatal residential fires will indicate to what extent our Dutch questionnaire is suitable for identifying risks that are internationally associated with fatal residential fires. This first review of the literature has indicated that we might need to add some risks for examining European fatal residential fire risks. Secondly, we studied country specific literature on fatal residential fires in the UK, Norway, Sweden, Denmark, Finland, Poland, Belgium and the Netherlands. Hereafter, the term 'selected European countries'[1] refers to this group of countries, also including Estonia. This literature indicates the country specific main characteristics and risks associated with fatal residential fires. Furthermore, this research attempts to collect the actual data from the databases of European countries. In order to be able to compare this data, those people who have access to national databases were approached, asking them about which items their country collects data on. We then focussed on the items that were most frequently collected by all countries and asked them for the exact data on these items. By combining the information from the literature and the exact data provided by the countries, this study provides greater insight into the factors associated with fatal residential fires throughout Europe. Furthermore, in this research we attempted to draw up national risk profiles and a European risk profile for fatal residential fires.

1.2 Data collection

1.2.1 Literature

For the literature review, a combination of fire related and risk factor related search terms have been used to identify potentially relevant articles from electronic databases such as ScienceDirect, ResearchGate and Google Scholar, as well as various European governmental websites. The keywords used in order to find literature about fatal residential fires are listed in table 1.

[1] Estonia is also included in the selected countries. Although we have not found any literature from Estonia, we have received the first questionnaire from our contact person from Estonia. Thus, the selected countries are: UK, Norway, Sweden, Denmark, Finland, Poland, Belgium, Estonia and the Netherlands.

Table 1 Word combinations used in the electronic database search

Fire related terms		Aetiological terms
Fire	AND	Risk Factor *or* Risk profile
Fire or Fires		Risk or risks or risky
Fatal Fire*		Cause *or* Causes, *or* Causation *or* Causal
Residential Fire*		Europe *or* European countries
Fatal Residential Fire*		Relation*
Housefire* or House-fire*		Characteristic*

A total of 22 relevant articles was found. Inclusion criteria refer to the year of publication (not older than ten years), but also to the research methodology: only articles which summarize recent statistics of official European databases on residential fires or high quality meta-analyses on fires in high income countries (including the USA, Canada and Australia) have been included in the literature list.

1.2.2 Data

To collect data from national databases of the selected countries, we made a list of contact persons by using the European contacts from the Dutch Fire Service Academy, the contact information on Nordstat.net, and any contact information that was found of the researchers from the literature. Furthermore, we asked people to forward our request to their contacts in Europe who might be able to provide us with data on fatal residential fires from national databases.

Questionnaire 1: most collected items

First, we asked these contacts about what items, regarding fatal residential fires, their country collects data on. The Dutch questionnaire on fatal residential fires was translated to English and a few additional items and categories that we found in the literature were added. Thereafter a survey[2] (see appendix 1) with these items was sent to the contacts, asking them about which items data is collected in their country and what definitions they use[3]. In total, we received answers from the following seven countries: Norway, Belgium, Estonia, Denmark, Sweden, Finland and England.

Questionnaire 2: excel sheet with country data

Secondly, we sent these contact persons a second questionnaire. We asked them to fill out an excel sheet in order to collect their data on the items that are most frequently collected. We received a full excel sheet from Norway and Estonia and as much information as possible from Belgium. Scotland, England and Sweden have indicated that they were unable to provide the data within the requested time frame.

[2] A link with an online survey in Survey Monkey was sent via e-mail.

[3] This survey was sent to contact persons in Denmark, Estonia, Finland, Iceland, Norway, Sweden, Belgium, Spain, Poland, Scotland, France, UK and Germany

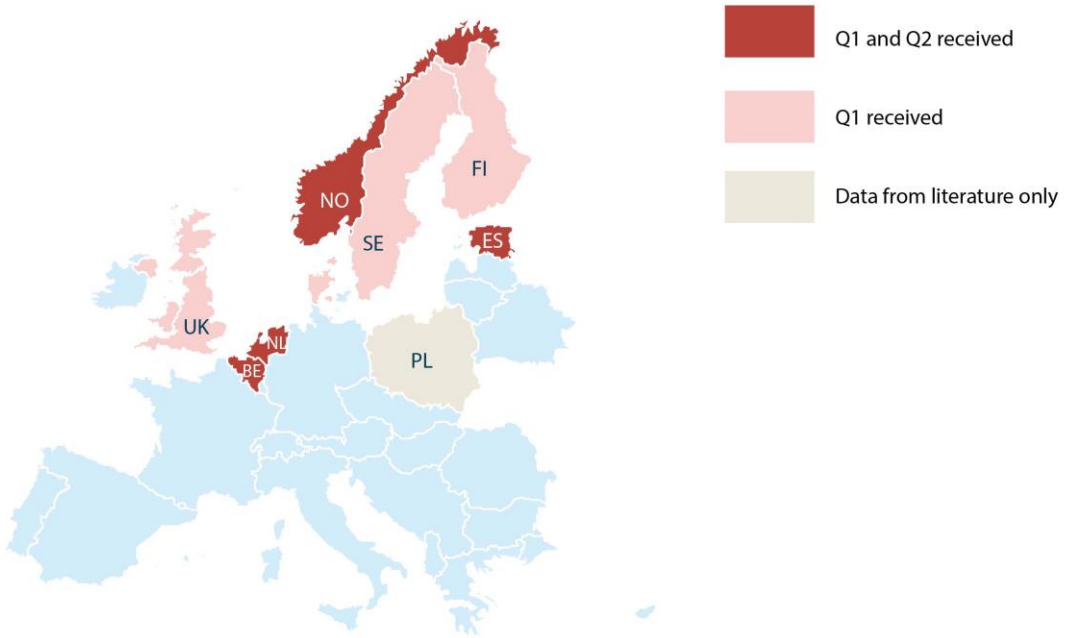

Figure 1 Data received on fatal residential fires per country

1.3 Analysis

As a first step of this research, a summary was made of the existing information (mostly from meta-analyses) of the risks related to fatal residential fries. Although the results of these studies cannot be directly applied to the European situation - since they mainly focus on the United States, Canada and Australia - it still provides us with an insight on the risk profiles that seem to be related to fatal residential fires in western countries. Furthermore, this review of the literature indicates to what extent our Dutch insights on risks associated with fatal residential fires fully covers the risks that are being related to fatal residential fires in general.

Before examining the literature and data on country specific risks, we examined the definitions and methods that are used for collecting information on fatal residential fires throughout Europe. In order to describe these methods and definitions, the literature was studied and information on definitions from the first questionnaire was used. This gave us an insight in the comparability of the information that has been collected by the selected countries.

Furthermore, we examined what data has been collected in the databases from the selected countries. We then analysed the first questionnaire to conclude which items are most frequently collected, and which are not.

Next, we studied several (governmental) reports and articles on national fire statistics. We combined these insights with the information from the data that was provided by the countries in the second questionnaire. We then created an overview of the main characteristics and, where possible, risk profiles for each country.

Finally, we tried to combine the national risk profiles into a European risk profile. We also indicated what information is missing in order to complete the European risk profile.

2 Identifying possible risk factors for fatal residential fires

In this chapter we answer the first sub-question: *Which possible risk factors for fatal residential fires are known in the Netherlands and international meta-analyses?* We first look at the factors that can be discerned in the Netherlands, before examining information on risks from international meta-analyses.

2.1 Main characteristics versus risk factors

So far, a variety of studies has been conducted in European countries in order to analyse the causes of, and identify risk profiles for, fatal residential fires. However, when looking at national statistics, one should keep in mind that data always need to be interpreted within its context. In order to talk about risk factors, any data on fatal residential fires needs to be related to its context. This means that the data needs to be related to demographic factors, the total number of fires or non-fatal fires. If the data is not related, we can only speak of the main characteristics of fatal residential fires.

For example, this is illustrated by fatal residential fires in Norway, which for a major part (54%) take place in detached houses (Sesseng, Storesund, & Steen-Hansen, 2017), a finding that might indicate that people living in a detached house are at greater risk than those living in non-detached houses. If we only describe the fact that most fatal residential fires take place in detached houses, we are talking about one of the *main characteristics* of fatal residential fires. However, if we relate this number to demographic statistics, one can see that the majority of Norwegians (also 54%) lives in detached houses. Therefore, concluding that the risk of experiencing fatal fires in detached houses is higher in Norway than in other European countries is fallible. When analysing the data more thoroughly, it becomes clear that actually the risk of dying in a fire is higher (31%) for people living in a 'block/apartment', since only 25% of the Norwegian residents lives here. Thus, it is only when we relate the number of fatal fires in detached houses to its context (demographic statistics) that we can speak of a *risk factor.*

Another example is age, where an opposite tendency can be observed. For example, between 2015 and 2016 approximately one third of the fire victims in Belgium was older than 70 years (Renders, 2017), a number that might, initially, not sound too alarming. However, bearing in mind that this age group represents less than 13% of the overall population, age should definitely be identified as a high risk factor. Similarly, the fatality risk can be related to fires in general. For example, a Swedish study shows that the number of people dying in a fire that started in a bedroom (286 fatalities) is almost similar to the number of deaths in fires starting in the kitchen (224 fatalities) (Andersson, Johansson, & Strömgren, 2015). However,

relating this to the total number of residential fires, bedroom fires are more often fatal (6% is fatal) than kitchen fires (less than 1% is fatal). Thus, when talking about 'risk', this should relate to the overall population or to fires in general.

2.2 Insights from the Netherlands regarding risk factors

In the Netherlands, we have built up an extensive questionnaire and database over the last 10 years which has given us more insight into the risks associated with fatal residential fires. We will use these insights as a starting point for examining the risks regarding fatal residential fires in the European context. However, in order to make sure that we do not overlook any important risk factors, we will also compare our insights regarding the risks that are associated with fatal residential fires with the international literature.

The Dutch study on fire fatalities[4] is limited to 'accidental fatal residential fires'. The study (or: database) only includes structures with a residential function, and in which there is more or less permanent habitation. This means that fatal residential fires in institutions like nursing homes are included[5]. Mobile homes and houseboats are also included. Furthermore, only accidental fires are included. This means that deliberate fires, caused by arson, murder and suicide, are excluded. Moreover, people that have died a natural death before the fire are not included as fire fatalities. The fatality has to be a result of the fire or a consequence of the injuries the victim has suffered from the fire. The moment of death is not relevant here. All residential fire fatalities registered prior to the start of the annual analysis are included in the analysis.

In the Netherlands we collect data on: *intervention characteristics, fire characteristics, building characteristics* and *human characteristics* (Brandweeracademie, 2018).

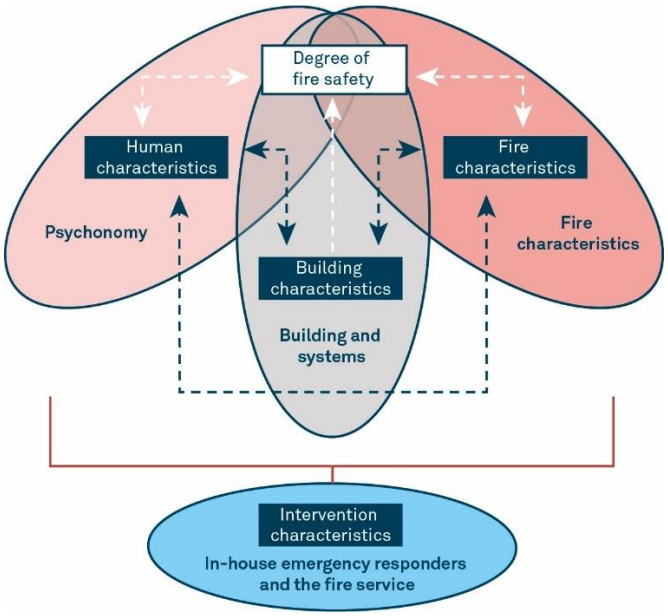

Figure 2 Degree of fire safety

[4] Parts from the questionnaire are also applied in a study on residential fires involving rescues by fire fighters.
[5] Hospitals are excluded, since people do not live there permanently.

For *intervention characteristics,* we looked at the moment of ignition of the fire and the moment of discovery of the fire. The manner of the discovery of the fire was also examined, as well as the first reaction, fire brigade response time, discovery of the victim and the extinguishing action. A late (discovery and) reporting of fire is a risk factor, since in that case the victim is more often not found alive compared to cases with a quick (discovery and) reporting of fire. The chance of finding a live victim decreases considerably after 30 minutes and more after the fire has started. In line with this, fires occurring at night and in the early morning are a risk factor for fatalities since fires occurring then are proven to be discovered later.

Regarding *fire characteristics,* we discerned the cause of the fire, the object in which the fire originated, and fire dynamics. We see that one of the most important risks factors is smoking, since a quarter of all fatal fires over the last 10 years was caused by smoking, while only 5% of all fires was caused by smoking. Cooking and being careless with open fire are also important risk factors, which means that most fatal fires are caused by human behaviour. Being asleep in the room where the fire originates is also found to be a risk factor, as most victims who are found in the room of fire origin were asleep when the fire started.

With regard to *building characteristics,* information was collected on the type of building, ownership situation, year of construction, smoke detectors, the position of inner doors and the influence of building characteristics on the fire. Risk factors that were found are living in an apartment and care homes. Open inner doors were found to be a risk factor for persons present in a room other than the room where the fire originated.

Concerning *human characteristics,* there is insight into the living situation, gender and age of people that die in fatal residential fires. Also, the degree of ability to leave without assistance and the alertness of fatalities is known. Moreover, information was collected on the location where the victims were found, their situation at discovery, and the moment and circumstances of their death. In this respect, we see that single-person households are more at risk. While only two-fifths of the households are single-person households, they comprise almost half of the total of fatal residential fires. Moreover, more men than women die from a fatal fire, while in the age category of 65 years and older, women are more at risk. Having a limited ability to leave without assistance is also a risk factor. In situations with an activated smoke detector, the victim is rarely alert and able to leave without assistance. Furthermore, persons with a limited ability to leave without assistance die more often in a room where the fire originated than persons who are alert and able to escape by themselves. Wearing flammable clothing is a risk factor for persons in the room where the fire originated and who are alert and able to leave without assistance.

Overall, many insights were gained into the main characteristics and risk factors of fatal residential fires from the information that was collected in the Netherlands. However, to make sure that no important items are overlooked in identifying risk factors in Europe, we also looked for any risk factors that can be identified from international meta-analyses.

2.3 Risk factors identified in international meta-analyses

It is clear that not all people or households are equally vulnerable to fires. Several national and international research studies identified a variety of risk factors for being involved in a (fatal) residential fire. Globally, studies on fires indicate that human characteristics such as age, gender, illness and mobility influence the chance of dying in a residential fire. According to a meta-analysis on fatal fires in high income countries (predominately the USA and Canada), men statistically seem to have a higher chance of being involved in fatal residential fires than women.

Furthermore, the elderly have a higher chance of dying in a fire (Turner et al., 2017). Residents aged 64 years and over are at greater risk of experiencing fatal fires than other age groups and the risk of dying in a residential fire becomes even greater as their age increases (Barnett, 2008): In the U.S. persons aged 65 years and over have a fire death rate 20% higher than the national average and this risk increases to double the national average at age 75 years, and is four times the average at age 85 years.

Likewise, people with low socioeconomic status and educational attainment are highly represented in statistics on fatal fires in the U.S. and Australia, especially non-working households (Barnett, 2008; Turner et al., 2017). Additionally, the meta-analysis of Turner et al. (Turner et al., 2017) shows that few studies focus on households with 'vulnerable' – i.e. physically or cognitively disabled - residents, but those that do, strongly indicate that vulnerable residents are at great risk of dying in a fire.

Individual choices and lifestyles also appear to increase the risk of experiencing a fatal fire. Results from a systematic literature review from their earliest records to January 2016 reveals that households in the U.S. and Canada with higher numbers of smokers are at a greater risk of fatal fires (Turner et al., 2017). Australian researchers also indicate that there is an association between alcohol intoxication and fire injuries and deaths (Barnett, 2008).

In addition to human characteristics, building characteristics seem to have an influence on the likeliness of experiencing a fatal fire. Furthermore, apartments and mobile homes are associated with an increased risk of fatal fires, particularly mobile homes with two or fewer exits and properties with higher numbers of stories/floors (Turner et al., 2017).

Finally, in Australia, rented housing properties, municipality owned and social housing properties were observed to be at greater risk of fire incidents and death compared with privately owned properties (Xiong, Bruck, & Ball, 2015).

2.4 Conclusions

So far, best evidence synthesis and meta-analysis on fatal fires in high income countries, (e.g. Turner et al., 2017), predominantly focus on risk profiles in the United States, Canada and Australia. Hitherto, for European countries, there is little knowledge about collective predispositions for fatal residential fires.

We concluded that the Dutch questionnaire for fatal residential fires and our insights in factors associated with fatalities cover the risks that have been identified by international

meta-analyses. For example, human characteristics like age, gender and mobility are included in our questionnaire. Moreover, these factors are also associated with a higher risk of dying in a residential fire in the Netherlands. However, some risks that are mentioned in meta-analyses are not found in the Dutch study and conversely, risks that are found in the Dutch study, are not mentioned in meta-analyses. This indicates that the facts for European countries are possibly different from the facts that apply for United States, Canada and Australia. Furthermore, we see that, in the Netherlands, intervention characteristics are also important in relation to fatal residential fires. For example, we see that about one third of the fatalities probably died before the fire was reported (112 call). This implies that the fire service intervention has no influence on the chance of survivability of the fire in a significant proportion of cases. On the other hand, we also see that in cases where the person is found within 30 minutes after the fire originated, about 80% of these persons[6] is still alive and rescued in first instance. For them a shorter intervention time conceivably has a positive influence on the chance of survivability of the fire. Therefore we have also included intervention characteristics in this study.

Lastly, due to significant differences in the normative and socioeconomic characteristics, it seems unreasonable to generalize the findings from North America, while trying to identify risk profiles for fire fatalities in Europe. Therefore, this report has studied the available information on fatal residential fires in European countries and examined their data collection (chapter 4) methods. By doing this, we will explore to which extent the information from European countries can be compared, merged and translated into a European risk profile for fatal residential fires. In order to compare the European countries, we first looked at the definitions they use, as described in the next chapter.

[6] In the Netherlands, in the period 2008-2018, about one out of six fatalities is found within 30 minutes after the fire originated and was still alive at that time.

3 Definitions of fatal residential fires

Although we are taking the Dutch questionnaire and our insights on risks as a starting point for this research, we cannot assume that the definitions we use are similar in other European countries. To be able to compare data from different databases, it is important to have insight into the definitions used by the selected countries. In this paragraph we answer the second sub-question: *Which definitions are used for the collected items and to what extent do they correspond per country?* First, we set out the context of the study of definitions. In addition the literature is analysed to examine what definitions are used in Europe. Finally, we look at the information on definitions available from the first questionnaire we sent to the selected countries.

3.1 Valuation and application of definitions

In this study we recognize the importance of using comparable definitions for the aspects related to fire in statistical studies. The definition of a concept, such as 'residential fire', indicates what is, and is not, part of the concept. In a database this has consequences for the number and type of cases that are included in the database. A difference between definitions can be of great influence, but can also have a very limited impact. In case the variation in definitions is negligible, for example in large data sets where the differences between aspects are marginal, a merger is, however, still possible provided that the differences between aspects are taken into account in the accuracy of the analysis, for example by representing percentages in tens. Definitions also provide insight into the way in which results from different countries can be interpreted in comparison to each other.

In this study, any differences in definitions are not considered as an insurmountable breaking point for the generation of collective statistics. It will be a functional starting point for the interpretation of statistical data for sketching a collective picture of the risk of fatal residential fires in the selected European countries.

3.2 Definitions from the literature

A study of the British Department for Communities and Local Government (DCLG) on European data collection methods indicates that there are differences between states in the recording of residential fires, housing types and fatalities (Greenstreet Berman, 2012). In order to make a comparison between countries possible, we are interested in the extent to which the definitions in the various countries are similar and in the impact of any difference on the number and type of collected data. The Dutch definition of fatal residential fires contains three key concepts, namely fatalities, housing types and fire causes. However, first we need to explain our choice of the term 'residential fires'.

3.2.1 Residential fires

In the literature, several equivalents can be found for the term 'dwelling fires': *home fires*, *housing fires*, *domestic fires* and *residential fires.* All might describe more or less the same type of incident, but one should pay attention to the specific inclusion and exclusion criteria of housing types (as we will compare hereafter). Compared to dwelling fire, the definition of residential fire is wider, since it also includes properties such as student houses and nursing/care homes. For home, housing or domestic fires, no clear definition could be found. In conformity with the definition used by the Dutch Fire Service Academy, in this report we will use the term 'residential fire'[7], which includes all types of structures in which people are living. When another term or definition is used in a study we will indicate this.

3.2.2 Housing types

The housing types included in the statistics on fatal domestic fires are comparable for most European countries. In the Netherlands[8], Sweden, Norway, Finland, Denmark and the UK, dwellings are simply defined as places occupied by households and divided into detached and non-detached properties and apartment buildings. In these countries, non-permanent structures used solely as a dwelling, such as mobile homes, houseboats and vacation houses are also often included into the statistics, whereas communal establishments, such as nursing homes, student halls of residences and hotels/holiday complexes and prisons, are often excluded (Andersson et al., 2015; Department for Communities and Local Government (DCLG), 2012b; Gummesen, 2017).

3.2.3 Fatalities

Furthermore, some international differences exist with regard to the definition, and therefore statistical inclusion, of fatalities. The Dutch Fire Service Academy for example, defines a fatal victim as someone who '[…] deceased as a result of the fire or as a consequence of the injuries he or she has suffered from the fire' (Kobes & Polman, 2017). The time elapsed between fire and death is not regarded as relevant, however deaths that occur *before* the ignition (e.g. natural deaths due to a heart attack) and intentional fires (i.e. suicide or homicide) are not taken into account.

Likewise, the UK-government defines fire-related fatalities as "[…] fatalities that would not have otherwise occurred had there not been a fire (Department for Communities and Local Government (DCLG), 2012b)." This includes *any* fatal casualty which is the direct or indirect result of injuries caused by a fire incident, also if the victim dies subsequently in hospital. Furthermore, in the IRS of the UK government, even uncertain cases of death – classified as 'unknown' in the questionnaire – are registered as fire-related deaths. In conformity with the definition of the DCLG, the Scottish Fire and Rescue Service (SFRS) defines fatal fires as '[...] any fatal casualty which is the direct or indirect result of injuries caused by a fire incident. Even if the fatal casualty dies subsequently, any fatality whose cause is attributed to a fire is included' (Scottish Fire and Rescue Service, 2016).

The Norwegian DSB applies a timeframe, which means that only victims who suffer death in a fire, or up to three months after the fire, are included into their statistics (Gummesen,

[7] The Dutch Fire Service Academy uses the Dutch term 'woningbranden' in their survey, which is comparable to residential fires.

[8] The Dutch Fire Service Academy also makes use of several sub- categories such as detached or non-detached single-family homes, gallery flats with an open gallery, not detached structure or closed galleries, flat with indoor partitioning structure/closed gallery, blocks of flats with a communal stairwell that serves as an entrance hall, homes divided into apartments/studios or rented rooms, homes above business/store and basement homes.

2017). Furthermore, the victim is supposed to have passed away as a direct result of the fire, from burns or asphyxiation injury. Persons dying as a result of a heart attack, impact, falling objects, fractures and similar are not defined as fire victims (Sesseng, Storesund, & Steen-Hansen, 2017).

The Danish DEMA is even more strict when it comes to the moment of passing away: only persons that die in a fire or at the latest 30 days after the fire and due to the stresses from fire are taken into account (Gummesen, 2017). The database of the Swedish MSB collects three categories of fire fatalities:

1. *Direct fire fatality* is defined as a fatality where the cause of death is due to direct exposure to fire through injury, toxicity or medical complication.
2. *Indirect fire fatality* is defined as those fatalities where the cause of death can be directed to:
    a. injury to the body through an attempt to try and get away from the fire.
    b. falling objects, collapse or similar caused by the fire.
3. *Fatalities due to faulty combustion*[9] *with fatality*, which is a faulty combustion that leads to one or more fatalities and contains also fire fatalities by murder and suicide. (Gummesen, 2017).

With regard to the definition of fatalities within the Finish data system 'PRONTO', no information could be obtained.

In the publication 'Comparison of European Fire Statistics' (Greenstreet Berman, 2012) extensive information is given on the definitions of fire deaths and the cause of death throughout Europe. However, since we encountered some deviations compared to the definitions of our respondents from the selected countries, we will rely on the information from our first questionnaire (see also paragraph 3.3).

3.2.4 Cause of fire

Another common variable to look at, when investigating fatal fires, is the cause of the fire. Comparing the national databases mentioned above, some similarities can be found with regard to the classification of causalities. All evaluated databases register the standard cause-categories 'electrical defect', 'carelessness with / wrong use of electrical equipment' and 'open fires (e.g. candles or chimneys).' In some databases, smoking is included into the last mentioned category (Department for Communities and Local Government (DCLG), 2011; Kokki, 2011; Sesseng, Storesund, & Steen-Hansen, 2017), while others register 'smoking' as a separate causality (Andersson et al., 2015; Kobes & Polman, 2017). In addition, cooking is not listed as a cause of fire in analyses of Andersson et al. (2015)[10] and Sesseng et al. (2015).

Furthermore, differences can be found with regard to the inclusion of deliberate fires in residential fire statistics. In several national and international studies, only accidental fires are incorporated into the reports or reviews (Harpur, Boyce & McConnell, 2014; Kobes & Polman, 2017; Turner et. al, 2017), whereas fire fatalities as a result of arson, murder or suicide are not. Additionally, some studies explicitly distinguish fatal outcomes intentionally caused by accountable adults from other types of arson, for example, fires caused by children playing or confused adults (Andersson et al., 2015; Brandweeracademie, 2017;

[9] Is defined as a malfunction or use of a combustion device that leads to an exposure to toxic combustion gasses (Gummesen, 2017).

[10] Cooking is not considered a fire cause, however there is a category 'forgotten stove' included as a fire cause in Sweden (Andersson et al., 2015).

Department for Communities and Local Government (DCLG), 2011). In those studies, only the latter have been included in the statistics of fatal fires. However, the Swedish database of the MSB also contains data from fire fatalities by murder and suicide, summarized in the category 'fatalities due to faulty combustion with fatality' (Gummeson, 2017). Likewise, in a comparative research study on fires in Scotland, England and Wales (based on data from the IRS), deliberate fatal fires have been included (Scottish Fire and Rescue Service, 2017), making it difficult to compare their results with data of other European countries. On the contrary, studies such as the study from the British DCLG (2011), in which data on deliberate fires are separately analysed from data on accidental fires, make an international comparison more valid.

3.3 Definitions used by the selected countries

In the questionnaire (questionnaire 1) we sent to the selected countries, we asked them what definition for fatal residential fires they used. In this paragraph, we will describe the answers given by our contact persons from the selected countries. First we will describe the general definitions and then we will compare the aspects that are included in the definitions for all selected countries, according to our contact persons.

3.3.1 Definitions for fire fatalities

In Norway, victims are considered a fire death when death occurs within 3 months from the fire. People that die from the indirect consequences of the fire are also considered fire deaths.

In Belgium there is no official definition, however, the aim is to exclude fatalities that die as a consequence of suicide or murder.

The Estonian definition of a fire fatality is: *a person who has died as a result of the effect of a fire, in or outside a building, within 30 days form the fire event*. This also includes persons whose death is caused by:

1. Mechanical injuries: due to the presence at the scene (e.g. falling or jumping from a building on a fire, and collapsing structures).
2. Health disorder caused by the fire: (e.g. stroke, infraction etc.) when, based on the evidence collected, there is reason to assume that the ignition of the fire preceded the health disorder, and that the fact of fire is the cause of the person's health disorder.

The definition excludes people that have died in a fire caused by a traffic accident, explosion, arson, suicide or unexpected health disorder. Furthermore, rescue officials who have died during rescue work are also excluded. When a person dies as a result of sustained injuries after 30 days, he or she is considered an injured person. Which buildings are considered as residential buildings is as in accordance with the Estonian Building Code.

In Denmark, people that die within 30 days of the fire, due to injuries sustained in a fire, are considered fire fatalities. Mostly the injuries that cause death are burns, or the toxic effects of smoke.

The definition for fatal residential fires that is used in Sweden includes residential fires that cause at least one death within 90 days. The death can be caused by the fire's direct effect

on the body (burns or poisoning) or by indirect effect such as injuries sustained while fleeing from the fire or when the building collapses due to the fire.

In Finland, a fire fatality is a person who has died as a result of the effect of a residential fire, in or outside a building, at the scene of fire or within 30 days from the fire event.

England defines residential fire fatalities as fire-related fatalities that would not have otherwise occurred had there not been a fire.

In the Dutch definition, only accidental fires are included. Therefore, deliberate fires, caused by arson, murder and suicide are excluded. Moreover, people that have died a natural death before the fire, are not included as fire fatalities. The fatality has to be a result of the fire or a consequence of the injuries the victim has suffered from the fire. The moment of death is not relevant here. All residential fire fatalities registered prior to the start of the annual analysis are included in the analysis.

3.3.2 Definitions for fatal residential fires

Fire fatalities
All countries include fatalities that die later in the hospital in their definition of fatal residential fires. The timeframe in which persons die varies from 30 days (Finland, Denmark and Estonia) to unlimited (England and the Netherlands). In the Netherlands, almost all fatalities occurred within 30 days, which implies that the timeframe for the fatality is of no importance.

Dwellings
The table below (Table 2) shows that all countries include dwellings which function as a home.

Housing types
Fatalities that occur in holiday homes are included by all countries. However, fatalities that occur in nursing homes are excluded by most countries. In the Netherlands, about 7% of the fatal residential fires took place in nursing homes, related to the dataset in accordance with the Dutch definition (IFV, 2018). Whether nursing homes fall within the definition or not, seems of marginal importance.

Three countries include fire fatalities outside the house in their definition. In the Netherlands, about 7% of the fatalities were found outside the home[11]. Thus, whether fatalities outside the house fall within the definition or not, seems of marginal importance.

Two countries include all kinds of buildings in their definition. In addition to an annual average of 31 fatalities of unintentional residential fires in the Netherlands[12] (Brandweeracademie, 2018) there are an estimated average of 27 fatalities of other types of building fires (CBS, 2014). Including all kinds of buildings results in 87% more fatalities in the Netherlands, compared to the Dutch definition, which has an important impact on the data.

[11] Person escaped initially and died later, or was found on the balcony, in the common stairwell or in a shed or garage.
[12] Including fire fatalities outside the house.

Fire causes

Most countries include intentional death or suicide. There are an average of 12 intentional deaths from residential fires (IFV, 2018). Including intentional deaths results in 39% more fatalities in the Netherlands, compared to the Dutch definition, which is of great importance. The two countries that include all kinds of buildings also include intentional deaths in their definition. Including both intentional deaths and fatalities of other types of buildings in the definition results in the Netherlands in a dataset with 125% more fatalities[13] compared to the current Dutch definition, which has an important impact on the data.

Table 2 Overview of inclusion and exclusion of items in the definition of fatal residential fires in selected countries.

Item included in definition	NO	BE	EE	DM	SE	FI	UK	NL
Residence/ home/ dwelling	✓	✓	✓	✓	✓	✓	✓	✓
Holiday home	✓	✓	✓[14]	✓	✓	✓	✓	✓[15]
Nursing home	✓	✗	✓	✓	✗	✗	✗	✓
Fire fatalities in all kinds of buildings	✓	✗	✗	✓	✗	✗	✗	✗
Fire fatalities outside the house	✓	✗	✗	✓	✗	✗	✗	✓
Fatalities that died later in the hospital	✓	✓	✓	✓	✓	✓	✓	✓[16]
Fatality timeframe	< 90 days	Unknown	< 30 days	< 30 days	< 90 days	< 30 days	No	No
Intentional death/ suicide	✓	✗	✗	✓	✓	✓	✓	✗

✓: Item is included into definition of fatal residential fires.
✗: Item is not included/excluded

[13] In the Netherlands, there are an estimated average of 27 fatalities of other types of building fires (CBS, 2014) and an average of 12 intentional deaths in residential fires.
[14] Summerhouse
[15] Holiday homes, like mobile homes and caravans are only included when people live there more or less permanently.
[16] Only included when there is enough reason to assume that the person died from the consequences of the fire.

3.4 Conclusions

In this chapter, the second sub-question: *which definitions are used for the collected items and to what extent do they correspond per country?* was answered. We can conclude that there is a variety in definitions used by the selected countries, as well as in the definitions from countries that are described in the literature. There is also a range in the time frame that is taken to count a fatality. Furthermore, not all countries include the same types of houses. Finally some countries include both intentional and accidental fire deaths, while others only include accidental deaths. When interpreting the data, these differences, and the estimated impact on the data, should be kept in mind. However, a comparison of the included and excluded items also shows that there are similarities in the separate items within the definitions that the different countries use. All countries include fatalities that died later, after the fire, and all include fatalities in holiday homes.

4 Information collected in the databases

In the last chapter we looked at the similarities between definitions in the selected countries and a method was proposed to overcome differences in definitions. In this chapter, we answer the third research question: *what information about fatal residential fires is collected in the databases in the selected European countries?*
First, we examined the literature to describe the databases, reporting procedures and collected data in the selected countries. Second, we looked at the results from the first questionnaire, studying which items concerning fatal residential fires are collected by the selected countries.

4.1 Databases in the selected countries

This paragraph studies the literature to indicate which databases there are at country level, and which organisations are responsible for them. We also examine by, and to whom, the data is reported in the selected countries. Furthermore, the content of the data that is collected in these countries, is explored.

4.1.1 Databases and responsible organisations

According to the Department for Communities and Local Government of the UK, the vast majority of European states collect data on fire incidents at a national or state level and use this data to inform government policy, raise awareness of the fire risk, and develop interventions (Greenstreet Berman, 2012).

In 2000, the Finish Ministry of Interior generated the web-based statistic system ‘PRONTO’. Here, incident data is stored which was submitted by emergency response centres and regional rescue services (Kokki, 2011).

The UK implemented their web-enabled Incident Recording System (IRS) in 2009. IRS uses information collected by automatic systems and those present at the time of an incident. The Fire and Rescue Services (FRSs) are responsible for the data in IRS and assure its quality (Home Office GOV UK, 2017). The system provides the Fire and Rescue Services (FRS) in the UK with the ability to collect, validate and transmit data to the government on all incidents attended by the FRS (Department for Communities and Local Government (DCLG), 2012a).

Likewise, the Swedish Civil Contingencies Agency MSB serves as the national focal point for fire prevention and keeps records of all emergency turnouts reported by local fire departments (Jonsson, Bonander, Nilson, & Huss, 2017). The MSB collects data on fires and their analysis and involves 40 local fire brigades (MSB Swedisch Civil Contingencies Agency, 2018).

In 2005, fire brigades in Denmark became obliged to report fires to the Danish Emergency Management Agency (DEMA) which stores the data in the ODIN system (Gummesen, 2017). DEMA collects statistics of municipal and national fire and rescue services to uncover trends and initiate prevention measures. DEMA also provides statistics on annual fire safety inspections from the municipalities (DEMA, 2008).

In Norway, both the SSB (Statistics Norway) and DSB (The Norwegian Directorate for Civil Protection) gather information with regard to fire fatalities. A study from Norway also incorporated police investigation reports and medical records (Sesseng, Storesund, & Steen-Hansen, 2017), whereas Swedish researchers consulted databases on forensic examinations held by the National Board of Forensic Medicine (Jonsson et al., 2017). Those databases help to draw up a more detailed picture of fatal fires.

The Dutch Fire Service Academy has structurally gathered data on fatal residential fires in the Netherlands since 2008. In this process, the Fire Service Academy cooperates with the fire brigades and fire research teams, which regularly fill out a questionnaire[17] about the characteristics of fatal fires they attended (Kobes & Polman, 2017).

In Belgium, the Federal Research Institute for Civil Safety (KCCE) is responsible for collecting and processing the data of fire service interventions. However, most information is collected through a private initiative[18].

Additionally, some attempts have been made to compare fire statistics of the Northern European countries, Denmark, Estonia, Finland, Iceland, Norway and Sweden. Information from national authorities on (fatal) fires are collected in the online database 'Nordstat'[19], however, it remains unclear as to the extent that differences in definitions are taken into account.

4.1.2 Reporting procedures

Regarding the reporting procedures, there are differences in which organisations report and collect the data, and whether this is obligatory or not.

The contents of Fire Statistics United Kingdom are based upon data reported on standard fire incident report forms by fire brigades throughout the UK. Since 2009, the method of data collection has changed to become all-electronic (Incident Reporting System (IRS)).

In Finland, rescue services as well as emergency response centres are involved in the reporting procedure. The latter submit information on call-out data, such as data on the alarm and emergency-calls, to the 'PRONTO' database. The regional rescue services add information on the incident, actions and losses. In case of a building fire, fire inspectors are in charge of submitting data, e.g. basic information on the building and covering the flammable range. In case of a fatal fire, additional data has to be provided by a fire investigator, such as information on the victims (Kokki, 2011). The system is accessible via the internet and used by rescue services authorities as well as other authorities and researchers.

[17] The questionnaire is based on research on human behaviour that identified relevant factors related to human, building, fire and intervention characteristics.
[18] The private initiative of Tim Renders, for more information see: www.timrenders.be
[19] For more information see http://nordstat.net/.

Likewise, the reports that the Danish fire brigades are obliged to fill in after every emergency response are registered in the ODIN system (Sesseng, Storesund, & Steen-Hansen, 2017).

In Norway, the DSB keeps official statistics on residential and structural fires based on reports from the police[20] and the fire brigade (Sesseng, Storesund, & Steen-Hansen, 2017).

In the Netherlands, fire brigades report their data voluntarily to the Dutch Fire Service Academy, nevertheless, the database includes virtually all fatal residential fires. In order to collect relevant data, fire brigades are approached whenever press reports are published about fatal residential fires in their region. By doing that, fatal residential fires where the fire service did not assist are included as well (Kobes & Polman, 2017).

Unlike other states, Swedish fire deaths are collected from the Board of Health data rather than from fire services (Greenstreet Berman, 2012; Jonsson et al., 2017). Whereas the national fire register mainly contains information based on incident reports that are filled in by the rescue services (Andersson et al., 2015), data on fatal fires is collected in a separate reporting system. The reason for setting up two databases is that in Sweden it is not possible for responding officers to follow up on people that were injured during a fire and (possibly) died at a later stage. However, these two different databases seem to cause some problems with regard to the accuracy of fatality registration: it has been observed that there has been under-reporting as well as overlaps in the reporting of fatal fires, indicating insufficient communication between the fire brigade and the health services (Sesseng, Storesund, & Steen-Hansen, 2017).

4.1.3 Data that is collected on fatal residential fires

Appendix 2 gives an overview of the items that are included in the questionnaires in several European countries, as gathered from the literature.

In the Netherlands and Norway, specific information on the fire characteristics and human characteristics is included, like the victim's degree of physical and mental ability to escape without assistance (Kobes & Polman, 2017; Sesseng, Storesund, & Steen-Hansen, 2017).

In the UK, information is collected on some aspects of fatal residential fires, though less extensive compared with the Netherlands and Norway. For example, with regard to the characteristics of the victim, only gender, age and ethnicity and their alcohol and drug consumption are assessed.

The survey of the Swedish MSB covers basic information on the cause of fire (room and object of origin, size of the fire) and alarming. Compared to the Dutch and British questionnaire, the survey is more extensive on the type of municipality where the (fatal) building fire was reported (i.e. suburban to big city, suburban to larger cities, rural municipality, sparsely populated region, densely populated region, commuter municipality, big city, larger city, tourism city, production city).

The Finish reporting system PRONTO incorporates questions on 'call-out data' (e.g. time of emergency call and alarm), data on the incident and actions, characteristic of the burning building and fire fatalities.

[20] In Norway, all fires must be investigated by the police in order to identify the cause, even though there may not be any suspicion of a criminal offense.

Based on the comparative research of (Gummesen, 2017), one can assume that, in the Danish DEMA, data on the type of dwelling, age and gender of the victims, time (month), room of origin, start item and cause of fire is collected.
Although part of the information that is collected in the databases becomes clear from the literature, we also assess what information is collected with our first questionnaire. The next paragraph describes the results of this questionnaire, giving a more detailed insight into what information is collected in the databases of the selected countries.

4.2 Items collected in the databases

In this paragraph, we analyse the results from the first questionnaire. This provides insight into the items that are used by the selected countries to collect information for their databases on fatal residential fires. In the first questionnaire we asked what information was collected with regard to: *information on victims, escape and rescue (attempts), intervention characteristics, fire characteristics, building characteristics, smoke alarms* and *human characteristics.*

4.2.1 Information on victims

In regard to the information that is collected on the victims of residential fires, we see that all countries collect data on the number of fatalities and injured people (see Table 3). However, only a few countries collect information on the number of people present in the dwelling at the moment of fire.

Table 3 Collected information on fire fatalities in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
Number of people present in the dwelling at the moment of fire	✓	✗	✗	✗	✗	✓	✗	✓
Number of fatalities	✓	✓	✓	✓	✓	✓	✓	✓
Number of injured people in addition to fatalities	✓	✓	✓	✓	✓	✓	✓	✓

✓: Information is collected.
✗: Information is not collected.

4.2.2 Escape and rescue (attempts)

Assessing the collection of information on escape and rescue, we find that half of the countries collects information on whether there was an escape attempt. Similarly, half of the countries collect data on the number of people that escaped independently but died later. The same holds for the number of people that were rescued by the fire brigade but died later. All of the selected countries gather data on the number of people that escaped with assistance of the fire brigade. Only three out of eight countries possess information on the number of people that escaped independently, and were injured or uninjured. Furthermore, only three countries collect data on the number of people that escaped with the assistance of others (not being the fire brigade). Most countries have information on the number of people that were rescued by the fire brigade and were injured, as well as those that were uninjured.

All except one know how many people have already died before the fire brigade arrived.

Table 4 Collected information on escape and rescue (attempts) in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
If there was an escape attempt	✓	✗	✗	✗	✓	✓	✗	✓
Number of people that escaped independently, and died later	✗	✗	✓	✓	✗	✓	✗	✓
Number of people that escaped independently, and were injured	✗	✗	✓	✗	✗	✓	✗	✓
Number of people that escaped independently, and were uninjured	✗	✗	✓	✗	✗	✓	✗	✓
Number of people that escaped with assistance of others (not the fire brigade)	✓	✗	✓	✗	✗	✗	✗	✓
Number of people that escaped with assistance of the fire brigade	✓	✓	✓	✓	✓	✓	✓	✓
Number of people rescued by the fire brigade, and died later	✗	✗	✓	✓	✗	✓	✗	✓
Number of people rescued by the fire brigade, and were injured	✗	✗	✓	✓	✓	✓	✓	✓
Number of people rescued by the fire brigade, and were uninjured	✗	✗	✓	✓	✓	✓	✓	✓
Number of people that had died already, and were removed from the building	✗	✓	✓	✓	✓	✓	✓	✓

✓: Information is collected.
✗: Information is not collected.

4.2.3 Intervention characteristics

Regarding the characteristics of the intervention, all countries have information on the day of reporting, the time of reporting and the fire brigade response time (see Table 5). Around half of the countries collect information on the type of municipality in which the fatal residential fire occurred and whether there was an extinguishing action by residents or others, before the fire brigade arrived. Concerning other information on the discovery and reporting of the fire, only a few countries collect information (for most items only Finland and the Netherlands).

Table 5 Collected information on intervention characteristics in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
The day of reporting	✓	✓	✓	✓	✓	✓	✓	✓
The month of reporting	✓	✓	✓	✗	✓	✓	✓	✓
The type of municipality	✗	✗	✓	✓	✓	✗	✓	✓[21]
Time between moment of arising of the fire and reporting of the fire	✗	✗	✗	✗	✗	✓	✗	✓
Time between moment of discovery of the fire and reporting of the fire	✗	✗	✗	✗	✗	✓	✗	✓
Time between arrival of fire brigade and moment of finding the victim(s)	✗	✗	✓	✗	✗	✗	✗	✓
The time of reporting of the fire (to the alarm centre/ fire brigade)	✓	✓	✓	✓	✓	✓	✓	✓
Fire brigade response time	✓	✓	✓	✓	✓	✓	✓	✓
Time between arrival of fire brigade and moment of death	✗	✗	✗	✗	✗	✗	✗	✓
Function of people who (first) reported the fire	✗	✗	✗	✗	✗	✗	✗	✓
Function of people who (first) discovered the fire	✗	✗	✗	✗	✗	✓	✗	✓
How the fire was discovered	✓	✗	✗	✗	✗	✗	✗	✓
First reaction after discovering the fire	✗	✗	✗	✗	✗	✗	✗	✓
Extinguishing action by residents or others, before the fire brigade arrived	✗	✗	✓	✗	✓	✓	✓	✓

✓: Information is collected.
✗: Information is not collected.

4.2.4 Fire characteristics

Concerning the fire characteristics, all countries except Belgium, collect information on the cause of the fire, the room where the fire originated, the fire situation when the fire brigade arrived, and the situation of fire development when the fire brigade arrived (fire limited to). All countries except Estonia collect information on the object in which the fire originated. Further, most selected countries have data on the final situation of fire development, the situation of smoke spreading when the fire brigade arrived and the final situation of smoke

[21] There is information on the safety region in which the fire occurred, including postal code

spreading. The presence of a fire accelerating factor is only known in the Netherlands and the presence of a factor that led to large smoke development is only reported in Sweden and the Netherlands.

Table 6 Collected information on fire characteristics in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
Cause of the fire	✓	✗	✓	✓	✓	✓	✓	✓
Object in which the fire originated	✓	✓	✗	✓	✓	✓	✓	✓
Room where the fire originated	✓	✗	✓	✓	✓	✓	✓	✓
Fire situation when the fire brigade arrived	✓	✗	✓	✓	✓	✓	✓	✓
Situation of fire development when the fire brigade arrived (fire limited to)	✓	✗	✓	✓	✓	✓	✓	✓
Final situation of fire development	✗	✗	✓	✗	✓	✓	✓	✓
Situation of smoke spreading when the fire brigade arrived	✗	✗	✓	✗	✗	✓	✓	✓
Final situation of smoke spreading	✗	✗	✗	✗	✓	✓	✓	✓
Presence of fire accelerating factor	✗	✗	✗	✗	✗	✗	✗	✓
Presence of factor that led to large smoke development	✗	✗	✗	✗	✓	✗	✗	✓

✓: Information is collected.
✗: Information is not collected.

4.2.5 Building characteristics

All countries collect information on the type of dwelling or house. Half of the selected countries collect information on whether there was a special use being made of the house, i.e. room rental or home care. Furthermore, most countries have data on the year of construction of the building, the number of floors of the building, and the floor of the building where the fire originated. However, data with regard to the floor of the building where the fire was raging is only collected by the Netherlands. Similarly only in the Netherlands is data collected on the position of the door (open or closed) for both the room where the fire originated and the room where the victim was found. Regarding the limiting influence of building characteristics on fire and smoke development, only three countries collect information.

Table 7 Collected information on building characteristics in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
Type of dwelling/house	✓	✓	✓	✓	✓	✓	✓	✓
Ownership situation	✗	✗	✗	✗	✗	✓	✗	✓
Special use of the house (room rental, 24-hour care or home care)	✗	✓	✓	✗	✗	✓	✗	✓
Year of construction of the building	✓	✗	✓	✗	✗	✓	✗	✓
Number of floors of the building	✓	✓	✓	✗	✓	✓	✓	✓
Floor of the building where the fire was originated	✗	✗	✓	✗	✓	✓	✓	✓
Floor of the building where the fire was raging	✗	✗	✗	✗	✗	✗	✗	✓
Limiting influence of building characteristics on fire and smoke development	✓	✗	✗	✗	✗	✓	✗	✓
Position of the door in the room where the fire was originated	✗	✗	✗	✗	✗	✗	✗	✓
Position of the door in the room where the victim was found	✗	✗	✗	✗	✗	✗	✗	✓

✓: Information is collected.
✗: Information is not collected.

Smoke detectors

As for information on smoke detectors in fatal residential fires, all countries except Belgium have information on the presence and functioning of smoke detector(s). All countries, except for Belgium and the Netherlands collect information on the presence of an automatic fire extinguishing system. Only a few countries know more about the reason for the malfunctioning of a smoke detector, whether the smoke detectors were linked, and whether the alarm was automatically forwarded. The Netherlands is the only country that has information about the room where the smoke detector was placed, regarding both smoke detectors that did come into operation, and smoke detectors that did not come into operation.

Table 8 Collected information on smoke detectors in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
Presence of smoke detector(s)	✓	✗	✓	✓	✓	✓	✓	✓
Functioning of smoke detector(s)	✓	✗	✓	✓	✓	✓	✓	✓
Reason for malfunctioning smoke detector	✓	✗	✗	✗	✗	✓	✓	✓
Room where smoke detector was placed, that did not come into effect	✗	✗	✗	✗	✗	✗	✗	✓
Room where smoke detector was placed that did come into effect	✗	✗	✗	✗	✗	✗	✗	✓
Smoke detectors being linked	✗	✗	✓	✗	✗	✗	✗	✓
Automatic forwarding to alarm centre, family of neighbours	✗	✗	✓	✗	✗	✓	✗	✓
Presence of automatic extinguishing system	✓	✗	✓	✓	✓	✓	✓	✗

✓: Information is collected.
✗: Information is not collected.

4.2.6 Human characteristics

Concerning human characteristics, all countries collect data on the age and gender of victims. Information on the living situation of the victim, their physical mobility and mental disability was collected by around half of the selected countries. Only Estonia and the Netherlands know more information about the hearing and sight of the victim. Three or more countries collect information on whether the victim was sleeping/awake, the victim being a smoker, substance abuse, and limited alertness due to; alcohol, drugs, and medicines. Furthermore, half of the selected countries have information on: the location of seat of the fire regarding the victim, the most important circumstances that led to not surviving the fire, the location of death, and the cause of death. Only in the Netherlands is information known about the degree of smoke density at the victim's location and the circumstances of the victim in the fire (e.g. enclosed, rescue attempt, flight attempt).

Table 9 Collected information on human characteristics in selected countries

Items	NO	BE	EE	DK	SE	FI	UK	NL
Living situation of victim	✗	✗	✓	✓	✗	✓	✗	✓
Age of victim	✓	✓	✓	✓	✓	✓	✓	✓
Gender of victim	✓	✓	✓	✓	✓	✓	✓	✓

Items	NO	BE	EE	DK	SE	FI	UK	NL
Living situation of victim	✗	✗	✓	✓	✗	✓	✗	✓
Age of victim	✓	✓	✓	✓	✓	✓	✓	✓
Gender of victim	✓	✓	✓	✓	✓	✓	✓	✓
Physical mobility of victim	✗	✗	✓	✓	✗	✓	✗	✓
Mental disability of victim	✗	✗	✓	✓	✗	✓	✗	✓
Hearing of victim	✗	✗	✓	✗	✗	✗	✗	✓
Sight of victim	✗	✗	✓	✗	✗	✗	✗	✓
Victim was sleeping/awake	✗	✗	✓	✓	✗	✗	✗	✓
Substance abuse	✗	✗	✓	✓	✗	✓	✗	✗
Limited alertness due to alcohol	✗	✗	✓	✓	✗	✓	✓	✓
Limited alertness due to drugs	✗	✗	✓	✓	✗	✓	✓	✓
Limited alertness due to medicines	✗	✗	✗	✓	✗	✓	✗	✓
Victim being a smoker	✗	✗	✓	✓	✗	✗	✗	✓
Room where the victim was found	✗	✗	✗	✓	✓	✓	✓	✓
Location of seat of the fire with respect to the victim	✗	✗	✗	✓	✓	✗	✓	✓
Degree of smoke density at the victim's location	✗	✗	✗	✗	✗	✗	✗	✓
Circumstances of victim in the fire (e.g. enclosed, rescue attempt, flight attempt)	✗	✗	✗	✗	✗	✗	✗	✓
Most important circumstances that led to not surviving the fire	✗	✗	✓	✓	✗	✓	✗	✓
Cause of death	✗	✗	✓	✓	✗	✗	✓	✓
Location of death (on spot/hospital)	✗	✗	✓	✗	✓	✓	✗	✓

✓: Information is collected.
✗: Information is not collected.

4.3 Conclusions

In this chapter, the following research question was answered: *what information about fatal residential fires is collected in the databases in the selected European countries?* Regarding the collection of data on fatal residential fires, in most countries the data is collected on a national or state basis. Furthermore, there are differences in which organisations report and collect the data and whether this is obligatory or not. Most data collection happens through electronic systems. Moreover, the selected countries differ in the how much information is collected in their databases and on what items they actually collect information. All countries that answered our first questionnaire collect information on: the number of fatalities, injured people and people that escaped with assistance of the fire brigade. Furthermore, all countries know the day and time of reporting of the fire, as well as the fire brigade response time. The type of dwelling or house, and the age and gender of the victim are also known in all countries. Since we see big differences in the extent to which items are collected, we focused our research on the most collected items.

5 Main characteristics and risk factors – Country level

In the last chapter, we assessed what data is collected in the database of the selected countries. In this chapter, we take a closer look at this data by exploring the main characteristics of fatal residential fires that can be found at the country level. When possible, we also constitute risk profiles for each selected country. We answer the fourth sub-question: *what are the main characteristics of, and risk factors for, fatal residential fires at country level?* In paragraph 5.1, we explain why it is not always possible to speak of risk profiles. Furthermore, both the literature and the data (from the second questionnaire) are analysed to arrive at a description of the main characteristics and risk profiles on a country level.

5.1 Preview

In the following paragraphs, the main characteristics and/or risk factors of fatal residential fires are described for the selected European countries. We use the information from the literature and the data that is provided to us by our contact persons. We have found literature for Norway, Belgium, Denmark, Sweden, Finland, the UK, Poland and the Netherlands. We have also received data from Norway, Belgium, Estonia and the Netherlands. This data is presented in the pie charts in this chapter. For some countries, risk factors can be identified from the literature and/or the data, while for other countries we can only speak of the main characteristics of fatal residential fires. We distinguish: *human characteristics, behavioural characteristics, building characteristics, fire characteristics* and *other characteristics.*

5.2 Norway

5.2.1 Literature Norway

For Norway, several combinations of risk factors have been identified for fatal residential fires (Sesseng, Storesund, & Steen-Hansen, 2017). Firstly, people who have reached retirement age have an increased risk of dying in a fire when they also have: *reduced mobility, impaired cognitive ability, mental disorders* and *are smokers.* Secondly, people under the retirement age are at higher risk when they are *substance abusers, have a mental illness, are under alcoholic influence*, and *are smoking.*

When looking at *human characteristics,* there is an increasing risk of fatality with increasing age (Sesseng, Storesund, & Steen-Hansen, 2017). When relating the number of fatalities to age groups, the number of fatalities per 100,000 inhabitants increases per age group, in particular the 70-79 and 80+ age groups have a high risk of dying in a fire. Furthermore, more men (56% average of 2005-2014) than women (44%) die in fatal fires. In general, men do not have a higher risk than women, though in some age groups the fatality risks are greater for men. For the 80+ age group, more women die in a fire than men, however, this

reflects the gender distribution in this group, which means the risk is equal. Generally, most people who died in a fire were physical mobile (69%), had good hearing (90%) and good sight (87%). Nevertheless, 61% of the group of 67 years or older has either impaired vision, hearing, or mobility, which may have contributed to their death. Unfortunately, the study does not relate this percentage to the total group of people of 67 years or older. Finally, many fatal victims had a mental illness (44%) but this number is also not related to the overall population. In general, there is a higher risk of dying in a fire for people who live alone and are single, related to fires in which all residents survived without serious injuries. Sessing et al. (2017) provide a possible explanation for this increased risk. Single people and people living alone are more often home alone. The likelihood that a fire will be detected in time to survive might therefore be reduced, and it can also be harder to escape if you are alone. Other human characteristics that can be related to many victims are: known substance abuse (37%), alcohol influence (41%, of whom 2/3 men and 1/3 women) and smoking (35 %), although it has to be noted that this information is often unknown.

Regarding *fire characteristics*, we see that human failure[22] often causes fatal fires. Since human behaviour varies throughout the year, so does the risk of fire. For example, there is a variation in causes between winter and summer months. Distributed across the year, most fatal fires occur in the winter, especially in December and January. In winter, people tend to stay indoors more, lighting candles, fireplaces and ovens, and they use more electrical heating than in the summer (Sesseng, Storesund, & Steen-Hansen, 2017). Open flames, in combination with cigarettes and candles, is a group of ignition sources which is also reflected in the number of fatal fires.
In most cases, the cause of death is asphyxiation (57%) and the reason for not surviving the fire that appears most is the 'toxic effect of carbon monoxide' (74%). Furthermore, fatal fires occur mostly in the living room and bedroom. Since these are the rooms where we spend most of the time, this also might be linked to human behaviour often being the cause of a fire.

When we look at *building characteristics,* we see that the dwelling type of most fatal residential fires is a detached house: 54% (single unit dwellings). However, most of the Norwegian population lives in these kind of houses (also 54%). In fact, the highest risk of fatality is in 'block/apartment' where 25% of the population lives, while this accounts for 31% of the fatal fires. In most cases, the victim is found in the room where the fire originated (40%), and in another room inside (43%) (Sesseng, Storesund, & Steen-Hansen, 2017).

5.2.2 Data Norway

In addition to information from the literature, we have received data from Norway thanks to our Norwegian contact person who filled out the second questionnaire. This data reports on 2016-2017. In this time period, 24 fatal residential fires occurred resulting in 25 fatalities. Overall there were 1,825 residential fires. In most fatal residential fires, only one person died and in most cases, there were no additional injured people (see Figure and Figure 4).

[22] Human failure indicates that the fire was directly caused by humans.

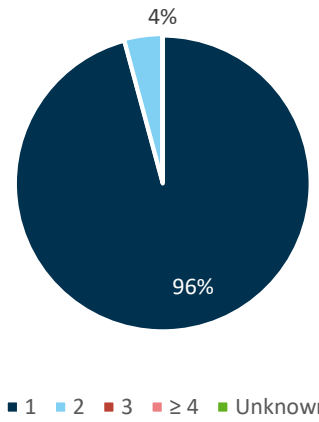

Figure 3 Number of fatalities per fatal residential fire (Norway, 2016-2017)

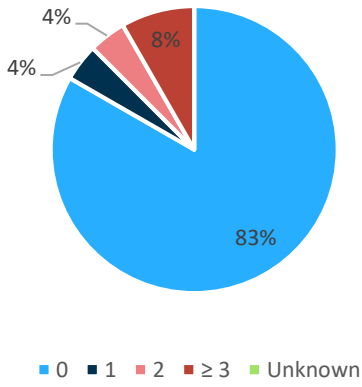

Figure 4 Number of injured people in addition to fatalities (Norway, 2016-2017)

With regard to *human characteristics,* most people died in the 50-69 age category (44%) and 70+ (36%). The age distribution of the victims is shown in Figure 3. This is more or less similar to what we found in the literature, although here we have not related this number to the overall population and can thus only speak of a main characteristic. Unfortunately, we did not receive any information on the gender of the victims.

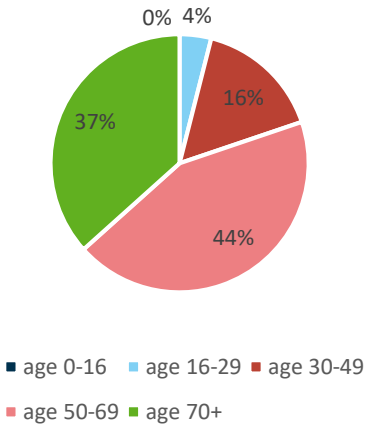

Figure 3 Age distribution of fatalities (Norway, 2016-2017)

Concerning the *intervention characteristics,* we see that most fires are reported during the night and in the morning (see Figure 6). While this time period from 00.00 hours till 12.00 hours comprises only half a day, more than 70% of the fires occur in this part of the day. This means that we can speak of an increased risk of a fatal residential fire between 00.00 and 12.00 hours. Unfortunately, we did not receive information on the day of reporting of the fire. When looking at the month of reporting (Figure 7), we see that most fatal residential fires occur in the winter months, as well as in April and June. This is partly in line with what we find from the literature, where we also see a higher risk in winter months. The data is only reported over 2 years, which might explain the peaks in April and June.

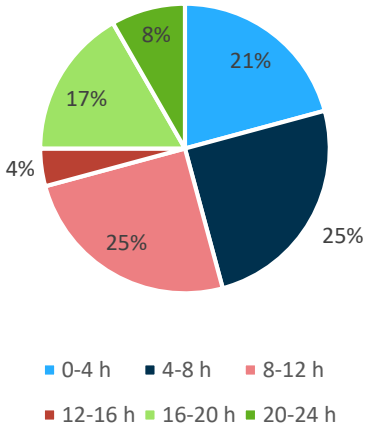

Figure 6 Distribution of time (h) of reporting (Norway, 2016-2017)

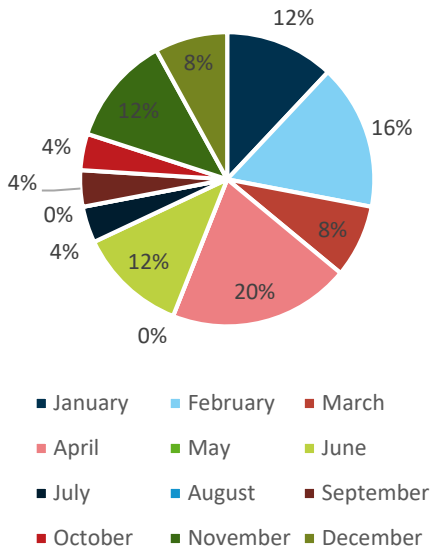

Figure 7 Distribution of month of reporting (Norway, 2016-2017)

Furthermore, the mean of the response times of the fire brigade in Norway was 12.69 minutes. When looking at the escape and rescue attempts, we see that in most cases (92%) people did not escape the fire with assistance of the fire brigade (see Figure 4). We did not receive any numbers on how many of these people had already died when the fire brigade arrived.

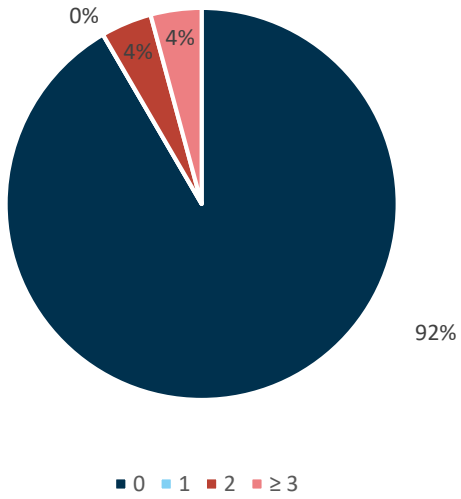

Figure 4 Number of people that escaped with assistance of the fire brigade (Norway, 2016-2017)

Regarding the *fire characteristics*, the cause of the fire was not reported in half of the 24 cases (see Figure 5). Of the remaining fatal residential fires, most fires were caused by smoking (17%), followed by an unknown cause (13%). In the literature, we have also seen that smoking is seen as a risk factor for dying in a residential fire.

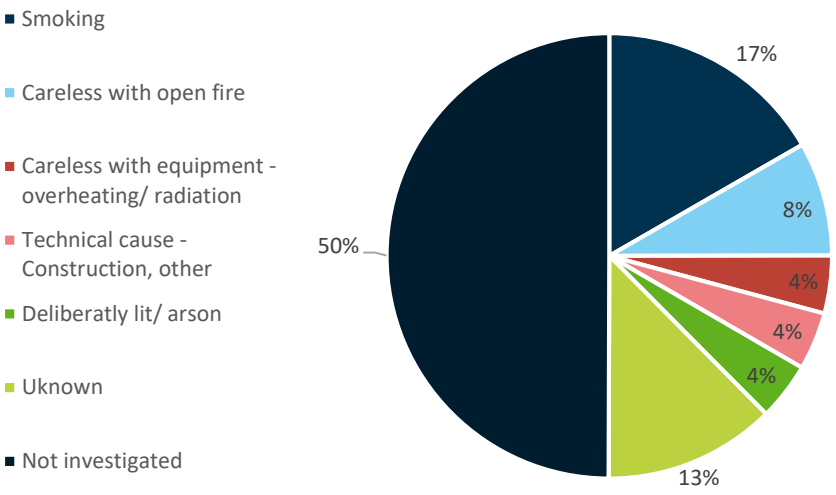

Figure 5 Causes of fatal residential fires (Norway, 2016-2017)

The room in which most fatal residential fires originated was the living room (38%). Of the 24 fatal residential fires, 9 fires originated in the living room (see Figure 6), followed by an unknown room (5 fires) and the kitchen (4 fires). This is only partly similar to what we found from the literature, where most also originated in the living room. However, in the data from 2016-2017, we see no fires originating in the bedroom, while this is identified as a main characteristic in the literature. Furthermore, we see that fires outside the house are also included in the definition of fatal residential fires in Norway (see also paragraph 3.2.2).

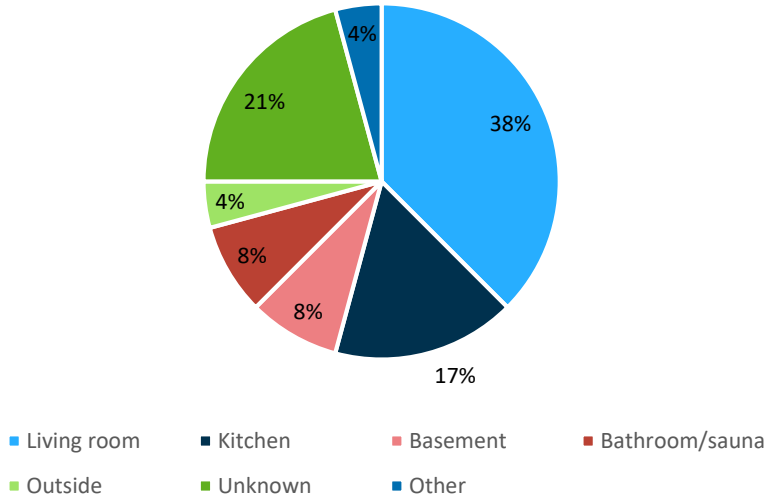

Figure 6 Distribution of room of origin of the fire (Norway, 2016-2017)

Similarly, in most cases, the object in which the fire originated was not investigated/reported (10 fires) or unknown (4 fires) (see Figure 7). Of the identified objects, most originated in furniture and electric equipment, although we are only speaking of 2 fires for each category.

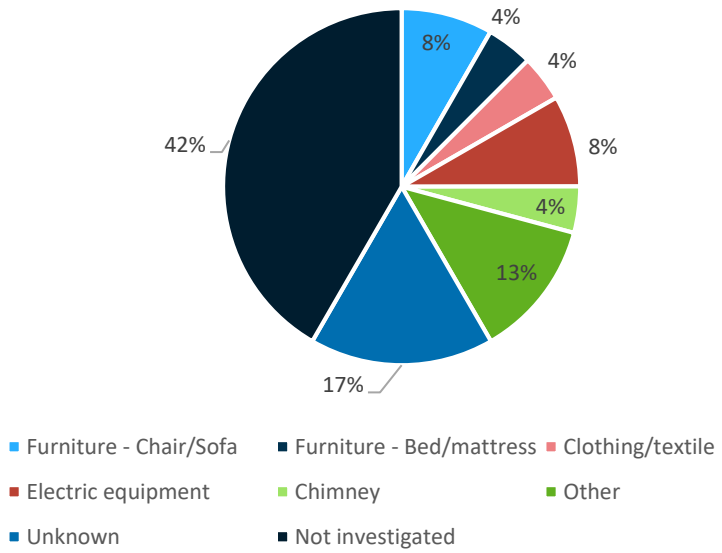

Figure 7 Distribution of object in which the fire originated (Norway, 2016-2017)

In most cases, the fire was still raging when the fire brigade arrived (18 fires, 75%) and in some cases there was only smoke (16,7%) (see Figure 12). Of the 18 fires that were still raging, most were still limited to the room in which the fire originated (see Figure 9), but in multiple objects, the other fires had already developed over multiple floors (44,4%).

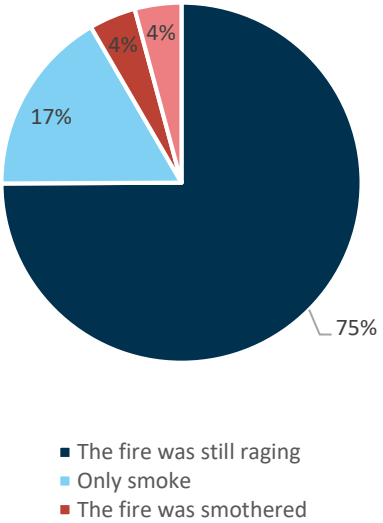

Figure 8 Situation of fire when the fire brigade arrived (Norway, 2016-2017)

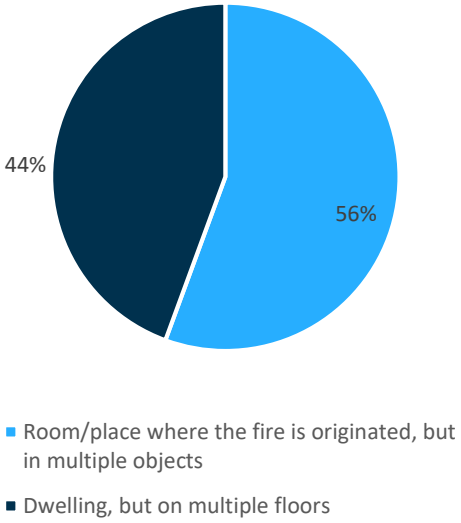

Figure 9 Fire development (Norway, 2016-2017)

With regard to smoke detectors, a smoke detector was present (45.8%) (see
4) in most fatal residential fires in Norway. However, in most cases it was either not reported or unknown whether the smoke detector was functioning (79.2% unknown) (see Figure).

Since these numbers are not related to the overall number of smoke detectors in Norwegian houses, and their functioning, we can only speak here of main characteristics.

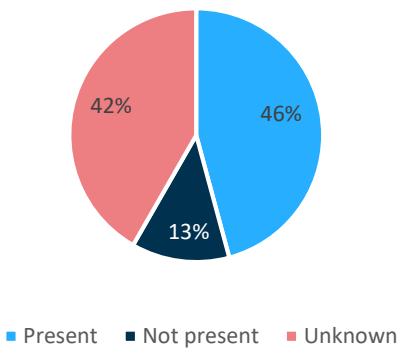

Figure 14 Presence of smoke detectors in fatal residential fires (Norway, 2016-2017)

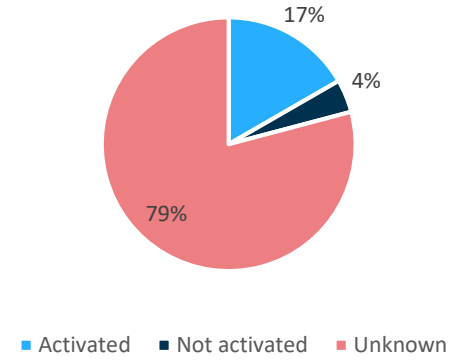

Figure 15 Activation of smoke detectors in fatal residential fires (Norway, 2016-2017)

Concerning the *building characteristics,* most buildings in fatal residential fires in Norway consist of one floor (25%), followed by two floors (21%) and three floors (13%), although in most cases the number of floors is unknown (29%) (see Figure 16). However, we cannot conclude anything regarding risk factors regarding the number of floors since we have no data on the number of floors that is common for Norwegian houses. The type of dwelling in which the victims lived was, in most cases, a detached single family house (50%) (see Figure 17). This is also similar to the findings in the literature. However, this number is not related to the overall number of detached houses. In the literature we found that most people in Norway also live in detached houses and that the chance of dying in a fire is relatively higher for people living in an apartment.

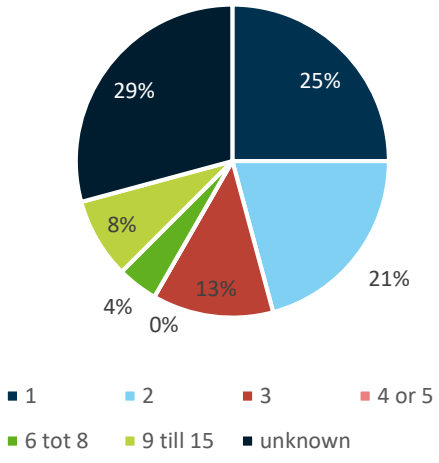

Figure 16 Number of floors in buildings where fatal residential fires occur (Norway, 2016-2017)

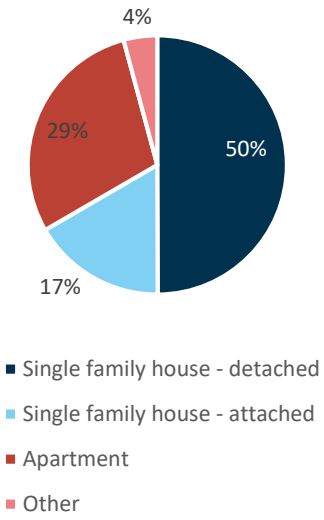

Figure 17 Type of dwelling where fatal residential fires occur (Norway, 2016-2017)

5.2.3 Conclusion Norway

When combining the findings from both the literature and the data we received, we can identify several risks factors and main characteristics of fatal residential fires in Norway and these are summarized below. In case these sources show differences, we have indicated this. When there is relatively a higher chance of dying in a fire, we speak of risk factors. These numbers are, for example, related to the overall Norwegian population, or to non-fatal residential fires. When the numbers are not related, we can only speak of cases that are most common - we call this 'main characteristics'.

Risk profile:

- Elderly people (median 59), with increasing age, the chance of dying in a fire increases.
- Men (only in some age groups)
- Elderly (67 years or older) in combination with:
  - physical disability
  - reduced mobility
  - mental disorder
- People under 67 years in combination with:
  - substance abuse
  - mental illness
  - alcoholic influence
- Smoking/ smokers
- Known substance abuse
- Alcohol consumption
- People living alone, single people (more often home alone?)
- Fires that are reported in the night and morning (00.00 till 12.00 hours)
- Winter time (especially December and January)
- People living in block/apartment

Main characteristics:

- Elderly (67 years or older) with impaired vision, hearing or mobility
- People with a mental illness
- Victim found in the room where the fire originated
- Fire originated in living room (literature; also bedroom/ data; also kitchen)
- Cause of death: asphyxiation
- Reason for not surviving the fire: toxic effect of carbon monoxide
- Mostly one fatality per fatal residential fire, and mostly no additional injured people
- In most cases no person escaped with the assistance of the fire brigade
- Object of origin: furniture and electrical equipment (although mostly unknown/ not reported)
- In most fatal residential fires, the fire was still raging when the fire brigade arrived, and the fire was in the room of origin but in multiple objects
- In most cases a smoke detector was present, but its functioning was mostly unknown
- Most fatal residential fires occur in houses with one or two floors
- Most fatal residential fires occur in detached single family houses (although relatively the risk is higher in an block/apartment, see risk profile)

5.3 Belgium

5.3.1 Literature Belgium

We first examined the *human factor* of fatal residential fires in Belgium. An analysis of the literature revealed that the percentage of male fatalities in 2015 (57%) and 2016 (54%), is marginally higher than the rate of female victims (Renders, 2017). The trends regarding the age of the fire fatalities are more significant, since, in 2016, 51% of all victims was older than 60 years. Moreover, in the same year, more than one third of the fire victims was older than 70 years, while representing less than 13% of the overall population of Belgium.

Referring to the *intervention factor* of the time when the fire was reported, we see that in 2015 and 2016, most of the fatal fires started in the evening or at night, however, no clear pattern is found for the number of fires throughout the year (Renders, 2017). As for *fire characteristics* and *building characteristics,* no information could be found in the literature.

5.3.2 Data Belgium

Our contact person from Belgium filled out the second questionnaire with the data that is available from Belgium. This means we only have data on age, gender, and the day and month of reporting of the fire. The data is reported over 2014 and 2015. In this timeframe, 103 fatal residential fires took place in Belgium, in which 128 people died. In total there were 20,414 residential fires in this period.

With regard to the *human characteristics,* we can conclude that most people that die in a fatal residential fire are between 31-45 years, followed by the age groups of 46-60 and 81-90. Although we have not compared these numbers to the overall age distribution of the Belgium population, and thus cannot speak of risk factors, we see that the number of children dying in a residential fire is low (see Figure 18). When looking at the gender of the victims, we see that more men (53%) than women (43%) died in a fatal residential fire. This difference is bigger than the difference we found in the literature. Furthermore, when looking at the general gender distribution of the Belgium population[23], we see that there are 103 women per 100 men, thus we can conclude that being male is a risk factor for dying in a residential fire (see Figure 19).

[23] https://ec.europa.eu/eurostat

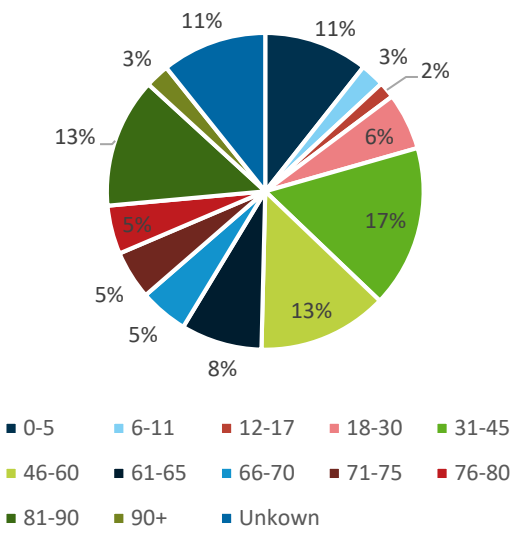

Figure 18 Age distribution of fatalities in Belgium (2014-2015)

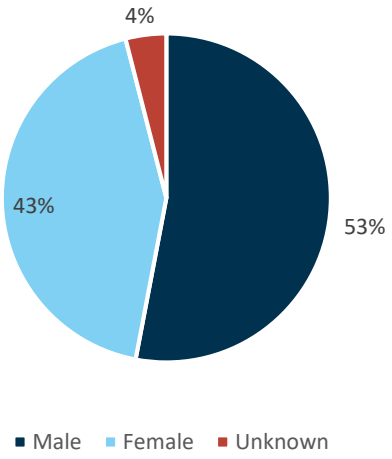

Figure 19 Gender distribution of fatalities in Belgium (2014-2015)

When examining the *intervention characteristics,* we find that most victims of fatal residential fires occur on Saturday (23%), while the number of victims is the lowest (5%) on Thursdays (see Figure 20). Since the days equally divide the week into seven, we can speak of a higher risk of dying in a fatal residential fire on a Saturday. When looking at the month, we see that most people died in fires that occur in June (16%), followed by January, March and December (each accounting for 13%). When looking at the season, we see that almost half of the fires (45%) occurred in the winter months (December- March). These four months only account for 25% of the year and so we can conclude that the winter is a risk factor (see Figure 21).

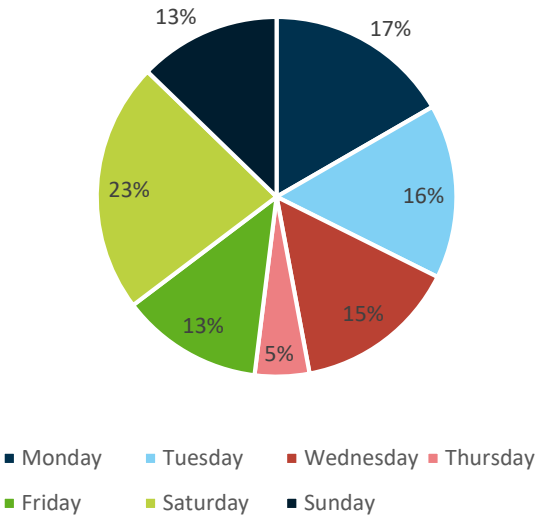

Figure 20 Distribution of day of reporting (Belgium, 2014-2015)

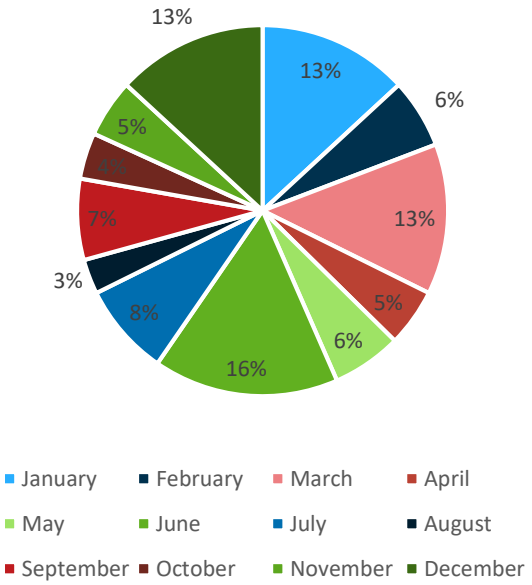

Figure 21 Distribution of month of reporting (Belgium, 2014-2015)

5.3.3 Conclusions Belgium

We combined the findings from both the literature and the data we received to identify a few risks factors and main characteristics of fatal residential fires in Belgium. The risk profile and main characteristics of fatal residential fires in Belgium are summarized below.

Risk profile:
> Elderly (> 60 year, especially > 70 years)
> Men
> Evening and night hours
> On Saturdays
> Winter months (December - March)

Main characteristics:
> Age categories 31-45, 46-60 and 81-90

5.4 Estonia

We have not found any (English) literature on fatal residential fires in Estonia. However, we did receive data from our Estonian contact person who filled out the second questionnaire. The data is reported over five years from 2013 till 2017. In this period, a total 176 fatal residential fires occurred, compared to 3,824 residential fires. In total there were 204 residential fire fatalities. Overall 195 fatal fires with 228 fatalities took place. In most fatal residential fires, only one person died (75%) (see Figure 22). We have not received information on the number of people that were injured, in addition to these fatalities.

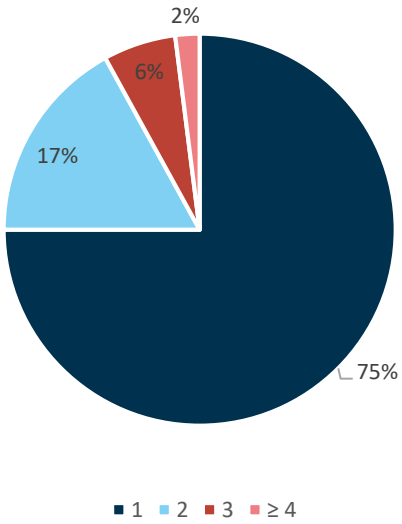

Figure 22 Number of fatalities per fatal residential fire (Estonia, 2013-2017)

Regarding *human characteristics,* we see that most fatalities occur in the 61-70 age group (25.5%) and that the number of fatalities generally increases with age, and decreases again in the age groups of 71 and over (see Figure 23). It is possible that this small decrease can be explained by a smaller population in these age categories, however, these numbers are not related to the overall population. For this reason, we cannot speak of risk factors, but only of main characteristics.

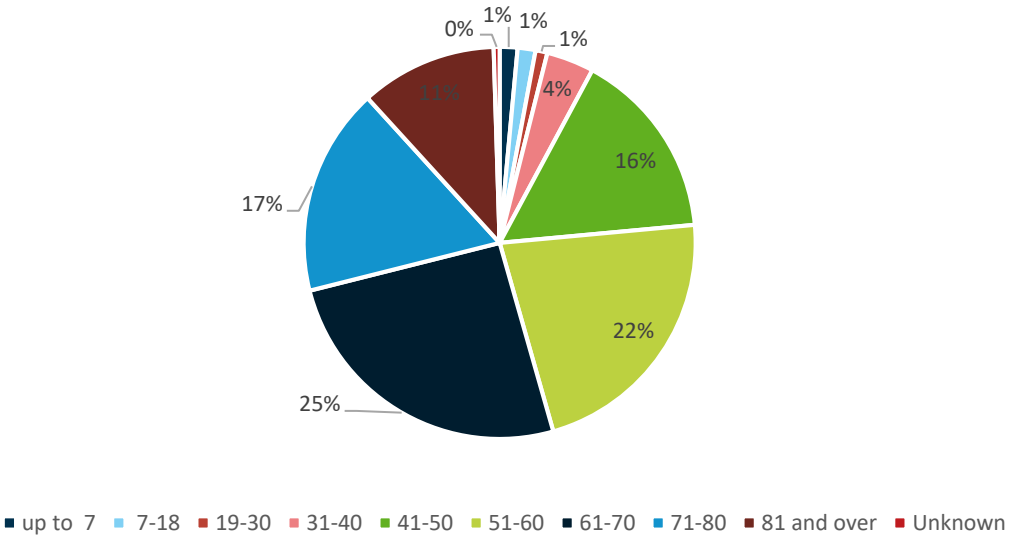

Figure 23 Age distribution of fatalities (Estonia 2013-2017)

Furthermore, we see that most fatalities are men (68%) (see Figure). When comparing this to data on gender distribution in Estonia from Eurostat[24], we see that over 2013-2017 there are more women than men living in Estonia. The average ratio is 113.72 women per 100 men. This means that it is possible to speak of a higher risk for men of dying in a residential fire.

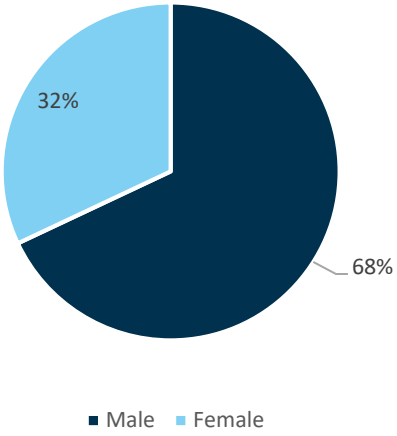

Figure 24 Gender distribution of fatalities (Estonia 2013-2017)

When looking at the *intervention characteristics*, we see that most fatalities occur during the night (02.00 hrs - 06.00 hrs), and relatively little during the afternoon (14.00 hrs – 18.00 hrs) (see Figure 25. In general, the time of reporting of the fire is relatively evenly distributed, except for the afternoon, when not many fatal residential fires are reported. Since these six timeframes each represent one-sixth of the day, we speak of a risk factors. Examining the days in which most fatal residential fires occur, we find that most fires occur on a Friday (17%) or Saturday (16%), and the least on Tuesday (11%) (see Figure 26). However, these differences are small, and fatal residential fires are quite equally distributed over the days of the week.

[24] https://ec.europa.eu/eurostat

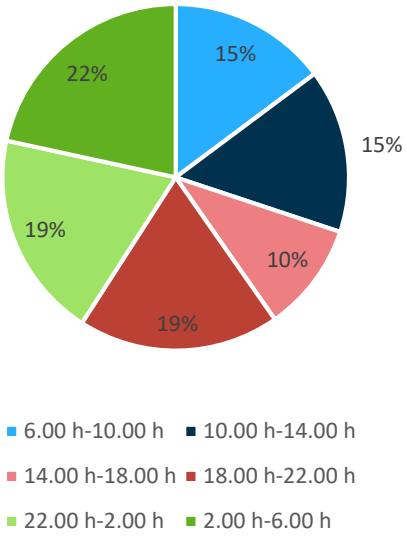

Figure 25 Distribution of time (h) of reporting (Estonia, 2013-2017)

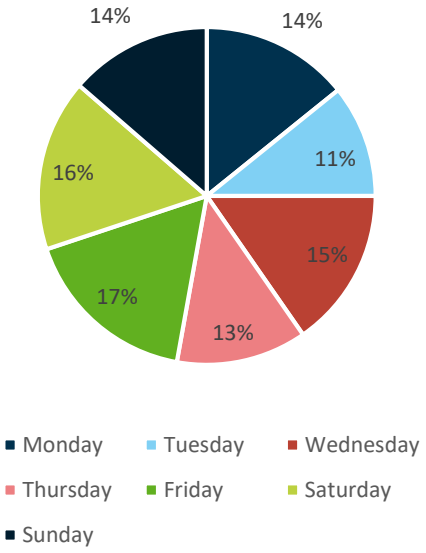

Figure 26 Distribution of day of reporting (Estonia, 2013-2017)

Considering the months in which the fatal residential fires occur, we see that most of the fires occurred in December (18%) and January (16%) and in winter time. Relatively few fatal residential fires took place in the summer months (see Figure 27).

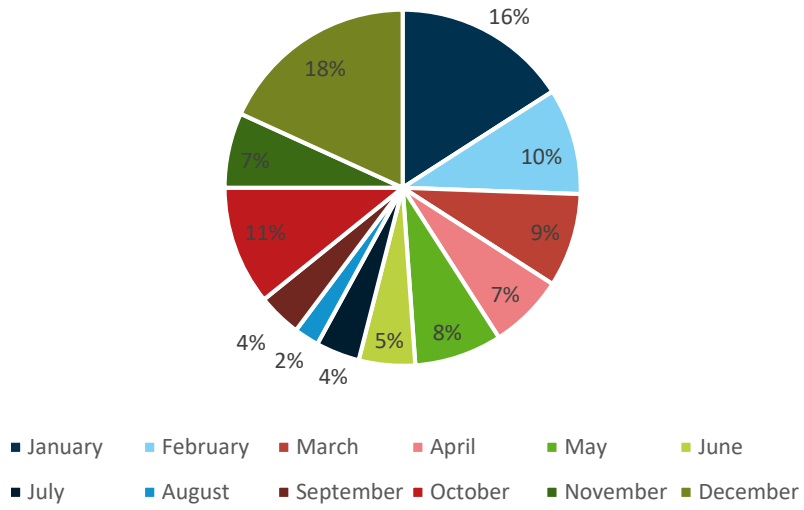

Figure 27 Distribution of month of reporting (Estonia, 2013-2017)

Regarding the *fire characteristics,* we find that by far the most fatal residential fires are caused by smoking (47%), followed by being careless with open fire (15%) and an unknown cause (14%). Cooking only comprises 1% of the causes of fire (see Figure 28). However, we

could not relate these numbers to the overall number of residential fires and their causes and we therefore cannot speak of risk factors, only main characteristics.

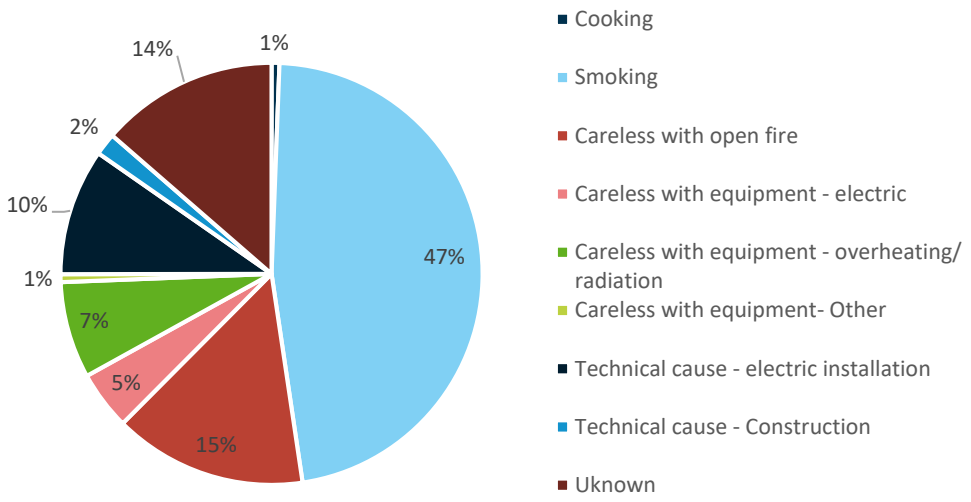

Figure 28 Causes of fire (Estonia, 2013-2017)

Considering the room of origin of fatal residential fires, we conclude that most fires occur in the living room (47%) and the least in the heating room, balcony and bathroom/sauna (all accounting for 1%) (see Figure 29). Only 15% of the fatal residential fires occur in the bedroom. We have no data on how much time people on average spend in each room, thus we cannot speak of risk factors. However, we would assume that people spend most of their time in the bedroom (especially when they are at work during the day) and living room. Information on the object in which the fire originated is not collected in Estonia (see also paragraph 4.2.4).

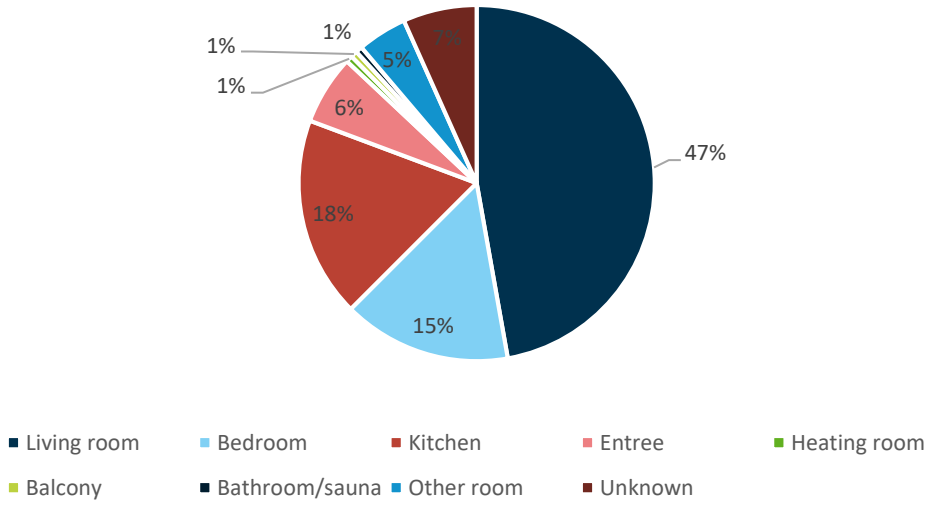

Figure 29 Room of origin of fire (Estonia, 2013-2017)

When examining the situation of the fire when the fire brigade arrived, we see that in most fatal residential fires, the fire was already in major parts of the building (48%). However, in 30% of the cases there was only smoke and no visible fire (see Figure 30).

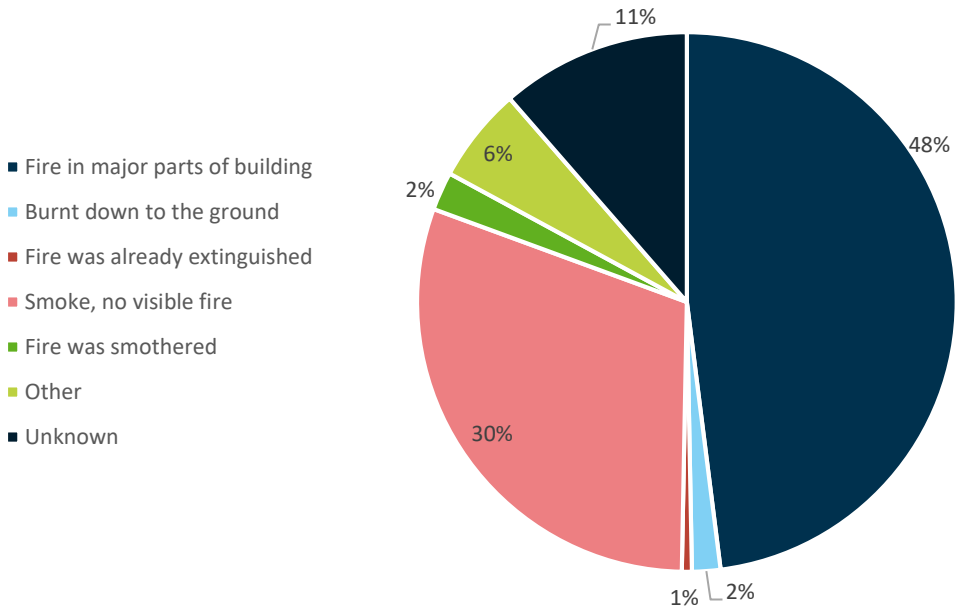

Figure 30 Situation of the fire when the fire brigade arrived (Estonia, 2013-2017)

When looking at the *building characteristics*, the type of dwelling in which most fatal residential fires occur is a detached single family house (52%), followed by an apartment (47%), while only 1% occur in a semi-detached house. Between 2013 and 2017, no fatal fires occurred in a multi-unit dwelling (see Figure 31).

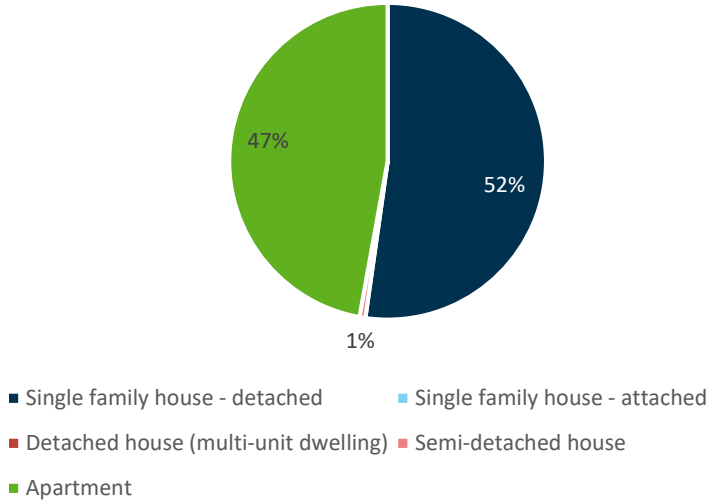

Figure 31 Type of dwelling where fatal residential fires occur (Estonia, 2013-2017)

Risk profile:
> Men
> Most fatal residential fires occur during the night, evening and morning (relatively few in the afternoon)
> Winter months, especially December and January

Main characteristics:
> One fatality per fatal residential fire
> Increasing age from 41 and over, although slightly decreasing from 71 and over
> Most fires occurred in detached single family house and apartments
> Most fires are caused by smoking
> Most fires occurred in the living room
> When the fire brigade arrived, in most cases the fire was in major parts of the building

5.5 Denmark

On the subject of *human characteristics,* we see that in Denmark men are more likely to die in a fire than women (Gummesen, 2017). Denmark had a high ratio in 2012, 2014 and 2015, when more than twice as many men than women died in a fire. Only in the 80-89 age group did more women die in a fire than men, which also reflects the population distribution in this age group. Furthermore, with increasing age, the number of fatalities also increases, most fatalities are 50 years or older. Generally, there is more than one fatality per fatal fire. On average, 1.2% of the residential fires were fatal in the period from 1998-2015. The study does not provide any information about the influence of alcohol, drugs or medicines and does not tell us whether the victims were asleep or awake.

When looking at the *intervention characteristics,* we see that the time of year when most fatal fires occur are the winter months. In general, there are more fires in December and January.

With regard to the *fire characteristics,* the two major causes of fire are smoking and the category where the cause of the fire is unknown. Regarding the room of origin of the fire, most fatalities occur in fires that started in the living room (32.2 %), followed by ‘unknown room’ (31.3%) and the bedroom (22.5%). Compared to residential fires, most kitchen fires end well, with no fatalities, while fires that start the bedroom (mostly fatal), and ‘unknown room’ and living room are more often fatal than not. Of all fatal residential fires, most fires start in an unknown object (34.2%), or bed (21.6%). The most common cause of fire is smoking (50.8%), followed by unknown cause (16.4%).

As for the *building characteristics,* the dwelling types in which most deaths occur are apartment buildings (1.65 per 100,000), followed by single family houses (0.94 per 100,000). However, people living in care homes and protected residents are most likely to die in a fatal fire (on average 14.78 per 100,000 between 1998-2015). Compared to Sweden and Norway, Denmark has a lot more fire fatalities in care homes and protected residents, while the total number of fire fatalities is similar. Unfortunately, the study does not include information on the use of smoke detectors (Gummesen, 2017).

Risk profile:
> Men
> People that are 50 years or older
> Winter months (especially December and January)
> Fire starting in living room and bedroom (and in unknown room)
> Fire starting in bed (and unknown object)
> Fire cause is smoking (and unknown cause)
> People living in apartment buildings (and to a lower extent) single family houses)
> People living in care homes and protected residents

5.6 Sweden

With regard to the *human characteristics,* information on gender and age is collected by the Swedish Civil Contingency Agency (MSB). However, the study by Andersson, Johansson & Strömgren (2015) does not provide us with information on the results. Other sociodemographic data, for example on impairment and the living situation is not collected. Usually only one person is present in the fire compartment when the rescue service arrives at a fatal residential fire (although the study does not provide information on the living situation, this might indicate that the fatal victims are more often are home alone).

When examining the *intervention characteristics,* we see that there is a difference in the time of the day between fatal fires and other residential fires. For fatal residential fires, the time when the fire alarm came peaks between 0200 and 0300 in the night, while for residential fires the general peak is between 1800 and 1900 hours in the evening. This might indicate that most fatal victims were asleep when the fire occurred, which might have influenced their state of alertness; unfortunately the study does not provide information on their being asleep or awake. The number of fatalities is highest in the winter, especially in the months of December and January, and lowest in the summer months. A similar pattern is found for the number of fires throughout the year. During the weekends there are slightly more fires, and the number of fatal fires is also higher towards the end of the week (Andersson et al., 2015). Furthermore, the study includes information on living areas and finds that fatal residential fires (as well as residential fires) are more common in more rural areas.

When looking at the *fire characteristics,* we see that for fatal residential fires in Sweden the most common cause is ‘unknown’ (39%) followed by smoking (27%). Other common causes are ‘deliberately lit’, ‘heat transfer’, ‘forgotten stove’ and ‘lit candle’, each counting for around 6% of fatal fires (Andersson, Johansson, & Strömgren, 2015). Fires starting in the living room and bedroom are the most fatal ones, including fires starting in an unknown room. Many people also die in fires that start in the kitchen. However, compared to the overall number of fires that start in the kitchen, these fires are less fatal. Most fatal residential fires start in bed (14%), in furnishing (11%), or in a sofa/ armrest chair (9%), although for 34% the start item was unknown. In most fatal fires, the fire had already spread to several rooms (46%) when the fire brigade arrived. Compared to non-fatal residential fires, in fatal fires the fire has already spread further.

Regarding the *building characteristics,* most fatal residential fires are in apartments and single family houses (Andersson et al., 2015). However, most people in Sweden live in single family houses, followed by apartment buildings. Relatively the number of fatalities is a little higher for apartment buildings. In most fires there was no smoke detector present (42%), and in fatal fires this was even (46%) with no smoke detector (32% with smoke detector, 22% unknown). Thus, there is only a small difference regarding the presence of smoke detectors in residential fires and fatal residential fires. Furthermore, fires seem to be more fatal in buildings with more floors, although the difference with non-fatal residential fires is small.

Another Swedish study that combines data from fatal fires with data from forensic examinations and the Swedish Cause of Death register, identifies the male sex, old age, alcohol and smoking as risk factors. Furthermore, the study identifies *six clusters of fatalities* (Jonsson, Bonander, Nilson, & Huss, 2017). The first cluster can be summarized as death caused by burns after the ignition of clothing or paper, often due to smoking. Victims were often elderly women (80+ years) living in an apartment or nursing home. In contrast to other clusters, victims were very rarely intoxicated. The second cluster consists of victims that mostly died after smoking-related furniture fires originating in the bedroom or living room in an apartment. Most victims where men and of the 45-64 age group. The third cluster is mainly characterized by fires in houses, originating in fireplaces or due to various types of electrical fires, which often caused large fires. The victims mostly died of toxic effects and were more likely to be either young (5-19 years) or old (80+ years). The fourth cluster consists of kitchen fires, where cooking appliance were left on. More often than in the sample average, alcohol was involved, and the victims often died of toxic effects. The fifth cluster contains fires occurring on weekday nights. The cause of the fire was often unknown, involving people from the 45-64 age group, and alcohol was more likely to be involved than the average. Most fires occurred in small municipalities with low average income, low levels of education and negative population growth. The sixth and final cluster was characterized by deliberately set fires, where flammable substances ignited. Most of these victims were men between the ages of 20-64 years.

Furthermore, the study finds that smoking is the most common cause of fire, accounting for almost one third of all fatal fires (Jonsson et al., 2017). The most common primary injury diagnosis was exposure to toxic gases. Fires that started in the living room and bedroom, and fires that started in beds/sofas/armchairs or clothing, were more likely to cause fatalities compared to fires starting in other objects and locations. Compared to non-fatal fires, fatal fires were more likely to occur at night.

Risk profile:
> One person present in fire compartment, when fire brigade arrives
> In winter, especially December and January
> In weekends, and the end of the week.
> Between 0200 and 0300 at night
> People living in rural areas
> Smoking
> Fire started in bed, furnishing, armrest chair or sofa
> People living in apartment buildings (and to a lower extent) single family houses
> No smoke detector present
> Buildings with more floors
> Men
> Elderly
> Alcohol
> Smoking
> Fires occurring at night
> Primary injury diagnosis: exposure to toxic gases
> Fires starting in the living room and bedroom
> Fires starting in beds/sofas/armchairs or clothing

5.7 Finland

For the Finnish Rescue Services, data on emergency calls is collected in a statistical data system (PRONTO) (Kokki, 2011). The data contains e.g. the time, address and coordinates of the emergency call, along with a status summary. Kokki (2011), mentions a risk profile, however we are not sure if we can speak of real risks or only main characteristics, since it is not mentioned that the data is related to the overall population or total number of fires.
The study by Kokki (2011) only provides us with the following information on a risk profile for Finland. Concerning the *human characteristics,* most victims were male and of the 60-69 age group. Most fatal victims lived alone, and a passer-by detected the fire. Living in a detached house is also considered a risk factor. Other risk factors that are associated with fatalities are being a pensioner, having a low income, and being divorced. A final risk was people with a lowered capacity to function, due to the influence of alcohol.

Risk profile/ main characteristics:
> Male, 60–69 years of age
> Pensioner
> Living alone
> Victim alone, passer-by detected fire
> Detached house
> Low income
> Divorced
> Lowered capacity to function due to the influence of alcohol

5.8 United Kingdom

England

Regarding the *human characteristics,* we see in England that age is a risk factor for fatal fires. Those aged 80 and over have a higher fire-related fatality rate, accounting for 5% of the population, but for 20% of all fire-related fatalities in 2016/17. Furthermore, males, aged 46-60 who live alone and drink and smoke in the home have a greater risk of dying in fires. Also young people aged 16-24 (including students) have a higher risk, as well as people with disabilities (Bryant & Preston, 2017). Moreover, Bryant & Preston (2017) refer to research by the British Department for Communities and Local Government which also indicates that people living in a single parent household have a greater risk of dying in a fire. Furthermore, human behaviour also plays a role in fatal residential fires. In addition to smoking, drugs and alcohol are a risk factor for dying in fires[25] due to the incapacity they cause. In 2016/17, there were 1,782 fires and 34 fire-related fatalities in which impairment due to suspected drug or alcohol use was recorded as a contributory factor. However, a steady downward trend can be observed when it comes to the consumption of drugs and alcohol.

On the subject of *fire characteristics,* the largest proportion of accidental dwelling[26] fire-related fatalities (36% in 2016/17) occurs where the source of ignition is smoking materials. Smoking can be considered as a risk factor for dying in a fire since only 6% of all accidental dwelling fires is smoking-related (Bryant & Preston, 2017). Otherwise, cooking appliances are the largest source of ignition for accidental dwelling fires (49%), while they only count for 9% of the fire related fatalities.

Regarding the *building characteristics*, no information could be found in the literature on the type of building. Bryant & Preston (2017) refer to data from the English Housing Survey which indicates that people living in rented households are more likely to experience a fire than owner occupiers, however this information regarding fatal residential fires is not known.

UK

Scotland, England and Wales all use the same Home Office managed IRS to report on incidents attended by Fire and Rescue Services. However, a comparative study of the Scottish Fire and Rescue Service (2017) indicates that the rate of fatal casualties from fires per million population differs between those three parts of the UK. More specifically, the fatality rate in 2016 and 2017 was, just as in previous years, higher in Scotland (8.1) than in England and Wales (4.7 and 6.1 respectively). However, certain missing details about the characteristics of fatal fires makes it hard to identify distinct information and risk factors for England, Scotland and Wales.

[25] The study examines the total number of fires (primary and secondary), while also looking at the number of fire related fatalities.

[26] Note that the IRS defines a dwelling fires as: fires in properties that are a place of residence i.e. places occupied by households such as houses and flats, excluding hotels/hostels and residential institutions. Dwellings also includes non-permanent structures used solely as a dwelling, such as houseboats and caravans.

Risk profile:

> Older people in general (80+)
> Males, aged around 40-60 years (especially those who live alone and drink and smoke)
> Adolescents and young adults, aged 16-24, including students
> People with physical or mental disability
> People living in single parent households
> Smoking materials as source of ignition
> Alcohol and drug consumption
> Smoking

5.9 Poland

We did not receive any data on fatal residential fires in Poland. However, we did find the following information about fatal residential fires in Poland in the literature. The data used in this study concerns 263 fire death cases in the Mazowieckie region of Poland covering the period of 2003-2011 (Giebułtowicz, Rużycka, Wroczyński, Purser, & Stec, 2017). Compared to the statistics of Poland in general, the Mazowieckie region shows similar patterns regarding the number of fire deaths and injuries per million.

Considering the *human characteristics,* approximately 20% of the fatalities were female, 70% male, and 10% where the gender is unknown. The number of fatalities of those living alone and living in families is almost equal (and of 30% the living situation is unknown). However, the proportion of the total population living in single person households is only around 9%. The data therefore indicates that people living alone have a considerably greater risk of dying in a fire. Regarding age, the fire death risk is almost similar for the 30-50, 50-70 and 70+ age groups. For the group under 20 years, the risk is lower (related to the total population).

With regard to the *intervention characteristics,* most fatal casualties are found in the room where the fire originated (up to 60%), often close to an exit. Of these, approximately 25% of the fatalities were found close to upholstered furniture (like sofas beds etc.). However, a large proportion (approx. 30-40%) is also found in locations beyond the room of origin. Of the remaining 10-20%, the location is not reported. When looking at the cause of death, around 50% of fatalities had inhaled toxic gases in doses that were lethal, and 80% had soot in their airways, which indicates that they were alive for some time during the fire because they inhaled significant quantities of smoke particulates. The study does not provide information on whether the victims were asleep or awake. The majority of fatalities died from causes other than CO inhalation, such as burns and/or effects of other gases. Although most fires are confined to the living room or bedroom, the toxic smoke of burning upholstery or bedding rapidly spreads throughout the dwelling, often within a few minutes, which impairs escape efficiency. This is often followed by collapse and loss of consciousness, due to the effects of asphyxiant gases (CO and HCN) or heat. The physiological effects of being exposed to toxic smoke may lead to permeant injury or death (either direct toxicity or the smoke lead to incapacity to escape and the victim dies later due to heat or toxicity).

Regarding the *fire characteristics,* the majority of fires were reported as accidental (approx. 70-80%). The main fire cause is carelessness (including fires involving direct action by an occupant, such as fires caused by candles or cooking (up to 50%)), followed by electrical

failure and cigarettes (10-20%), although in some cases (up to 30%) the cause is unknown. Approximately 70% of the fire victims had consumed alcohol.

Regarding the *building characteristics,* a large percentage (80%) of fire fatalities occur in dwellings[27]. Furthermore, most fatal fires occurred in houses made of bricks (75%)[28]. Other building characteristics, like the dwelling type or presence of smoke detectors (although the possible influence is recognized), are not mentioned in this study.

Risk profile:
> Male
> People above 20 years old
> Single person household, living alone (and unknown living situation)

Main characteristics:
> Accidental fires[29]
> Death due to burns and/ or effects of gases, other than CO
> Victim found in room of origin of the fire (often close to an exit)
> Fires confined to living room or bedroom, but toxic smoke spreads throughout the dwelling
> Fire cause is carelessness (e.g. candles and cooking)
> Victims had inhaled lethal doses of toxic gases
> Victims had soot in their airways
> Under influence of alcohol
> Houses made of bricks

5.10 The Netherlands

In the Netherlands, about 4,200 residential fires are reported each year. Since 2008, statistics on fatal residential fires have been collected and analysed. During the last ten years (2008-2017), 287 fatal residential fires have occurred which have led to 311 fatalities (Brandweeracademie, 2018). Figure 32 shows the distribution of fatal fires and fire fatalities per year.

[27] The study focuses on fatal dwelling fires, note that this term differs from fatal residential fires (as mentioned before).
[28] Since the study does not provide information on the percentage of the population living in houses made of brick, this does not clarify what the risk is of living hoses made of bricks.
[29] Note that in some countries only accidental fires are taken into account.

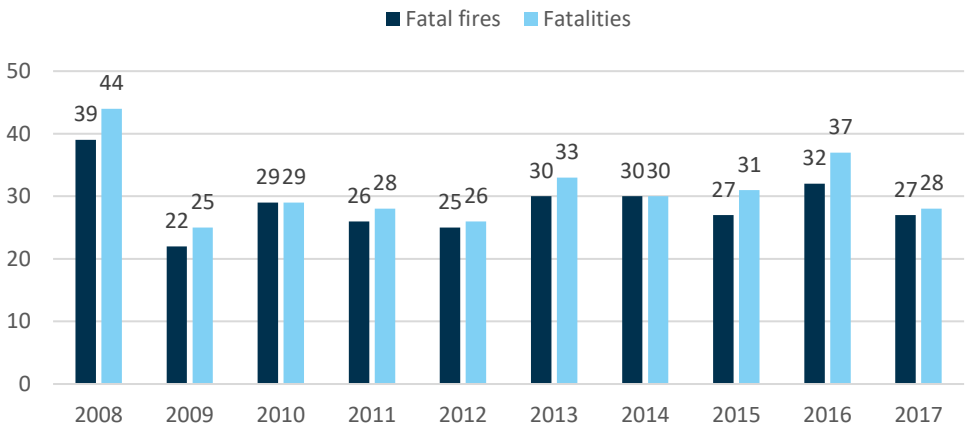

Figure 32 Number of fatal residential fires and fatalities in the Netherlands between 2008 and 2017

With regard to the *human characteristics*, 60% of all victims are male. Most people died in the age category of 61-80 years old (28%) and age 81 and above (22%). The age distribution of the victims is shown in Figure 33. In two third of all cases, the victim was the only person at home during the fire.

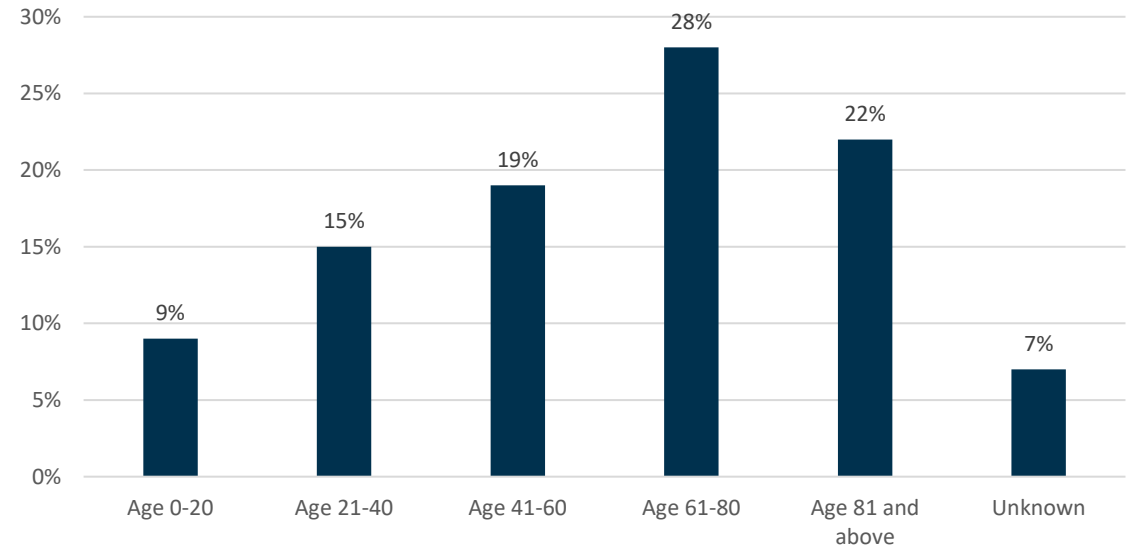

Figure 33 Age distribution of fire fatalities (the Netherlands, 2008-2017)

Compared with the gender distribution of the inhabitants of the Netherlands who die annually, on average men die slightly more often as a result of a residential fire than women. 60% of victims of fatal residential fires are men, while 48% of all inhabitants of the Netherlands who die every year are male (CBS, 2018). 40% of the victims are older than 65, while only about 20% of the Dutch population is older than 65 (CBS, 2018). On the other hand, on average, about 80% of all Dutch residents who die every year are aged 65 years or older (CBS, 2018). Looking at the age of victims by residential fires compared to the age of all causes of death, people younger than 65 are more likely to die due to a fire than people older than 65 years. When looking at the relationship between age and gender, it is striking that almost 60% of the female victims are 65 years of age or older. This is only a third for the

male victims. Compared to the age structure per gender of the Dutch population (CBS Statline, reference date January 1st 2016), women aged 65 or older are most likely to become a victim of a residential fire.

The ability to leave without assistance is determined by the degree of mobility, vision, hearing and intellectual capabilities. We distinguish four levels namely a good, limited, absent, or unknown ability to leave without assistance. Almost half of the victims have a limited or absent ability to leave without assistance. 40% of the victims have a good ability to leave and for 14% of the victims the ability is unknown. 44% of the victims are independently mobile, 32% has a reduced mobility, and 10% is not independently mobile. For 15% of the victims, the degree of mobility is unknown.

The degree of alertness is determined by the level of wakefulness and if a person is under the influence of alcohol, medication or drugs. We distinguish five levels, namely alert, under influence of narcotics while awake, asleep, under influence of narcotics while asleep, and unknown. A person is alert if the person is awake and not under the influence of alcohol, medication or drugs. A third of the victims is asleep and not under the influence of narcotics (Figure 34).

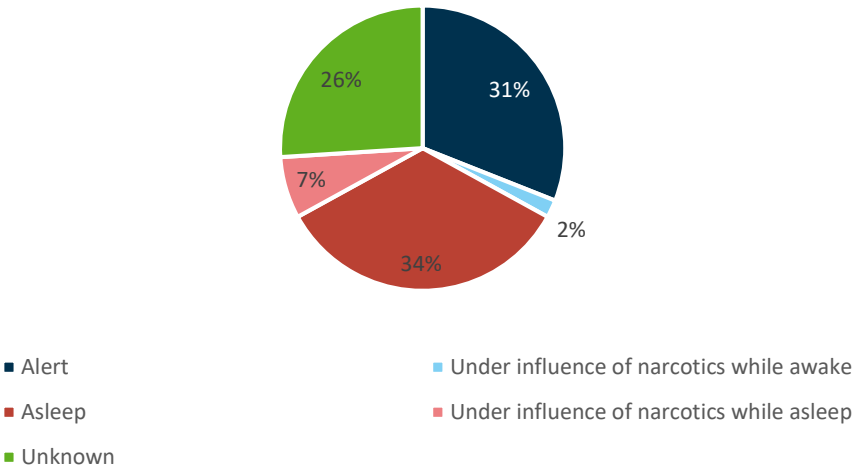

Figure 34 Level of alertness of fatalities (the Netherlands 2008-2017)

Concerning the *intervention characteristics*, we see that the time of reporting the fire is almost evenly distributed over six timeslots in a day (see Figure 35). Looking at the day of the reporting of the fire, we see that slightly more fires are reported during the weekend days (see Figure 36). When looking at the month of reporting of the fire, we see that most fatal residential fires occur in the winter months (December-February) (Figure 37).

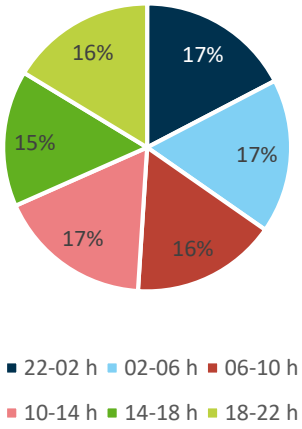

Figure 35 Distribution of time (h) of reporting of the fire (the Netherlands, 2008-2017)

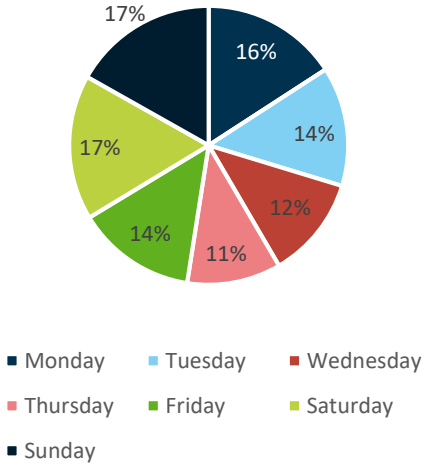

Figure 36 Distribution of day of reporting of the fire (the Netherlands, 2008-2017)

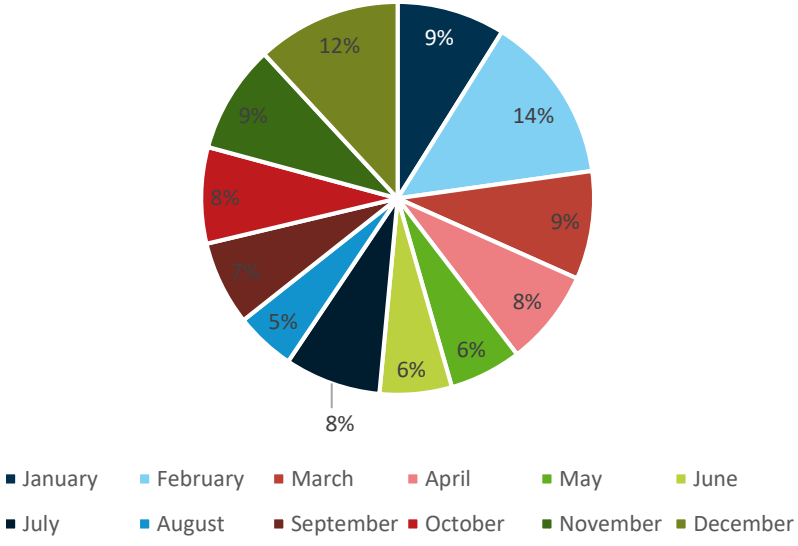

Figure 37 Distribution of month of reporting of the fire (the Netherlands, 2008-2017)

Furthermore, the mean of the response time of the fire brigade in the Netherlands was 7.2 minutes.

As for the *fire characteristics*, 60% of the fatal residential fires in the Netherlands are caused by human behaviour. Carelessness with smoking is the most common cause of fire (26%). Other common causes of fatal residential fires are cooking and carelessness with open fire. In almost a sixth of all fatal residential fires, a technical cause is the cause of the fire. Some fires are caused by an explosion while the cause of almost 20% of all fatal fires is unknown (see Figure 38). Looking at the total of residential fires in the Netherlands, 5% of these fires is caused by smoking (CBS, 2018). This means that it is rare that a residential fire is started

by smoking, but that the chance of this fire causing a fatality is relatively high. This makes smoking a risk factor for fatal residential fires.

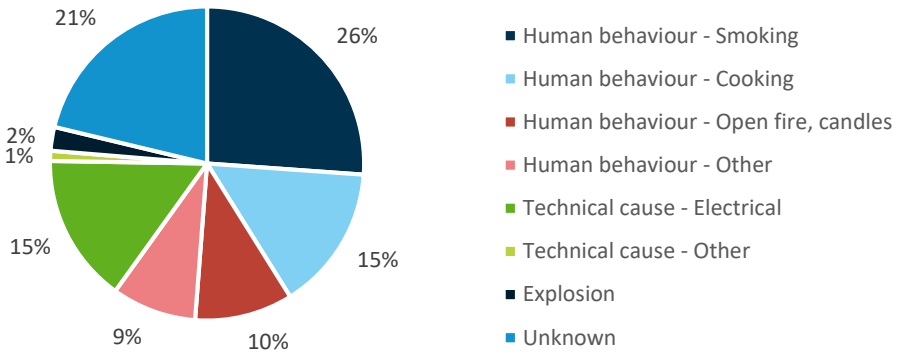

Figure 38 Cause of the fire (the Netherlands, 2008-2017)

Four out of ten fatal residential fires originate in the living room, followed by the bedroom and kitchen (see Figure 39). The category 'different' contains fires that started in a basement, attic, bathroom or study room.

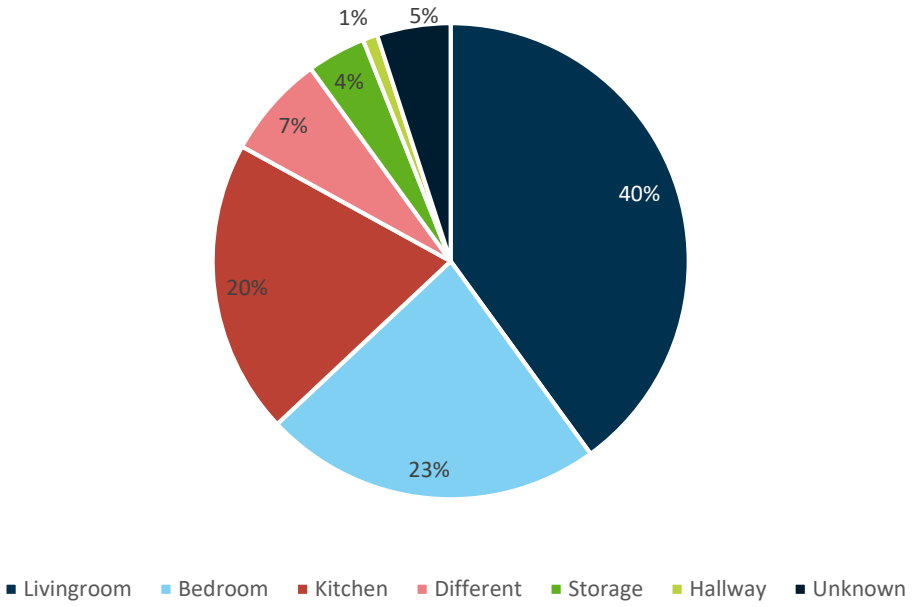

Figure 39 Room of origin of the fire (the Netherlands, 2008-2017)

Of almost 20% of all residential fires, the object of origin is unknown. In cases where the object of origin is known, we see that most fires start in a chair or sofa, clothing/textile or an electrical device (see Figure 40).

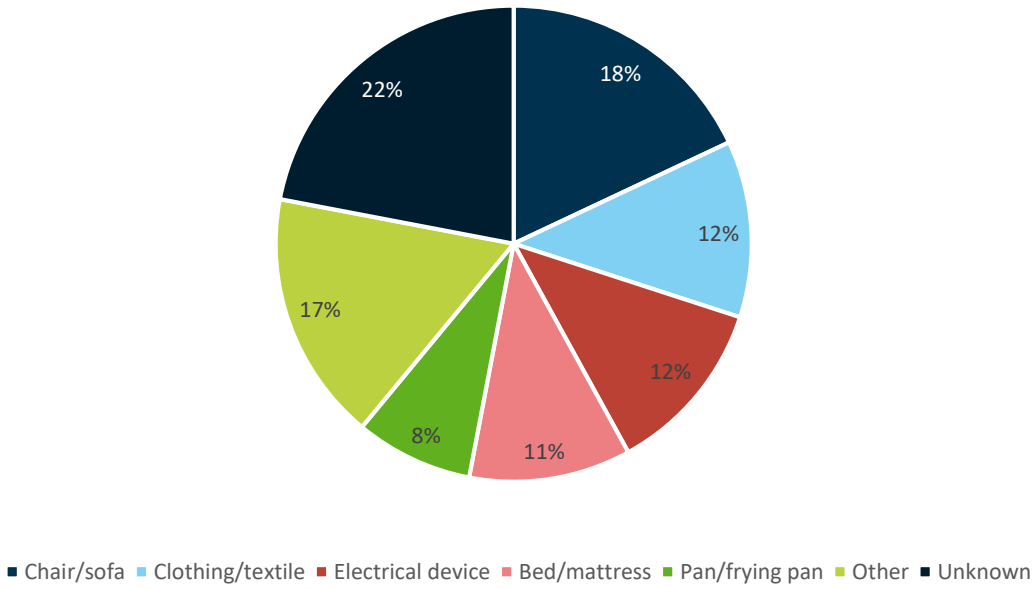

Figure 40 Object of origin of the fire (the Netherlands, 2008-2017)

In three-quarters of all cases of fatal residential fires, the fire was still raging at the arrival of the fire service. For the remaining quarter of fires, it was out (extinguished or smothered). In order to get a better insight into the development of a fire and the spread of smoke, the fire and smoke situation of fatal residential fires is recorded at two moments: on the arrival of the fire brigade and the final situation after the fire.[30]

Fire development

In the vast majority of cases, the fire has not been extended to a subsequent cascade after the arrival of the fire brigade. In more than half of the cases the final fire development was limited to the room of fire origin, sometimes even to the object of origin.

Smoke spread

During the firefighter's operations, the smoke had hardly extended to a subsequent cascade. In most cases the smoke had spread to outside the dwelling.

[30] Recorded since 2010, n=226.

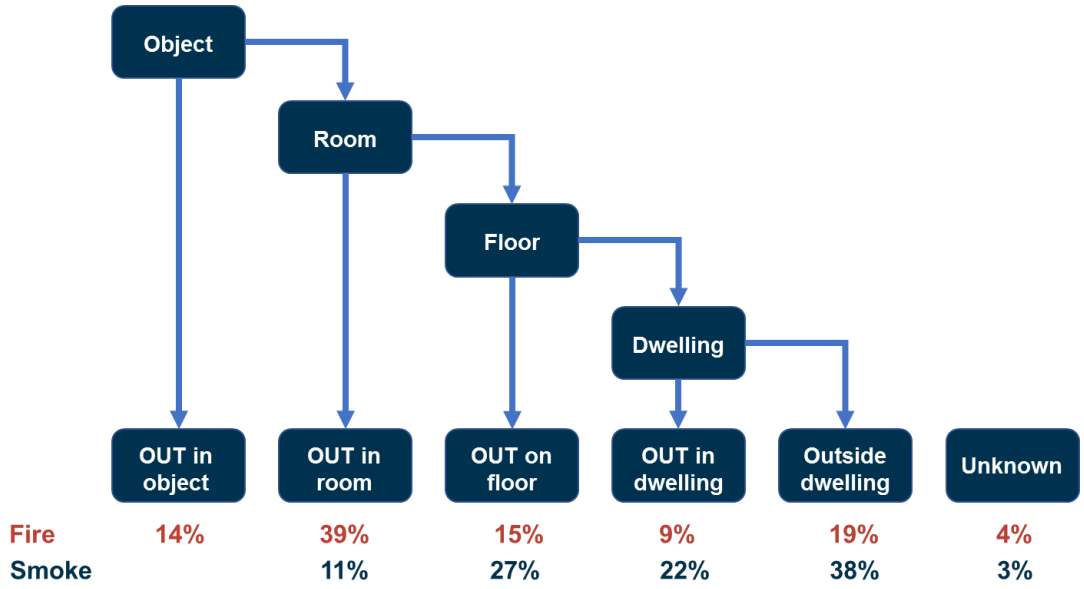

Figure 41 Fire and smoke spread

With regard to smoke detectors, in most fatal residential fires in the Netherlands there was no smoke detector present (46%) (see Figure 42). In almost 25% of all fatal fires, there was a smoke detector present which was functioning in almost 20% of the cases. Since these numbers are not related to the overall number of smoke detectors in Dutch houses, and their functioning, we can only speak here of main characteristics.

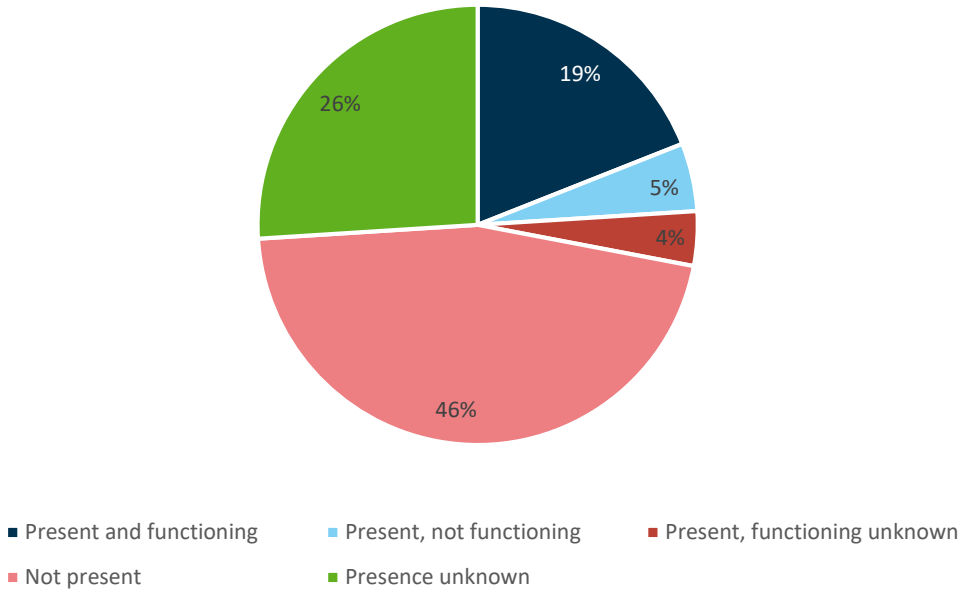

Figure 42 Presence and functioning of smoke detectors (the Netherlands, 2008-2017)

In 5% of all cases, the smoke detector did not work because there was no battery or because the smoke did not come close to the smoke detector. The non-functioning smoke detectors usually hung in the hallway/landing on the floor where the victim was found or in the room where the fire started. The smoke detectors that did give an alarm were mainly

present in the room or origin (78%) or in the hall/landing on the floor where the victim was found (63%).

Concerning the building characteristics, the type of dwelling in which the victims lived was in most cases an apartment, followed by an attached single family house (see Figure). Fatal residential fires are about as common in a single-family home (47%) as in an apartment (44%). Compared to the Dutch housing stock, fatal residential fires occur more often than average in an apartment. In the Netherlands, about 40% of the households live in an apartment (CBS Statline, 2018). Therefore, apartments are a risk factor for fatality in residential fires.

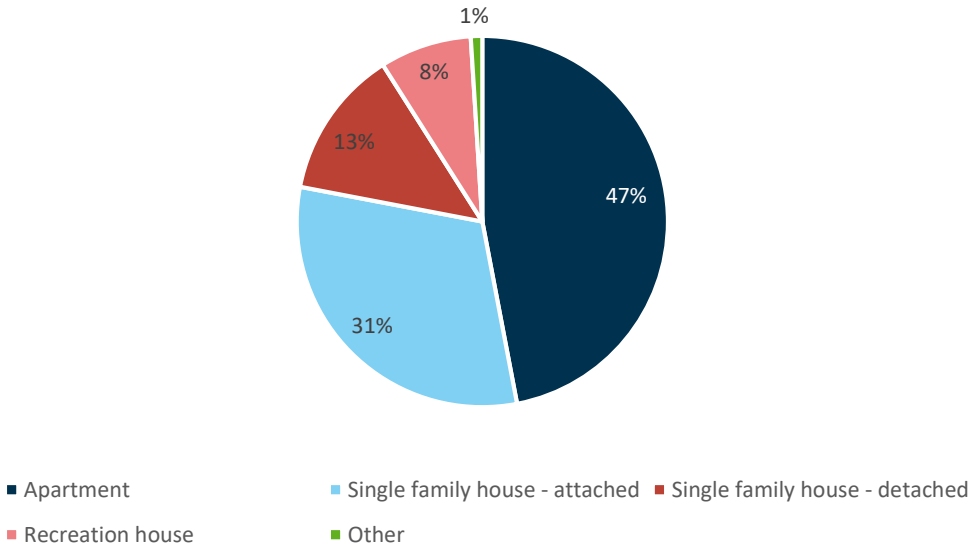

Figure 43 Type of dwelling where fatal fires occur (2008-2017)

5.10.1 Conclusions for the Netherlands

We combined the findings from the Netherlands to identify a few risks factors and main characteristics of fatal residential fires. The risk profile and main characteristics of fatal residential fires in the Netherlands are summarized below.

Risk profile:

> Smoking as a cause of fire.
> Apartment as type of dwelling
> Men, both in relation to people who die annually as the living population
> People younger than 65, compared to people who die annually
> Women older than 65, compared to the living population
> Reporting the fire, between 02.00-06.00 hrs or 06.00-10.00 hrs. Due to the late discovery and reporting of the fire
> People having a limited ability to leave the house without assistance, due to a higher change of fatality despite an activated smoke detector
> Reduced alertness of victim that is found in the room of origin, as in that case there are more often fatalities than when the victim is alert
> Single-person households

Main characteristics:

- People between 61-80 years old or aged 81 and above
- People who are the only person at home during the fire
- Fires reported during the weekend
- Fires reported during the winter months (December-February)
- The absence of a smoke detector
- Fires start in a chair or sofa, clothing/textile or an electrical device
- Fires starting in the living room
- A late (discovery and) reporting of fire
- Cooking and being careless with open fire
- Being asleep in the room wherein the fire originates
- Open inner doors (risk factor for persons present in a room other than the room of fire origin)
- Wearing flammable clothing

5.11 Conclusions

In this chapter we have analysed the risk profiles and main characteristics of the selected countries. We combined the literature and data (from the second questionnaire) in our analysis of the risk profiles and main characteristics of fatal residential fires per country. Overall, we need to make a careful distinction between risk factors and main characteristics, which are only factors that occur most. Although these main characteristics might indicate risks, they first need to be related to the overall population or non-fatal fires. In this chapter we have seen that from the selected countries information is known about many similar factors. When comparing these findings, we can look for similarities and differences between these countries. In the next chapter these findings are combined into a European risk profile and main characteristics are identified which show what additional information is still needed to arrive at a more extensive risk profile.

6 European risk profile

In this chapter we answer the final sub-question: *Is it possible, based on the available information, to draw up a risk profile at a European level? If not, what is necessary to provide the information required for this risk profile?* We will examine the risks at European level by looking at the *general information*, *human characteristics, intervention characteristics, fire characteristics* and *building characteristics* that are associated with fatal residential fires.

6.1 General information

In a few countries, we see as a main characteristic that there is usually only one fatality per fatal residential fire and there are mostly no additional injured people. In addition, in many countries we see that living alone is considered a risk factor.

Furthermore, the number of fatalities per capita per year differs between the selected countries. In the table below, we have listed the number of fatalities per capita per 100,000 inhabitants (see Table 10). The table also shows over which years these numbers have been reported. If possible, we have related the number of fatalities to the total number of residential fires, showing the percentage of fires that were fatal. Furthermore, the population per country is given in the table. Together the nine selected countries represent about one fifth of the population of Europe.

Table 10 Population, fatalities per capita per year and percentage of fatal fires in selected European countries.

Country	Population (million)	Fatalities per capita per year (approx.)	% fatal fires (related to all residential fires)
Belgium (2014-2015)	11,4	0,6 per 100.000	0,5%
Denmark (2011-2012)	5,8	1,1 per 100.000	1,2%
Estonia (2013-2017)	1,3	3,7 per 100.000	4,6%
Finland (2011-2012)	5,5	1,4 per 100.000	
Netherlands (2011-2014)	17	0,2 per 100.000	0,6%
Norway (2016-2017)	5,3	0,5 per 100.000	1,3%
Poland (2011-2012)	38	1,3 per 100.000	
Sweden (2011-2013)	10	1,1 per 100.000	1,2%
UK (2014)	66	0,6 per 100.000	
Total	160,3		
Total Europe	742,9		

6.2 Human characteristics

6.2.1 Gender

Comparing the human characteristics of the selected countries, we see that all countries include information on gender. Generally, more men than women die in fires in all countries, although for some countries this only applies to certain age groups. In the Netherlands and the United Kingdom, men in the 40-60 years (UK) age group or younger than 65 years (NL) appear to have a greater risk of dying in a residential fire. In the Netherlands, women in the 65 years or older age group also have a greater risk of being a fatality in a fire.

6.2.2 Age

Age is a factor in all countries. In general, compared to the average age distribution in the selected countries, the elderly have a higher risk of dying in residential fires than people from other age groups. In the Netherlands, older women appear to have an especially greater risk of dying in a residential fire. In several countries the risk of dying in a fire increases with an increasing age. However, in some countries, other age groups also have a higher risk of dying in a fire (e.g. see Poland and England).

6.2.3 Smoking

In three out of nine countries, we can see that smoking has been identified as a risk factor. However, some countries do not include this as a human factor since smoking can also be approached as the cause of the fire. We need to keep in mind that there is a difference between the risk of dying in a residential fire when you are a smoker, and the risk of fatalities in fires caused by smoking. However, it is not very surprising that these two factors are often confused, since fires that are caused by smoking most likely are caused by an inhabitant that was a smoker. Despite this, people who smoke might still have a higher chance in dying in a residential fire, even if the fire is not caused by smoking. Thus, being a smoker, and smoking as a fire cause are not the same things. Furthermore, when talking about a victim being a smoker, it should be clarified as to how we have measured or determined that victim was a smoker.

6.2.3 Substance abuse/drugs

In only two countries did we see that drugs or substance abuse is identified as a risk factor for dying in a fatal residential fire. However, this information is not collected by many countries and the information is often unknown. Again, it should be clarified as to how the use of drugs is measured or determined when a victim is found. Furthermore, in order to be able to speak of a risk factor, the information on the use of drugs regarding fatalities needs to be related to the use of drugs in non-fatal fires.

6.2.4 Alcohol influence

In four out of nine countries, being under the influence of alcohol is found to be a risk factor. In the figure below (Figure 44), alcohol consumption as related to the number of fatal residential fires is shown per country. In some countries, we have seen alcohol influence combined with gender, where it is especially men under the influence of alcohol who have a higher chance of dying in a residential fire. Similarly, to determine if a victim was a smoker or had used drugs, we need to describe how the influence of alcohol was measured when we report on victims and alcohol.

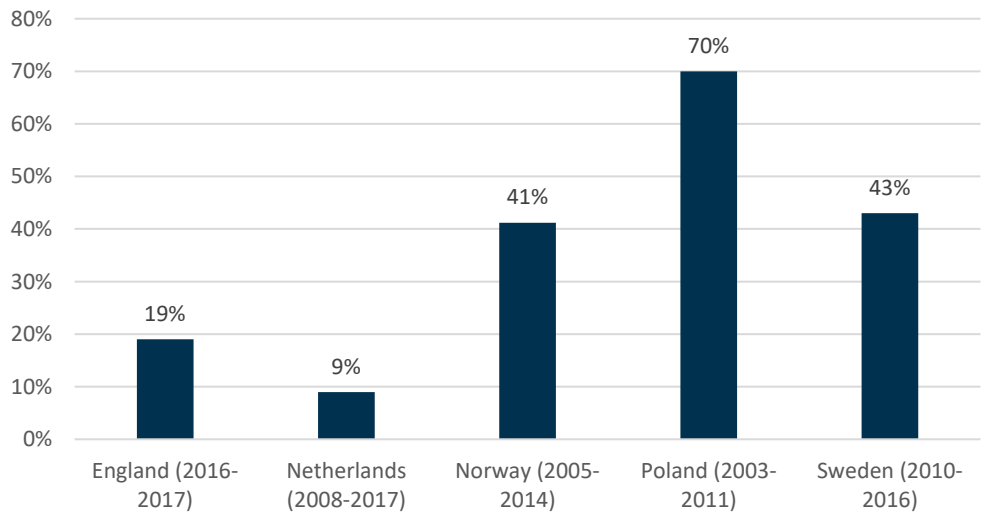

Figure 44 Alcohol consumption in European countries related to fatal residential fires

6.2.5 Living situation

The majority of the studies provide us with information on the living situation of victims of fatal residential fires. Living alone (single persons, and single parent household) is associated with a higher risk of dying in a fire. This is either related to non-fatal fires or to the total population. The hypothesis here is that people who are alone during a fire (single household, or home alone) have a lower chance of discovering the fire and have to escape on their own, and therefore have an elevated chance of dying in a fire (see Sessing, et al. 2017). Interestingly, we also see the victim being alone (in the fire compartment) as a risk factor in two countries, which might also be associated to the living situation.
Furthermore, in two countries (Denmark and the Netherlands), people living in care homes and protected residents appear to have an increased risk of dying from a residential fire.

6.2.6 Impairment

Only three countries (Norway, England and the Netherlands) include data on impairment, like mental illness and physical and mental disability. Both physical and mental disabilities count as risk factors in those three countries. However, in both Norway and the Netherlands, the majority of victims had no impairment (Brandweeracademie, 2018; Sesseng, Storesund, & Steen-hansen, 2017). Nevertheless, in the Netherlands, the percentage of victims with an impairment is compared with the percentage of people with impairments in the overall population and turned out to be a risk factor. Again, it needs to be specified which definitions are used for mental disability, since this seems to differ from the definition of mental illness.

6.2.7 Other items

Sweden collects data on the number of people present in the fire compartment when the fire brigade arrives. Similarly, the Netherlands collects data on the number of people present in the house when the fire brigade arrives. In Finland, background information is collected on income and marital status. The data indicates that both low income and being divorced can be related to fire fatalities.

6.2.8 Conclusions human characteristics

We find that the human characteristics gender and age play a role in all nine countries. In general, the elderly and male gender have a higher risk of dying in a fatal residential fire. In a few countries, the influence of smoking, drugs and alcohol is identified as a risk factor. With regard to the living situation, living alone is considered a risk. Concerning impairment, few countries collect data on impairment and only two countries found a risk for physical and mental disabilities. However, in more countries, having a mental illness or being impaired is associated with fire fatalities. In order to speak of a risk factor, these characteristics need to be related.

European Risk profile – Human characteristics:

> Male
> Elderly
> Smoker
> Drugs
> Alcohol
> Living alone/ single (parent) household
> Victim being alone

Main characteristics:
> Impairment

6.3 Intervention characteristics

6.3.1 Time of reporting

When looking at the *intervention characteristics*, we see that the time at which most fires occur is during the night. There are some differences between the countries; in some countries the evening or morning is also a common factor. Only a few countries relate these findings to the number non-fatal residential fires and speak of an elevated risk. For example, in Sweden most fatal residential fires occur in the night (between 0200 and 0300) in comparison to other residential fires, which mostly occur in the evening (between 1800 and 1900). In order to speak of a higher risk, we need to have the numbers of non-fatal residential fires from more countries.

If we compare the data received, we see that the data was collected on different time frames which makes it harder to compare the countries. However, we do see that in the afternoon the percentage of fires that is reported seems lower than during other times of the day (see Figure 45). This is also in line with our general finding that the risk of a fatal residential fire seems higher at night, and in some countries, in the morning and evening. This also indicates a lower risk in the afternoon.

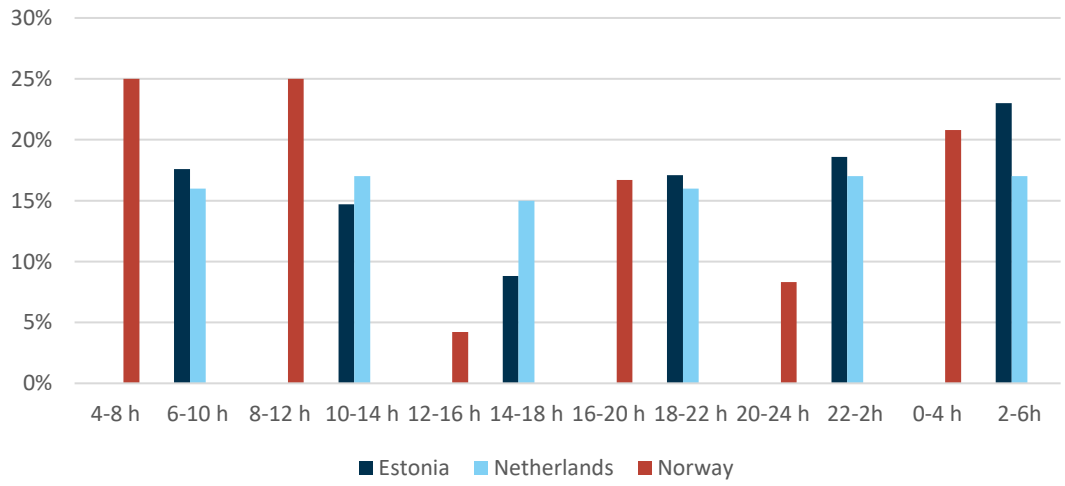

Figure 45 Distribution of time of reporting in Estonia (2013-2017), the Netherlands (2008-2017) and Norway (2016-2017)

6.3.2 Day of reporting

Overall, we found information from a few countries regarding the days on which most fatal residential fires occur. This indicates that there are more fatal residential fires towards the end of the week and in the weekends.

We received data from four countries regarding the day on which the fires are reported. In general, we see a peak of fatal residential fires on Saturdays. Since we can equally divide

the week into seven days, we could speak of a higher risk when the percentage rises above 14% (the complete week counts for 100%, divided into 7 days is an average of 14% per day). Looking at the graph below (see Figure 46), we do not see a very clear pattern, but in general we do see a higher risk on Saturday and a lower risk on Thursday. However, in order to point out specific days as a risk factor for fatality, the figures need to be compared with the figures for non-fatal fires.

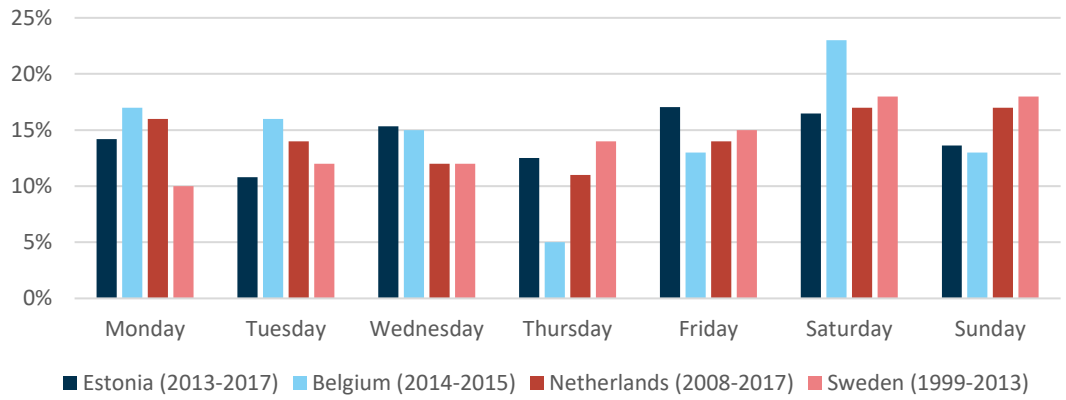

Figure 46 Distribution of day of reporting in Estonia, Belgium, the Netherlands and Sweden

6.3.3 Month of reporting

In almost all countries, we see a peak in the number of fatal residential fires during the winter months. While this is one-fourth of the year, we see that almost half of the fires occur during this period, so we can speak of a high risk for a fire occurring. In many of these countries, the number of fatal residential fires is especially high in December and January. Only in Belgium could no clear pattern be found regarding the month in which most fatal residential fires occur. The figure below shows the data of six countries. Here we can discern a small u-shape, showing that most fires occur in winter and the least in the summer months (see Figure 47). We have no information on non-fatal residential fire and this makes it difficult to point out the winter months as a risk factor for fatalites.

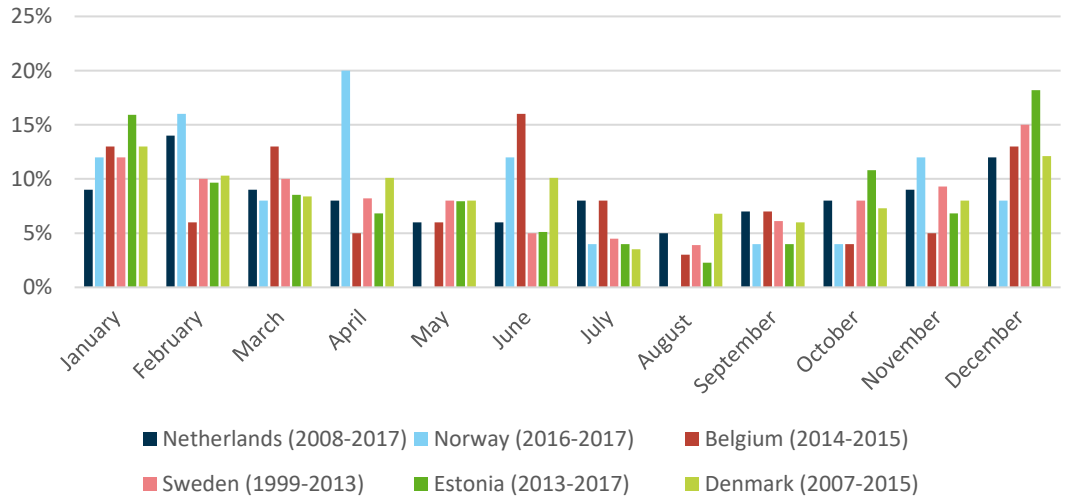

Figure 47 Distribution of day of reporting in Denmark, Estonia, Belgium, the Netherlands, Norway and Sweden

6.3.4 Conclusions intervention characteristics

Regarding the intervention characteristics, we find that most fires are reported during the night. In Sweden it is also shown to be a risk factor for fatality. Furthermore, most fires occur during the weekend, especially on Saturdays. Moreover, in all countries, except Belgium, we see that there is a higher occurrence of fatal residential fires in the winter months. Overall, we are able to speak of higher risk that a fatal residential fire occurs then. However, due to the lack of information about non-fatal fires, we cannot determine whether these factors are also risk factors for residential fire fatalities.

Regarding the type of municipality, only Sweden collects information and finds a higher risk for fatal residential fires in rural areas. It would be interesting to see of this risk can be found in other countries as well. Therefore, more countries should collect data on the type of municipality in which the fire occurs.

In addition to these risk factors, we see that the main characteristics we found show a similar picture regarding fatal residential fires. To expand our knowledge on fatal residential fires in Europe, these main characteristics should be turned into risk factors so that we can come to a better conclusion about the risk factors of fatal residential fires.

Risk profile – Intervention characteristics:
> Reported during the night (in Sweden)
> Rural areas (in Sweden)

Main characteristics – Intervention characteristics:
> Reported during the night (varying in night, evening to night, evening to morning or night to morning)
> Occurred during the weekend
> Occurred during winter months

6.4 Fire characteristics

6.4.1 Cause of the fire

Almost all countries find that *smoking* is related to residential fire fatalities (see Figure 48). Some conclude that the victims are often smokers, while in other countries smoking is identified as a major cause of fatal fires. As mentioned before, it is important to make a distinction between the fatalities being a smoker and smoking as a cause of the fire. Compared to causes all residential fires, it becomes clear that fatal fires caused by smoking have a high risk for causing a fire fatality. We have not been able to find any information on the influence of smoking for Belgium.

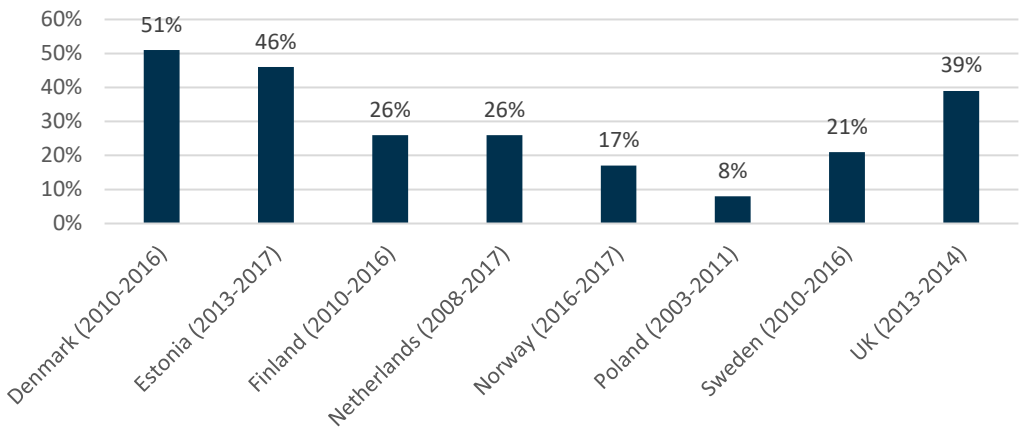

Figure 48 Percentage of smoking as a cause of fatal residential fires in European countries

Cooking is identified as a common cause of fire in all countries. However, in comparison to non-fatal residential fires, fatal residential fires are very rarely caused by cooking. We see this difference in most countries (see Figure 49). This may indicate that cooking often leads to fires, although most of these fires are not fatal. For example, in the Netherlands, on average cooking is responsible for about 15% of the fatal, and 13% of all residential fires (Brandweeracademie, 2018). In the UK, even less fatal residential fires are caused by cooking (0.2%), while about half of all residential fires between 2011 and 2012 were caused by cooking (Department for Communities and Local Government, 2012). Thus, although cooking is a common cause of fatal fires, it has a low risk for fire fatality.

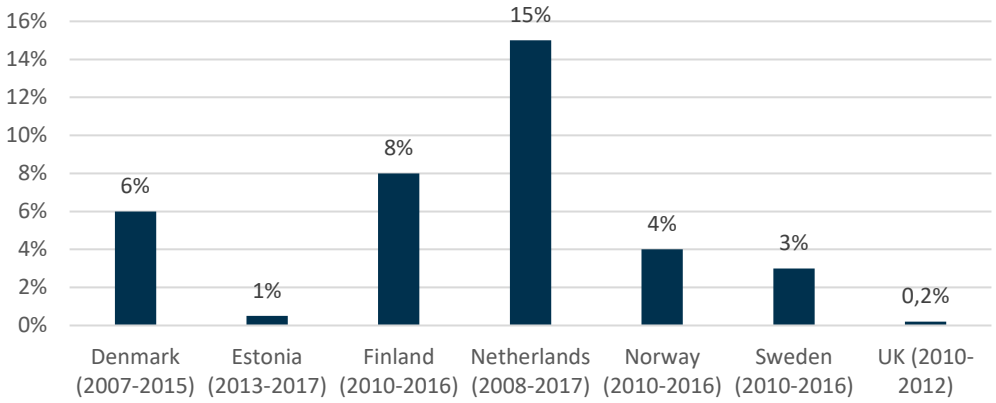

Figure 49 Percentage of cooking as a cause of fatal residential fires in European countries

In Estonia and the Netherlands, a significant percentage of fatal residential fires is caused by *carelessness with open fire* or by *an electrical fire cause*. Due to a lack of information on the causes of non-fatal fires, it is uncertain if carelessness with open fire is a risk factor. Carelessness with open fire involves direct action by an occupant, for example candles, children playing with fire etc. In some countries, the link is made with human behaviour, concluding that most fatal fires are caused by human behaviour. However, it does not become clear from the literature what exactly is included in this category for each country.

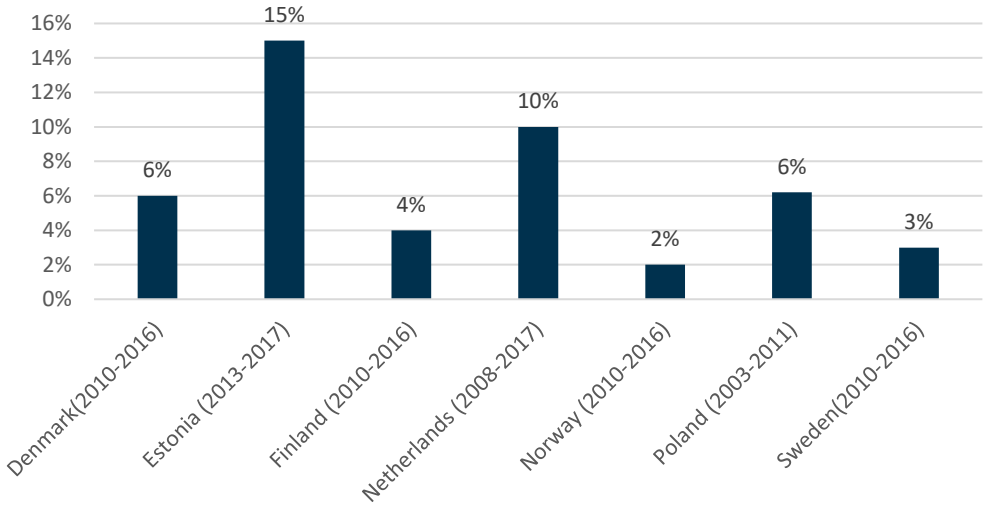

Figure 50 Percentage of 'carelessness with open fire' as a cause of fatal residential fires in European countries

6.4.2 Room of origin

Most countries collect data on the fire ignition room. Most fatal fires start in the living room or in the bedroom (see Figure 51). These numbers are often related to the non-fatal fires, so here we can speak of risk factors. The fact that many fatal fires start in the living room or bedroom might be related to the fact that people also spend most of their time in these rooms, although there is no data to support this hypothesis. Human behaviour being mostly the cause of fatal fires might also relate to this. Another explanation for the bedroom as fire ignition room, might be that people are asleep when the fire starts. Although most fatal fires occur at night, we are not sure if the fatal victims were asleep. The Netherlands is the only country that collects data on the victim being asleep or awake. Furthermore, when looking at non-fatal fires, many fires start in the kitchen while these fires are not often fatal. This is in line with our conclusion regarding cooking as a cause of fire.

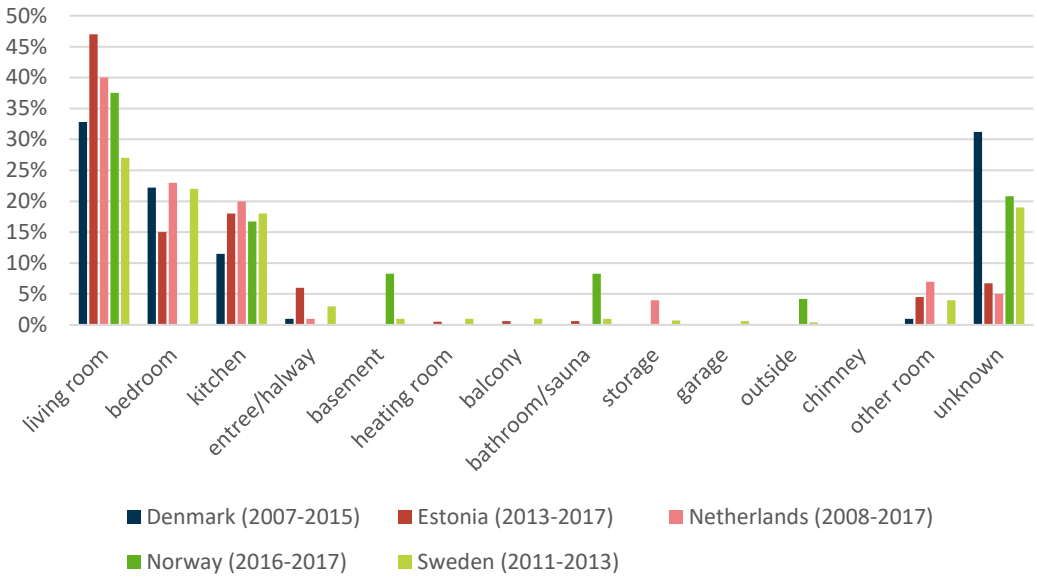

Figure 51 Distribution of rooms of origin of fatal residential fires in Denmark, Estonia, the Netherlands, Norway and Sweden

6.4.3 Object of origin

When looking at the object of origin of the fire, we see that fatal residential fires seem to mostly start in beds, but also in other furniture and clothing. This might also be related to the fact that most fires start in the living room or bedroom, although the studies do not specifically address this hypothesis. In both Denmark and Sweden, the bed is identified as a risk factor, related to non-fatal fires. The study from Sweden concludes that fires that started in beds/sofas/armchairs or clothing, were more likely to cause fatalities compared to fires starting in other objects. It is also interesting that the object of origin of the fire is unknown in many cases.

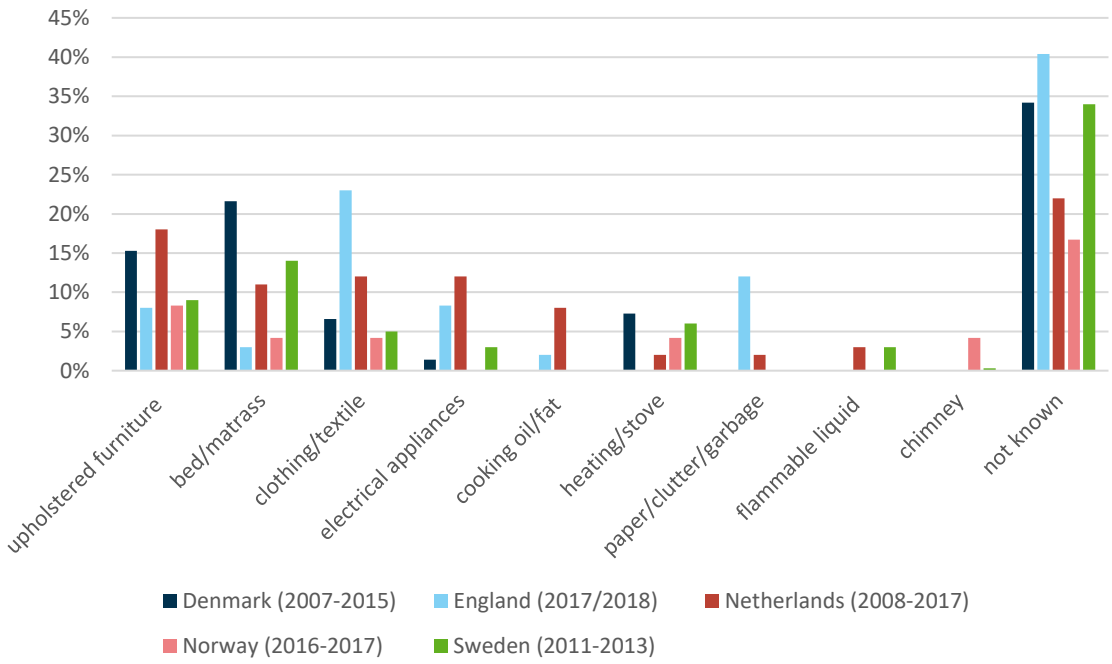

Figure 52 Distribution of objects of origin of fatal residential fires in Denmark, England, the Netherlands, Norway and Sweden

6.4.4 Room where the victim was found

Only Poland, Norway and the Netherlands seem to gather information on where the victim was found; this is mostly the room of fire origin.

6.4.5 Cause of death

Regarding the cause of death, we see that Norway, Sweden, Poland and the Netherlands collect data on the (most likely) cause of death. This data becomes more reliable if it can be combined with medical data/reports, which we only see in Poland and Norway.

6.4.6 Conclusion Fire characteristics

We find that smoking is often identified as a cause of fatal residential fires, however, not many countries relate this to the overall number of fires. When fatal residential fires caused by smoking are related to the overall number of fires, we see that smoking is a risk factor. Furthermore, most fatal residential fires seem to start in beds. In comparison with non-fatal fires, this can be considered as a risk factor. Fires starting in the living room and bedroom are also more often fatal than fires starting elsewhere.

Risk profile – Fire characteristics:
> Smoking-related fire cause
> Fire originated in living room
> Fire originated in bedroom
> Fire originated in beds/mattresses/sofas/armchairs/clothing (in Sweden)

Main characteristics – Fire characteristics:
> Electrical fire cause
> Carelessness with open fire
> Cooking, though it appears to have a small risk for fire fatality
> Fire originated in kitchen (low risk for fatality)
> Fire originated in beds/mattresses/upholstered furniture (in Sweden, Denmark and the Netherlands)
> Fire originated in clothing/textiles (in the United Kingdom and the Netherlands)

6.5 Building characteristics

6.5.1 Type of dwelling

When looking at the building characteristics, we see that not much information and data can be found. Most countries seem to collect data on the dwelling type. People living in apartments seem to have an especially higher risk of dying in a fire than people living in other dwelling types. The overall number of fatalities per dwelling type does not seem very different, but when relating it to the percentage of the total population living in these dwelling types, there is a higher risk for people in apartments.

6.5.2 Number of floors

Information on the number of floors is only known from Sweden, Norway and the Netherlands. Both the Swedish and Dutch study indicate that having more floors is related to fire fatalities. In Norway, most fatal residential fires occur in buildings with only one floor. However, the number of floors has not (yet) been related to the total housing situation in both countries. Therefore we cannot conclude whether the number of floors of a building is risk factor.

6.5.3 Smoke detectors

So far, we have only found information on the presence of smoke detectors in relation to fatal fires for Sweden (Andersson et al., 2015), Norway (data), England (GOV.UK, 2018), and the Netherlands (Brandweeracademie, 2018). We cannot draw any conclusions on risks related to the presence and functioning of smoke detectors. To be able to understand the influence of smoke detectors, we need to compare more data and look for crosslinks. However, the data possibly indicates that in countries in which smoke detectors are obligatory, a smoke detector is more often present.

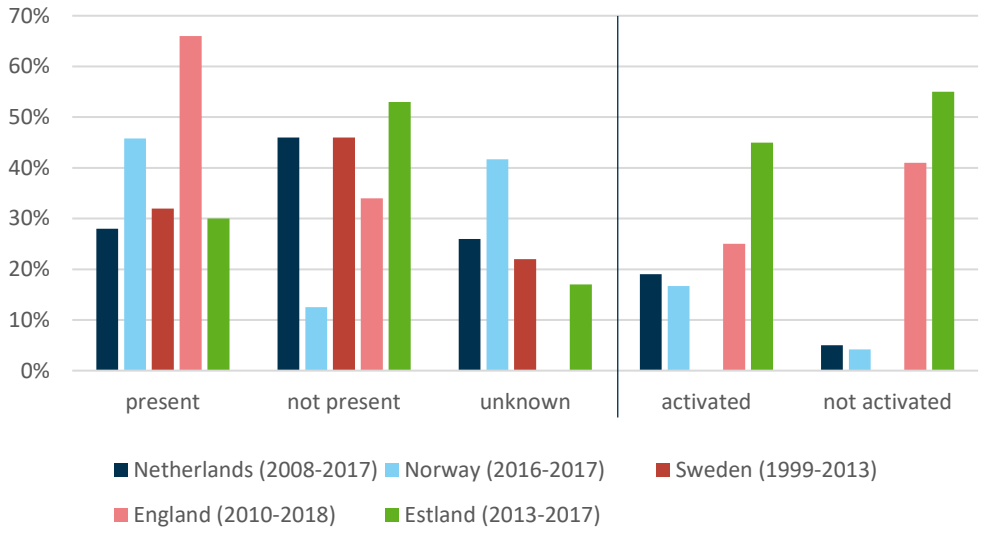

Figure 53 Presence or absence of smoke detectors in fatal residential fires, and their activation when present

6.5.4 Conclusion building characteristics

With regard to the building characteristics, we can only conclude that in most countries there is a higher risk of dying in a fire for people living in apartments. More people die in buildings with more floors, however, in order to speak of a risk, this needs to be related, for example, to non-fatal residential fires. Furthermore, to draw conclusions as to the role of smoke detectors in fatal residential fires, more information and crosslinks are needed.

Risk profile – Building characteristics:
> Apartments

Main characteristics:
> More floors, more fatalities?

6.6 Conclusions

This chapter answers the following research question: *Is it possible, based on the available information, to draw up a risk profile at a European level? If not, what is necessary to provide the information required for this risk profile?* Based on the above data, it is possible to create a first draft of a European Risk profile.

With regard to the *human characteristics,* we see that the following risk profile can be discerned: male, elderly, smoker, drugs, alcohol, living alone or having a single (parent) household, and being alone at home. In order to be able to speak of a risk factor. The data on impairment still needs to be related to the overall population or non-fatal fires.

Furthermore, regarding the *intervention characteristics,* we conclude that living in a rural area, and fires that are reported during the night, are found to be risk factors in Sweden. In other countries, fires that are reported in the night, weekends and winter are more often fatal. The chance of dying in a fire seems higher in these periods, as related to the overall day, week, or year, and so we can speak of some kind of risk here. However, it would be more interesting to relate these numbers to the overall non-fatal fires. In this way, we would arrive at more solid risk factors, as shown by the example of Sweden.

Moreover, concerning the *fire characteristics,* we found the following risk factors: fires caused by smoking, fires originating in the living room and bedroom, and fires originating in furniture and clothing. The main characteristics that are found are: electrical cause, carelessness with open fire, cooking (low risk), fires originating in the kitchen (low risk), fires originating in beds/mattresses/upholstered furniture, and fires originating in clothing/textiles. In order to come to a conclusion regarding the risks, it is necessary to relate these main characteristics to non-fatal fires.

Finally, when looking at the *building characteristics*, we see that in many countries people living in apartments have a higher risk of dying in fatal residential fire. Whether the number of floors of a building should be seen as a risk, needs to be investigated further by relating this to the overall population or the total number of non-fatal fires.

7 Conclusions and discussion

7.1 Conclusions

In this report we have answered the question: What information is available on fatal residential fires in European countries? This question was answered by analysing both the literature (international and national) and the data which we received from the selected countries by asking them to fill out two questionnaires.

A first step was to look for factors associated with fatal residential fires. Regarding our first sub-question 'which possible risk factors for fatal residential fires are known in the Netherlands and international meta-analyses?', we combined our own knowledge on risk factors from the Netherlands with findings from international meta-analyses. As a result, the following characteristics can be related to fatal residential fires: intervention characteristics, fire characteristics, building characteristics and human characteristics. These characteristics are covered by the Dutch questionnaire and formed the basis and main focus of this research.

Thereafter, we examined the definitions that are used, answering the following question: *which definitions are used for the collected items and to what extent do they correspond per country*? Although we found a variation in the definitions, there are certain similarities between the definitions that are used by the selected countries. All countries include fatalities that died later after the fire, and all include holiday homes. These minor differences should not be hard to overcome, as long as we keep them in mind when interpreting the data.
In case of greater differences in definitions, we should look for definitions that are more comparable.

We also analysed what information was collected in the databases of the selected countries, answering the third sub-question: what information about fatal residential fires is collected in the databases in the selected European countries? Although, the selected countries differ with regard to the information they collect, many similarities were found. All countries collect information on the number of fatalities, injured people, and people that escaped with the assistance of the fire brigade. Furthermore, all countries that answered our first questionnaire have information on the type of house, and the age and gender of the victim.

We investigated this information further by analysing both the literature and a second questionnaire in which we asked for actual data, meaning that we can identify the risk factors and main characteristics per country. In doing so, we answered the following question: what are the main characteristics of, and risk factors concerning, fatal residential fires at a country level? Although we found many risk factors, there are still many factors that remain main characteristics, because they are not related to the overall population or non-fatal fires.

The final question was: Is it possible, based on the available information, to draw up a risk profile at a European level? If not, what is necessary to provide information for this risk profile? We have identified several risk factors regarding human characteristics, intervention

characteristics, fire characteristics and building characteristics, enabling us to draft a first European risk profile. Overall, the risks that were found are not (yet) found in all countries. Furthermore, the main characteristics we found, still need to be related to the overall population or non-fatal fires, to conclude on risk factors.

7.2 Discussion

7.2.1 Creating commitment

In this research we combined information from the literature with information we received from the selected countries. Our first questionnaire was answered by nine countries (including the Netherlands), and the second by four countries. We tried to involve more countries by reaching out to our contact persons (of thirteen countries), however, we did not manage to include more than nine countries. As a result, most of our information is based on Northern and Western European countries. To arrive at a more extensive European wide risk profile, we really need the involvement of southern and eastern European countries. We also would like to incorporate the literature from these countries, but unfortunately the literature we found from southern European countries was not available in English. Although four countries provided us with extensive data from their databases on fatal residential fires, we need more countries to do so in order to improve the possibilities of comparing data and arriving at a reliable sample. Moreover, we should look for data reported on the same years, so we are comparing similar years or time periods as this makes the comparisons more reliable. Finally, we have seen that, despite the differences in definitions, there are many similarities between the countries, and differences can be overcome by correcting for the deviations.

7.2.2 Relating the main characteristics to the general population and non-fatal fires

In order to transform the main characteristics we found into risks, the data needs to be related. Data can be related to the overall population or to non-fatal fires. For example, if most fires occur in detached houses, we cannot conclude that living in a detached house is a risk factor. The percentage of people that die of a fatal residential fire in a detached house should be related to either the percentage of non-fatal fires occurring in a detached house or the overall percentage of detached houses in the country. This can mean that we identify another risk. For example, if 60% of the houses in a country are detached, while only 30% of the fatal fires occurred in a detached house. Or when 50% of the non-fatal fires occur in detached houses, while only 30% is fatal. We might even find that the risk of dying in a fire is higher for people living in an apartment. If we turn the main characteristics into risks, we are able to build a more solid European risk profile. For now, the risks that are identified are still based on several, but not all, the selected countries.

7.2.3 Examples of possibilities of risk assessment with existing data

Almost all studies find that more men die in a fire than women. Most countries relate these male and female fatalities to the total number of fatalities or to the total population. In the figure below, we have related the percentage of male and female fatalities to the distribution of the total population (see Figure 54[31]).

[31] For the percentages of the total population per country, we have used the Eurostat database, selecting the corresponding years for each country.

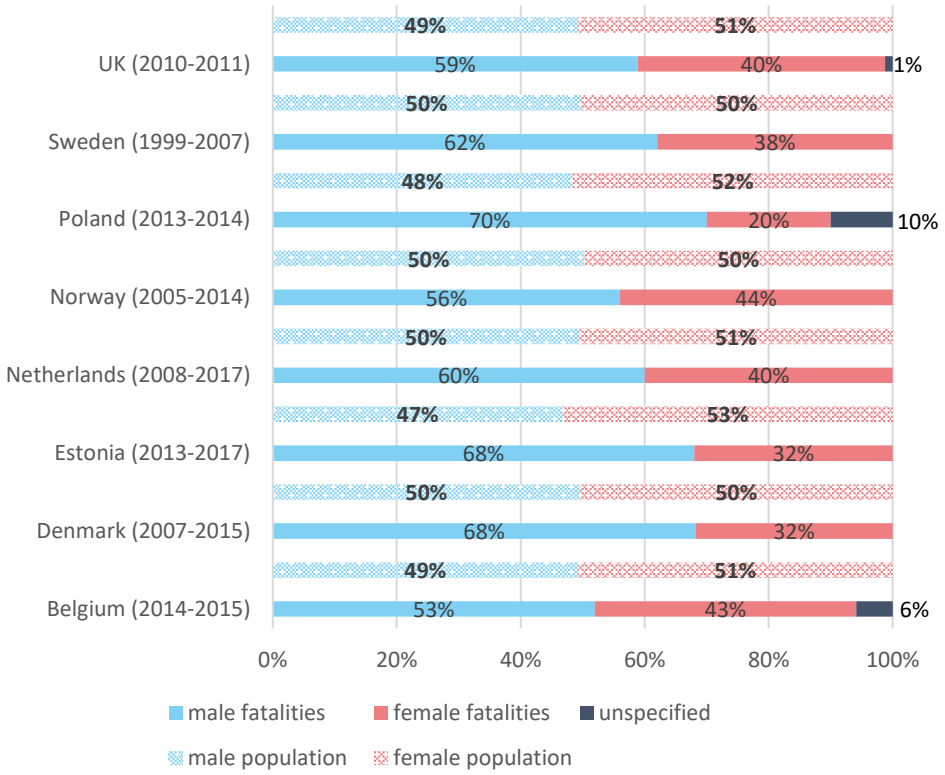

Figure 54 Gender distribution of population *and* fire fatalities in selected European countries

It would be interesting to make cross-links between age and gender, something which is already done by some countries. These crosslinks need to be related to the overall population in that age group in order to be able to speak of a higher risk for either women or men in a certain age group (e.g. see Norway or Belgium). For example, in the oldest age categories, more women than man are still alive, so when more women die, this does not necessarily mean there is a higher risk for women. Therefore, when looking for crosslinks, it is also important to relate them to the overall population or non-fatal fires.

The age groups that are defined by the countries show a great variety which makes it hard to compare age groups. It is therefore recommended to collect data on age level, instead of age-group level, as this would create more exact and comparable data. In trying to overcome these difficulties, we were able to identify five age groups, with a corresponding number of fatalities per group, per country (see Figure 55). The figure also shows the average age distribution of the population of the selected countries[32]. This shows that relatively fewer people die in the age groups below 65 years, and more people die of fatal residential fires in the age groups of 65 and older.

[32] Here Eurostat is also used.

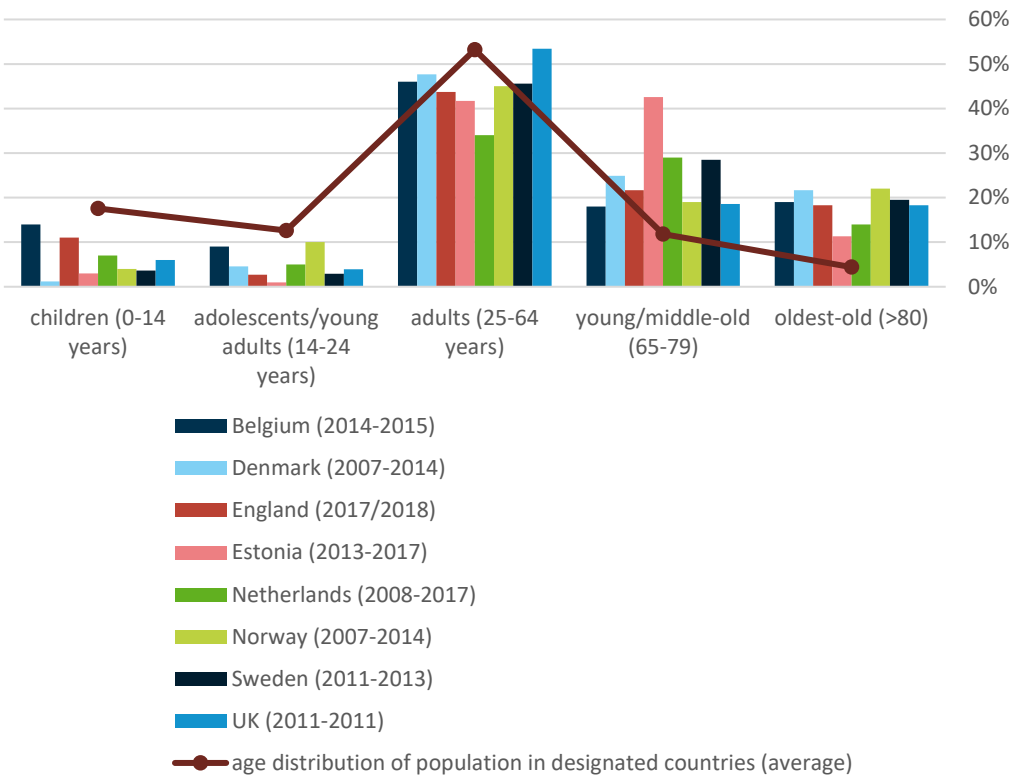

Figure 55 Age distribution of fatalities related to average age distribution in selected European countries

In the Dutch study on fatal residential fires between 2008 to 2018, several items are compared in crosstabs. Some of these analyses give a clearer picture of the actual risks for fatalities. For example, it appears that a smoke alarm is activated in a significant number of fatal residential fires. A more in-depth analysis of the human characteristics of the victims shows that especially those persons with mobility disabilities (58%) die in residential fires with an activated smoke alarm, half of whom were conscious and alert (29%). The mobile persons who died were mostly asleep or under the influence of substances (13%), which made them less alert. This analysis shows that smoke alarms are insufficiently effective for persons with mobility disabilities (see Figure 56).

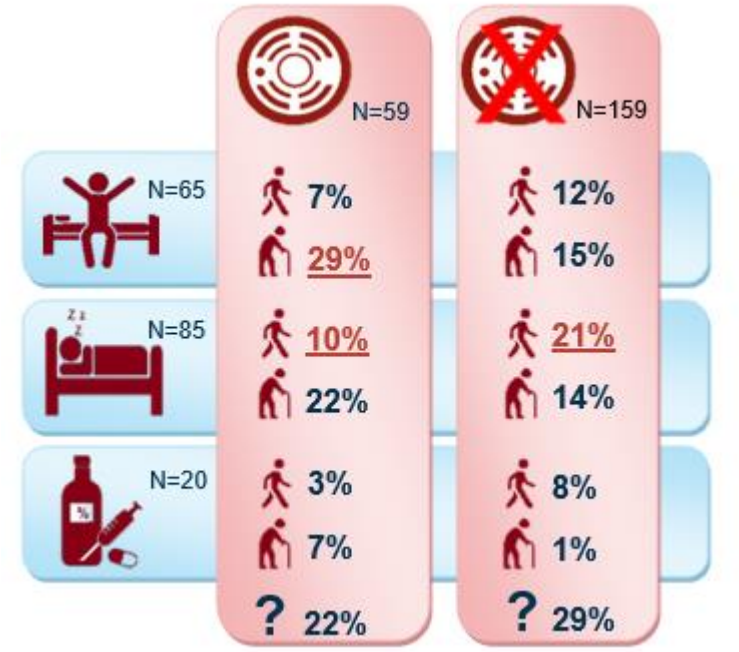

Figure 56: Activated smoke detector linked to alertness and mobility

The examples show the possibilities of further analysis of data in existing databases in Europe. It would be useful to extend the analysis to more items and to more countries. Therefore, the cooperation of the administrators of the databases in Europe should be sought in order to provide the data needed for an analysis at the European level.

7.2.1 Proposed method for risk assessment with existing definitions

In chapter 3, we have seen that there is a great variety in the definitions used by the selected countries. However, there are also some similarities in the separate items within the definitions that the different countries use. In order to assess the impact of any difference between the definitions, we made a preliminary estimate by using the Dutch dataset as a starting point.

Fire fatalities

For including victims in the fire fatalities, there is a difference in the timeframe in which persons die, starting with a timeframe of 30 days. In the Netherlands, almost all fatalities occurred within 30 days, which implies that using a larger timeframe for fatality is of no importance.

Housing types

Fatalities that occur in nursing homes are excluded by most countries. In the Netherlands, about 7% of the fatal residential fires took place in nursing homes, related to the dataset in accordance with the Dutch definition (IFV, 2018). Whether nursing homes fall within the definition or not seems of minor importance.

Two countries include fire fatalities outside the house in their definition. In the Netherlands, about 7% of the fatalities were found outside the home[33]. Thus, whether fatalities outside the house fall within the definition or not seems of minor importance.

[33] Person escaped initially and died later, or was found on the balcony, in the common stairwell or in a shed or garage.

Fire causes

Most countries include intentional death or suicide. In the Netherlands, there are an average of 12 intentional deaths from residential fires (IFV, 2018) per year. Including intentional deaths results in 39% more fatalities in the Netherlands, compared to the Dutch definition, which is of great importance.

Comparable definitions

Further analysis is needed to determine the actual difference in the definition and to estimate the impact of the included item. Norway, Denmark, Sweden, Finland and the United Kingdom include intentional deaths in their definitions. Including the separate item results in 0.4 times more fatalities compared to the current Dutch dataset. Other differences found in the items within the definitions do not appear to have a major impact on the data.
Based on the combination of included or excluded items in the definitions per country, we see three groups of countries with comparable definitions. Group 1 includes Norway and Denmark. Compared to the Dutch definition their datasets are estimated to have 1.3 times more fatalities. Group 2 includes Sweden, Finland and the United Kingdom. Their datasets are estimated to have 0.4 times more fatalities compared to the Dutch definition. Group 3 includes Belgium, Estonia and the Netherlands.

7.2.2 Other findings

Furthermore, there are some other findings that need to be discussed. Firstly, information on whether the is victim awake or asleep is not collected by many countries, while this can be interesting with regard to the limited alertness of the victim. Secondly, we note that for some items, our contact persons mention that they are not collected in their country, while we find information on these items in the literature. Finally, we came across the hypothesis that people who are alone during a fire (single household, or home alone) have a lower chance of discovering the fire and have to escape on their own, and therefore have an increased chance of dying in a fire (see Sessing, et al. 2017). It would be interesting to test this hypothesis in future research, especially since we see that single (parent) households, living alone and being alone, are identified as risk factors, which supports this hypothesis.

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