

Fire safety and the ageing population



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Credits

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Text: René Hagen, Charlotte van Ruijven, Clemon Tonnaer, Lieuwe de Witte (Institute for Safety, IFV) and

Eva van Zoonen (Dutch Burns Foundation).

Final editing: Karin Dangermond (IFV)

Pictures: Pieter van Foreest and IFV

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Institute for Safety
Information Centre for Safety (Infopunt Veiligheid)
P.O. Box 7010
6801 HA Arnhem www.ifv.nl info@ifv.nl
026 355 23 00

Foreword

How old will you be in 2040?

Nothing is as complicated as trying to predict the future. At least, this is what policy makers try to impress upon one another during meetings. Yet this policy motto doesn't always apply. Research into sequencing of cases and causal links offers a certain prognosis.

By 2040, life and well-being permitting, I shall have reached the respectable age of 70 for instance. Then I'll be living in the beautiful, safe Netherlands together with many of my age peers. After all, longevity is being achieved time and again. So there's a big chance that you, the reader, will be part of it. In this research information and conclusions, scientists portray a future which doesn't look so sunny for you and me. But fortunately we can do something about it on time. If we take action now, we'll make a safe difference then.

In the future you and I will be part of the increased number of elderly living independently. Together, we will be confronted with important points of attention concerning fire safety. As the elderly, for example, we will probably run a greater risk of experiencing an accident with fire (injuries). In addition, we run a greater risk of serious injury, which might mean a prolonged rehabilitation or even possibly death. The risk factors and their causes have been researched in the last few months and the conclusion is indisputable. As a target group we will have to get a sense of how we can avoid risks and be prepared to change our habits and act safer. In short, we will have to learn to live more fire safe.

Our generation has the possibility to deploy and secure the innovation of technical facilities in common practice. In forthcoming years home automation will be very convenient. An added bonus is that this offers a good basis to bolster our (fire)safety. This increasingly enables faster adequate fire alarms to be built and prevent fire development by linking automatic fire-fighting equipment to our personal needs.

With this information we can work on our own fire-safe future. However, it is possibly up to the policy makers to adapt regulations for senior citizen complexes, so that these complexes are also compliant with the starting points of the Buildings Decree. I've got a tip for you and them: it's not complicated to predict the future if you have the information.

Rob Baardse
Director of the Dutch Burns Foundation

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Introduction

As part of the Institute for Safety (IFV), the Fire Service Academy and the Dutch Burns Foundation have observed that the elderly (over-65s) are a vulnerable group in cases of fire. The elderly are more often involved in fires in a domestic environment, in which they are often (fatally) injured. Research by the Fire Service Academy (2007) has shown that more than 2.5 times as many fatalities occur amongst people aged over 65 than for people aged younger than 65. In addition, the treatment of burns of the elderly is more complicated due to the physiological regression of the body. When this observation is considered in terms of an ageing population it's easy to reach a conclusion: if nothing is done, then the number of burns victims among the elderly will rise rapidly.

The first question that arose was: how extensive is the problem? Ageing, living independently at home for longer, and the presence of more elderly who are vital, are developments that jointly determine the extent of the problem, both in a positive and negative sense. We also wondered why the elderly were often victims of fire. Could this be, for example, because they cause fires more often, respond incorrectly when there's a fire and/or does a reduced self-rescuing capacity play a role in escaping from a fire? The last question that we posed was which interventions are required to curtail an increase in the number of burns victims amongst the elderly and provide the elderly with the same degree of fire safety as people under 65 years of age.

To find answers to these questions, the Fire Service Academy and the Dutch Burns Foundation carried out a study in 2015 into the influence of the ageing of the population on fire safety. This study initially resulted in three interim reports.

- > Interim report 1: The extent of the problem
- > Interim report 2: Risk factors and their causes
- > Interim report 3: Solution strategies

During the study we observed that many fires occurred in so-called senior citizen complexes, residential buildings which were turned into independent homes through acquisition by the owner or through transformation from care homes, and were almost exclusively inhabited by elderly who had less ability to leave without assistance. It is for this reason that a fourth study was conducted into a large number of incidents in similar housing types which involved fatalities, wounded people or at least undesirable evacuation.

After publishing the often extensive study reports, we noticed that the subject matter and problems get attention across a much wider field than only the fire department. For example, in politics and at public authorities, housing and care institutions, and representatives of associations for the elderly and (home)care organisations.

This edition has been published to get all those involved to easily understand all the ins and outs of fire safety in consequence to the ageing of the population and longer independent living of the elderly.

The studies

The key question that we posed is: “What is the influence of the ageing of the population on the number of victims of domestic fires, and what preventive measures exist?” In the first study we examined the composition of the population from now until 2030. The influence of the government’s national policy plans on the number of elderly living in deinstitutionalised and institutionalised housing was also examined. On the basis of this data we then drew up a projection, if policy remains unaltered (also in comparison to the current situation) in 2030, of the number of elderly that would fall victim to a fire.

In the second study we examined both the national and international risk factors of fatalities of the elderly as a result of a fire. The physical, mental and social characteristics were identified which specifically apply at a later stage in life, and investigated what the characteristics of elderly victims are in fatal fires. We have established to what extent specific characteristics of the elderly correspond with the characteristics of victims in fatal domestic fires, and which risk factors are identifiable. To summarise, the following risk factors can be given.

- > People who have certain physical and mental restrictions or impairments have an increased chance of fire and burns. These restrictions occur more often among the elderly than for those under the age of 65, and also often in combination with each other.
- > Aside from physical and mental factors, certain social factors form an additional fire hazard among the elderly. This includes living alone and social isolation (loneliness).
- > Smoking and cooking are the biggest causes of fire for those under 65 as well as those over 65 years of age. In combination with physical and/or mental restrictions this risk is particularly big.
- > Older housing (roughly houses built before the 1992 Buildings Decree) usually has a higher chance of fire and is not built for a safe escape from fire. In addition, in recent years new forms of housing has come about, namely senior citizen complexes for living independently. During a fire a substantial portion of inhabitants are less self-rescuing and the fire brigade is often faced with the almost impossible task of rescuing these people.

In the third study we established groups of measures and solutions on the basis of the second study's results. We ascertained that it is not easy to resolve the larger fire safety risks of the elderly and their consequences. Solutions such as installing smoke detectors and fire extinguishers as well as electric cooking, portray a picture that is too simple. National and international studies have shown that there are three groups of factors which all require a solution.

So resolving merely one of these problems is not sufficient.

- > Among the elderly fires often start 'close to the body', with smoking and cooking being the biggest causes. So, it is important to prevent this chance of fire as much as possible by not only providing information, but also by making the direct surroundings of the elderly as fire-resistant as possible. This applies to chairs, couches, mattresses, bedding, clothing and the cooking environment (such as electric cooking, gas cooker safety switches, gas burners adjacent to and not behind each other).
- > Smoke inhalation is sooner life-threatening for the elderly than for those aged under 65. Besides, during a fire the elderly are less accurate and less mobile. Literally, a fatal combination. When fire breaks out, sounding the alarm, escape assistance and fire-fighting must happen a lot faster than for younger people. So solutions must include smoke detectors linked to alarm response services, rescue mattresses and in some cases automatic fire extinguishing by (portable) sprinklers in the home, for example.
- > Senior citizen complexes are not built for a safe housing or safe escape of the elderly. The foremost starting point of the Buildings Decree is safety of those present during a fire. At housing complexes, account is kept of the self-rescuing ability (of the majority) of those present. In buildings where such self-rescuing ability is not considered to be present, such as prisons, child daycare centres and hospitals, additional measures are required such as fire detection systems, evacuation systems, monitoring and an in-house emergency services team. Senior citizen complexes, where the elderly live independently, don't have these facilities, whereas the elderly are less self-rescuing. So these complexes do not comply with the starting points of the Buildings Decree. In such complexes fires occur almost on a weekly basis where it concerns fatalities, wounded or at least a large-scale evacuation. Measures to be taken at such complexes include better smoke barriers to keep the elderly protected from smoke for longer periods, and escape possibilities that have been tailored for the older, less self-rescuing inhabitants.

We undertook a further investigation because so many fires had been observed in senior citizen complexes. In order to identify where the practical scenario deviates from the theoretically presupposed scenario, we compared the scenario assumed in the building regulations for fires in such housing complexes with the scenarios that occur in common practice. In this way we were able to ascertain where it goes wrong, and based on this, we were able to formulate proposals for specific measures.

A mix of measures is required to enable the three solution strategies to be effectuated.

- > Influencing fire-safe behaviour of the elderly (and their social environment such as neighbours, children, caregivers, home carers, et cetera).
- > Applying innovative technical facilities such as rescue mattresses, gas cooker safety switches, smoke detectors with automatic alarm response services and portable sprinklers.
- > Adapting regulations for senior citizen complexes, so that these complexes are also compliant with the starting points of the Buildings Decree.

Literature references

This study into senior citizens and fire safety is mainly based on a large number of national and international reports and scientific articles. In the three previously mentioned interim reports, use was made of extensive literature references. For the sake of legibility in this knowledge publication the literature references have been omitted. However, the literature list is included at the back of this publication. If, as a reader, you are interested in the origin of certain information, we refer to these reports which are available for downloading free of charge via the IFV website.¹ The source of statistical data, unless indicated otherwise, is Statistics Netherlands (CBS).



1 Scope

How many victims of fatal fires aged 65 years or older can be expected in a domestic environment up to 2030? To enable this question to be answered, first the composition of the population until 2030 is examined. Then the influence of the government's national policy plans on the number of elderly living in deinstitutionalised and institutionalised housing is examined. On the basis of this data a projection is finally given, if policy remains unaltered (also in comparison to the current situation) in 2030, of the number of elderly that would fall victim to a fire.

1.1 Ageing of the population

This publication focuses on the definitions 'ageing of the population' and 'the elderly'. Ageing of the population is understood to be the increasing percentage of elderly in Dutch society. However, the definition elderly is not a sharply outlined static definition. In the context of fire safety it relates to people who, due to their age, show characteristics that, in a statistical sense, make them more than moderately vulnerable to fire. For ease of reference, literature often refers to 'elderly' (also as 'old-aged' or 'senior') when someone is 65 years or older. This age is linked to the pension-entitlement age, which has applied over the past few decades in the Netherlands and in other western countries. When examining the prevalence of disorders and ailments which could be linked to ageing, the threshold of 65 years, however, is not an adequate threshold which, nowadays, should sooner be set to 70 or 75 years (see also paragraph 2.2.1). To tie in with the usual definition of an elderly person, however, the age of 65 has also been maintained in this publication.

The ageing of the population in the Netherlands is closely related to the baby boom after the Second World War. Since this post-war baby boom took place some fifty to seventy years ago, it means that the generation born in the period between 1945 and 1965, the 'baby boom' generation, have now reached the older (over-65) age phase. After 1965 the number of births reduced again and fewer children per woman were born. In 1965 the fertility rate was still 3.2 children per woman, which is now around 1.7 children per woman. The Dutch population is also progressively getting older, resulting in people being in the older age phase for longer. These demographic developments impact the number of elderly in the Netherlands compared to the number of younger generation.

The two developments together (reduced birth rate plus the rising life expectancy) are also referred to as the ‘twofold ageing of the population’. Around 2040 it is expected that the ageing of the population will have peaked; the number of elderly in the Netherlands is projected at 4.8 million, more than 26% of the total Dutch population. Until 2060 the number of elderly will continue to fluctuate around 4.8 million.

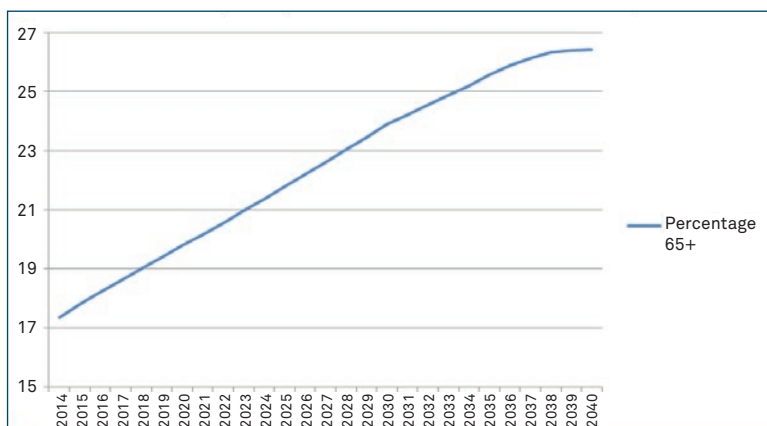


Figure 1.1 Projected share of over-65s in the Netherlands

In January 2014 the Netherlands had 16.8 million inhabitants. At that time 2.9 million inhabitants were 65 years or older, i.e. 17.3% of the total Dutch population. For 2030 the Netherlands expects to have 17.6 million inhabitants, of which 4.2 million will be aged 65 years or older. Then the number of over-65s will be 23.9%. The number of elderly aged 65 years and older will therefore increase by 44%, whereas the total population only increases by 4%.

The highest percentile increase of the population over 65 will occur in the group aged 80-85. Between 2014 and 2030 the group aged 80-85 will increase by 79%. In that regard, the raising of the age threshold of 65 years for confining the ‘risk group of elderly’ does not add anything.

The number of women aged over 65 will increase slower than the number of men, i.e. more men will reach an age above 65 years than in the past. This trend can also be seen in the life expectancy. For 2030 the life expectancy for men is predicted at more than 82 years and for women at 85 years. In 2013 the life expectancy for men was more than 79 years and for women 83 years.

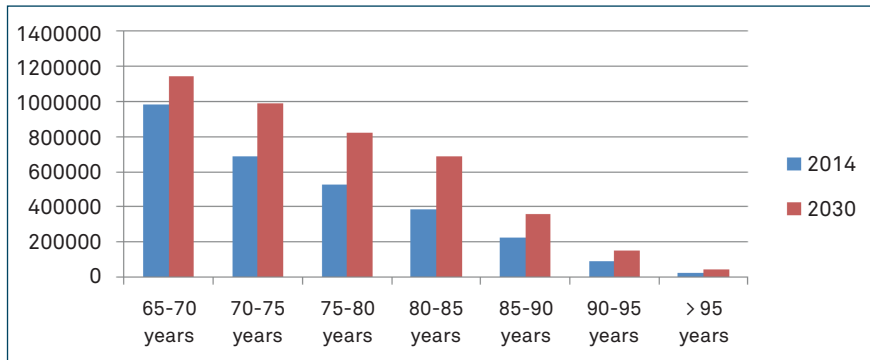


Figure 1.2 Projected number of inhabitants in the Netherlands

1.2 Increase in impairments and healthcare pressures

The elderly of today is no longer the elderly of one or two generations ago. Levels of education and disposable income have increased over the past hundred years. Nowadays the elderly stay healthy and vital for longer than preceding generations. When the elderly retire at 65, they usually have a lot of time and financial resources available to spend on leisure activities. Moreover, the elderly of today are more mobile. This makes the current generation of elderly a lot more active than those of preceding generations.

At the same time, diminished physical (and sometimes also cognitive) possibilities are inherent to becoming older. Generally, older people have more impairments than the younger generation. Here the word 'impairments' is meant in the sense that people have difficulties in carrying out 'normal' daily activities. The physical and cognitive restrictions of the elderly will be dealt with in detail later on in this publication (see paragraphs 2.2.1 and 2.2.2). Together with the increase in the number of elderly, this has also led to more younger people being needed to care for the elderly who are in serious need of assistance.

General health condition of the elderly in the Netherlands

Ageing takes place due to the unavoidable finite capacity of human cell division and a gradual increase in errors occurring in DNA. Ageing is a gradual process that already starts from the beginning of life. For the one person ageing happens faster than for another person. Through ageing, eventually an imbalance of the internal environment comes about, which causes ailments and diseases to occur faster and more often. In the first instance, ageing does not influence the quality of life; a middle-aged person will generally not suffer from diminished physical and mental functions. Only in the last phase of life one can see that old-age ailments and disorders cause people to perceive their health as being diminished.

Very old people who are still healthy, have a higher chance of still staying healthy for a number of years. Figure 1.3 shows that healthy men and women aged 65 in 2013, can generally expect to reach the age of 77 in a condition of health perceived as good, and will live up to the age of 79 without restrictions. This means that the elderly of today, at an average age of 80, perceive their health as being diminished and are faced with physical restrictions and a deterioration of their mental health.

Another indicator for the state of health is the use of healthcare facilities. The graphs below on the use of healthcare facilities in the Netherlands show that both the use of care facilities excluding accommodation (deinstitutionalised) as well as the use of care facilities including accommodation (institutionalised) is about 1% in the age groups under 65 and from the age group of 65-70 it shows a development of at least double the value of the age group before.

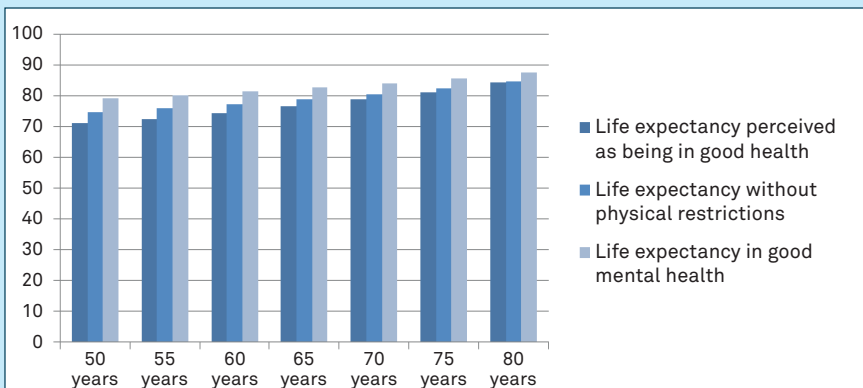


Figure 1.3 Healthy life expectancy in the Netherlands, 2013

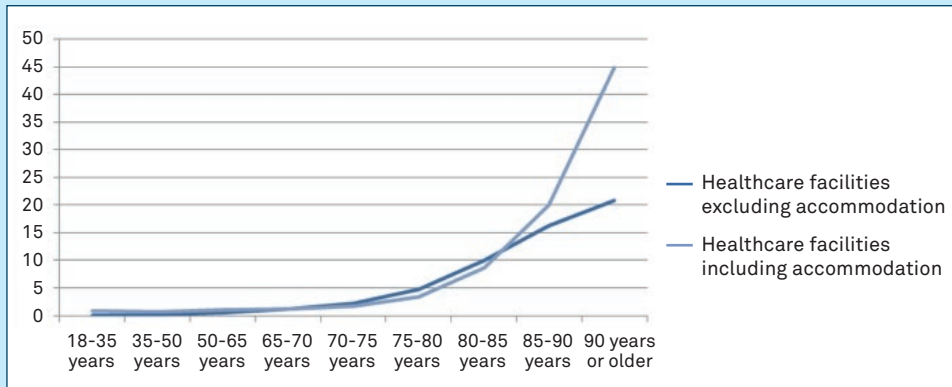


Figure 1.4 Use of healthcare facilities in the Netherlands, 2013

1.2.1 Government policy

Aside from increasing healthcare pressures, at an unchanged policy, the costs of care for the elderly will increase tremendously. It is also for this reason that the government wants to reallocate expenditure for outsourcing professionals to more societal involvement in care for the elderly. The intention of the policy is to get more elderly to live independently at home for longer, while making use of network-based care when this is possible, and professional care when this is necessary. Hence the percentage of elderly who get referrals for placement in a nursing or care home will reduce.

Central government used to pay for long-term care pursuant to the Exceptional Medical Expenses Act (Awbz). As of 1 January 2015 this legislation was split into the Social Support Act (Wmo), the Health Insurance Act (Zvw), the Youth Act and the Long-Term Care Act (Wlz). In future, care for the elderly living at home (deinstitutionalised care) will be paid by the health insurance or by the municipalities via the Wmo or Zvw. Care for the elderly living in a nursing or care home (institutionalised care) is paid by Central government through the Wlz. The contribution paid by Central government for the costs of long-term care have thus been substantially restricted. The Wlz is a National Social Insurance Scheme for all inhabitants of the Netherlands. It is a mandatory public health insurance which covers for claims in cases where full-time intensive care or supervision is required.

1.2.2 Referrals to a nursing or care home

When someone requires care, the Care Assessment Centre (CIZ) provides referrals in the form of a Care Intensity Package (acronym = CIP). Somatic and psychogeriatric institutionalised care is arranged via the CIP Nursing schemes. The severity of CIPs are incremental in CIP Nursing, where CIP Nursing-1 is the package offering the least care, and CIP Nursing-10 is the package offering the most care. The former Exceptional Medical Expenses Act (Awbz) entitled someone with a CIP Nursing-1 referral to placement in a regular nursing or care home. The coalition agreement of 29 October 2012, *Bruggen slaan*, establishes that only people with referrals of high severity are entitled to placement in a nursing or care home. Hence, since 2013 the gradual deinstitutionalisation of the lightest CIP Nursing schemes came into force. Since 2013, people with CIP Nursing-1 and 2 referrals no longer have entitlement to placement in a nursing or care home. Since 2014, no longer for CIP Nursing-3 referrals and as from 2016, no longer for CIP Nursing-4 referrals. Half of the CIP Nursing-4 schemes are being deinstitutionalised. It specifically concerns the elderly with the following profiles, who are no longer entitled to placement in a nursing or care home.

Resident of senior citizen complex: "I went to the toilet at quarter past five (in the morning), I couldn't see anything because of the smoke in the corridor. Then I unlocked the front door. I grabbed something to eat and drink and phoned my daughter. She said, 'place a wet towel in front of the front door.' When I later stood on the balcony (probably), I felt a hand on my shoulder. It was the fire brigade, they were going to take me away in an aerial platform. They asked me if I could climb over the railing. I would have been able to do so "when I was 18". I succeeded in doing so with a small step stool from the kitchen."

Table 1.5 CIP Nursing-1 to 4

CIP Nursing	Profiles
CIP Nursing-1: care by appointment and on call	Some supervision required in social competence, such as taking decisions, household tasks or participating in the community. Independent general daily activities (GDA), sometimes requiring help for minor care tasks such as clipping nails. Mobility usually independently. There is possibly evidence of loneliness, no problematic behaviour.
CIP Nursing-2: care by appointment and on call	<ol style="list-style-type: none"> I. Starting psychogeriatric problems. This brings about the start of losing control of one's own life. By having problems with thinking, memory and concentration, there is a need for (daily) supervision, assistance and guidance. II. Somatic symptom disorder. Many service users in this target group use a walker-rollator. Daily need for supervision and care. Sometimes assistance is needed for mobility. Possible need for temporary nursing care such as recovery after being hospitalised.
CIP Nursing-3: continuously in close proximity	Somatic symptom disorder. Assistance needed for GDA, mobility indoors. Concerns intensive care and nursing attention in cases of chronic illness. No problematic behaviour or psychogeriatric problems.
CIP Nursing-4: continuously in close proximity	<ol style="list-style-type: none"> I. Moderate dementia. Need for intensive supervision and extensive care. Assistance required for cognitive functions such as orientation, memory and thinking. Supervision and guidance needed for GDA. Possible problematic behaviour. II. Serious impairments of the senses in combination with physical impairments such as deafness and/or blindness at a later age. A great deal of assistance needed in self-supportiveness in a range of areas: GDA, mobility, participating in the community. III. Long-term psychiatric problems in combination with old-age impairments. Not only psychiatric problems but also a need for care, assistance for GDA, nursing care. Possible problematic behaviour.

On the one hand, due to government policy, relatively fewer elderly will go to live in nursing or care homes, on the other hand, the ageing of the population will result in a rising number of elderly needing placement in a nursing or care home. To establish how many elderly would possibly live in a nursing or care home in the future (using 2030 as the point of departure in this study), account must not only be kept of the demographic developments, but also of developments as a result of government policy, and the dynamism in the community. The following assumptions should therefore be made to be able to predict the number of elderly in a nursing or care home in the future.

- > The percentage of elderly with a CIP Nursing referral remains the same.
- > There will be no elderly with a referral other than a CIP Nursing referral in a nursing or care home.
- > Exactly half of those with CIP Nursing-4 will be deinstitutionalised.
- > An equal percentage of elderly will live in a nursing or care home in the future when they have the required referral to do so.

Taking into consideration that since 2013 government plans impact the number of elderly in nursing or care homes, for the calculation of the effects, use is made of statistics from prior to the introduction of the government policy. To obtain a well-balanced picture, averages over 2010 to 2012 have been used for the calculations.

1.2.3 Partners move too

When someone goes to live in a nursing or care home, the partner sometimes moves too. The partner, however, does not have a referral to live in a nursing or care home and will personally have to pay a large portion of the costs. A condition for also moving the partner to a nursing or care home is that there is sufficient space for the partner in the particular home. In a nursing home this is almost never the case; so the number of partners who also move to a nursing home is nil. Sometimes a partner is able to move to a care home. According to the Dutch Social and Cultural Planning Office (SCP), 7% of the care home residents lived in the care home together with their partners in 2008. In addition, it is also possible that both partners have referrals for admission in a care home, which was the case for 5% of the cohabiting care home residents. In 2008, of the residents who lived in a nursing or care home, 39% of them were in a nursing home and 61% in a care home. Assuming that the percentage of cohabiting care home residents in 2010 to 2012 stayed the same, and that the spread between the nursing and care homes stayed the same, then between 2010 and 2012 about 2% of the people living in nursing and care homes were partners who also moved in without CIP Nursing referrals.

1.2.4. Trends in care needs

From 2010 to 2012 an average of 113,000 people aged 65 years and older lived in a nursing or care home. In 2030 there will be about 112,000 elderly living in a nursing or care home. So it is expected that somewhat fewer people will live in a nursing or care home in 2030 than is the case at present. Where an average of 2.5 million elderly lived independently in 2010-2012, there will be about 4 million elderly living independently in 2030. This means that the number of over-65s living independently will increase by more than half in the future.

The calculations assume that in 2030, as a percentage, there will be equally as much need for living in care homes amongst the elderly with a CIP Nursing referral, as the average in 2010-2012. The trend, however, is that older people increasingly have more vitality. So in future, older people of the same age will be apportioned a lighter care referral than in the past. The percentage of elderly of the same age who require care home facilities will probably reduce taking this trend of vitality into consideration. On the other hand, the percentage of elderly aged 80-85 will increase in respect of the number of elderly in the younger age groups. This means that, as a percentage, there will be an increased number of older elderly in the future. The older they are, the more care they need. So the percentage of elderly with a high need of care will increase when taking this ageing trend into consideration.

For both trends it is difficult to predict what their influence will be on the number of elderly in a nursing or care home. In the calculations we assume that the influence of both trends will more or less level each other out.

This study assumes a reliability interval of the number of elderly in a nursing or care home at 111,773 (based on prior calculations) to 122,141 (based on 83% of the number of elderly in an institutionalised household).

Table 1.6 Overview of the number of over-65s with referrals and type of accommodation

	2010-2012	2030	Difference in numbers	Difference %
Over-65s	2,616,547	4,197,860	+1,581,313	+60.4
Over-65s with CIP Nursing referrals	179,337	287,719	+108,382	+60.4
Over-65s with CIP Nursing 1-4 (50%) referrals	68,782	110,350 - 11,241	+41,568 -	+60.4
Over-65s in a nursing or care home	113,045	111,773 - 122,141	-1,273 - +9,641	-1.1 - +8.6
Over-65s living independently	2,503,502	4,086,087 - 4,075,719	+ 1,582,585 - +1,594,801	+ 63.2 - +64.3

1.2.5 Who will be living independently for longer?

On average the younger age groups will sooner get a higher referral than a low one, and the higher age groups will sooner get a lower referral than a high one (figure 1.7). The turning point is approx. at care intensity package CIP Nursing-5 (CBS, 2015b). An explanation is that elderly who have lived to a high age without a care referral, will probably not suddenly need a lot of care. Most elderly in the 'younger' age category on the other hand, do not need as much care (because they still have physical vitality), but when they need care it is often immediately heavy duty care.

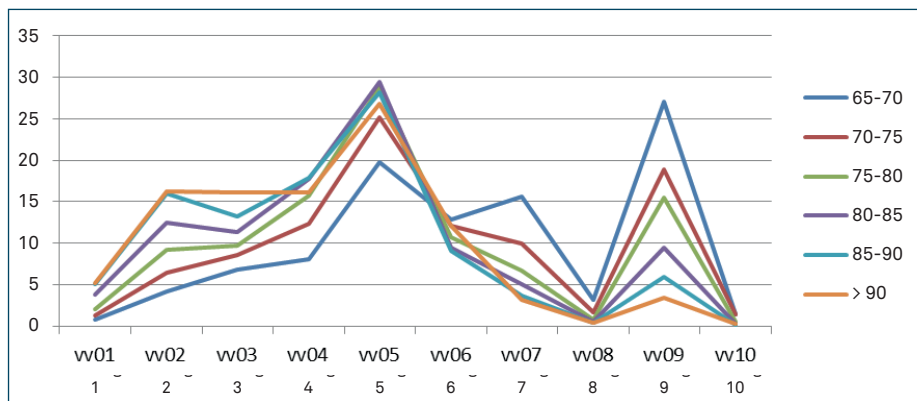


Figure 1.7 Population with CIP Nursing referrals per age group (percentage)

Most elderly with a light referral are in the higher age groups (figure 1.8). So when referrals CIP Nursing-1 to CIP Nursing-4 (50%) are cancelled, mainly the elderly in the higher age groups will be excluded from institutionalised living. It then concerns the elderly in the higher age group who need light duty care.

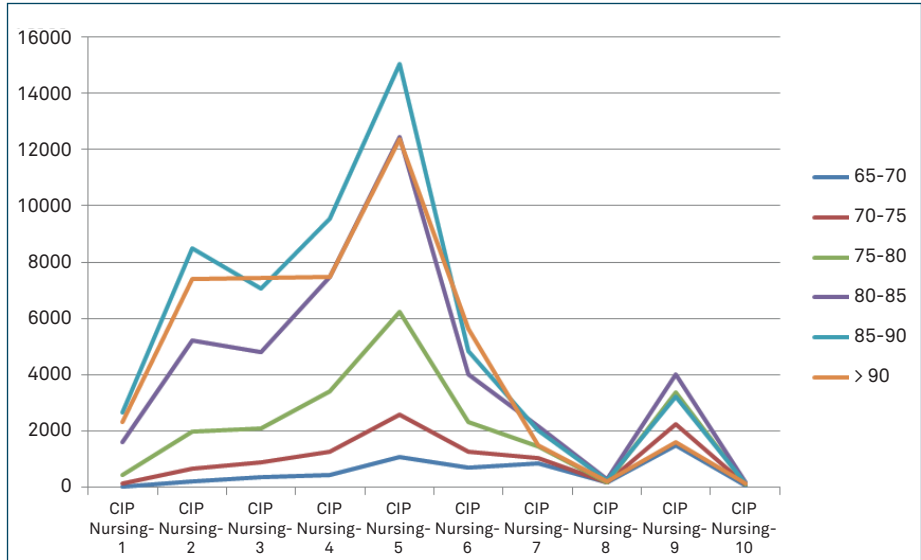


Figure 1.8 Population with CIP Nursing referrals per age group (number)

1.3 Increased number of victims

1.3.1 Current number of victims of fatal domestic fires

The number of victims of fatal domestic fires have been maintained annually in a database by the Institute for Safety (IFV) since 2008. In doing so, the IFV works in conjunction with the National Fire Service Documentation Centre (NBDC) and the relevant fire brigades and fire research teams who supply data about fatal domestic fires on the basis of a questionnaire. These questionnaires pose questions on the circumstances at the time of fatal domestic fires and a number of personal particulars (e.g. age) of the victim. It also maintains whether the domestic fire was caused deliberately, e.g. in the case of suicide. This study only uses the database of accidental fatal domestic fires; deliberate domestic fires by adults, cases of murder and suicide have not been taken into consideration.

With the help of the database, the number of victims of fatal domestic fires from 2008 to 2013 has been identified and subdivided into age categories. In this way the victims aged 65 years and older have been subdivided into 5-year age categories (65-70, 70-75, etc.). Unfortunately the exact ages were not known in all cases. In some cases it states 'older than ... years' or 'about ... years'. In those cases, in the first instance reports were sought on the internet about the relevant

fire, in which the age of the victim was mentioned. If this yielded no results, the victims were subdivided into the possible age categories that they belonged to. For example, 'about 70 years' was subdivided into age categories (65-70, 70-75). Then at each of these two possible age categories half a victim was counted.

Table 1.9 Number of fatalities as a result of domestic fire including age categories (IFV, 2013)

Age	2008	2009	2010	2011	2012	2013	Average	Total
65-70 years	3.5	1	4	2	2	0	2.1	12.5
70-75 years	6.5	3	0	3	3	6	3.6	21.5
75-80 years	3	2	1.5	1	0	1.5	1.5	9
80-85 years	3	1	5.5	6	3	2.5	3.5	21
85-90 years	0	2	3	1	0	1.5	1.3	7.5
90-95 years	1	1	1	1	3	3.5	1.8	10.5
95> years	0	0	0	1	0	1	0.3	2
Total	17	10	15	15	11	16	14	84

In the years 2008 to 2013 there was an average of 32.5 victims of an accidental fatal domestic fire. On average 14 of these victims were 65 years or older. In total, an average of 2 per million inhabitants died at a fatal domestic fire. For those in the Netherlands aged 65 years and older an average of 5.4 per million inhabitants died. So the elderly are 2.7 times more prone to being victims of a fatal domestic fire than an average inhabitant in the Netherlands.

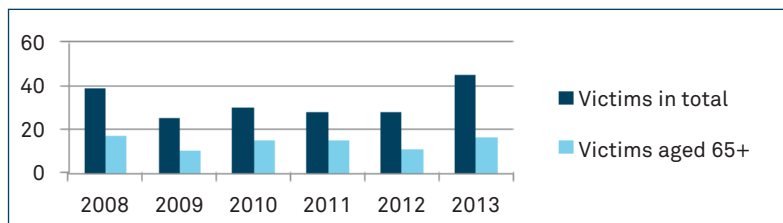


Figure 1.10 Number of fatal victims due to a domestic fire per year (Zantinge, Van der Wilk, Van Wieren, & Schoenmaker, 2011)

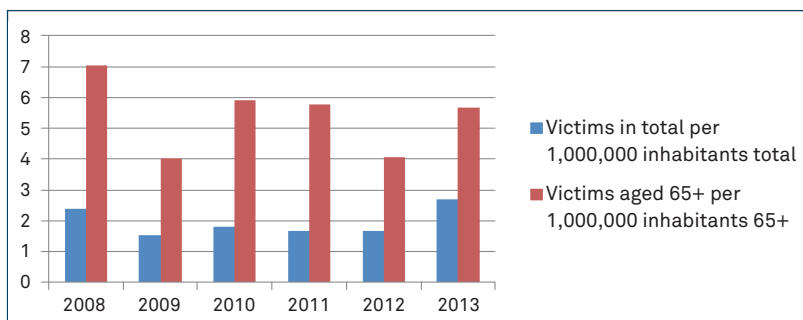


Figure 1.11 Number of fatal victims due to a domestic fire per year/million inhabitants (Zantinge et al., 2011)

1.3.2. Current number of victims of fatal fires in nursing or care homes.

IFV's *Fatal domestic fires* database also maintains in what type of accommodation the victims have died. In the event of a victim in a nursing or care home, the type of home is registered:

'Other, being' and 'Nursing home' or 'Care home'. If it was unclear which type of home the victim lived in, an attempt was made on the basis of other particulars, e.g. an address, whether the victim lived in a nursing or care home.

Table 1.12 Victims of fatal domestic fires (source: IFV Fatal domestic fire database)

	2008	2009	2010	2011	2012	2013	Total	Average	%
Living independently	15	7	13	13	10	14	76	12	85.7%
Living in a nursing or care home	2	3	2	2	1	2	12	2	14.3%
Total	17	10	15	15	11	16	88	14	100

So in recent years there were six times as many victims of fatal domestic fires amongst the over 65s living independently, than victims living in a nursing or care home.

1.3.3 Number of victims of fatal domestic fires in 2030

As stated previously, the number of elderly will rise strongly in the coming period due to the ageing of the population. Since the elderly more often fall victim to a fatal domestic fire than those under the age of 65, the number of victims of fatal domestic fires will also rise in the future. Multiplying the number of victims by a million and then dividing that by the population will result in the number of victims per million inhabitants. Assuming that the number of victims per million inhabitants stays the same in the future, then the population of 2030 can be divided by a million and multiplied by the number of victims per million inhabitants. The result is the expected number of victims in 2030.

Resident of senior citizen's complex: "When I woke up there was a funny smell, the windows were dark. I grabbed the insurance policy papers and medicines, then my husband and I had something to eat. There was a pounding on the door, that was the fire brigade. One fire fighter walked with me and two others with my husband. They put an orange mask over my head. It was terrible."

Table 1.13 Estimated number of victims as a result of a fatal domestic fire

Age	Population 2008 to 2013	Victims 2008 to 2013	Victims per million inhabitants	Population 2030	Victims 2030	Percentage increase
65-70 years	809,266	2.1	2.8	1,147,407	3	41.8
70-75 years	627,659	3.6	6.0	989,462	5.6	57.6
75-80 years	498,001	1.5	3.1	825,365	2.5	65.7
80-85 years	357,728	3.5	10.3	686,644	6.7	91.9
85-90 years	207,708	1.3	6.1	357,673	2.2	72.2
90-95 years	75,018	1.8	23.6	149,279	3.5	99.0
95> years	18,060	0.3	19.8	42,030	0.8	132.7
Total	2,593,438	14	5.7	4,197,860	22.7	61.9

In 2030 about 23 victims aged 65 years and older will die as a result of a domestic fire. So the total number of victims aged 65 years and older will increase by 9 victims: from an average of 14 victims in 2008–2013 to 23 victims in 2030, this is an increase of 62%.

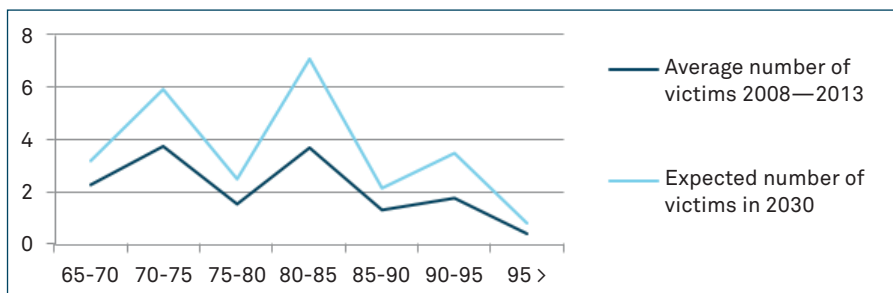


Figure 1.14 Number of fatal victims 2008—2013 in comparison with 2030

1.3.4 Number of victims in 2030

Not only will there be more elderly, but in the future, government policy will also cause a rise in the percentage of elderly living independently. In 2008—2013 an average of 112,520 elderly lived in a nursing or care home. On average there were two victims per annum in a nursing or care home. So of the one million elderly living in nursing or care homes, 17.8 were victims of a fatal domestic fire. In 2030 there will be about 111,773–122,141 elderly living in a nursing or care home. Assuming that the number of victims per million inhabitants in nursing or care homes stays the same (17.8 per million), then it is expected that there will be two victims in nursing or care homes in 2030.

In 2008–2013 an average of 2,480,918 elderly lived independently. Within this group, there was an average of 12 victims. So per million elderly living independently, 4.8 fell victim to a fatal domestic fire. Assuming that the number of victims per million inhabitants stays the same (4.8 per million), then it is expected that in 2030 there will be 19.8 independently living elderly who fall victim to a fatal domestic fire.

Table 1.15 Number of fatal victims between 2008–2013 in comparison with estimated number of fatal victims in 2030

	Average inhabitants 2008 to 2013	Average victims 2008 to 2013	Victims per million inhabitants	Inhabitants 2030	Victims 2030	Percentage increase
Living independently	2,480,918	12	4.8	4,086,087	19.8	64.7
Living in a nursing or care home	112,520	2	17.8	111,773 - 122,141	2	-0.7 - +0.2

What is significant, is that the number of victims per million inhabitants in a nursing or care home, is more than three times as high in comparison to the number of victims per million elderly living independently. Here it must be noted

that, on average, the elderly living in a nursing or care home are older than the population aged 65 years and older living independently, and the chance of dying as a result of a domestic fire increases as the age progresses. In addition, the population in the nursing or care home are in more serious need of assistance than the population living independently.

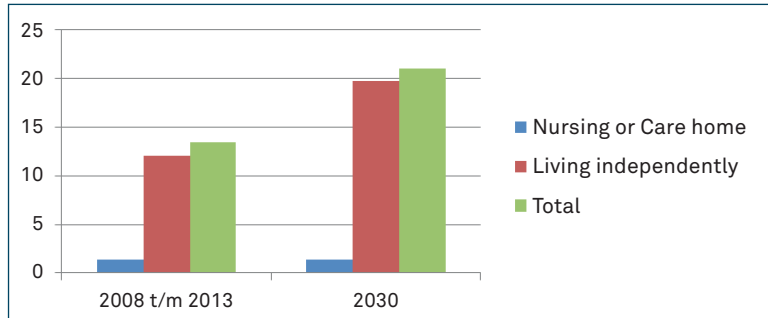


Figure 1.16 Number of fatal victims of a domestic fire 2008—2013 and in 2030

The number of victims that live independently in 2030 will rise by about 65% in respect of the average over 2008–2013, while the number of victims that live in a nursing or care home will almost stay the same. So the expected number of victims who live independently in 2030 will be more than one-and-a-half times as many as the current number of victims living independently.



2 Theoretical risk factors

As was apparent from the previous chapter, that the elderly have an above-average chance of falling victim to fire. Taking into consideration that the percentage of elderly will only increase due to demographic developments, it is expected that in the forthcoming decades we will see an increase in elderly victims of fires.

This chapter addresses how it happens that the elderly fall victim to fires. What are the risk factors recognised in reports and scientific publications?

The term 'risk' indicates a certain chance of a certain effect. So when it concerns risks, it's always a combination of chances (the probability that an event takes place) and effects (the results of that event). In most articles 'fire risk' is defined as a 'chance to die as a result of fire'. Other definitions are also possible, such as 'chance of bodily harm' or 'chance of material damage'. In this publication, fire risk is defined as the chance of dying or suffering bodily harm as a result of a fire.

2. Classifying risk factors

There are all kinds of risk factor variations. Some factors are related to the chance of fire, other factors are related to the results of a fire. Some factors can be influenced, other factors are barely influenceable, if at all. A behavioural risk factor (like smoking in bed) is often influenceable, but the fact that someone has a physical impairment and can therefore escape less fast during a fire, is often very difficult to influence or to a limited extent, with fire safety measures (though there are possible measures which facilitate the safe escape of people who have physical impairments). It has been evidenced in literature that people with a lower socio-economic status have a greater chance of falling victim to a fire. This factor is also very difficult to influence with fire safety measures. Installing smoke detectors, for example, will not improve someone's socio-economic status.

Besides, this concerns *statistical* connections (correlations) and not causal connections. It is a statistical given that people with a lower socio-economic status more often fall victim to fire, but that does not necessarily mean that the socio-economic status is the cause of this. Other factors also possibly play a role, for example, that people with a lower socio-economic status more often live in housing that is less fire safe.

Risk factors can also be classified into phase of the fire. There are risk factors relating to the origin of fire and risk factors relating to the consequences and course of the fire once it has started. Use of materials that are not easily combustible can ensure that a fire that has already started, spreads less rapidly, giving residents more time to evacuate the premises. For a safe evacuation there are also influential factors which include the layout of the building (escape routes) and the self-rescuing capacity of the residents. The most effective of course, is keeping the chance of a fire starting as small as possible.

See figure 2.1 below for an overview of the aforementioned risk factors



Figure 2.1 Risk factors

2.2 Vulnerability of the elderly

The chance of a fatality as a result of a domestic fire is greater among the elderly than for other age groups. In addition, the elderly more often have burns as a result of a domestic fire than other age groups. This is due to the fact that fire occurring with the elderly often starts close to the body. The physical condition of the elderly can therefore be of influence on both the chance of becoming a burns victim as well as the severity of the injuries.

2.2.1 Physical impairments

Physical impairments cause a significant increase in fire risk. This applies to all age groups, but among the elderly we see a more than average occurrence of physical impairments. The chance of suffering from physical impairments rises as the years go by and besides, for the elderly there could be typical 'age-related ailments', certainly for those aged 75 years and older. The elderly with physical impairments are more often victims of fatal burn(injuries) than the elderly without physical impairments, certainly when there is a combination of impairments or disorders (co morbidity).

Besides, it is not the case that all age-related ailments contribute to the same degree to an increased chance of becoming a burns victim. Literature mainly refers to a diminished functioning of the senses as being an important risk factor, such as loss of hearing and loss of vision (particularly a risk on evacuation), but also loss of smell and deterioration of the sense of touch (the elderly have a reduced sensitivity to pain, which is perhaps why they notice heat less quickly).

Aside from a diminished functioning of senses, reference is made to a reduced reaction time as a risk factor. Considering that the elderly will react less rapidly when there's fire and the survival time in a domestic fire has reduced in the course of time, a rapid reaction time is essential for the chance of survival.

As a consequence to age-related ailments or physical impairments, there is often also a reduced mobility. Due to a reduced mobility, the elderly are less able to evacuate the home in case of fire. Especially in combination with a delayed reaction time, the chance of a fatal domestic fire is significantly increased with reduced mobility.

Also, disorders relating to breathing and cardiovascular disorders qualify as risk-increasing. In both disorders the physical condition is reduced which causes people to be vulnerable. Cardiovascular diseases are ranked in 4th, 9th and 10th place in the Top 10 of the most common illnesses and disorders among the elderly in the Netherlands.

Resident: "I woke up in a room full of smoke and could hardly breathe anymore. I panicked and didn't know what I had to do. So I just pressed the (home care)button."

The lung disease COPD is ranked in 6th place with a prevalence of about 8%. With heart diseases, loss of consciousness could also occur, which likewise increases the chance of becoming a burns victim. In addition, victims with respiratory disorders could be using oxygen. Use of oxygen increases risks (fire can occur faster and the fire develops more ferociously).

Accidents will sooner occur due to a reduced coordination capability, balance, assessment ability and reduced rate of movement. Particularly while cooking, when a fast, coordinated action is often required. Elderly with serious impairments are sometimes bedridden and therefore have an increased chance of becoming a victim. Escape is then only possible with assistance from others, such as caregivers.

As a result of ageing, strength also reduces and frailty comes about. Frailty causes certain actions carried out to be slower or with less strength, and will also cause a delayed escape from a fire. So frailty is also often considered as a risk factor for the elderly.

Restrictions can also be caused by age-related impairments as well as disorders, though not always to the same degree. There are all kinds of restrictions and nowadays some impairments can be reasonably compensated by means of technical aides. Impairments are measured with the following four indicators:

1. Restricted activities involving hearing
2. Restricted activities involving sight
3. Restricted mobility
4. Restricted General Daily Activities (GDA).

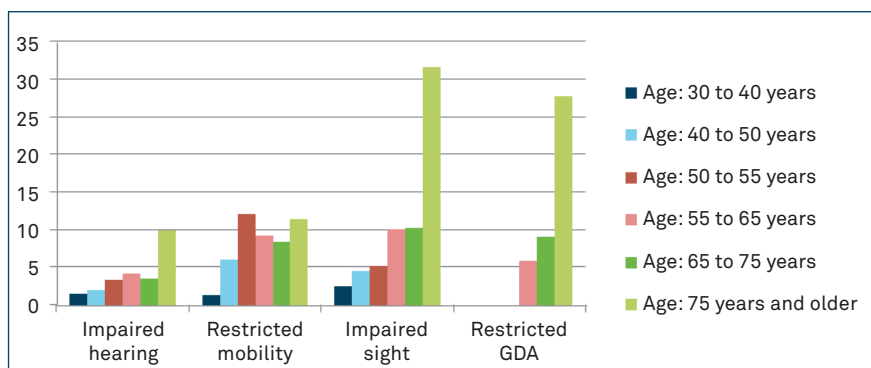


Figure 2.2 Physical restrictions (percentage)

As the age progresses, so the degree of physical impairment increases. Over the years a relatively gradual increase in the degree of physical impairment takes place, but there is no sudden increase at 65 years. On the other hand, for the age group of 75 years and older there is a significant increase. About 10% of the age group 65-75 experience a restriction in mobility. In the age group 75 years and older this is no less than 31.7%. The Dutch population aged 65 years and older suffers more often from an impairment or restriction than younger age groups. This means that if having an impairment or restriction (so too in international literature) appears to be a risk factor for a fatal domestic fire, the elderly in the Netherlands run a higher risk than the younger age groups in becoming a victim of a fatal domestic fire.

In the period 2008 to 2013 IFV registered 84 victims of a fatal domestic fire aged 65 years and older.

In more than 38% of the fatal domestic fires the victim had a restricted independent mobility. This could mean that the victim was dependent on aides such as a walker-roller to be able to move themselves. In more than 8% of the cases the victim was not independently mobile. Hence we see that in more than half the cases (restricted or not independently mobile) the victim was in the same room as where the fire arose.

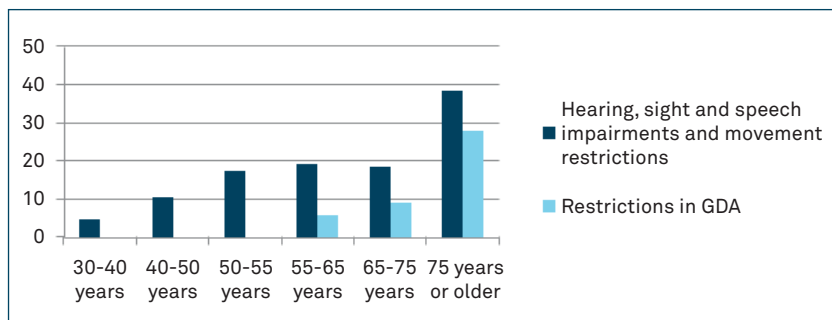


Figure 2.3 People with at least one restriction (percentage)

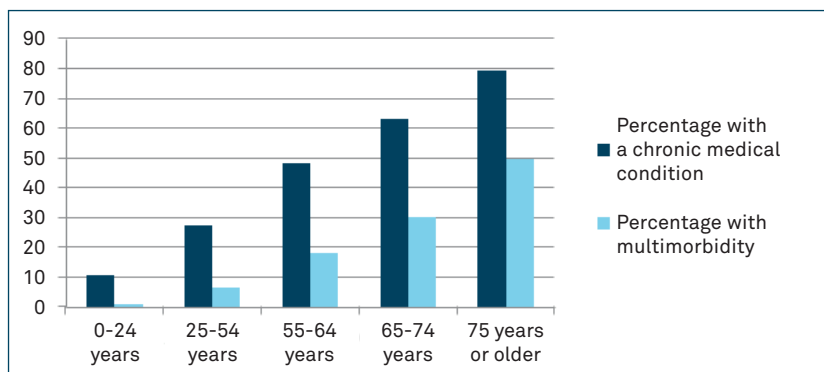


Figure 2.4 Chronic illnesses (percentage) (Gijsen, Oostrom & Schellevis, 2013)

In more than 10% of the cases the victim was hearing-impaired or deaf, which is a higher number than is expected, based on occurrences in the population. In about 7% of the cases the victim was visually impaired, which is a normal occurrence in the population. However, for both risk factors the number of registered victims is so low, that in a statistical sense no conclusions can be drawn.

For four victims of fatal domestic fires it is known that they became unwell just before or directly after the fire came about. In two cases it involved a heart attack and for two cases the cause is unknown. It was also mentioned in two cases that the presence of a pulmonary disease was of influence to the deaths as a result of the fire.

2.2.2 Mental and cognitive limitations

Aside from physical (bodily) degradation, mental degradation also takes place as a result of ageing. Cognitive ability can reduce. When this happens quickly it involves a Mild Cognitive Impairment (MCI). MCI patients run an increased risk of suffering from dementia-related illnesses. Due to a cognitive degradation the elderly could have difficulty in remembering recent events or in taking decisions. Reduced mental capacity and cognitive competences cause an increased risk of getting burnt and the coming about of (fatal) burn(injuries). There is a higher chance, for example, that a pan will be left on the stove, which could cause a fire.

In 2014, according to Alzheimer Nederland, there were more than 260,000 people suffering from dementia in the Netherlands. Dementia is a collective name for a combination of symptoms in which the processing of information is disrupted in the brain. Alzheimer disease is the most common form of dementia and in the beginning it is particularly characterised by loss of memory. Dementia mainly occurs among the elderly. The older they are, the higher the chance of developing dementia. Until the age of 50 dementia rarely occurs, after which the incidence gradually rises with increasing age. When a fatal domestic fire occurs, without an autopsy it cannot always be stated with certainty whether the victim had some form of dementia. In a number of scientific publications dementia is indicated as a risk factor in respect of fire. In another article, however, it is concluded that not enough literature is available to establish that dementia is a risk factor in the coming about of (fatal) burn(injuries), but that all the available literature does point in that direction. This article also points out that dementia mainly forms a risk while cooking.

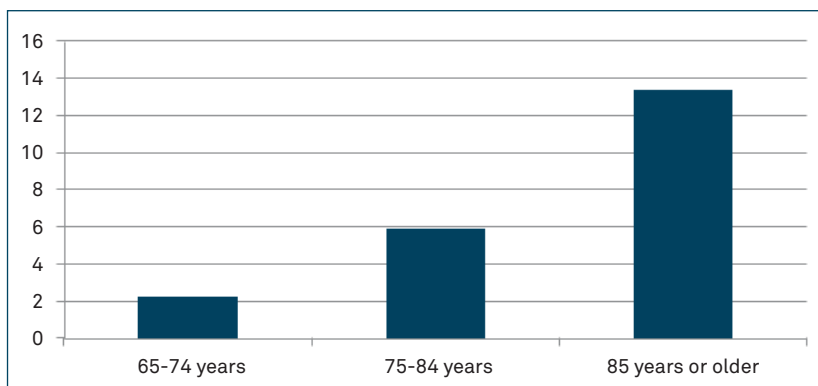


Figure 2.5 Cognitive impairments (percentage) (Comijs, 2012)

When we use the prevalence figures derived from both the ERGO Institute study and Matthews et al. (2013) in calculating the number of Dutch elderly with dementia in 2030, we see that 328,374 elderly with dementia are to be expected based on the prevalence of the ERGO Institute. Based on the prevalence of Matthews et al., 272,316 elderly with dementia are to be expected.

Resident: "I was on my balcony and heard something falling off a chair inside. I went to have a look and saw that the chair was on fire. I then first went to warn the neighbours."

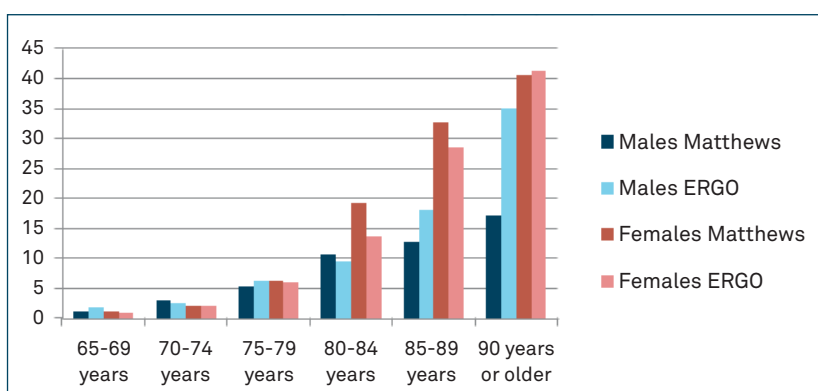


Figure 2.6 Prevalence dementia (percentage) (Breteler et al., 1996; Matthews et al., 2013)

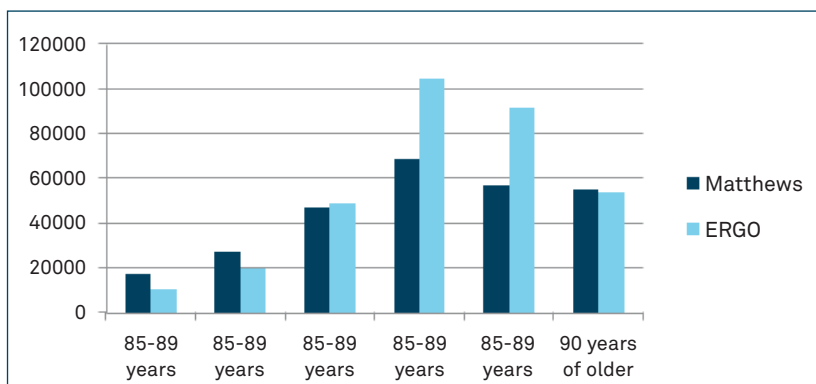


Figure 2.7 Number of Dutch people with dementia in 2030 (percentage) (Breteler et al., 1996; Hagen & Van Zoonen, 2015; Matthews et al., 2013)

Since a large portion of these elderly will continue to live at home in the future and dementia is a risk factor in becoming a victim of a fatal domestic fire, then dementia is an important factor to keep account of for the fire safety of the elderly.

Psychological disorders generally also form an increased risk of burn(injuries) among the elderly, but psychological disorders are not specific risk factors for them. Burn(injuries) in which a psychological condition plays a role, occur far more often in other age groups than among the elderly. Psychological disorders in other age groups are even one of the most important risk factors for the coming about of (fatal) burn(injuries).

In the descriptions of fatal fires it is mentioned twice that confusion or a psychological disorder was an influence in the coming about or the development of the fire. Dementia is mentioned five time as the most influential factor.

2.2.3 Use of medication

Due to a higher prevalence of disorders and more co-morbidity, the elderly use more medication and often various medications simultaneously. It is difficult to prove that the use of medication plays a role in the coming about of burn(injuries), since there is often no track record of which medication the victim has taken. Furthermore, so many people use self-care medication, that a correlation would be difficult to prove. Yet for some medication it can be assumed that they have an effect on the chances of burn(injuries) coming about. For example, often prescribed benzodiazepines have an influential effect on consciousness, certainly in combination with alcohol. The relationship between benzodiazepines and burns has been proven for burns resulting from skin contact with hot liquids. Medication, in relative terms, is not often described as a risk factor for fire or burns. Considering the extent of the use of medication among the elderly, more research would be useful into the relationship between the use of medication and burn(injuries).

2.2.4 Social circumstances

Composition of households

In the last few decades in the Netherlands, as is the case in many other western countries, it is no longer common practice that elderly live in the same house as their children (if they have children). 'Multiple generation households', which occurred more often in the olden days, are an exception in modern Netherlands. Most elderly live alone or together with their partners. Elderly who, in the first instance, want to continue living at home with a partner, will often end up living on their own. In many cases it is the husband who passes away sooner, leaving more women than men who live alone within the group of elderly. The consequences of this trend, for that matter, have diminished somewhat due to the fact that the life expectancy gap between men and women is gradually closing.

Of all the over-65s about 52% live alone, and of all those over 75 about 64.6% live alone. In the forthcoming years it is expected that the number of elderly living alone will rise because more people are getting divorced and live together less often.

Victims of a fatal domestic fire aged 75 years and older live alone more often than younger victims. These elderly were also a victim more often in comparison to elderly who do not live alone. Being 'alone' can therefore also be considered as a risk factor. However, if there is a young adult like a caregiver present in the vicinity of the elderly, that counts as being risk-reducing.

Social network

Another phenomenon with which the elderly are confronted is that, as people get older, more and more of the age group peers in the social environment of the elderly pass away. This means that in many cases the elderly are left with a less extensive social network. Elderly with a small social network and those who live alone could have difficulty with loneliness. Literature shows that the problem of loneliness among the elderly is indeed higher than for other age groups, whereas the problem mainly occurs in the age group over 75. Elderly with a limited social network, statistically speaking, have a greater chance of becoming a victim of fire.

Poverty

When old age is combined with poverty, statistically speaking, there is likewise an increased risk of death as a result of a domestic fire. What's remarkable is that more than twice as many elderly that are living alone live below the poverty line, than the elderly with a partner. Of the over-65s living alone, 6.4% live below the poverty line and of the couples, 2.6% live below the poverty line. This, for that matter, is significantly lower than the 10.3% of the whole Dutch population. Research has shown that these relatively low percentages are caused due to income from the State pension. This income alone, without a supplementary pension, is sufficient to stay above the poverty line (CBS, 2014a).

2.2.5 Behaviour

When a fire comes about due to electrical wiring becoming overloaded for example, it is obvious to designate this wiring as the cause of the fire. However, when examining the problems in more depth, it appears that human action has caused a situation in which the chance of such a disastrous event is enormously increased. For example, this could be due to poor maintenance or the connection of too many or heavy duty electrical equipment on one circuit or onto one extension cable for which it is not suitable. Also, specific equipment could be used incorrectly, causing a fire hazardous situation.

Incorrect usage of electric blankets is often mentioned in this connection. Portable electric heaters are also an important cause of fatal domestic fires. Many burn(injuries) are caused due to the elderly, sooner than other age groups, being prone to placing themselves or things too close to a fire source.

For Dutch elderly we relatively often see that electric blankets are the electrical devices involved in fatal domestic fires. In 21 of the cases it concerned short-circuits or burned-through electric wiring or electric devices. In three cases the electrical device was an electric blanket and in seven cases household appliances. Hoarding was mentioned four times as being the risk factor involved in the coming about or development of fire. Waste can also relatively often be traced as the fire-causing materials. In nine cases it concerned a candle or lamp that had fallen over, or materials that had caught alight due to the candle or lamp becoming so hot that they caught fire. This is odd, because international literature rarely shows the falling over of a candle or lamp as an important risk factor for the elderly.

Among the elderly, burn(injuries) are often caused while cooking. Burn(injuries) come about more often among the elderly than in other age groups while cooking or working in the kitchen. Burn(injuries) as a result of cooking is particularly linked to reaction speed and alertness. It's mainly clothing that catches fire which is the biggest cause of burn(injuries) among the elderly. In an article that specifically addresses older people's clothing catching fire while cooking, it describes clothing fire mainly occurring among women, and can be attributed to often wearing fabrics that are easily flammable such as polyester and because the sleeves often hang loosely.

Clothing fire is especially the reason that fire occurs close to the body of elderly than for other age groups. So, to a significant degree, clothing fire is responsible for the high mortality rate among the elderly in cases of fire.

Ten out of every 84 fatal domestic fires were caused while cooking. In about 55% of the cases it was known that the victim lived alone. In literature it mentions that particularly clothing fire occurs more often among elderly than among younger age groups. In six out of ten fires that came about during cooking it involved clothing that had caught fire while cooking. Flames in the pan occur less often and in two cases the victim became unwell while cooking.

Consumption of Alcohol

Although the consumption of alcohol generally has a disadvantageous effect on fire safety, consumption of alcohol is not a specific risk factor for the elderly. On the contrary: on average the elderly consume less alcohol than people under the age of 65.

Consumption of alcohol is only mentioned once as a risk factor which was of influence in the fatal domestic fires in the Netherlands between 2008 and 2013. It is not routinely investigated whether a victim has an alcohol content in the blood; so perhaps consumption of alcohol is (often) overlooked.

Smoking

In the Netherlands approximately one in five people over the age of 12 smokes. The number of smokers reduces as people get older. Smokers among the over-65s average

18.6% and 8.8% of those over 75, smoke. The percentage of smokers is related to the level of education. The higher the education, the lower the percentage of smokers. Smoking is one of the most important causes of a fatal domestic fire among the elderly. As mentioned before, smoking in combination with the consumption of alcohol is extra hazardous.

As is the case for consumption of alcohol, smoking is not a specific risk for the elderly. On the contrary: in comparison with younger age groups fewer fatal domestic fires among the elderly are caused by smoking. But for all age groups, smoking is one of the most important factors for the coming about of fatal domestic fires. The described mechanisms for the coming about of (fatal) burn(injuries) through smoking are the thoughtless discarding of lit cigarettes, falling asleep while smoking, and the use of oxygen while smoking.

Smoking in combination with oxygen treatments are extremely risky. In principle, patients in the Netherlands are not eligible for oxygen treatments if they smoke. Smoking behaviour is checked by the general practitioner at the time that the GP confirms that a patient will benefit from an oxygen treatment.

In 22 of the 84 fatally injured victims, smoking was the cause. In all the cases where smoking was the cause of the fatal domestic fire, it was registered how the smoking could have led to the coming about of the fire. In 11 of the 22 cases the cigarette fell onto the chair or couch on which the victim was sitting, and set the particular furniture on fire. Mostly the victim had fallen asleep and in some cases the victim was physically or mentally disabled, which restricted the person from removing the cigarette.

2.2.6 Physical effects of fire

If, after experiencing a domestic fire, an elderly ends up in a hospital or burns centre, the chance that they will die is 2.7 times higher than for people below the age of 60. This difference can also be explained because, in a physiological sense, the body degrades as the age progresses. So an older body recovers less easily from the results of burns than a younger body. In addition, burns among the elderly are often more serious because the thickness of the skin reduces as they get older. This is also evident in the so-called Baux score, in which the burned surface of the skin plus the age, gives an indication of the chance of death. This score shows that the chances of dying from burns is related to age. Inhalation injury is included as a determining factor in the score. Where inhalation injury is also involved the chances of dying increases even more significantly.

In the burns centres in the Netherlands 11.8% of the patients are aged 60 years or older.² In comparison with other age groups there is no question of an over-representation of patients in the age group of 60 years or older. But mortality is significantly increased; more than half of the 371 patients who died in a burns centre in the Netherlands between 1995 and 2011 were 60 years or older. In addition, most of the elderly die of burns as a result of fire and flames and the majority of burns take place in a domestic environment. So the elderly die faster than victims of other ages as a result of a domestic fire.

Among the age group 80 years or older, males run a relatively higher risk than females of becoming a victim of fires. In absolute numbers, there is not such a big difference in the number of male and female victims in this age category. Because more women reach the age of 80 years or older than men, the relative share of male burns victims can still be considered as high.

2.3 The home and its layout

Due to physical impairments (see paragraph 2.2) some of the group of elderly are less able to maintain their own home. The result is that a faster deterioration of the home occurs, especially when it's an owner-occupied home (for rental homes the landlord usually takes care of the maintenance). A deteriorated home means a higher chance of domestic fire.

In homes where the elderly (continue to) stay, amongst the possibilities for escape, account is only kept with mobile people, which means that in the event of a fire, the elderly *can evacuate the home less quickly*.

According to some authors the elderly are less likely to purchase modern electric appliances, whereas among the elderly more outmoded electric appliances are present in the home. Outmoded appliances are an increased risk of fire and burns. Poorly maintained or defective appliances have also caused many victims. So domestic fires also arise more often among the elderly because of outmoded electrical wiring.

Means of fire prevention

The elderly have an operational smoke detector hanging from the ceiling less often than younger age groups do. It is assumed that operational smoke detectors reduce the chance of a fatal domestic fire. The lower prevalence of smoke detectors amongst the elderly is therefore also considered as a risk factor.

In this regard it has to be said that for some groups of elderly, a smoke detector will have a relatively limited effect. Due to a restricted mobility many elderly can react less quickly to a smoke detector's warning, for example. Impaired hearing can also negatively influence the signals of the smoke detector's warning.

In 25% of the fatal domestic fire cases a smoke detector was present. In one case it was unknown whether the smoke detector worked, but in all other cases the smoke detectors worked properly. Yet those elderly who had a working smoke detector died. Factors such as hearing-impaired or a restricted mobility could have played a role here. So a working smoke detector is not always a guarantee for a successful escape for the elderly.

Risk profile

Often a stacking of risk factors eventually results in a fatal domestic fire. Risk factors could also compound one another.

It is difficult to identify the correlation between all risk factors, but on the basis of literature, a profile can be drawn up of the combination of risk factors which provide the greatest risks of a fatal domestic fire among the elderly. In contrast to most domestic fires that take place between 24:00 and 06:00, literature has also shown that fatal domestic fires among the elderly, more so than among other age groups, take place during the day. Then the riskiest situations are:

1. a *single person*
2. *male*
3. during the *winter*
4. who *smokes*
5. and consumes *alcohol*
6. is *less mobile*
7. is in a *small living space*
8. with *lots of furniture and stuff*
9. makes use of *electric or gas heaters*
10. and *does not have a working smoke detector* in the house.



3 Incidents and solution strategies

Whereas the previous chapter described the extent of the problems and the risk factors, this chapter describes in which direction solutions must be sought. On the one hand this happens on the basis of existing theory (as mentioned in reports, international trade literature, at congresses and in professional consultations); on the other hand this happens on the basis of fires that have actually taken place in the Netherlands. No matter how tragic such incidents are for those involved and their social environment, they often illustrate very well the importance and urgency of certain solution strategies.

During 2015, the Fire Service Academy searched the internet on a daily basis for news bulletins about fires in homes and residential buildings that house the elderly.³ Based on these bulletins, in 2015 at least 105 fires took place in such homes and residential buildings, of which 15 resulted in fatalities. In consequence to the news bulletins, for every fire a (limited) supplementary investigation took place aiming to verify the data in the news bulletins and to obtain additional details in view of the issue. The details gathered in this manner have been incorporated in a database.

Aside from the gathering of case studies, the Dutch Burns Foundation and the Fire Service Academy have drawn up an inventory of interventions which aim to prevent fire among the elderly or to limit the consequences of these fires. These interventions are not only geared towards the physical environment, but also the social environment of the elderly. The interventions can be enforced through formal regulations and enforcement, but they can also have a less forceful character. A special type of intervention is influencing behaviour. In this, an endeavour is made to influence both the behaviour and the elderly in such a manner, that this behaviour is beneficial for the fire safety and risk-increasing behaviour is counteracted. This happens by providing information and education. The majority (23 out of 33) of the interventions that have been described, were found in the field of influencing behaviour, of which a number are in combination with regulations and enforcement or engineering.

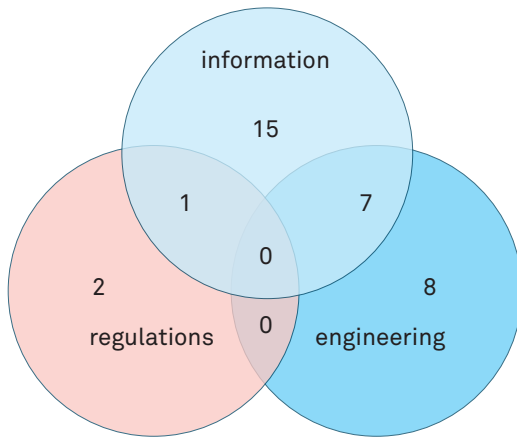


Figure 3.1 Spread of interventions over categories

The study into interventions was carried out in the first instance to get an idea of the possible solution strategies within the Netherlands. However, it is not always possible to incorporate international, interesting and/or effective interventions one-on-one in the Dutch context. In the Netherlands the circumstances could differ to such a degree from the studied interventions that it is impossible to incorporate the intervention. For example, there may not only be socio-cultural differences, but the constitutional situation could differ to that of the Netherlands. After all, the possibilities for implementation could differ (manpower or financial means). Therefore it has been found to be necessary to assess interventions on the possibility of implementation within the Netherlands.

This chapter addresses the possibilities for intervention, such as those found in literature and in discussions with experts, classified according to the Cascade model. The inventoried case studies are also analysed according to the Cascade model. The Cascade model is an analysis model used by the fire service and professionals in the field of fire(prevention). Fire is an extremely complex and haphazard phenomenon. By dividing the development of a fire into different phases, a fire can be understood better and it is also easier to indicate which intervention options are possible in which phase of the fire.

The inventoried interventions cannot be equally divided over the various phases of the Cascade model. This is the reason why some tables are largely empty. Generally applicable: the further along in the Cascade model, the less interventions were found.

Cascade Model

The Cascade model is a model that describes the physical development of a fire, in which various phases are differentiated. This model starts with the coming about of a fire in which it is assumed that a fire always starts in an object. In the absence of adequate measures, the fire will spread to the immediate surroundings of that object. If the fire then develops further (having sufficient fuel and oxygen and in the absence of any extinguishing), the fire can even spread to outside the space of its origin, outside the compartment and even outside the building. In contrast to other models (like the fire growth curve), the Cascade model does justice to the various phases in the physical spread of the fire and to the dynamism which a fire and smoke can have.

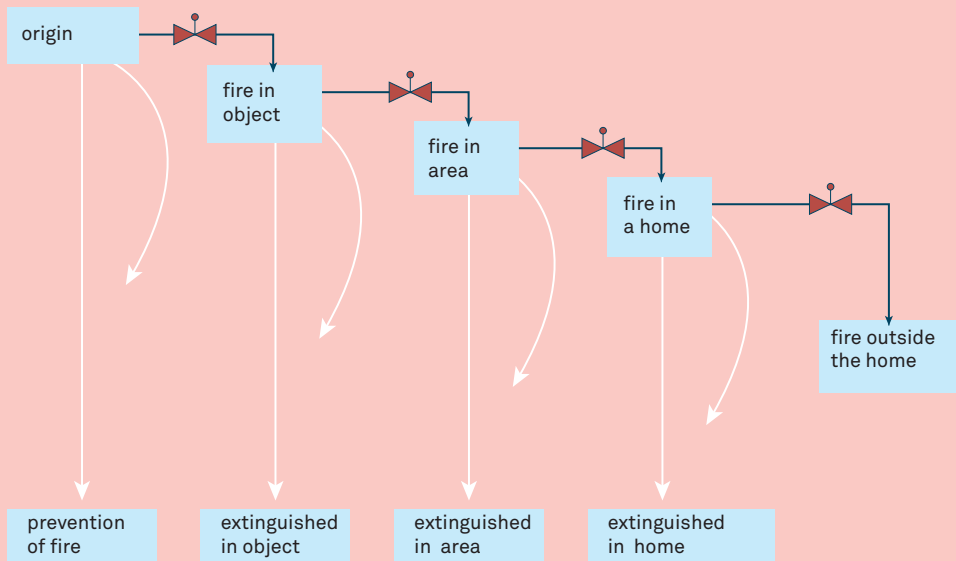


Figure 3.2 Cascade model

The essence of the Cascade model is that the various demarcated locations (phases) are differentiated, in which transitions between the phases are considered as crucial undesirable events. An important aspect of this model is acknowledging that the spread of smoke at the transition is often one or even more phases further than the spread of fire.

Each phase in the model has two possibilities: the fire extinguishes or the fire goes over into the next phase. Whether fire goes over into the next phase depends on a large number of influential factors. These influential factors could be constructional or electrical and mechanical engineering measures. These measures prevent fire from spreading further or flash-over to another compartment. But human behaviour too, such as actions by residents or in-house emergency responders, forms part of the influential factors. These influential factors jointly form the 'valve' that determines whether a fire develops to a next phase. By closing the 'valve' in a manner of speaking in the model, the fire or smoke cannot develop itself further. Accordingly actions and measures can eliminate further spread.

In order to actually improve fire safety it should be clear which factors are of influence to fire safety, how effective this influence is and how these factors relate to each other. Then it can be calculated or explained what the effects are of certain (fire safety)measures.

For this publication the phase 'origin' has been added to the original Cascade model, because this creates more possibilities to consider in the prevention of fire.

3.1 Origin of fire

The most obvious measure to prevent victims and damage by fire is to ensure that no fire is even able to start at all. In this paragraph we first look at the manner in which fire originates in the gathered case studies (3.1.1), then we examine theoretically argued solution strategies (3.1.2) and finally, a clarification of these solution strategies (3.1.3). This structure will also be used in the following paragraphs.

3.1.1 Case studies

Fire can originate in a wide variety of ways. Sometimes it is immediately clear how a fire started, but often it's not. Fires are increasingly being investigated by the fire service, although, because of the enormous extent of the number of fires in the Netherlands, it will never be the case that all fires will be investigated.

In the case studies of domestic fires among the elderly we've come across a wide spectrum of fire causes. 'Smoking' is mentioned often (Helmond, Bolsward, Beuningen, Eindhoven), possibly in combination with the resident falling asleep (Rhenen, Eindhoven). In a single case the fire was caused by smoking in combination with the use of medicinal oxygen (Rotterdam).

Further, an accident also happened while cooking (Vlaardingen, Heemstede, Zwijndrecht, Oentsjerk, Beverwijk, Vriezenveen, Reuver, Delft, Wervershoof, Hellevoetsluis, Wormer), sometimes in combination with loosely hanging flammable clothing. These are fires that originate close to the body; they're often also fatal. Figures derived from the Fire Service Academy's multi-year research programme into fatal domestic fires endorse this finding.

However, fires can also originate in another place in the home than where the resident is present. For example, it could be caused by defective or incorrectly used equipment such as heaters or air conditioners (Groningen), an over-heated stove (Thorn), a defective tumble dryer (Eemnes, Rhenen, Oegstgeest).

In a few cases the fire was (presumably) caused deliberately (Den Helder, Amersfoort, Delft, Doorwerth). There were two cases of a gas explosion (Rotterdam, Hoogeveen).

3.1.2 Solution strategies

Literature refers to various possibilities to prevent fire. An often mentioned effective measure is the providing of good information to thus stimulate fire safe behaviour. Various scientists have conducted research into providing information to the elderly. Some of them specifically deal with encouraging awareness of the dangers of smoking in bed or point out the importance of information about safe cooking, making safe use of electrical equipment, regular house checks and the use of portable (radiant) heaters. Providing information can be organized in different ways, amongst other things presented by pensioned fire-fighters or by means of short video presentations.

Home care employee: "A notification came in via the alarm being sounded at an address where a gradually dementing resident falls from time to time. Coincidentally there were two of us who could go together. It was a 6 to 7 minute drive. Once we arrived, on opening the front door it appeared that the house was full of smoke. The search started in the kitchen, where things usually go wrong. We found the resident sitting on the edge of her burning bed. We were barely able to endure, but with our jackets in front of our mouths we reached the resident and took her outside. My colleague was left with a headache and I had a strange feeling in my stomach. In the worst cases it takes us about 30 minutes to be on location."

According to a few authors the coming about of fire could also be prevented by means of stricter rules relating to smoking. They suggest for example, that people with dementia should not be allowed to smoke in care or nursing homes or that smoking is prohibited in certain rooms (e.g. bedroom).

Literature also mentions technical measures which limit the chance of a fire starting. Product safety checks by manufacturers and importers of ovens, stoves and heating elements could provide a contribution. Heaters mounted against the wall as an alternative to portable (radiant) heaters. One author further advocates that electrical wiring should be earthed and wired safely, and that no electrical wiring runs under a carpet or is stuck together with tape. The author advises against the use of extension cords and recommends using equipment with a safety marking.

Various articles mention cooking appliances. For example, it is proposed that independent cooking should be restricted for the elderly with cognitive impairments. If independent cooking is permitted, the set-up of the cooking appliance must limit the chance of accidents. For example, cooking rings can better be placed adjacent to each other rather than behind one another. Here it is of importance to avoid loosely hanging sleeves and to stimulate easily removable clothing in connection with the treatment of burns. Aside from the loosely hanging sleeves, fire-retardant clothing and bedding would also reduce the chance of fire. Gas cooker safety switches would also restrict the chance of fire. Finally, according to some authors, the use of an electric water boiler (instead of boiling water on a gas stove) reduces the chance of fire.

Table 3.3 Interventions relating to the origin of fire

	Influencing behaviour		Private regulations	Technical facilities
	Resident	Social environment		
Fire development	Information, equipment or installation.	Information (awareness of smoking hazard) Information (risks) to care providers.	Regulations on smoking. Safety marking on equipment.	Replace/remove fire hazardous equipment/ installations. Fire-retardant materials Aides to reduce chance or impact.

3.1.3 Clarification of solution strategies

Although it's common knowledge, it is still something that is often taken for granted: the best thing to do to improve fire safety is to prevent any fire coming about at all. Prevention is better than cure. So the (potentially) most efficient fire safety measures can also be found in the first phase of the Cascade model. Taking into consideration that smoking and cooking are two activities where fire comes about relatively often (certainly among the elderly, as we've seen in the gathered

case studies), it is meaningful to make people aware of the risks attached to these activities. Where an elderly resident receives care, the care giver could discuss this with the particular resident and possibly make arrangements about this. In the researched literature some authors suggest regulating smoking or even a complete ban on smoking in a care home. Although such measures would be effective in respect of improving fire safety, they will probably be perceived as being too radical in the personal lifestyle and would therefore not be feasible.

A measure that could probably be simpler to implement is the promotion of safe electronics and equipment. A gas cooking appliance where the gas rings are not placed behind one another but side by side, according to literature, could reduce the number of fires that come about close to the body which limits the number of fatal domestic fires. Some of the causes of fatal domestic fires identified include defective or incorrectly used appliances such as electric heaters, air conditioners, cooking appliances and tumble dryers. Quality control contributes to the elimination of these causes of fire. Nonetheless, this will have to go hand in hand with the proper usage and maintenance of appliances.

3.2 Fire in object

Most fires come about in an object. A pan containing food, a waste bin, a table cloth. If the object is at a safe distance away from a person and no undesirable spread of smoke occurs, the damage usually stays confined. As long as the fire doesn't go further than that object, however, and as long as that object is not on or near the body of a person. So precautionary measures must be targeted to counteract a further spread of fire.

When the particular object produces too much smoke, however, a fire can be highly disadvantageous for the damage and survivability, even if the fire remains in the object. Escaping safely is therefore necessary in the first phase of the fire.

3.2.1 Case studies

In the gathered case studies there are various cases in which the fire comes about on or near the resident (Eindhoven, Rheden, The Hague). This resident most likely has a reduced self-rescuing capacity (mentally or physically and sometimes both) and is not in a position to extinguish the fire. All the fires that were inventoried in which this was the case, were fatal. For such fires, the question whether the fire has or has not remained in the object it originated in, is not relevant.

Insofar as the object is known in which it originated, it includes: a mattress (The Hague), pan (Vlaardinggen, Heemstede, Oentsjerk, Delft, Wormer), couch (Bolsward), waste bin (Beuningen), plant pot (Eindhoven), deep-fryer (Reuver) and a tumble dryer (Eemnes, Rheden).

3.2.2 Solution strategies

It's been known for a long time that it's important to prevent the spread of a fire once it has started and to prevent the fire spreading outside the object it originated in. The sprinkler system and other suppression systems are based on this. Domestic sprinklers ensure that the fire is detected and combated. A simple form of a domestic sprinkler system is a so-called water supply sprinkler. This sprinkler is not compliant with the standards for domestic sprinklers, but in relation to the survivability and escape possibilities for residents the same result is envisaged. An even simpler form of domestic sprinkler is a so-called portable sprinkler. This can be installed without pipework needing to be constructed in the home. The system comprises a detector, a sprinkler head and a water supply. Another type of sprinkler is a sprinkler fitted in the extraction hood, which ensures that a fire on the cooking appliance, like a flame in the pan, is extinguished quickly.

Another measure often used in common practice is the application of non-flammable or fire-retardant materials. By impregnating furniture for example, it can be avoided that fire develops further in that furniture.

As said before: even if a fire remains confined to an object, it could still be relevant to be able to escape safely. Even in a confined fire, an unhealthy amount of smoke can also arise quickly. Smoke at eye level causes orientation to be difficult in a building, because people have reduced visibility. Moreover, the inhalation of combustion products has a negative impact on the orientation capacity and ability to react. Finally, hazardous substances in the smoke as well as the heat of the smoke fumes could lead to people becoming unconscious and even immediate death. So it is important that people evacuate a room full of smoke quickly and safely and are able to get to a safe area.

A senior's reaction on receipt of a smoke detector:

"Thanks for the smoke detector, but I won't be able to get outside on time."

In the analysed literature various possibilities are mentioned to improve the escape route. For example, providing information about the importance of keeping escape routes free of rubbish and belongings. This information can be disseminated to both the residents and the social environment. Information can also point out the importance of having and practicing an escape plan, and then also dealing with the possible actions to be taken at the time that fire comes about on or close to the resident. Various authors infer the importance of training care personnel and their role in the safe evacuation in case of fire.

Aside from information, attention is also paid in various articles to technical facilities which enlarge the possibilities for escape. If residents cannot escape independently, then it is important that the emergency services are warned quickly. For this purpose, residents with restricted mobility can be equipped with a necklace with an emergency button, or emergency buttons can be fitted in every room of the house. For the elderly with visual and auditive impairments it is important that special detection and warning systems are installed with light, vibration or warning scents so that they are alerted too.

Also mentioned as being of importance are sturdy treads and balustrades at the entrance, windows that can open easily and are not locked. The same applies for locks which would also need to open easily. Other possibilities to support escaping are: keyless locks, doorknob extenders and electric window and door openers. As a condition it should be specified that emergency lighting and signposting of escape routes must be understandable and universal, in which the use of lifts could also play a role in the evacuation.⁴

Rescue options could be supported by placing emergency telephone numbers next to the residents' phones. An alternative to this was found in Japan. People in Japan can phone an emergency number 24 hours per day and when the emergency services cannot be at the location fast enough, citizens are warned. Another possibility (likewise applied in Japan), smoke detectors are linked between neighbours so that the neighbours can also be alerted.

Rescuing incapacitated people can be supported with physical aides such as an evacuation chair. To be able to take a bedridden resident, including mattress, to a safe environment, there is the S Cape Pod. This rescue mattress is kept permanently under the mattress and in case of an emergency, the evacuation aide can be wrapped around the mattress with the person. The person is wrapped in a cocoon, as it were.

A safe evacuation is possible thanks to the thick mattress.

Table 3.4 Interventions relating to fire in object

	Influencing behaviour		Private regulations	Technical facilities
	Resident	Social environment		
Fire development				Suppression system, Fire-retardant materials
Smoke spread				
Escape options	Information	Information		Layout of escape routes, Detections and signage
Rescue options				Warning possibilities Evacuation aides Emergency buttons

3.2.3 Clarification of solution strategies

An automatic fire suppression system can ensure that a fire that originates in the object does not spread and is preferably extinguished. Adequate actions by residents or third parties (neighbours, by-standers, personnel) can also ensure this; so it is obvious that these people should be warned quickly. An automatic detection and alarm warning system could be useful, in which modern technology can be deployed for 'smart' alarms (forwarding alerts to neighbours and/or smartphone of care workers). But a great deal of smoke can also be released when a fire is confined or extinguished. So in this phase measures relevant for a safe escape are already made possible, certainly when the resident is present in the same room as the fire, but also for those in-house emergency responders or neighbours who possibly come to the rescue. These measures are not only geared towards a proper implementation of the escape route (in a building and equipment context), but also to ease possible rescue actions using a 'rescue mattress' for example.

Despite a fire remaining rather confined, this could already have major consequences for the resident(s) and neighbours. An object can produce a great deal of smoke, in which, due to the danger of smoke inhalation, could result in an evacuation. Particularly in the case of people who are less self-rescuing due to their reduced mobility, at that point in time an important task awaits the fire brigade and other service responders present, particularly at multiple-storied complexes, in which the lift is placed out of order.

3.3 Fire in area

If there has been no success in keeping a fire confined to the object where it started, then the fire will spread to other objects in the area. If this has not happened as yet, it is still important that the people present can still escape safely. So the measures mentioned in paragraph 3.2 continue to remain in force in this phase of the fire.

It is further of importance that surrounding areas remain free of fire and smoke for as long as possible.

3.3.1 Case studies

At a number of fires in the previously mentioned case studies the fire remained confined to the object (Eindhoven, Rhenen, Bolsward). When the detection, alarm warning, evacuation or extinguishing of the fire happens less adequately, a fire could spread from the object it originated in to the rest of the area (Purmerend, Heemstede, Amsterdam). In various cases the fire remained confined to the area. Except it was not the fire, but the spread of smoke which appeared to form a greater threat. In the first instance this was for the resident (Heemstede), in which the emergency services discovered a fire in the kitchen, but the house itself was already full of smoke. There are also examples of fires in which, despite the fire remaining confined to the area, the spread of smoke was as such that residents in the adjacent premises could become threatened by this smoke (Roggel, Thorn, Zutphen, Purmerend).

3.3.2 Solution strategies

In the analysed literature, discussions on fire in an area were mainly about various technical facilities to confine the fire. The technical facilities can be subdivided into inhibiting the fire spread and improving the escape and rescuing possibilities. In the business community various facilities are available which inhibit fire spread such as the development of fire-safe furniture and mattresses. The problem, however, is that these types of furniture and mattresses are barely available in the Netherlands for private individuals. However, this does not apply for fire-resistant covers for mobility scooters. These covers ensure that a fire in a mobility scooter does not spread further so that the entire area does not catch fire.

As described in paragraph 3.2.2, the business community has developed various sprinklers which contribute to detecting, extinguishing or keeping a fire under control. A similar automatic fire suppression system could also be useful in this phase of the Cascade model.

Both the escape and rescuing possibilities are improved by detecting a fire in good time. When a fire has been detected it is important that not only the residents are warned, but third parties too. This can be done in different ways. Aside from equipping smoke detectors with a link to the neighbours, it is possible to get the smoke detector to transmit a (wireless) warning signal to a company or person, whether via a smartphone or not.

Table 3.5 Interventions relating to fire in an area

	Influencing behaviour		Private regulations	Technical facilities
	Resident	Social environment		
Fire development				Fire-retardant materials Impact-reducing aides Evacuation aides
Smoke spread				
Escape options				Warning possibilities
Rescue options				Warning possibilities Evacuation aides

3.3.3 Clarification of solution strategies

If a fire cannot be confined to the object it originated in, then it is important that the fire spreads as little as possible through the area. This can be achieved through the use of less flammable materials. Yet the problem in the Netherlands is that a great deal of modern furniture is not made fire-retardant. Of course the previously mentioned measures relating to own actions, extinguishing, detection, alerting and safe escape in the earlier phases of the Cascade model also remain of importance in this phase.

3.4 Fire in a home

During a ferocious fire load with sufficient fuel and oxygen, it is possible that the fire will spread further within the home. This effect is augmented by doors standing open.

3.4.1 Case studies

In the case studies we found various fires that have spread to outside the object it originated in and involved (part of) the house in the fire. Examples of such fires were found in The Hague, Amstelveen, Helmond, Amsterdam, Eindhoven and Groningen.

In the case studies we also found fires in which it was not the fire but the spread of smoke that was problematic where it concerned survivability and damages (Nijmegen, Maassluis, Lisse, Rotterdam, Delft, The Hague). In these fires too, the

question whether the fire remains confined to the object or area was less relevant. The smoke mainly ensures that the other residences in the complex must be evacuated in connection with the danger of smoke inhalation. This is not only a heavy task for the fire brigade, in-house emergency responders and other possible emergency services present, but this could also have a major impact for the residents themselves.

3.4.2 Solution strategies

In the analysed literature, discussions on fire in a home were mainly about various technical facilities. However, the elderly appeared not to be inclined to use new technologies unless they really needed it. If existing technologies could be improved that would sooner take preference. To illustrate, the examples mentioned to improve escape possibilities during a fire in a home: adapted smoke detectors which transmit warning signals to a company or person when that is necessary, automatic lighting, keyless locks, or programmes that can be operated via a mobile telephone. Other technologies are door handle extenders, landline and mobile telephone amplifiers and electric window and door openers.

With regard to the rescuing possibilities, in the analysed literature a model is discussed in which the movement of groups of elderly is identified. The aim here is to predict the rate of movement based on predefined groups of elderly. When an evacuation plan must be drawn up, by using this comparison and the relevant categories of elderly, it can be determined at what maximum rate the evacuation will take place.

Since there is often very little time in the evacuation during a fire, and the elderly are often slow to evacuate, the creation of safe areas is possibly a solution. In these areas the elderly are safeguarded from fire and smoke for a certain amount of time. They can then be evacuated individually from here. This requires that fire-resistant structures in the Netherlands must be smokeproof, for example, by applying an overpressure or partitioning which also restrains (cold) smoke.

Table 3.6 Interventions relating to fire in a home

	Influencing behaviour		Private regulations	Technical facilities
	Resident	Social environment		
Fire development				
Smoke spread				
Escape options				Warning possibilities
Rescue options				Evacuation possibilities

3.4.3 Clarification of solution strategies

If a resident stays in another area than the area where the fire has originated, there are three important matters. Firstly, the resident must know as soon as possible that there is fire elsewhere in the house (or elsewhere in the complex). Secondly, they must also have the possibility to leave the premises safely, so that the fire brigade can be warned. The escape route must therefore be in good order. And thirdly, structural measures and electrical and mechanical installations within the house must ensure that the spread of fire and smoke remains confined. This latter measure is not mentioned in the studied literature and does not emanate from the requirements in fire safety regulations (a home, after all, is considered to be a single fire compartment). But from fire tests conducted by the Fire Service Academy it appears that keeping interconnecting doors closed could mean the difference between life and death in connection with the spread of smoke.

3.5 Fire outside the home

When a fire (in an object) starts in the home and is not extinguished in good time, it can spread to outside the home. Another possibility is that a fire does not originate inside, but outside the home. Both scenarios are dealt with in this paragraph.

3.5.1 Case studies

Examples of fires that originate in the home and then spread to outside were in Wijchen and Haarlem. In these two cases the fires even spread themselves to an adjacent house.

When a fire starts outside the home it is possible that the released smoke draws into the home. This could cause an awkward situation for the resident. There are known cases that a fire originated in a (communal) meter cupboard (Maassluis), telephone switch board (Rijswijk), roof ventilator (Lisse), plant room (Vlagtwedde), paper warehouse (Doesburg) or even in a light fitting of a gallery (Rotterdam). Sometimes residents can even be threatened by a fire which starts outside the senior citizen complex (Hogeveen, Nijmegen, Den Helder, Delft, Eindhoven, Amsterdam, Doorwerth).

3.5.2 Solution strategies

Measures prescribed in regulations are geared towards preventing a fire from migrating from one house to another. Here regulations prescribe fire compartments. Other regulatory measures are geared towards making a safe evacuation possible. This is dealt with in the following chapter.

Safe evacuation can also be improved by means of providing information. People can be encouraged to think about the escape route that they could take in case of fire, to practice this and to ensure that passage is free of obstacles (no walker-rollers or mobility scooters in the corridor).

Table 3.7 Interventions relating to fire outside a home

	Influencing behaviour		Private regulations	Technical facilities
	Resident	Social environment		
Fire development				Compartmentation
Smoke spread				Compartmentation
Escape options	Information			Warning possibilities
Rescue options				Evacuation possibilities

3.5.3 Clarification of solution strategies

Possible solutions involved in the Cascade ‘fire outside the home’ on the one hand are geared towards preventing a fire from spreading further, through fire compartments, and on the other hand are geared towards making a safe escape possible. A safe escape starts by discovering a fire in good time and adequately alerting those present. It must be avoided that the evacuation of residents must be done by the fire brigade, as we saw in case studies (Nijmegen). Measures geared towards safeguarding the escape route and surrounding homes from fire and smoke also improve a safe evacuation. Though it must be noted here that a fire-resistant partition is not always a smokeproof partition.

From the incidents it has come to the fore that there are varying lines of thought about the manner of evacuation. In two incidents it indicates that residents in surrounding houses may possibly not need to be evacuated, because the home is assumed to be a safe place. Here the starting point is probably that every house is a fire and smoke compartment. In one incident (Nijmegen) it came to the fore that a home in a complex of apartments is not automatically a ‘safe haven’ when there’s a fire. In the Netherlands there are requirements in respect fire compartments of houses, but these requirements do not prevent smoke from penetrating into the home from the outside. At this incident it appeared that smoke spreads through gaps, ventilation ducts and doors standing open, and cannot be held back by compartment partitions. For other case studies in the recent past, smoke also penetrated into homes.⁵



4 Fire safety of senior citizen complexes studied at greater length

As was apparent in the previous chapters, fire safety of the elderly is often more problematic than for other adults. When these elderly live together in so-called 'senior citizen complexes', this creates an additional risk. In principle, senior citizen complexes are 'normal' residential buildings where people live independently (not an institution), but which is subject to an age criterion (e.g. of the tenant), so that these residential buildings almost exclusively house the elderly.

Because of this higher risk and due to a few distinctive incidents in the recent past, the Fire Service Academy conducted studies at greater length into the fire safety issue in senior citizen complexes. This study is reported in *Fires in senior citizen complexes*. This chapter addresses this further, in which we've limited ourselves to the four fires dealt with previously in Sub report 2: a fire in Nijmegen, The Hague, Rhenen and Eindhoven.

Current regulations assume that in cases of fire people should be able to escape safely and that no massive evacuations are needed by the fire brigade. Yet in recent case studies we see that common practice is often different. In this chapter we deal with this discrepancy in finer detail. In doing so it is important to zoom in on the aim of the Dutch fire safety regulations.

4.1 Buildings Decree

4.1.1 2012 Buildings Decree

The comprehensive explanatory notes of the 2012 Buildings Decree mentions the following starting points which form the basis of the expected scenario for fires in senior citizen complexes.

The aim of fire safety regulations have remained unaltered (in respect of the 2003 Buildings Decree): preventing victims (injuries and fatalities) and preventing a fire from spreading to other premises. Preservation of the structure and the prevention of damage to the environment, monuments or social facilities or interests are not objectives of this decree.

In comparison to the 2003 Buildings Decree, the general starting points also remain unaltered.

- > Within 15 minutes after the coming about of the fire, that fire must be discovered and people threatened by that fire as well as the fire department must be alerted.
- > Within 15 minutes after sounding the alarm, the people being threatened by the fire should be able to escape without assistance from the fire brigade.
- > The fire brigade must be present and operational within 15 minutes after being alerted about the fire.
- > The fire brigade must have the fire under control within 60 minutes after it has started, which means that a spreading of the fire is prevented. At that point in time the last of the threatened people should have been rescued assisted by the fire brigade.

4.1.2 Basis for fire safety

The publication *Basics for fire safety* offers the same starting points as the comprehensive explanatory note of the 2012 Buildings Decree and expands this with the time of discovery, alerting, notifying, escaping and evacuation. These starting points are shown for homes and residential buildings (self-rescuing people) in the figure below.

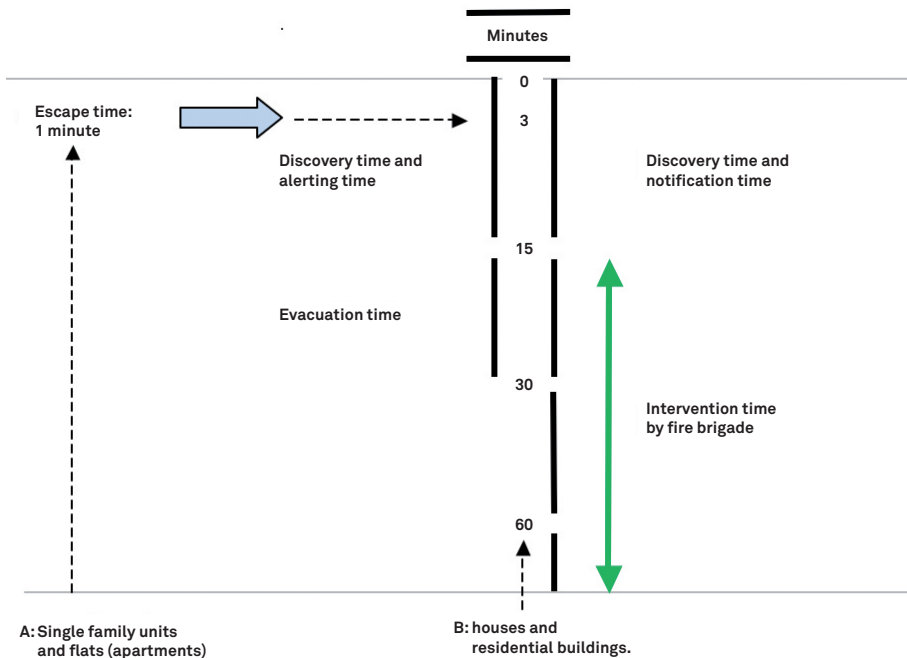


Figure 4.1 Diagram basics for fire safety.

As shown in the figure above, various phases are distinguished (not to be confused with the Cascade model phases).

Phase 1

In a house it is assumed that within 3 minutes after the start of a fire it is discovered, the residents (if present) have been alerted and that the residents have evacuated the house.

When no residents are present, it is assumed that within 15 minutes after the start of the fire, this fire is discovered, the people threatened by the fire have been alerted (outside the burning house) and notification to the communal control room has taken place.

Phase 2

After discovery (maximum 15 minutes) according to these starting points, the residents still have a maximum of 15 minutes to leave the premises safely without assistance from the fire brigade. So at a maximum of 30 minutes after the start of the fire the people will be safe outside.

Phase 3

Within 15 minutes after notifying the communal control room the fire brigade is present and operational. In other words: the fire brigade is present and operational within 30 minutes after the start of the fire.

Phase 4

The fire brigade must have the fire under control within 60 minutes after it has started, which means that spread of the fire is prevented. At that point in time the last of the threatened people should have been rescued assisted by the fire brigade.

4.1.3 Expected scenario

Based on the four phases and according to the starting points of the building regulations, the following scenario is summarized for senior citizen complexes.

- > Fire breaks out in an apartment. The residents present have a self-rescuing capacity and within 2 minutes after the start of the fire they are alerted by the smoke detector present. 1 minute later the residents threatened by the fire have left the apartment.
- > Fire and smoke do not spread for 30 minutes outside the apartment. Due to open doors smoke can enter the escape route. But despite that, the residents threatened by the fire brought themselves to safety within 30 minutes.
- > Within 30 minutes after the start of the fire the fire brigade is present and operational and has the fire under control within 30 minutes.

If the people threatened by the fire have not yet brought themselves to safety on arrival of the fire brigade, then the fire brigade first pays attention to these residents. In this the starting point is first to rescue the people in the apartment where the fire is and then the other people threatened by the fire.

4.1.4 Analysis

From the analysis of the building regulations in respect of protected sub fire compartments it appears that this objective was supplemented in the 2012 Buildings Decree. Until then, the aim of the protected sub fire compartment was to keep the other areas in the fire compartment safe for longer against smoke and fire. In the 2012 Buildings Decree this was updated by also being able to rescue those present in the burning protected sub fire compartment, and even placing priority on this task for in-house emergency responders and fire brigade. For the residential function, with the exception of the 24-hour care residential function, an in-house emergency response organisation is not a necessity and the Buildings Decree assumes that the residents are self-rescuing in cases of fire.

4.2 Case studies

Four of the fires relevant to this issue are discussed in more detail in this chapter.

4.2.1 Notenhout Nijmegen

The Notenhout is a senior citizen's flat for independent living for people aged 55 years and older. So this is a residential building with regular housing functions. The residential building has been built partially above an existing shopping centre. There are 71 apartments in the residential building which access onto a closed gallery. This gallery is divided into a number of segments. Escape from the building takes place via three stairwells whereby one of the stairwells does not extend down to the ground floor, but ends at the first floor.

In this incident it involved a fire in the cafeteria situated underneath the residential building. The fire spread via the flat roof to a building shaft containing the discharge channel from the cafeteria. This shaft is situated in the bend of the building directly in front of the main stairwell. Due to the fire spread to and via the structural materials of the shaft, the closed galleries on all floors are filled with smoke. The smoke also reaches the apartments via these galleries and the ventilation ducts. Due to this a safe evacuation from the apartments is no longer possible. All the residents in the building are evacuated because of the spread of smoke to the apartments. The spread of smoke severely obstructs the evacuation.

The fire leads to bodily harm for some of the residents, especially due to smoke inhalation. According to reports 16 people are transported to hospitals in the vicinity. A couple of residents are critical. In the weeks afterwards, four residents died as a result of the fire.

From the fire investigation it appeared to be highly plausible that the fire originated in the meter cupboard of the cafeteria. Thus the alleged place of origin was established, but the cause could no longer be traced.

4.2.2 Flat adjacent to a care home in Rhenen

It concerns a block of flats with care apartments adjacent to a care centre. The care apartments are suitable for people who need support in their everyday personal care. Here it also involved independent living. There are 25 apartments in the block of flats which access onto a closed gallery. Escape from the building takes place via three stairwells.

In this incident it involved a fire in a home on the fifth floor. The fire did not spread to outside the home. However, by opening the access door to the home smoke spread to the closed galleries and central lobby. Due to the spread of smoke to the closed gallery and central lobby the residents could no longer escape. It was decided to evacuate some of the residents on the fifth floor with an aerial platform and via the fire service lift.

The fire caused one fatally injured victim, the resident of the home where the fire originated. From a fire investigation it appeared to be likely that the fire originated from smoking.

4.2.3 Wilgenhof Eindhoven

The Wilgenhof is a residential building which houses both independent living as well as nursed living. The fire took place in an independent living section. This section involved independent living with an option for domestic service and care service. The residential building partially has a residential function including care and partially apartments ('housing adjacent to care centre') with an 'independent living' function. The apartments are situated along a closed corridor. This corridor is divided into a number of segments. Escape is possible through this corridor via a number of stairwells.

Fire brigade: "You arrive at a location and see a whole block of flats with people hanging out of the windows calling for help, waving with cloths and lamps. Something doesn't make sense here."

At this incident it involved a fire in a home on one of the floors. The fire did not spread to outside the home. However, by opening the access door to the home, smoke spread to the closed corridor. From the description the spread of smoke looked confined. Because there were various residents in the passage, an evacuation takes place. It was decided to evacuate some of the residents to the library and others to another part of the building.

The fire caused one fatally injured victim, the resident of the home where the fire originated. It is not absolutely clear what the cause of the fire was (probably involved smoking).

4.2.4 Freezerhof The Hague

The Freezerhof is a residential care facility where people can live independently. The apartments are furnished for people with physical disabilities and for people with a (light) form of dementia. The apartments are (probably) situated along a closed passage. The fire took place in an apartment on the fourth floor. The fire did not spread to outside the home.

It is not clear whether smoke spread to the passage, but there were self-closing doors. Based on the description and the presence of self-closing doors this would have been confined. Only the home in question was evacuated. The fire caused one fatally injured victim, the resident. The cause probably involved smoking. In addition, there were four wounded, all of them in-house emergency responders and carers.

4.3 Buildings Decree versus incidents in practice

Table 4.2 Overview of factors in case studies

	Eindhoven 2-2-2015	Nijmegen 20-2-2015	The Hague 20-2-2015	Rhenen 1-3-2015
All residents in apartments (address of fire) have self-rescuing capacity	no	n.a.	no	no
Other residents in complex have self-rescuing capacity	no	no	no	yes/no
Residents of apartments left the home within 1 minute after being alerted	no	n.a.	no	no
Despite possible smoke in escape route residents in apartments could bring themselves to safety within 30 minutes	no	n.a.	no	no
Despite possible smoke in escape route other residents could bring themselves to safety within 30 minutes	no	no	n.a.	yes
Fire brigade had fire under control within 60 minutes after it originated	yes	no	yes	yes
Within 60 minutes after it originated the people threatened by the fire left the premises or were rescued		no	n.a.	no

If it is assumed that residents of senior citizen complexes are not self-rescuing or have a reduced self-rescuing capacity in cases of fire, the expected scenario (see paragraph 4.1.3) can be revised to a practical scenario. As is apparent in the table, the practical scenario deviates from the expected scenario according to the Buildings Decree, on the following points.

- > The residents threatened by the fire are not in a position to leave the apartment safely within 1 minute without assistance.
- > The residents threatened by the fire in the building are not in a position to bring themselves to safety within 30 minutes after the fire has originated. The fire brigade needs all its resources to get the residents of the building to safety. Here the situation could occur that the resources are inadequate to bring all the residents threatened by the fire to safety within 60 minutes after the fire has originated. The sequencing to be maintained for the evacuation is dependent on the situation.

At the same time, practical incidents have shown that there are many disadvantages and impossibilities attached to first paying attention to the burning protected sub fire compartment, especially by non-professional service providers and the fire brigade too. Naturally there are situations where actions can be effective without danger and without the risk of fire and smoke spreading to outside the burning sub fire compartment, those present being rescued quickly, and perhaps the fire being extinguished. But if this situation is perceived incorrectly, then many people are rapidly threatened by fire and smoke.

In addition, it seems that the building regulations (still) do not keep account of the situation in senior citizen complexes where people live independently, but who are not self-rescuing and no in-house emergency responders are at hand. That makes the expected scenario different to the care homes for example.



5 Clarification

In the Netherlands there are increasingly more elderly, our elderly are getting older and they also live independently for longer. Since it appears that this leads to a (potentially) higher fire risk, not only on the basis of reports and articles, but also on the basis of gathered case studies, additional attention is required to be paid to the fire safety of senior citizens.

A great deal is known from literature about risk factors among the elderly in respect of fire safety. Risk factors could involve physical restrictions, mental and cognitive impairments, use of medication, social circumstances, behaviour and accommodation.

Researchers have collected a large amount of data concerning fires among the elderly. Literature was also researched for possible solution strategies for the issues observed. These case studies have been classified based on the Cascade model. The solution strategies found have also been classified on the basis of the Cascade model. In this way a good picture of the bottlenecks has been created and the way in which to resolve these bottlenecks.

The issue is complicated. The elderly are not always in a position to take adequate measures themselves, for example due to a degradation in cognitive capabilities. Although the elderly living independently are considered to be self-rescuing to a certain degree in case of fire, this is often not the case in common practice. When the elderly are not in a position to care for themselves, they often receive various forms of (domestic) care. The issue of fire safety among the elderly, however, attracts less public interest and is also difficult to address. In principle, the elderly living independently are personally responsible for their own fire and escape safety.

At the same time it can be observed that generally there are already many institutions and people involved in the (safe) care of elderly. Of course this not only means the elderly themselves or their social environment, but also care providers, municipalities and the fire service. Legislators can also have a duty in this care. In order to improve fire safety for the elderly, it would be a good idea if all those involved could provide a contribution from within their own role. Eventually it involves an interaction of measures of:

- > influencing behaviour
- > technical resources and
- > legislation and regulations

Fire brigade: "I stood there in the senior citizen's flat, and felt helpless. Where were the helping hands, but I knew that the helping hands were needed on all the floors of the complex."

In order to effectuate a certain solution strategy (to reduced the number of burns victims amongst the elderly), numerous strategies must be deployed.

Fire safety starts with awareness. All the people and organizations who could play a role in improving fire safety must be aware of the issue. They would not only include care providers, landlords, insurance companies, municipalities and fire service, but also the elderly themselves and their social environment.

In addition, it is of importance that organizations involved with the elderly collaborate well to improve the effect of interventions among the elderly. Both in numbers and in possibilities to reach those elderly who are difficult to access. It is important to train professionals at organizations who are involved with the elderly. In this way, fire safety of the elderly can partially become the responsibility of those professionals. Aside from the professionals, cooperation with the social environment of the elderly is also important. This would include children, neighbours and caregivers. Vulnerable elderly can possibly no longer be in a position to do so, for example, because of dementia or reduced mobility.

It is also necessary to invest more extensively in providing information and education, so as to encourage the elderly themselves to show fire safe behaviour and take measures for improving fire safety. Here the social environment of these elderly can also get involved by providing information and training.

By providing technical solutions such a non-flammable furniture and mattresses, automatic suppression systems (like sprinklers) for homes and smoke detectors for existing homes, fire safety can likewise be improved. It is not obvious that such technical solutions are enforced through legislation and regulations, but such solutions should be able to be promoted.

Measures that could be tackled by legislation and regulations relate to the building regulations in the Netherlands. Experience shows that an important objective in the Dutch building regulations, namely, that fire may not lead to victims, is no longer achieved in various practical situations. The building

regulations are structured mainly for housing self-rescuing persons. Where there is housing mainly for non-self-rescuing persons, such as prisons and hospitals, additional fire prevention measures are prescribed. In this regard, housing complexes for the elderly fall through the cracks. Though this concerns housing for non-self-rescuing people, but there are no fire protection facilities adapted for it. It is recommended that a study should be undertaken to see whether this category can be improved via fire safety regulations.

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End notes

1. See the IFV website at: <http://www.ifv.nl/advieseninnovatie/Paginas/Onderzoek-naar-de-invloed-van-de-vergrijzingop-de-brandveiligheid.aspx>.
2. The Dutch Burns Foundation maintains 60 years as the threshold. So this deviates somewhat from the threshold of 65 years which is maintained in this publication.
3. This was done by making use of expertise and software from the company Meltware and OBI4wan.
4. The use of lifts for the evacuation is not common practice in the Netherlands yet and is sometimes even discouraged.
5. For example, this was the case in the fire at 'Het Lichtpunt' in Rotterdam (Blijlevens et al., 2014) and 'De Kelders' in Leeuwarden (Ebus, Schreerder, Van den Ende, & Van der Ploeg, 2014).

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The Institute for Safety (IFV) contributes to a safe society by complementing the safety regions and their partners in professionalising their tasks. We develop and share relevant knowledge, we have the expertise to acquire and manage communal equipment and we advise the managements involved. In this our motto is: detecting and connecting.

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The task of the Fire Service Academy, part of the Institute for Safety (IFV) is to professionalise and retrain fire service employees and people active in combating disasters and crisis management. The Fire-Fighting and Fire Prevention research departments envisage bringing about an optimal interaction between research, education and professional practice, to provide a contribution to a further professionalisation of relief workers.

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Institute for Safety
Information Centre for Safety (Infopunt
Veiligheid)
P.O. Box 7010
6801 HA Arnhem
026 355 23 00
www.ifv.nl
info@ifv.nl