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Bostadsbränder och äldre personer – tvärvetenskapliga framgångsfaktorer för reducering av döda och svårt skadade

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Förord

Som ett led i samhällets strävan att minska antalet omkomna vid bostadsbränder har ett flertal forskningsinsatser genomförts. Historiskt har flertalet av dessa fokuserats på dödsbränder och åtgärder för att undvika dessa. Det finns dock alternativa angreppssätt där forskningsfokus snarare är på s.k. ”Happy Fires”, dvs att undersöka vad som kännetecknar bränder med ett mer lyckosamt utfall. Föreliggande projekt (*Brandforsk 202-171; Bostadsbränder och äldre personer – tvärvetenskapliga framgångsfaktorer för reducering av döda och svårt skadade*) bygger därmed vidare på ett tidigare projekt (*Brandforsk 301-151; Framgångsfaktorer vid bostadsbränder*) som anammat detta angreppssätt.

Detta projekt skiljer sig också från andra forskningsprojekt inom brandområdet genom dess omfattande tvärvetenskaplighet. Genom att knyta samman fem forskningsaktörer inom olika discipliner har projektet haft möjlighet att angripa frågeställningarna från flera olika perspektiv. Projektgruppen har bestått av följande personer;

- Finn Nilson, Karlstads universitet (projektledare)
- Carl Bonander, Göteborgs universitet
- Marcus Runefors, Lunds universitet
- Lotta Vylund, RISE
- Linnea Lundgren, Ersta Sköndal Bräcke Högskola

Projektet har genomförts mellan 2018 och 2019 och har varit finansierat av Brandforsk. Brandforsk är statens, försäkringsbranschens och industrins gemensamma organ för att initiera, bekosta och följa upp olika slag av brandforskning. Under projekttiden har arbetet följts upp av följande referensgrupp;

- Hans Andersson, Brandskyddsföreningen
- Lynn Ranåker, Räddningstjänsten Syd
- Anders Lundberg, MSB
- Nina Bergström, Stor Stockholms Brandförsvar
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Referensgruppens aktiva medverkan i projektet uppskattas och ett särskilt tack riktas därför till dessa. På stark uppmaning av referensgruppen har också denna projektsammanfattning en struktur där den sammanfattande texten kortats ned och där de underliggande arbetena

bilagas till sammanfattningen[1]. Den bakomliggande orsaken är att resultaten därigenom blir mer lättillgängliga för aktörer inom branschen.

[1] Observera att bilaga 1–3 är artikelmanus som är inskickade till vetenskapliga tidskrifter. Enligt review- och publikationsprocessen kan innehållet och formatet i dessa artiklar därför förändras framöver. Eftersom dessa bilagor kommer att publiceras i vetenskapliga tidskrifter och att de därmed ska vara opublicerade resultat är det önskvärt att spridningen av bilaga 1–3 är kontrollerat.

Bakgrund

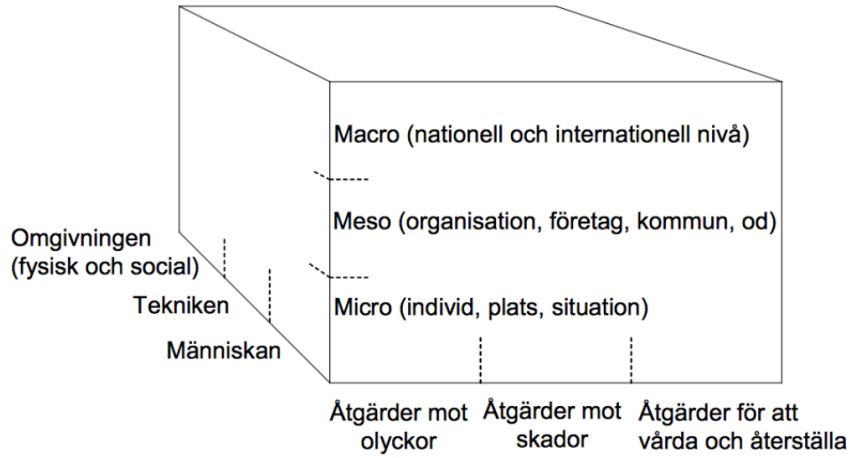
Trots en stor nedgång i antal omkomna i Sverige sedan 1950-talet är brandrelaterad dödlighet fortfarande ett problem med omkring 100 döda per år i bränder. Sett utifrån ett trendperspektiv har minskningen i antalet döda dessutom nära nog avstannat de senaste 10-15 åren (Jonsson, Runefors, Särdqvist, & Nilson, 2016), trots en etablerad nollvision (MSB, 2010).

Av de cirka 100 dödsbränder som förekommer i Sverige varje år sker omkring 75 procent i bostaden (Jonsson, Bergqvist, & Andersson, 2015) och flertalet svenska studier har påvisat betydande skillnader i risken för dödsfall vid brand mellan olika åldersgrupper, socioekonomiska grupper och geografiska områden (t.ex. (Guldåker & Hallin, 2014; Jonsson, Bonander, Nilson, & Huss, 2017). En grupp som återkommer som särskilt utsatt är äldre personer (Jonsson et al., 2017), en grupp som också utgör den åldersgrupp som procentuellt sett ökar mest i samhället i populationsstorlek (Oecd, 2003). Trots att äldre är överrepresenterade i brandrelaterade dödsfall, är risken för bränder, oavsett behov av räddningstjänst eller omfattning, relativt låg (Nilson, Bonander, & Jonsson, 2015). Detta innebär att risken att omkomma givet en bostadsbrand är mycket hög för äldre personer jämfört med yngre åldersgrupper.

Problemet med denna riskökning kan närmas från flera olika vetenskapliga discipliner. Från ett medicinskt/tekniskt perspektiv, i enlighet med t.ex. Haddons preventionsteorier (Haddon, 1980), kan risken för att omkomma i en brand minskas vid flera olika steg från det att ett startobjekt börjar brinna till dess att individen ådrar sig skador så omfattande att denne avlider. Haddon kompletterade också sina strategier genom en matris där tre olika tidsbaserade preventionsalternativ förtydligades; att förhindra olyckan, att förhindra skadan, eller förhindra konsekvenserna. Dessutom utgår modellen från de tre epidemiologiska komponenter som samspelar; bäraren, värden, och den omgivande miljön (Haddon, 1980).

Vad gäller äldre har vissa faktorer identifierats både vad gäller tidsaspekten (att förhindra olyckan, att förhindra skadan, eller förhindra konsekvenserna) men också specifika aspekter vad gäller de tre komponenterna (bäraren, värden, och den omgivande miljön). Till exempel har det i ett tidigare Brandforskfinansierat projekt (Brandforsk 301-151; Framgångsfaktorer vid bostadsbränder) identifierats att äldre oftare än genomsnittet har fungerande brandvarnare vilket bör innebära att möjligheterna till upptäckt är stora, sett utifrån populationen i stort (Nilson & Bonander, 2019). Dock finns problem vad gäller äldre personers upptäckande och agerande vid bränder, som följd av den ökade risken av fysiska och psykiska funktionsnedsättningar som medföljer åldrandet. Funktionsnedsättningar såsom minnesproblematik, syn- eller hörselnedsättningar, nedsättningar i rörelseförmåga eller styrka, m.m. kan påverka möjliga insatser, tid samt effektivitet av insatser (Gilbert & Butry, 2017). Därtill ska tilläggas den ökade skörheten och minskad motståndskraft till yttre påfrestningar som ålderdomen medför (Eggert & Huss, 2017).

Även om den medicinska/tekniska preventionsmatrisen som utvecklades av Haddon är viktig och praktisk användbar, finns också preventions- och förklaringsmekanismer som snarare kan fördelas på olika samhällsnivåer och som ligger utanför den ofta studerade individen. I ett försök att inkludera dessa element har den s.k. preventionskuben utvecklats där de tre nivåerna makro (nationell och internationell nivå), meso (organisation, kommun, m.m.) och mikro (individ, plats, m.m.) finns inkluderade (figur 1).



Figur 1. Preventionskuben (Andersson & Menckel, 1995)

Uppdelat i dessa nivåer syns både risk- och skyddsfaktorer vad gäller äldre och bostadsbränder. Från ett makroperspektiv har den s.k. kvarboendeprincipen, dvs den nuvarande samhällsinriktningen som eftersträvar att äldre personer ska bo kvar i sin bostad så länge som möjligt, varit diskuterad som en potentiell riskfaktor utifrån ett brandskyddsperspektiv (Jönsson & Gustavsson, 2016). Också kulturella eller strukturella faktorer kan vara relevanta, såsom det faktum att Sverige som helhet, till skillnad mot många andra länder, har en stor andel ensamhushåll, en faktor som tycks öka effekterna av bränder (Vermina Lundström & Andersson, 2018). Också på meso- och mikronivån finns det faktorer som hypotetiskt kan öka eller minska mortalitetsrisken. Agerande från allmänheten eller hemtjänsten, tid till ankomst för räddningstjänst och kunskap till följd av förebyggande information är exempel på skyddsfaktorer som tidigare studier berört (t.ex. (Jaldell, 2015) och (Sund, Bonander, Jakobsson, & Jaldell, 2019)). På mikronivå kan fysiska och mentala faktorer, så som nämnts ovan, påverka risken avsevärt men också tekniska hjälpmedel eller utbildning.

Både Haddons strategier, Haddons matris samt preventionskuben har traditionellt utgått från att identifiera riskfaktorer som förhöjer risken för skada och sedan modifiera eller eliminera dessa. Som nämnts ovan finns det många riskfaktorer för äldre med avseende på allvarliga konsekvenser av bränder. Därav finns det med automatik också skyddsfaktorer som är antiteser av riskfaktorerna. Enligt den säkerhetspromotiva traditionen finns det även ett värde i att vända frågan och undersöka skyddsfaktorer i förhoppningen att hitta nya

vägar att hantera problem, kanske även skyddsfaktorer som inte har någon uppenbar motsvarande riskfaktor (Andersson & Nilsen, 2015). Denna strategi har använts i tidigare projekt (Brandforsk 301-151; Framgångsfaktorer vid bostadsbränder) och syftet blir då att upptäcka framgångsfaktorer, snarare än riskfaktorer, till att bränder inte utvecklats till att bli stora bränder utan stannat som s.k. ”happy fires”. Dessa bränder kännetecknas ofta av att branden i ett tidigt skede upptäcks och att den boende har förmåga att agera på ett riskreducerande sätt eller att det finns andra riskreducerande funktioner som kan träda i kraft.

Syfte och mål

Målet med detta projektet är därför att undersöka och analysera framgångsfaktorer som inneburit att bostadsbränder bland äldre inte lett till allvarligare skada eller död utifrån olika samhällsnivåer och ett tvärvetenskapligt perspektiv. För att uppnå detta har projektet delats i fyra olika arbetspaket;

1. Mikroperspektivet (se bilaga 1)
2. Mesoperspektivet (se bilaga 2)
3. Makroperspektivet (se bilaga 3)
4. Framtidsperspektivet (se bilaga 4)

Sammanfattande resultat och diskussion

Detta projekt har resulterat i fyra stycken vetenskapliga artiklar eller forskningsrapporter och finns som bilagor i detta dokument (bilagor 1–4). Genom att angripa dödsbrandsproblematiken utifrån en tvärvetenskaplig, multidisciplinär ansats där preventionskuben och skyddsfaktorer varit vägledande kan projektet belysa flera intressanta fynd men i synnerhet ett genomgående tema; vikten av att ha andra personer i sin närhet för att förhindra att en brand utvecklar till en dödsbrand.

Samboende bland den generella befolkningen, men i synnerhet bland äldre personer, är en känslig samhällelig fråga som berör djupa ideologiska och kulturella aspekter. Medan vi historiskt har bott i täta familjegrupper har det sedan 1980-talet funnits en samhällstrend i Sverige och Europa som innebär att äldre personer alltmer bor ensamma (De Jong Gierveld & Van Tilburg, 1999) och är en trend som förutspås öka (Iacovou, 2000). Att multisjuka äldre bor kvar hemma i allt större grad uppmuntras generellt av skattefinansierade samhällsinstitutioner, inte minst utifrån de samhällsekonomiska fördelarna då kostnaderna för äldreboende vida överstiger kostnaderna för omvårdnad i hemmet (Da Roit, 2010). Från ett jämställdhets- och arbetsmarknadsideologiskt perspektiv uppmuntras det också att yngre generationer mer sällan vårdar deras äldre släktningar, vilket sannolikt är en bidragande faktor till att äldre personer bor allt mindre med andra generationer (Fernandez-Carro, 2016). Samtidigt är det viktigt att poängtera att en minskad samboende bland äldre inte enbart är pådrivet från statligt håll. Snarare har en stark samhällsnorm av individualism förstärkt denna utveckling där äldre personer i ökande grad vill bo kvar i sitt eget hem (De Jong Gierveld & Van Tilburg, 1999) och i mindre grad bo med sina barn.

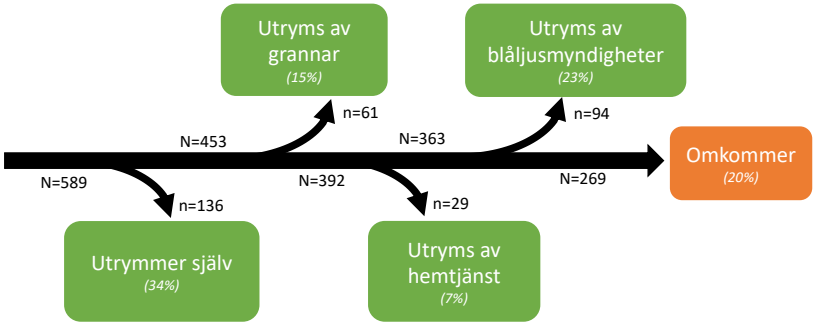
Utifrån ett makroperspektiv kan de dödsbrandsrelaterade effekterna av denna utveckling tydligt ses. Även om samhällstrenden av individualism och ensamboende verkar ske i de flesta europeiska länder finns det fortfarande stora skillnader i hur äldre personer bor i Europa, inte minst avseende om de bor med sina barn (De Jong Gierveld, De Valk, & Blommesteijn, 2001). Till exempel utmärker sig de nordiska länderna där enbart 5% av äldre personer bor med sina barn jämfört med en tredjedel av äldre i länder såsom Spanien, Grekland och Italien (Ogg & Renaut, 2006). Trots dessa skillnader kan vi påvisa att ett lands övergripande ”samboendekvot” bland äldre är starkt korrelerat till risken att omkomma i bränder när ett lands ekonomiska villkor kontrollerats för (bilaga 3). Att samboende, oavsett om detta är med samma generation eller yngre, verkar skydda mot dödsbränder i hela Europa är anmärkningsvärt då kulturer, traditioner, samhällsutveckling och inte minst välfärdssystem kan skilja avsevärt mellan länder (Daly & Lewis, 2000; Esping-Andersen, 1990).

Då samboendets effekter syns i en europeisk jämförelse är det föga förvånansvärt att ensamboende/samboende visats vara en av de viktigaste risk- och skyddsfaktorerna också inom Sverige (Jonsson et al., 2017; Jonsson & Jaldell, 2019; Runefors, Johansson, & van Hees,

2017). I synnerhet vad gäller preventionen av dödsbränder bland äldre, då dessa personer har nedsatta förmågor att hantera bränder (Gilbert & Butry, 2017), innebär denna förhöjda risk kopplad till ensamboende att samhällets förmåga att agera vid en brand blir allt viktigare.

Traditionellt i Sverige, samt med stöd i litteraturen (Jaldell, 2015), har tidsfaktorns betydelse, dvs. vikten av att räddningstjänsten är snabbt på plats för att förhindra dödsfall, poängterats starkt. Samtidigt är Sverige ett generellt glesbefolkat land där samhällskostnaderna för att säkerställa en tillräckligt snabb responstid från räddningstjänsten kan anses för höga, inte minst då antalet räddningstjänstinsatser minskar (Danielsson & Sund, 2016) i likhet med andra höginkomstländer (Knight, 2013). Som en konsekvens av detta har samhällsförsök genomförts där ett större räddningsansvar lagts på hemtjänst eller väktare, dock med begränsad effekt (Sund & Jaldell, 2018). Ett grundläggande problem är nämligen att trots omfattande samhällsinterventioner för att respondera snabbt vid bränder verkar individens sårbarhet och ensamhet vara åtminstone likvärdig i risken att omkomma i bränder (bilaga 2). I en kommunal jämförelse, där dödsbrandsrisken kan variera avsevärt, kan dessa två faktorer; samhällets respons och individens sårbarhet, till stor del förklara kommunala skillnader. Problematiken är samtidigt att dessa faktorer ofta kan samexistera. Sverige har en hög urbaniseringstakt från glesbygden, särskilt bland välutbildade yngre individer (Smas, 2018). Detta resulterar i en allt äldre och skörare befolkning i glesbygdskommuner som därmed får svårigheter att bibehålla snabba responstider eller ett fullgott samhälleligt skydd till följd av urbaniseringens effekter på den lokala samhällsekonomin (Lindblad, Tynelius, Danell, Pichler, & Anderstig, 2015).

På individ- eller mikronivån innebär makro- och mesoförändringar att andra skyddsfaktorer kan behöva ersätta eller komplettera samhällets skyddsnät. Som syns i figuren nedan (från bilaga 1), kan äldre personer evakuera en brand genom att utrymma själv, få hjälp av grannar, få hjälp av hemtjänst eller få hjälp av blåljusmyndigheter. Som visats på mesonivån kan kommuner ha svårt att kompensera sårbarheten genom hemtjänsten eller blåljusmyndigheter och därmed blir att evakuera självmant eller med samboende/grannar eftersträvansvärt, inte minst med bakgrund i tidsfaktorns betydelse i att rädda liv (Jaldell, 2015). Trots detta evakuerar enbart drygt 50% av äldre sig själva eller med hjälp av grannar, utifrån samtliga bränder som räddningstjänsten larmats till. Risken att inte klara evakueringen själv eller med hjälp av grannar ökar bl.a. vid högre ålder samt i kommuner med lägre populationstäthet. En ökad sannolikhet för överlevnad (givet en brand) finns bland små bränder, bränder i utrymmen annat än sovrum/vardagsrum samt i urbana områden (bilaga 1).



Sammantaget, när mikro-, meso- och makrodata kombineras med befintlig forskning, kan det konstateras att mycket liknande bilder av skyddsfaktorer framkommer. I grova drag verkar skyddsfaktorerna för dödsbränder bland äldre kunna samlas i två typer av samhälleliga grupper. Den första, som bygger mycket på samhällets faktiska organisering, inkluderar en välfungerande, snabb räddningstjänst med närhet till utsatta grupper. Tidsfaktorns betydelse tillsammans med en välfungerande organisering av samhället där hemtjänst, social omsorg, väktare och räddningstjänst samarbetar verkar därmed vara viktiga skyddsfaktorer.

Den andra kategorin är snarare en samhällsutveckling som kännetecknas av urbanisering, individualism, en ökad andel multisjuka äldre, m.m. I denna kategori ingår därmed faktorer som leder till en ökad riskbild, i synnerhet med avseende på andelen ensamboende äldre som förväntas klara sig själva. Bakgrunden till denna utveckling är betydligt mindre kopplad till brandproblematiken utan snarare en samhällelig utveckling där kultur, ideologi och samhällsekonomi sammanvägs till en ökad riskbild. Som indikeras i bilaga 1 och 2 verkar denna aspekt vara en starkare riskfaktor än samhällets skyddsfaktorer. Från ett preventivt perspektiv blir därmed arbetet mot en nollvision inom brand betydligt mer komplicerat och omfattande. Samtidigt ska det poängteras att även om ensamhet är en mycket stark riskfaktor för att omkomma i bränder, är detta enbart en effekt av ensamboende. Samboende är en känd skyddsfaktor för ett flertal olycks- och sjukdomstyper vilket tyder på att det skulle kunna vara samhällsekonomiskt lönsamt och eftersträvansvärt att vända på den ensamboendetrend som ses i Sverige och övriga Europa.

Att samboende verkar skydda mot ett flertal olycks- och sjukdomstyper är sannolikt en konsekvens av att boendet med en annan person påverkar individens liv på ett flertal olika plan. Från ett brandperspektiv är det uppenbart att de tre sista stegen i brandprocessen (förhindra brandtillväxt; påbörja evakuering; och genomför evakuering (Runefors, Johansson, & Van Hees, 2016)) är betydligt enklare och sker betydligt snabbare vid samboende jämfört med att bo själv. Men även vid de tidigare stadierna (minska värme; och förhindra antändning) påverkar ensamboende/samboende. Till exempel är rökning och förhöjd alkoholkonsumtion korrelerade med att bo ensam (Kharicha et al., 2007; Rosén, Hanning, & Wall, 1990), faktorer som också ökar risken för andra olyckor. Också sannolikheten att ha preventiv utrustning såsom brandvarnare, brandsläckare och brandfilt

är mindre bland ensamboende (Nilson & Bonander, 2019). Huruvida dessa riskfaktorer utvecklas av att vara ensam eller är några av skälen till att individerna är ensamma, är inte känt. Dock har studier konstaterat att risktagning ökar bland individer som skilt sig eller blivit änka/änkeman (Kharicha et al., 2007) vilket skulle tyda på att risk- och skyddsfaktorer inte är fasta utan kan förändras beroende på individens livssituation.

Då samhällsutvecklingen i Sverige och i Europa, från både ett samhällsekonomiskt och ideologiskt perspektiv verkar eftersträva en större kvarboende av äldre, sköra och multisjuka människor samt att äldre personer i lägre grad vill bo med andra, finns ett behov av att undersöka vilka potentiella preventiva möjligheter som finns som kan kompensera för riskerna med ensamboende. Som visas i bilaga 4 finns både befintlig och kommande teknik som effektivt kan förhindra bränder, släcka eller minska spridning. Mycket av denna befintliga teknik (t.ex. olika sprinklersystem) är passiv och skulle därmed lämpa sig väl för individer med olika typer av funktionsnedsättningar. Samtidigt anses den dyr och kräver stora bostadsanpassningar och används därmed inte fullt ut. De hjälpmedel som är under utveckling eller som kan ses komma i framtiden bygger till stor del på digitala lösningar som i hög grad fokuserar på att underlätta för andra att hjälpa den utsatta, antingen innan något hänt eller när något oönskat skett.

Även om dessa typer av hjälpmedel kan komma att underlätta räddningsaktioner och därmed rädda liv, verkar det vara svårt att ersätta den multifaktoriella skyddseffekten som samboende har med hjälp av teknik. Att underlätta för exempelvis grannar att släcka eller rädda bygger på en hög lokalsamhällestillit och skapandet eller bibehållandet av sociala relationer, något som kan vara svårt att skapa genom teknik.

Sammanfattningsvis kan detta projekt konstatera att ett av de största hindren för att uppnå nollvisionen inom brandområdet, i synnerhet vad gäller äldre personer, är de samhällsprocesser som stödjer ett ökat ensamboende. Den skyddseffekt som samboende innebär verkar inte heller gå att kompensera fullt ut genom räddningstjänstrelaterade samhällsåtgärder eller teknik. När det dessutom konstateras att samboendet är en skyddsfaktor för många andra oönskade händelser är det uppenbart att den ökade branddödligheten bland ensamboende är snarare ett symptom på en större samhällsutveckling som svenska samhällsaktörer kan behöva se över.

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Bilaga 1

Factors contributing to survival and evacuation in fires involving older adults

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Abstract

It has been known for a long time that older adults suffer a significantly higher risk of dying in residential fires compared to younger people. Characteristics of these fatal fires and the fatalities are also well known. However, less is known about older adults who survive fires and how they differ from those who die. This distinction can be assumed to be of great importance when designing and targeting effective prevention efforts.

In the current paper, factors that contribute to survival of older adults (65+), in contrast to cases with non-fatal injuries, has been investigated together with factors that contribute to different modes of evacuation (e.g. evacuation by neighbors).

The results show that self-evacuation is not as frequent as could have been expected (39%) and a large part of the group rely on evacuation by neighbors (18%), first-responders (27%) or homecare personnel (8%). The latter was found to be of particular importance in the oldest age group (80+).

Living in urban areas was found to increase the odds of survival. Based on the results from the analysis of evacuation, this is likely due to a combination of proximity to neighbours and a short response time. For successful evacuation by non-trained personnel (i.e., neighbours and homecare), the fires often had to be confined to the object of ignition. The evacuation was more likely to be performed only by the rescue services when the fire that had spread beyond this point. This can probably be explained by the fact that the rescue service have breathing apparatus and are therefore able to perform rescue in worse conditions.

Implication for practice

The results show that evacuation by actors around the older adults (neighbours, homecare and rescue services) are very important for a majority of the cases with successful outcome. More effort should therefore be put on preparing actors, that do not usually respond to fires, that their help might one day be needed to save an other persons life in a fire.

Keywords: Fire fatality; Rescue services; Non-fatal injury; Evacuation; Residential fires

1. Introduction

For a long time, it has been known that residential fire fatalities are disproportionally distributed in the population. In an early study from the US [1], the highest death risk, compared to the general population, were seen among the older adults (60+). Such results have been confirmed and detailed many times since then and repeatedly (e.g., [2]–[6]). Concerns have therefore been raised about the effects of the growing population of home-dwelling, older adults on fire mortality rates (e.g., [7]).

A prerequisite for designing effective prevention efforts, and incident response, regarding residential fires and injuries is a thorough understanding of the problem and the current risk groups and risk factors. It is therefore important to learn more about the differences between older adults who are injured in fires and the older adults that die in fires, particularly since the older adults both represents the largest group of fatalities, in absolute numbers, and is the population group with the highest risk. Research has also shown that different measures have different effectiveness for different groups in society (e.g., [19], [20]), which further motivates this study.

Further, several studies conducted in different countries and time periods ([8]–[10]) report that demographic characteristics, cause of fire, and primary diagnosis differs between non-fatal injuries and fatalities. In recent study [11], the main conclusion was that holding ignition exposure constant, a proxy developed for vulnerability completely could explain the effects of age on the likelihood of death in fire for adults. Differences has also been found when comparing the characteristics of fire and non-fire households (e.g., [12] & [13]), and the characteristics of households that have been exposed to home fires do not correspond to fires with causalities [14]. This implies that the characteristics of the events and populations that are at high risk of dying in a fire differs significantly from those who tend to survive.

However, existing studies including comparison with a control population are infrequent [15]. Focus has been on comparisons of fatal residential fires with a general population of residential fires ([16], [17]), comparisons of residential fire fatalities with survivors from residential fires [23], and comparisons of those who die and those who survive in the same residential fire [18]. A comparison between non-fatally injured and fatalities, as in the current paper, has the benefit, in contrast to comparing to all residential fires, that it only includes fires that pose a significant risk to the residents. The benefit in relation to comparing the fatalities to survivors in the same fire is that also fire related variables and variables to location and time can be assessed.

Therefore, this study aims to identify predictors of survival for older adults using a case-control design considering non-fatally injured people as cases and fatalities as controls. The study also aims to investigate factors contributing to different modes of evacuation (e.g. evacuation by neighbours) to gain a better understanding of how older survivors tend to escape residential fires.

2. Methods and Data

We employed a case-control design to study individual, fire-related and contextual factors as potential predictors of survival in residential fires among older adults (aged 65 years and above) in Sweden, treating surviving (non-fatally injured) individuals as cases and fatalities as controls. We also studied self-evacuation, evacuation by neighbors, evacuation by homecare and evacuation by first-responders as secondary outcomes.

2.1 Data

We matched different data sources to generate the dataset needed for the analysis. The two main sources was the fatal fires database and the incident report database, both maintained by the Swedish Civil Contingency Agency (MSB). We also collected contextual, municipality-level data (e.g., population density and fraction of older adults with homecare) from official sources (Statistics Sweden, the National Board of Health and Welfare, and the Kolada database maintained by the Council for the Promotion of Municipal Analyzes).

In total, we identified 345 cases (individuals injured in residential fires) in the incident reports database. Our sampling period for the cases was 2017-2018. The reason for choosing this period is that major changes in the reporting form was implemented before that and, for example, the age of the victim was not included prior to these changes. Since the cases with injuries needs to be filtered for age in the current analysis, only the period after this change could be included.

The fatal fires database has always included information on age, which allowed us to use a longer sampling period to identify a sufficient number of controls to increase statistical precision (fatalities are less common than non-fatal injuries). In total, we identified 269 controls (fatalities) in the fatal fires database between 2012 and 2017. The analysis included all direct and indirect fire fatalities occurring in residential occupancies (excluding care homes) with a victim at the age of 65 years or above.

The fatal fires database consists of reports that are systematically collected from the rescue services, Police and the National Board of Forensic Medicine and is therefore deemed to be of very high quality. The incident reports consist of a form completed by almost all rescues service organizations after alarms (the coverage is above 99% [21]). For fatal fires, the incident report database and fatal fires database was combined so that fatalities that occurred later in the hospital were also included. This also led to a higher quality of the different fire related variables such as cause and origin since the fatal fires database typically account for fire investigations performed at site, in contrast to the incident reports. Another reason for the matching of databases was to complement the fatal fires database with variables that are only available in the incident reports (e.g. response time).

Each observation of both fatal and non-fatal fire victim were also matched with municipality-level data such as fraction living in urban areas and gross regional product (GRP). The matching was performed based on the municipality of the event, but not the specific year since few quantities vary significantly between years and not all quantities are measured annually.

The full list of variables included in the analysis can be found in appendix A.

Most variables are categorical (e.g. cause of fire) and are coded as dummy variables. For increasing comparability in effect measures, we opted to dummy code the municipality-level predictors to discriminate between low- and high-level municipalities. The cutoff was chosen to be the median of all Swedish municipalities for all continuous municipality-level quantities. For the remaining continuous variable, the response time, the cutoff was chosen to be 10 minutes since previous studies have indicated that this time represent a shift towards a reduction in the probability of rescue [22]. A sensitivity analysis of this choice was performed and the results was not sensitive to changes in the cutoff value.

2.2 Methods

We performed a logistic regression analysis to discriminate between non-fatally injured (cases) and fatalities (controls) and estimate odds ratios (ORs) for each predictor. To increase statistical power in the final output, we performed variable selection as follows. First, we grouped the predictors into different levels that represent (i) fire-related variables, (ii) factors relating to the individual, location and time of the event and (iii) municipality-level predictors. Variable selection was then performed by first identifying which fire-level variables that were significant predictors of survival using logistic regression. Following this, factors related to the location, time and individual were added and non-significant variables on this level was excluded. Finally, variables related to the municipality where the event occurred was added and a final logistic regression with the predictors that remained from all three levels was performed. In each step, all variables with a p-value above 0.10 were removed and the step was reiterated until all included variables achieved this p-value before progressing to the next level of analysis. As a final step, after all levels has been completed, a more restrictive significance level ($P<0.05$) was employed. The reason for having a less restrictive criteria in the initial variable selection was to not miss any potentially multivariate significant quantities as suggested by Ranganathan et al [23].

We also note that when coding categorical variables into dummy variables, one variable-value-pair is always chosen as reference category and excluded from the analysis, to avoid collinearity. However, for the variable selection procedure to be independent of the choice of reference category, the reference category was reintroduced in the following iteration after some other variable-value-pair has been excluded from the analysis due to lack of significance (which occurred for all variables and all analyzes). This resulted in that each factor (i.e. variable-value-pair) has all other outcomes for that variable as reference category (e.g. for “winter” the reference is “spring”, “fall” and “summer” combined).

In addition to the main statistical analysis, the cases with injured individuals was classified according to their mode of evacuation based on an analysis of the free-text fields in the incident reports

To assess the reliability of the classification, a subset of XX cases was assessed by an independent researcher and the level of agreement was found to be XX%.

We then studied each mode of evacuation as secondary outcomes using the same variable selection and analysis procedure as described above.

3. Results and discussion

In section 3.1, the fatalities and non-fatal victims are compared to find factors discriminating between the two. In the following section, 3.2, the factors that are characteristic for specific evacuation scenarios are described.

3.1 General survival factors

In figure 1, it can be seen that the probability of survival is greatly increased if the fire is small (i.e. confined to object of ignition (OR=12.5; 95% CI, 6.8 – 22.8) or room of origin (OR=6.4; 95% CI, 3.8 – 10.8)) or occurring in a room where victim tends to be awake if present (e.g. kitchen (OR=1.9; 95% CI, 1.2 – 4.2) or outside (OR=5.0; 95% CI, 1.5 – 16.5)). This is in line with previous findings that has found fires that are intimate with the victim to be more hazardous [24]. It will also probably give other actors such as neighbors and rescue services an increased time frame to evacuate the individual.

Interestingly, one of the macro-level variables, high fraction living in urban areas (OR=2.3; 95% CI, 1.5 – 3.5), is a significant predictor of survival. As can be found when the mode of evacuation is analyzed in section 3.2, this might be a combination of proximity to neighbors and short response time of first-responders.

Among the factors that reduce the probability of survival, many of the well-known risk factors are found. These include high age (80+) (OR=0.41; 95% CI, 0.27 – 0.64) and causes of fire where the victim is often intimate with the fire (smoking (OR=0.089; 95% CI, 0.045 – 0.174) and candles (OR=0.11; 95% CI, 0.04 – 0.29) which often ignite clothes [20]. Also, electrical appliances (OR=0.37; 95% CI, 0.19 – 0.74) which has previously been found to be a major risk factor in the absence of smoking [20] can be found.

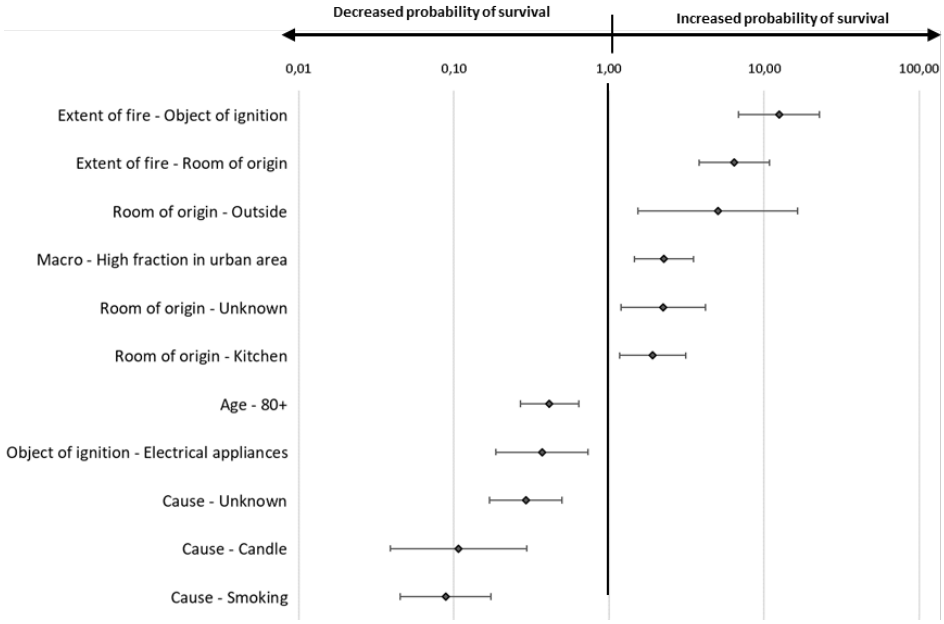

Figure 1 – Multidimensional odds-ratio for factors that significantly (P<0.05) affect probability of survival with injury compared to fatality.

3.2 Survival factors for different egress scenarios

The cases with injured individuals comprised of a range of different scenarios, from self-evacuating individuals to individuals extracted by first responders. In order to provide more detailed results for each mode of evacuation, the cases were divided into different categories based on the free-text available in the incident reports. The distribution of different modes of evacuation can be found in figure 2.

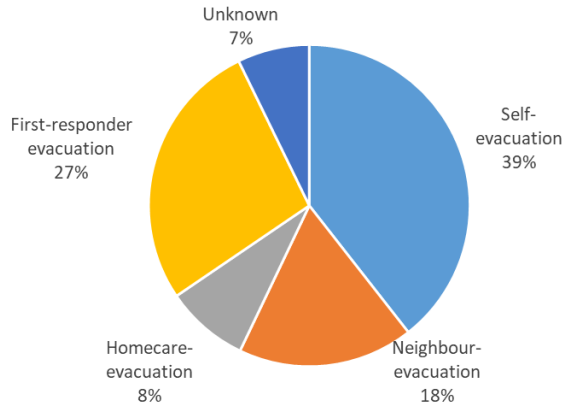

Figure 2 – Distribution among different modes of evacuation for the cases with injured older adults (65+ years) (N=269)

The results show that a rather high proportion (at least 54%) of the individuals depended on other actors to evacuate. The three important other actors identified (neighbors, homecare and first-responders) appear to all be of great importance for successful evacuation. The fraction of individuals evacuated by homecare is a bit lower, but since only approximately 10% of the older adult population receive homecare in Sweden it appears to be of very high relevance for this group.

We assume that neighbors are at scene before homecare and first-responders, and that first-responders will be the one performing the evacuation if both homecare and first-responders are on scene. We derived a flow model based on these assumptions, which is presented in figure 3.

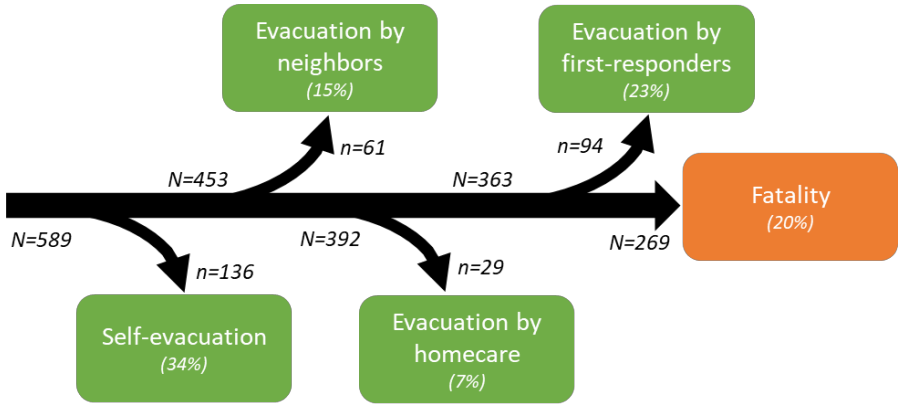

Figure 3 – Flow-model for older adults (65+) injured by residential fires. Percentages corrected for difference in time range for fatal and non-fatal cases. Cases with unknown mode of evacuation (N=25) has been excluded.

We use the flow model in the following sub-sections to analyze how the cases with different modes of evacuation is different from the cases that continue in the main flow. The analysis was performed with the same methods as for the analysis of survivals and fatalities in general.

3.2.1 Self-evacuation

The factor with the highest effect on the probability of self-evacuation was fires with paper as the object of ignition (OR=7.8; 95% CI, 2.0 - 30.6). An analysis of the free-text field for these cases show that these are exclusively very small, fuel-limited, fires with cigarettes or stoves igniting paper. It is therefore likely that these would not have resulted in fatalities even without evacuation.

Also, living in a house (OR=2.3; 95% CI, 1.5 – 3.6) and if the fire occurs during the winter (OR=1.7; 95% CI, 1.1 - 2.6) increase the probability of self-evacuation. This might partly be due to that chimney and other fire place related fires has a significantly lower number of fatalities per fire than do other objects of origin [6] and are more common during the winter [25].It can also be seen that individuals over 80 years old has a decreased probability of self-evacuation (OR=0.38; 95% CI, 0.23 - 0.62). This might be due to limited both cognitive and physical abilities which has previously been identified as an important risk factor in the group (e.g. [26]).

The following two factors are relating to the size of the fire at the time of arrival; if it stays within the fire compartment, but outside the room (OR=0.19; 95% CI, 0.11 - 0.34) or even outside the fire compartment (OR=0.24; 95% CI, 0.09 - 0.63). This points to that larger fires are more difficult to evacuate from than are smaller fires.

The last two factors describe the cause of the fire. The first factor is intentional fires (OR=0.13; 95% CI, 0.02 - 0.79) and since intentional fires often are suicides, it can be expected that the motivation for self-evacuation is lower. The last factor, which has the highest influence in reducing the probability of self-evacuation, is smoking (OR=0.099; 95% CI, 0.039 - 0.250). This is probably due to that it is very common for the cigarette igniting clothes within this group [6] and if the clothes are on fire; evacuation is unlikely to be successful.

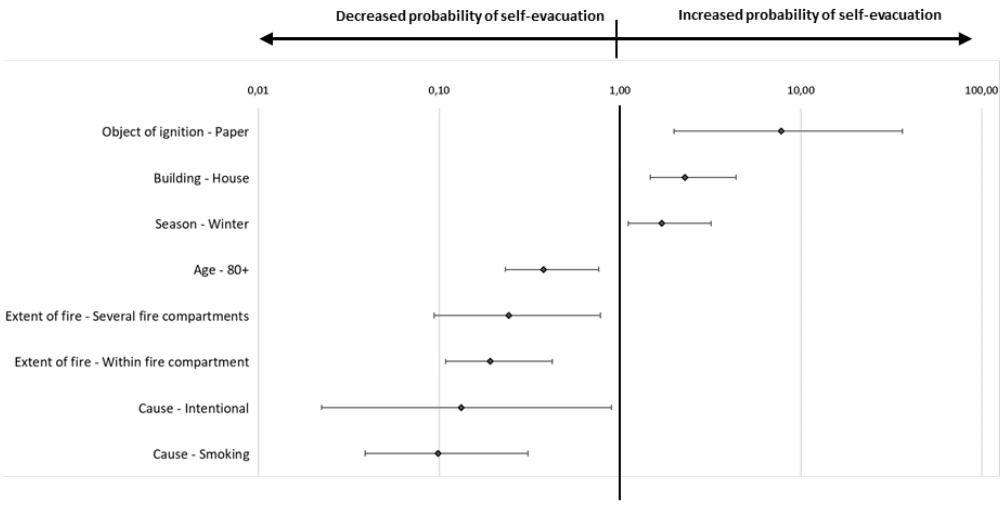

Figure 4 – Factors that significantly ($p<0.05$) influence the probability of self-evacuation (n=136) compared to neighbor, homecare, first-response evacuation or fatality (n=453).

3.2.2 Neighbor-evacuation

The second mode of evacuation is evacuation by a neighbor. It was attempted to extract how the neighbors were alerted about the fire from the free-text in the incident reports. Unfortunately this was rarely stated which lead to a very high number of unknowns (64%). In the remaining cases, they either heard a smoke alarm (18%), saw flames or heard fire related noise (12%) or smelled smoke (6%), but given the high number of unknowns only very limited conclusions can be drawn based on this. However, since factors like sound insulation of apartments and air tightness might influence the availability of these cues for neighbors, it is suggested that this should be systematically collected in the future.

The factor that increases the probability of neighbor evacuation the most is a fire in a non-residential area (OR=6.7; 95% CI, 2.0 – 22.8). These are primarily located in storage rooms and since the victim is normally not located within the storage room, it makes it easier for a neighbor to reach the victim without risking their own life. This is probably also a factor in the increased probability for fires originating in the kitchen (OR=5.3; 95% CI, 2.6 – 10.9), but for this scenario it is probably combined with stove related fires that most often do not lead to fatal conditions [6].

The factor between the two mentioned above, when the cause is “heat transfer” (OR=6.3; 95% CI, 2.4 – 16.4), is difficult to interpret since the category is quite vague (since all fires are in reality caused by heat transfer). An analysis of the free-text for these cases yielded a range of different scenarios where fires originating around the fireplace were common, but also a number of cases in the microwave oven or lamp falling down in the bed or other combustible. No clear interpretation of how this factor influence the ability of neighbors to evacuate has been found and this is also the case for unknown room of origin (OR=3.1; 95% CI, 1.1 – 8.3).

The next factor is a municipality-level factor, high population density (OR=2.7; 95% CI, 1.3 – 5.9). It is likely that this increases the likelihood of a close proximity to neighbors and since most of the cues presented in the first paragraph of this section is dependent on a short distance, it is likely that a high population density is beneficial for evacuation by neighbors.

Finally, high age (OR=0.26; 95% CI, 0.12 - 0.54) is a factor decreasing the probability also for neighbor-evacuation.

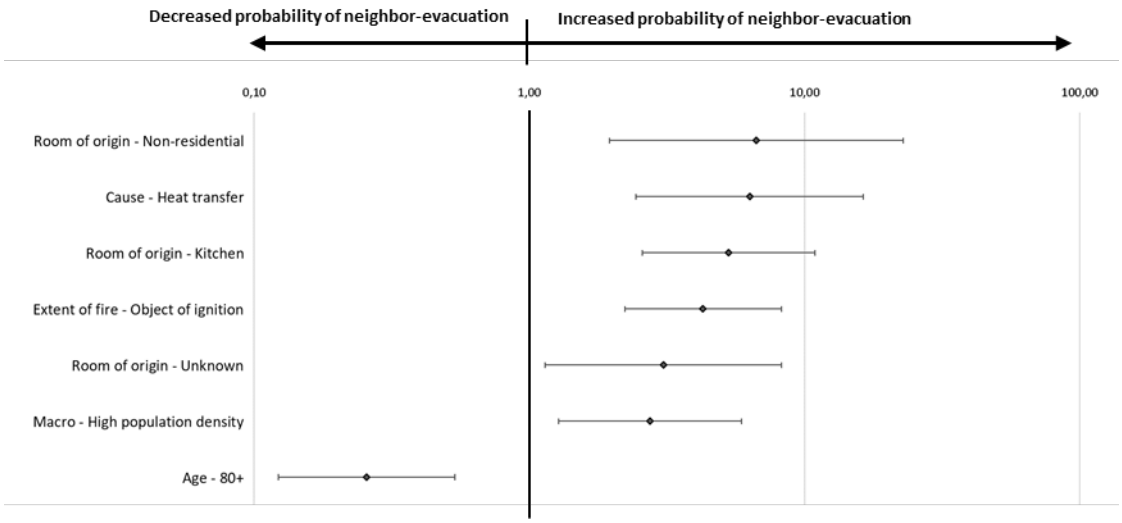

Figure 5 – Factors that significantly ($p<0.05$) influence the probability of neighbor-evacuation (n=61) compared homecare, first-response evacuation or fatality (n=392)

3.2.3 Homecare-evacuation

For cases where the individual was evacuated by homecare, the free-text in the incident reports was analyzed to assess how they were notified about the fire. For these cases, fewer were unknown (28%) compared to neighbor evacuation and for the largest fraction (41%) it was stated that they were alerted when the victim pressed the safety alarm that disabled older adults people often have. In 28% of the cases, the report only state that the homecare identified the fire, this might either be for that they arrived to take care of the individual, but probably, in a high portion of these cases, they were alerted by the safety alarm without the fire commander knowing. In the remaining few cases (3%) they were alerted by neighbors of the victim.

Perhaps due to the rather limited number of cases (n=29) fewer variables became statistically significant. The most important factor was that the fire was confined to the object of ignition at the time arrival of the fire department (OR=23.6; 95% CI, 7.7 – 71.9). This is indicative of a fuel-limited fire and is likely due to that homecare can be expected to often have a quite long response time, therefore a fire spreading outside the first object is likely to develop conditions where the homecare personnel are unlikely to be able to perform an evacuation.

The second factor is “other” object of ignition (OR=6.4; 95% CI, 1.8 – 22.9). A closer assessment of the these events revealed that they consisted primarily of fires originating in the fire place spreading to building contents (e.g. firewood or undefined) or misclassified objects of ignition (e.g. clothes and furniture).

A factor that increases the probability of successful rescue by homecare is a fire originating in the kitchen (OR=5.1; 95% CI, 2.0 – 12.8). This is likely a combination of that stove fires are

often small [25] and that it is probably less likely that the victim is in direct proximity to the fire.

This mode of evacuation is the only one where it is more probable for a person of age above 80 to be evacuated (OR=3.1; 95% CI, 1.2 – 7.9). This is logical given that the fraction of individuals with homecare increases with ages, but it also points to the importance of the interventions by homecare by this group which has been identified as having the highest number of fatalities per fire [6].

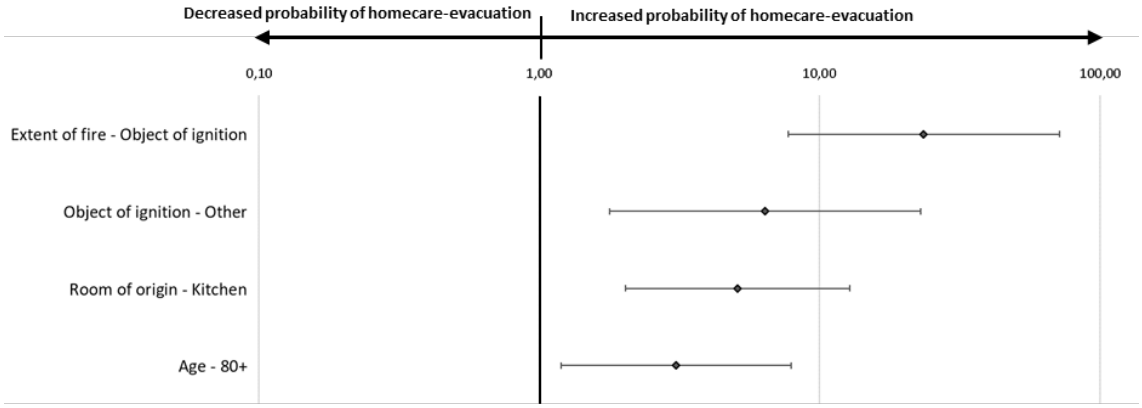

Figure 6 – Factors that significantly ($p<0.05$) influence the probability of homecare-evacuation (n=29) compared to first-response evacuation or fatality (n=363)

3.2.3 First-responder-evacuation

The last possibility for evacuation is by first responders which are most commonly fire departments (94%), but there are also cases with ambulance (3%) or police (3%) performing the rescue. This has previously been shown to be an important factor for saving lives in residential occupancies(e.g [22], [27]).

The factor that most strongly discriminates between cases with first-responder-evacuation and those without (i.e. becoming a fatality), is fires originating outside (OR=11.6; 95% CI, 2.9 – 45.5). A closer examination based on free-text in the reports showed that those fires exclusively occurred on the balcony and was generally not perceived as life threatening by the victim, despite that they did result in some level of injury, so the responders needed to force the individual outside. One exception was a case were an earlier fire in a mattress that was “extinguished” by homecare and then later reignited on the balcony while the victim was fully bedridden and could not evacuate until the fire department arrived.

The second important factor, a response time below 10 minutes (OR=3.6; 95% CI, 1.9 – 6.9), is concurrent with previous findings [22], [28] that a short response time is of paramount importance for the fire department to be able to perform a rescue. The third factor is likely partly correlated with the second, high fraction in urban areas (OR=2.8; 95% CI, 1.5 – 5.2), but it is probably also of importance since someone needs to alert the fire department and that is likely to be dependent on the same set of cues that are of importance for evacuation by neighbors presented in section 3.2.2.

Also for this mode of evacuation, high age is detrimental to chances of rescue (OR=0.46; 95% CI, 0.26 - 0.83).

It can also be found that a fire that has spread outside the room of origin is a major risk factor (OR=0.32; 95% CI, 0.17 - 0.59). This is probably due to that if the fire is confined to a single room, the victim is more likely to be able to take rescue into another room and close the door which has been found to greatly extend the time frame were a rescue is possible [29]. The reason for that the effect is particularly significant for this mode of rescue is probably that the fire department has breathing apparatus and therefore has the opportunity to intervene in much worse conditions.

The last important factor is when the cause of the fire is smoking (OR=0.26; 95% CI, 0.13 - 0.55). Similar to the other cases, this is probably due to that the victim is often in direct proximity with the fire and therefore the time scales are often too short for an intervention to be possible.

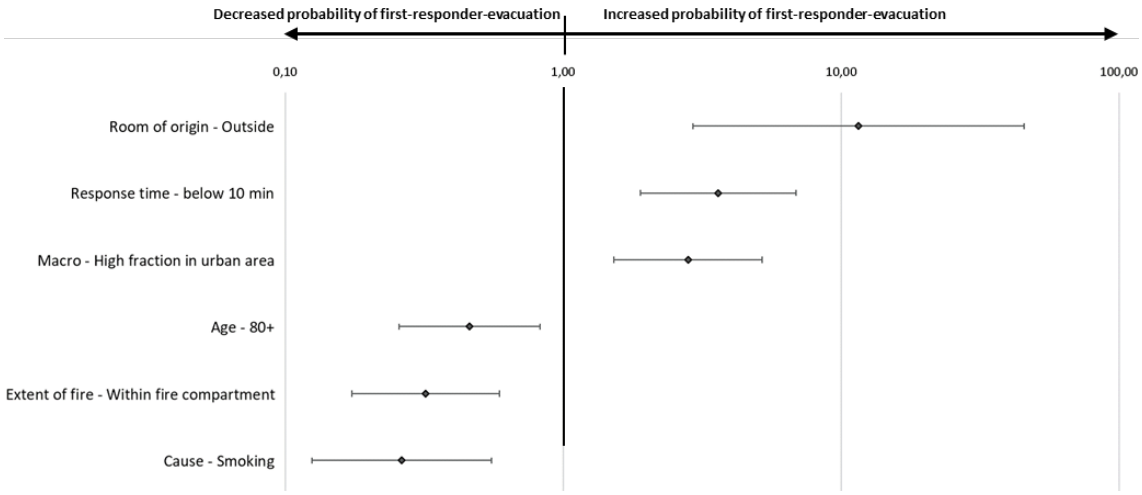

Figure 7 – Factors that significantly ($p<0.05$) influence the probability of first-responder-evacuation (n=94) compared to fatality (n=269)

3.3 Summary of survival factors

In table 1, a summary of the variables with a statistically significant effect ($p<0.05$) on the probability of different modes of rescue can be found.

Table 1 – Factors that significantly ($p<0.05$) influence the probability for survival and different modes of evacuation.

Level	Variable	Value	Survival	Evacuation by …			
				Self	Neighbor	Homecare	First-responder
Fire	*Cause*	*Candle*	–				
		Smoking	–	–			–
		Intentional		–			
		Heat transfer			+		
		Unknown	–				
	Object of ignition	Paper		+			
		Electrical appliances	–				
		Other				+	
	Room of origin	Outside	+				+
		Kitchen	+		+	+	
		Non-residential			+		
		Unknown	+		+		
	Extent of fire	Object of ignition	+		+	+	
		Room of origin	+				
		Within compartment		–			–
		Several compartments		–			
Location-temporal	Response time	below 10 min		N/A	N/A	N/A	+
	Building	House		+			
	Season	Winter		+			
	Age	80+	–	–	–	+	–
Macro	High fraction in urban area		+				+
	High population density				+		

4. Concluding discussion

The results show that causes that often ignite objects in direct proximity of the victim (e.g. clothes) significantly reduces the possibilities for successful evacuation regardless of the mode of evacuation. Intentional fires (i.e. most often suicide) naturally reduces the prevalence of self-evacuation.

The origin of the fire are also of importance with fires occurring in rooms were the victim is less likely to be in (at least sleeping) such as non-residential area, kitchen and outside will decrease the risk for the individual. Also a fire which is small when the fire department later arrive (which is indicative of a fuel-limited fire) is also a strong predictor of survival.

While high age is an important risk factor, it increases the probability of evacuation by homecare. Even if this is logical given who have access to safety alarm connected to homecare, it stresses the importance of homecare to be able to make an early intervention in case of fire since they serve the group with the highest risk of fire.

Also, response time was found to be highly significant for the rescue services to be able to evacuate the victim. This is in line with previous findings [22], [28].

The two municipality level factors that has a significant effect on the probability of rescue are both linked to closer proximity to others and various institutions. For example, living closer to neighbors will increase the probability that they identify a cue indicating that a fire has occurred (e.g. smoke alarm noise or smell of smoke).

The results also indicate that rescue by neighbors are important, but there are lacking information on how the neighbors was alerted about the fire in a high fraction (64%) of the cases. Since changes in, for example, sound insulation and air tightness of apartments might influence the availability of those cues to neighbors, this should be systematically collected in future versions of the incident reports.

4.1 Strengths and limitations

Some strengths and limitations to our study should be noted. The study is based on rich and detailed data, but is still limited by information available from secondary sources. While free text descriptions allowed us to derive evacuation scenarios, the quality of the databases could be improved by including more details on the causes of survival in their standardized reporting systems. The data on cases and controls were also (partially) derived from different databases and from different time periods, which may introduce some degree of bias in the estimated odds ratios if the quality of the reporting differs or if there are strong temporal trends in the variables included. However, given the general plausibility of the findings, it seems unlikely that the (potential) bias introduced by these factors could explain the entirety of our estimates. We also opted to categorize the continuous variables to simplify the interpretation of their ORs in comparison to categorical variables, and to relax linearity assumptions. This may result in some loss of information, but sensitivity analyses using continuous predictors show similar results to those presented in the paper (albeit that the ORs are more difficult to compare).

5. Conclusions

In summary, the results imply that the context around the older adults is very important for survival and that it is therefore important to increase the cooperation between various actors that each play a role in preventing the fatalities. More attention should also be put on preparing the general public about that they might be an important part in, not only their own fire safety, but also that they might need to evacuate neighbors that are not able to escape on their own. Also, since the results show that such a large proportion of the victims are not able to evacuate themselves, the growing number of home-dwelling, older adults needs to be problematized from a fire safety perspective.

5 Acknowledgement

The financial support by Brandforsk (grant no 202-171) is gratefully acknowledged.

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Appendix A – List of variables included in the analysis

Table A.1 – Variables included in the analysis and the source of data. For description of the data source, refer to section 2.1.

Level	Variable	Values	Source
Fire	Cause	Intentional Electrical equipment Candles Smoking Stove Other Unknown	Fatal fire database (fatal fires) Incident report (non-fatal fires)
	Object of ignition	Upholstered furniture Clothes Paper Combustible liquid Chimney Other Unknown	Fatal fire database (fatal fires) Incident report (non-fatal fires)
	Room of origin	Bedroom Kitchen Other residential room Non-residential area Outside Unknown	Fatal fire database (fatal fires) Incident report (non-fatal fires)
	Extent of fire	Object of ignition Room of origin Within fire compartment Several fire compartments Unknown	Incident report
Location-temporal	Age	65-79 80+	Fatal fire database (fatal fires) Incident report (non-fatal fires)
	Gender	Woman Man	Fatal fire database (fatal fires) Incident report (non-fatal fires)
	Response time	10 minutes or above Below 10 minutes	Incident report
	Day of week	Weekday (Mon-Fri) Weekend (Sat-Sun)	Incident report
	Time of day	Daytime (06-22) Nighttime (22-06)	Incident report
	Season	Winter (December to-February) Spring March-May) Summer (June to August) Fall (September to November)	Incident report
Macro	Fraction 65+ with homecare (above/below median municipality) - Average 2007-2012		National board of Health and Welfare
	Fraction 65+ in elderly care (above/below median municipality) - Average 2007-2012		National board of Health and Welfare
	Reply to “Often bothered by loneliness” among people with homecare - Average 2012-2015		Kolada
	Reply to “Reduced mobility in house” among people with homecare - Average 2012-2015		Kolada
	Population density - Population per 1000 km^2 - Average 2011-2015		Kolada
	Fraction in urban areas - Average 2005-2015		Kolada
	Fraction living alone among 65+ - Average 2011-2015		Kolada
	Fraction of older adults (65+) financially exposed, i.e. disposable income below 60% of median - Average 2012-2018		Kolada
	Fraction of people feeling safe in their area - Average 2012-2018		Kolada

Dependence ratio, logarithm of the quota between working people and retired - Average 2012-2015	Kolada
Gross regional product per captia - Average 2012-2016	Kolada

Bilaga 2.

Societal protection and population vulnerability are equally important in explaining local variations in fire mortality among older adults in Sweden

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Abstract

We study local variations in fire mortality among older adults (65+ years) in Sweden. Using municipal-level data coupled with dimensionality reduction techniques (principal components analysis), we confirm previous results suggesting that an efficient rescue service is important for low fire mortality rates. However, we also find evidence that the vulnerability of the older population plays an equally important role. This implies a need for a multifaceted approach to local fire mortality prevention that targets both rescue service efficiency and population vulnerability.

Introduction

In high-income countries such as Sweden, the issue of fire-related mortality has increasingly become an issue primarily concerned with those over 65 years (Istre, McCoy, Osborn, Barnard, & Bolton, 2001; Jonsson et al., 2016; Marshall et al., 1998). Coupled with the demographic development and projected increases in the percentage of older people in the population (Oecd, 2003), the overrepresentation of older people in the risk of fire-related deaths is a problem that requires attention.

Although the risk of fire initiation appears to be lower among older adults compared to younger age groups (Nilson et al., 2015), the risk of fire-related mortality per fire in the older age groups is very high due to a decreased ability to evacuate or extinguish the fire caused by age-related physical and cognitive decline (Gilbert & Butry, 2017; Jonsson et al., 2017; Runefors et al., 2016). As a consequence of decreased capabilities, the issue of co-living has been shown to be the most important protective factor for older adults (Jonsson & Jaldell, 2019). Despite this, however, the current societal trend in high-income countries is that older, multi-ill adults are increasingly living alone (De Jong Gierveld & Van Tilburg, 1999) and less in multigenerational households (Fernandez-Carro, 2016). Also, evidence suggests that this societal development will continue (Iacovou, 2000) and that this is encouraged both from an economic and individualistic perspective (Da Roit, 2010). As a consequence, it is feared that fire-related mortality among older adults can increase considerably without appropriate interventions (Nilson, Lundgren and Bonander, 2019 (submit)).

From a societal, reactive perspective, a prioritized fire mortality intervention is obviously a well-functioning rescue service. More specifically, as shown in previous studies (Jaldell, 2015), the response time from the rescue services is crucial in reducing the number of deaths. However, quick response times require high geographical and personnel coverage and thereby higher costs. In Sweden, as in many other countries, fire protection efforts are organized at the local municipal level meaning that the financial situation for rescue services is dependent upon local taxes. Due to general reductions in attended fires in many high-income countries, questions regarding the cost-effectiveness of full-time municipal rescue services have been raised (see for example (Knight, 2013)). In response to these discussions, as well as a consequence of other societal changes such as increased homecare of older adults, expectations are increasingly placed on other societal institutions (such as private security companies or healthcare deliverers) to improve the health and welfare of older adults as well as assisting in rapid response. However, while cost-effective, the effects of these types of interventions on the risk of death appears to be relatively low (Sund & Jaldell, 2018).

This paper, therefore, aims to investigate the relationship between municipal fire-related mortality rates among older adults in Sweden and two well-known groups of determinants related to (i) population vulnerability and (ii) societal protection. We find that the

vulnerability of older populations plays an equally important role in determining municipal-level fire mortality rates as access to efficient rescue service organizations, which highlights a need for additional focus on measures that decrease the vulnerability of the older population to fire hazards.

Methods

We employed an ecological design with Swedish municipalities as the unit of analysis. Our outcome measure was the number of fatal fires involving at least one older adult (65+ years) recorded over the period 1999-2015 (16 years) per 100.000 person-years of observation. We used municipality-level covariate data from public and official sources to quantify characteristics pertaining to the municipality as well as the health of the older population. The covariates are defined and detailed in Table 1. Many covariates were highly collinear (see Appendix Table A1), so we opted for a dimensionality reduction approach to reduce the number of variables into principal components. Specifically, we used principal components analysis (PCA), followed by Varimax rotation (Kaiser, 1958). We selected the number of components to retain by visual inspection of a scree plot, after confirming that the data was suitable for PCA (Kaiser-Meyer-Olkin's measure of sampling adequacy: .783; Bartlett's test of sphericity: $X^2(45)$: 948.7, $p<0.001$). We used Poisson regression to quantify incidence rate ratios for each covariate and to analyze how and if the identified principal components relate to the outcome. The PCA was conducted in SPSS Version 25, and the results were exported to Stata version 15.1 for the remaining analyses.

Table 1. Covariate information with descriptive statistics and data sources.

Variable	N obs.	Mean	Std. Dev.	Min	Max	Period	Source
Share living alone, 65+ years (%)	290	35.1	3.4	24.2	45.1	2011-2015	Statistics Sweden
Fall injury incidence (hospital admissions per 100.000 person-years).	290	3345.2	650.9	2085.3	5956.9	2010-2015	The National Board of Health and Welfare
Gross regional product (GRP) per capita	290	302.8	123.3	123.3	1228.4	2012-2015	Statistics Sweden
Dependency ratio (ratio of inhabitants 0-19 years and 65+ to 20-64 years, logged)	290	-0.2	0.1	-0.7	0.1	1999-2015	Statistics Sweden
Share living in nursing homes, 65+ years (%)	290	5.2	1.2	2.7	8.6	2007-2012	The National Board of Health and Welfare
Share with home care service, 65+ years (%)	290	8.7	1.7	4.5	13.2	2007-2012	The National Board of Health and Welfare
Rescue service response time (median)	287	12.8	3.1	7.8	28.1	2010-2015	SOS Alarm
Share living in urban areas (%)	290	74.3	14.5	31.0	100.0	2005-2015	Statistics Sweden
Population density (inhabitants per 1000 km^2, logged)	290	3.3	1.7	-1.4	8.5	2011-2015	Statistics Sweden
Share of applications with longer than 90 days wait time (nursing homes) (%)	258	20.6	16.3	0.0	97.0	2014-2018	Swedish Association of Local Authorities and Regions

Results

A total of 669 fatal fires involving at least one person over the age of 65 years was recorded in the data, which corresponds to an expected rate of 2.36 fatal fires 100.000 person-years of observation. However, the observed rate varies from 0 to 16.92 across municipalities (Figure 1).

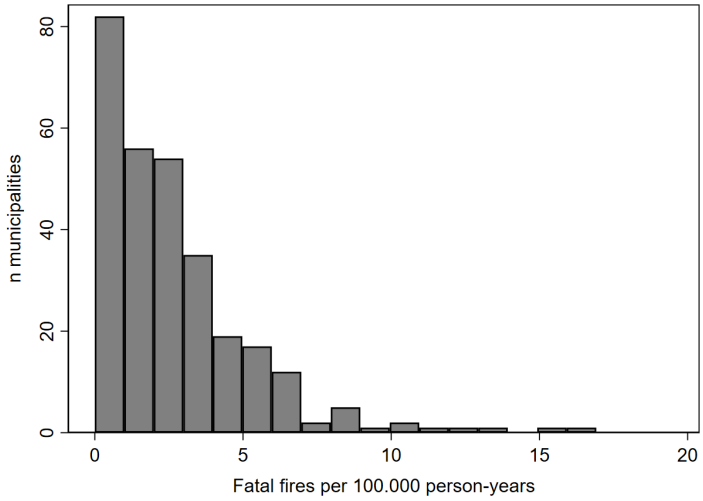

Table 2 shows how each covariate is associated with municipal fire mortality rates. Thus far, the results imply that greater urbanization and shorter rescue service response times are associated with lower rates. The opposite can be said for greater shares of the older population living alone, having home care or living in nursing homes, and for higher fall injury incidence rates. Together, this suggests that rescue service organizational factors and context (e.g., distance) matters, and that the vulnerability of the population does as well. However, entering all of these covariates into a multiple Poisson regression model (not shown) yielded results that were difficult to interpret due to the high collinearity between these factors. For instance, Spearman's rho for the correlation between urbanization and median response time is -0.7, probably because the travel distance is smaller in urban areas. We found correlations of similar magnitude for the population variables, indicating that they are proxies for the same underlying phenomena (e.g., the vulnerability of the population), which motivates a dimensionality reduction approach.

Table 2. Univariable Poisson regression results showing the unadjusted association between each predictor and the incidence of fatal fires per person-year.

Variable	Percentage change in risk per one unit increase in covariate	p-value
Share living in urban areas (%)	-0.66 (-1.19, -0.12)	0.02
Fall injury incidence (hospital admissions per 100.000 person-years).	0.01 (0.00, 0.02)	0.01
Dependency ratio (ratio of inhabitants 0-19 years and 65+ to 20-64 years, logged)	-3.33 (-44.05, 67.05)	0.90
Gross regional product (GRP) per capita	0.03 (-0.01, 0.07)	0.17
Population density (inhabitants per 1000 km^2, logged)	-2.47 (-6.21, 1.41)	0.21
Rescue service response time (median)	3.29 (0.16, 6.51)	0.04
Share of applications with longer than 90 days wait time (nursing homes) (%)	-0.35 (-0.87, 0.17)	0.19
Share with home care service, 65+ years (%)	4.98 (0.64, 9.50)	0.02
Share living in nursing homes, 65+ years (%)	6.42 (-0.94, 14.32)	0.09
Share living alone, 65+ years (%)	2.46 (0.54, 4.41)	0.01

Notes: The estimates are based on the coefficients from Poisson regression models with the logarithm of the sum of person-years over the entire period as an offset. The outcome is the number of fatal fires involving at least one person over the age of 65 years. The coefficients were converted to percentage changes using (exp(B)-1)*100, where *B* is the regression coefficient. Confidence intervals (95%) are presented in parentheses.

Using the 256 municipalities with complete covariate and outcome data, the PCA resulted in two components which we interpreted as (1) (municipal) urbanization and (rescue service) efficiency and (2) population vulnerability (the factor loadings for each covariate is presented in Table X). Together, these components explain 56% of the variance in the covariate data.

Table 3. Results from the principal components analysis.

	Principal components	
	(1) Urbanization and efficiency	(2) Population vulnerability
Share living alone, 65+ years (%)		0.83
Fall injury incidence (hospital admissions per 100.000 person-years).		0.70
Share of applications with longer than 90 days wait time (nursing homes) (%)	0.21	
Gross regional product (GRP) per capita	0.44	0.64
Dependency ratio (ratio of inhabitants 0-19 years and 65+ to 20-64 years, logged)	-0.82	
Share living in nursing homes, 65+ years (%)	-0.48	0.51
Share with home care service, 65+ years (%)		0.56
Rescue service response time (median)	-0.80	
Share living in urban areas (%)	0.86	
Population density (inhabitants per 1000 km^2, logged)	0.89	

Notes: The component loading are based on principal components analysis (PCA) followed by Varimax rotation. Small loadings (<.20) are suppressed. Results for Kaiser-Meyer-Olkin's measure of sampling adequacy: .783; Bartlett's test of sphericity: X2(45): 948.7, p<0.001.

Figure 1 shows how the two components, divided into quintile groups, relate to the outcome while keeping the other component constant at its median value (estimated using a Poisson regression model with the two [quintile-grouped] components as independent variables). As might be expected, the results show that higher urbanization and efficiency is associated with lower fire mortality rates, whereas the vulnerability of the older population is associated with higher rates. In terms of magnitude, the rate difference is -0.8 per 100.000 person-years between the highest and lowest quintile group on the urbanization component (-33% in relative terms) and +1.1 per 100.000 person-years between the highest and lowest group on the vulnerability component (+56%). The difference is statistically significant (p=.008 in both cases).

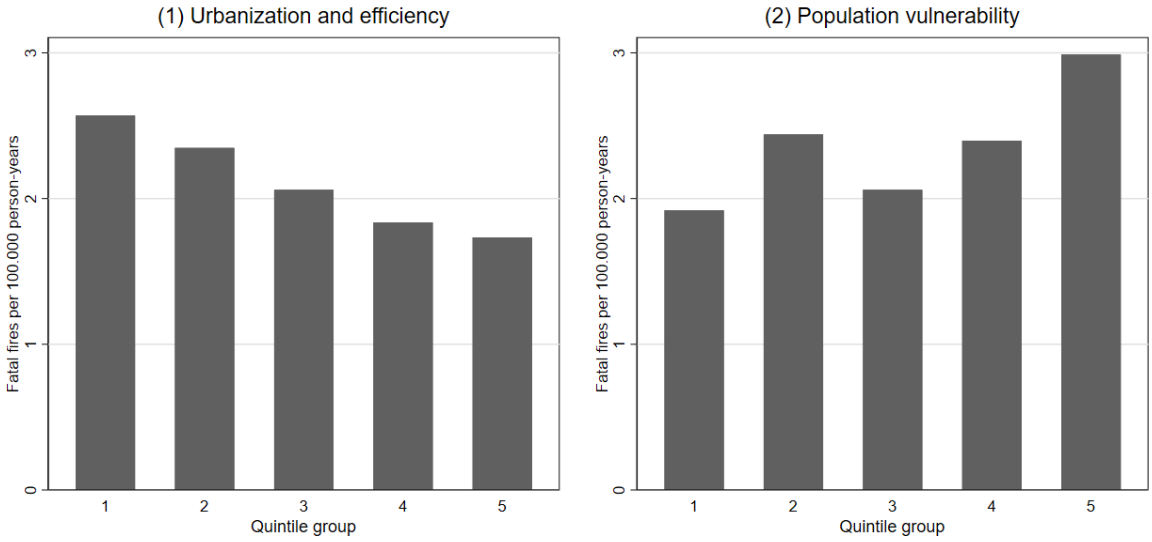

Figure 1. Expected number of fatal fires per 100.000 person-years involving at least one person over the age of 65 years depending on the municipalities score on (1) urbanization and efficiency and (2) population vulnerability. In each subplot, the other component is held constant at its mean.

As a final analysis, we plotted the components in a two-way scatter plot, including reference lines that divide the sample of municipalities into four groups: (i) high urbanization-low vulnerability, (ii) high urbanization-high vulnerability, (iii) low urbanization-high vulnerability and (iv) low urbanization-low vulnerability (Figure 2). We then calculated the observed mortality rates per group. As shown in the plot, we found the lowest rates in the high urbanization-low vulnerability group and the highest in the low urbanization-high vulnerability group. In fact, the rate reduction from the high risk group to the low risk group is larger than the rate reductions in the “medium risk” (lower left and upper right) quadrants combined, which implies an interaction effect in the sense that societal protection efforts may be more efficient in low vulnerability populations.

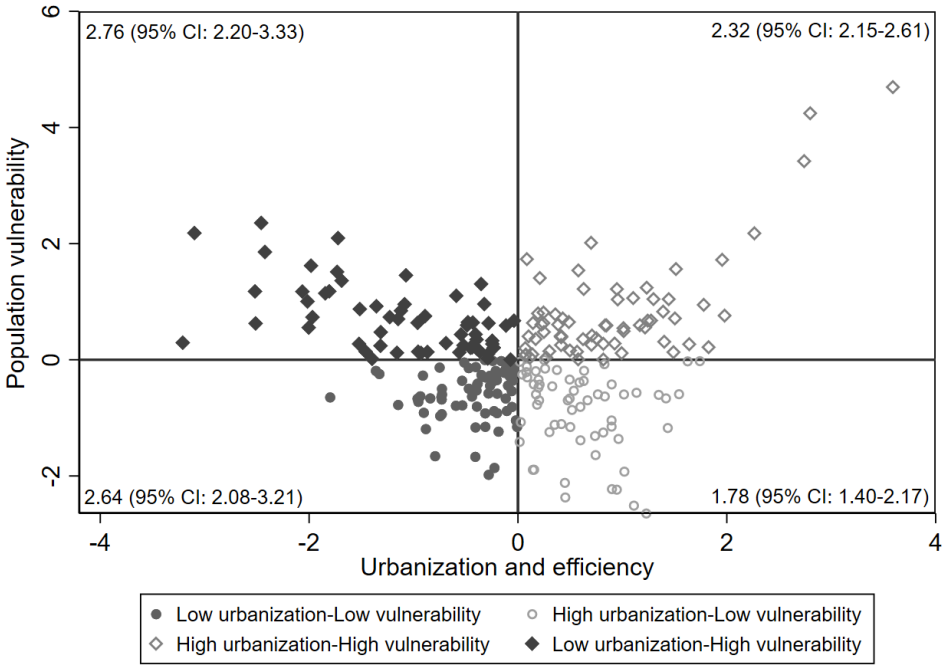

Figure 2. Scatterplot showing the distribution of municipalities across the two dimensions (population vulnerability; urbanization and efficiency) identified in the principal components analysis. The data is split into four groups. The numbers reported in each quadrant represents the group-wise rate of fatal fires (per 100.000 person-years) involving at least one person over the aged of 65 years.

Discussion

Overall, the results from this study imply that there are (at least) two separate, underlying components (individual vulnerability and societal protection) that determine fire-related mortality rates among older adults at the local level. While it is ill-advised to infer causality from observational data, prior evidence supports the plausibility of these two mechanisms. Importantly, the results suggest that while societal protection, through for example short response times, does lower the fire-related mortality rates, they do not eliminate the risk-increasing aspect of individual vulnerability.

The importance of individual vulnerability in explaining fire-related mortality is well-known with several studies having shown the increased risk amongst those living alone (Jonsson & Jaldell, 2019; Marshall et al., 1998), belonging to an ethnic minority (Chandler, Chapman, & Hollington, 1984; Jennings, 1999), having low educational attainment (Duncanson, Woodward, & Reid, 2002; Jennings, 1999), as well as having a low disposable income, receiving social allowance, being unemployed and receiving health-related early retirement pension (Ballard, Koepsell, & Rivara, 1992; Jonsson & Jaldell, 2019; Xiong, Bruck, & Ball, 2015). Interestingly, many of these socio-demographic differences have been observed since the 1970s (Berl & Halpin, 1978; Jonsson, 2018) though seem to have become even more pronounced in recent years (Xiong et al., 2015). From a public health perspective, the importance of sociodemographic risk factors in explaining inequality in mortality is well established, as are the necessary preventative measures, for example increasing the general

educational level, increasing health literacy and improving access to healthcare. General public health measures, such as those aimed at increasing physical activity and sense of coherence in the population, may also be potentially important interventions, provided that they lead to lower individual vulnerability and increased co-living.

While decreasing individual vulnerability is an important long-term goal, not merely from a fire-related mortality perspective, such interventions take time. Therefore, in order to reduce fire-related mortality rates amongst older adults in the short term, other interventions need to be promoted. The results from this study reiterate the importance of rescue service response times, as shown previously (Jaldell, 2015). However, in order to accomplish a high level of service as required, the societal costs risk being high. This is further complicated by the fact that Sweden, in similarity to other high-income countries, has a high urbanization rate, particularly among younger, well-educated individuals (Smas, 2018). This urbanization pattern has a dramatic effect on the financial status of rural municipalities (Lindblad et al., 2015) meaning that rural communities are therefore more likely to be forced into cost-cutting. The municipal organization of rescue services, as well as public health interventions, could thereby be an organizational barrier to reducing fire-related mortality among older adults.

There are some limitations to our study worth mentioning. A potential problem with our data is that is collected from secondary sources and may therefore vary in quality. The mortality data also covers a longer period than many of the covariates, which may introduce some bias if there are strong municipality-specific time trends. However, the precision of the estimates would be too low to provide any meaningful information if we had used the same periods as the covariates. It also appears unlikely that the observed associations can be attributed entirely to such artefacts, especially given the theoretical plausibility of the observed associations. However, we cannot rule this out, and replication in other settings is therefore strongly warranted. Our results motivate further research and focus on societal efforts both in the short- and long-term perspective. On a broader scale, the results also imply that public health agencies and rescue service organizations could benefit from working together to decrease fire mortality rates at the local level, especially in communities with vulnerable populations.

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Bilaga 3.

Can Co-Living Decrease the Risk of Death? – A Case study on Fire-Related Mortality Amongst Older People in Europe

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Abstract

Background. Socioeconomic status and living conditions affect fire mortality risk substantially. Given a demographic transition in Europe towards a larger older population, less co-living and increased homecare, this study investigates the relationship between co-living rates and fire mortality rates among older adults in Europe. **Methods**. Freely available online datasets with aggregated European data on fire mortality, living arrangements among older adults, population statistics and GDP were analysed using Poisson regression models. **Results**. The fire-related mortality rate among older adults in Europe is shown to be 2.86 (range 0.55-14.65) per 100,000 person-years. Adjusting for GDP, the results predict that when the share of older adults living alone increases by one percentage point, the fire mortality rate increases by roughly 4 percent for both sexes. Consequentially, the results suggest that if the number of older people living alone in Europe increases by 10 percentage points, twice as many will be killed in fires compared to if the number living alone decreases by 10 percentage points. **Conclusion**. This study indicates that the share of older people co-living in a country is an important determinant for low fire mortality rates on a national, European level.

1. Introduction

Globally, fires are a considerable societal problem with approximately 200,000 fire-related deaths occurring annually (WHO, 2004). Although fire-related injuries and fatalities amongst younger groups is predominantly an issue in low-income countries (Haagsma et al., 2016; Murray et al., 2012), in high-income countries the issue is one primarily concerned with those over 65 years (Istre et al., 2001; Jonsson et al., 2016; Marshall et al., 1998). Given the demographic development with a projected increase in the percentage of older people in the population (Oecd, 2003), the overrepresentation of older people in the risk of fire-related deaths is a problem that needs to be investigated further.

Evidence suggests that socioeconomic status and living conditions affect mortality risk substantially in the general population as well as amongst older adults. Specifically, studies have indicated that co-living with another person is amongst the most protective of all sociodemographic factors (Jonsson et al., 2017; Runefors et al., 2017; Turner et al., 2017). In terms of how older people live, however, considerable differences are seen between different countries. These differences, often based on how welfare, such as the availability of public elderly care, pension systems, availability and cost of childcare, etc., is organised in a state (Daly & Lewis, 2000; Esping-Andersen, 1990), mean that the living arrangements for older people in Europe differ between countries, especially in regards to whether they live with their children (De Jong Gierveld et al., 2001). For example, whilst in Nordic countries such as Sweden and Denmark 5% of older people live with their children, in southern European countries such as Spain, Greece and Italy, up to a third of older people live with their children (Ogg & Renaut, 2006). Theoretically, given the importance of co-living as a protective factor in fire mortality risk, it could be hypothesised that country-level differences in living arrangements could lead to variations in fire mortality between countries. Also, it could be hypothesised that living with younger generations would give increased protection compared to living with the same generation, given their improved physical and psychological capabilities. Therefore, this study's first aim is to investigate differences in fire-related mortality rates amongst older people in European countries and whether living arrangements can explain differences in rates.

The second aim of this study is to attempt to predict how future changes in the living arrangements would affect fire mortality rates in Europe. Although the organisation of social care and living arrangements are somewhat related to different welfare states, these are not static and since the beginning of the 1990s, financial concerns and ideological shifts have led to a restructuring of welfare and the organisation of care in high-income countries. In the case of elderly care, many European countries, have shifted focus from institutional care programs to home care, in order to reduce costs and to allow an increasing autonomy of elder individuals (Da Roit, 2010), leading to an increased percentage of older adults living alone (De Jong Gierveld & Van Tilburg, 1999). Given that this trend of living alone seems likely to increase (Iacovou, 2000), the potential effects on fire mortality need to be assessed.

2. Methods

2.1. Data

For this study, three freely available online datasets with aggregated data were used. The first dataset was fire mortality data for older people (75 years and above), as reported in the World Health Organizations (WHO) mortality database. This data is based on the ICD registration systems and the death certificates for deceased individuals. The national data from each country then reports the data to the WHO. The second dataset, involving age- and sex-specific population data for the relevant years and countries, was retrieved from the European Unions (EU) official data source (Eurostat). The third dataset was also retrieved from Eurostat and was data from the 2011 Population and Housing Census, specifically data concerning the living arrangements of older people. The Population and Housing Census is a European Union (EU) initiative where National Statistical Institutes collect comparable data in all EU countries. Due to differences in underlying data sources, the methodology varies between countries. For example, in some countries, information is registered regularly as part of the national statistics, whilst in other countries a specific census is sent to the entire population or a representative sample.

2.2. Statistical analysis

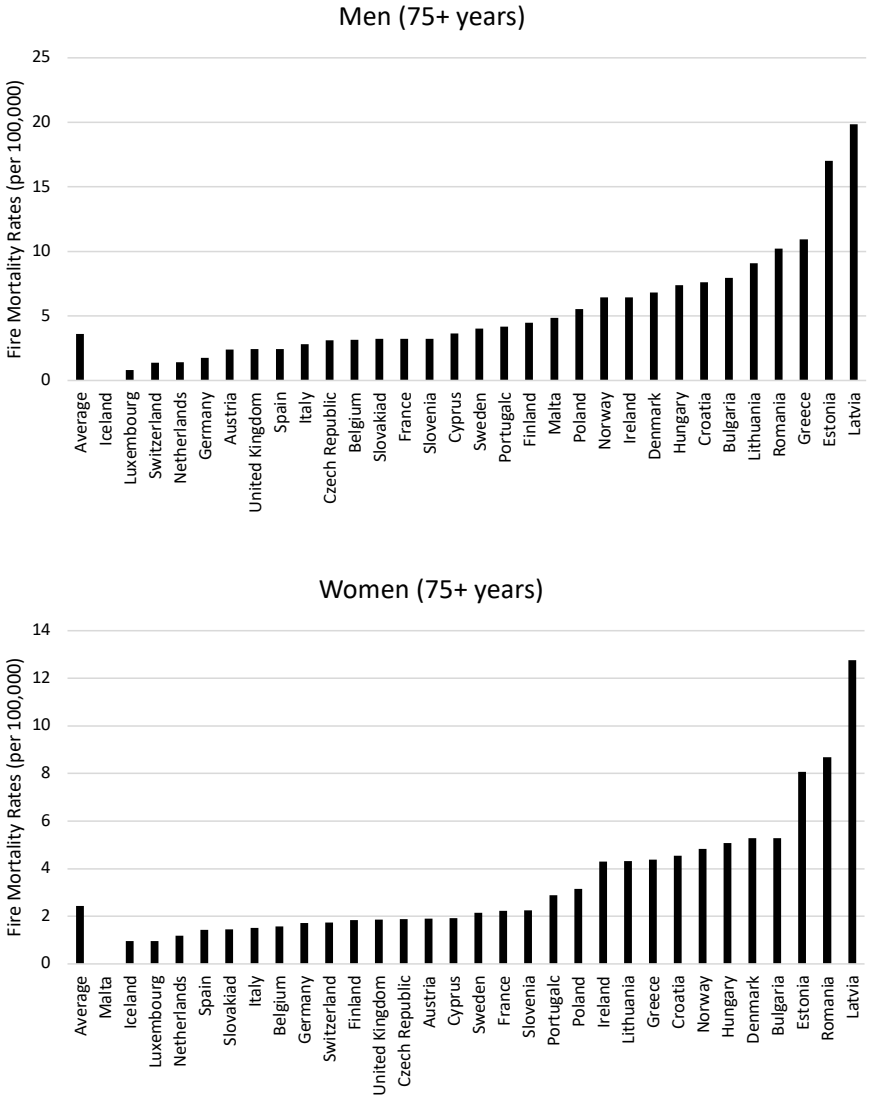
Age- and sex-specific mortality rates (per 100,000 person-years) were calculated by dividing the sum of fire-related deaths and the number of person-years of observation for the period 2005-2014 (excluding missing years for Portugal [2005-2006] and Slovakia [2011] from the nominator and denominator). Population-weighted averages were calculated to obtain living arrangement estimates for the entire region (all 31 included countries) and Spearman's rho was used to assess correlations. Poisson regression models were used to estimate the association between living arrangement shares and fire mortality rates, and to adjust for GDP per capita. The sum of fire-related deaths was used as the outcome variable and the (logged) sum of person-years as an offset. These were converted from incidence rate ratio (IRR) estimates into percentages changes, i.e. (IRR-1)*100, to increase interpretability. Finally, regression models were used to obtain the expected number of fire-related deaths per year under different scenarios where we artificially modified the share of individuals living alone. The population size from 2014 was used for this analysis and four scenarios were considered: -10, -5, +5, +10 percentage points in the share of individuals living alone (truncating negative shares to 0). These were compared to the base case estimates based on the actual shares. All analyses were stratified by sex. Stata version 15.1 was used to perform the analyses.

3. Results

The data suggests that 12,057 fire-related deaths occurred from 2005 to 2014 among older adults (75+ years) in the 31 included countries (5642 among men, 6415 among women; outcome data missing for Portugal 2005-2006 and Slovakia in 2011). Summing the age- and sex-specific population from each country and year gives a total of 421,156,637 person-years

of observation (men: 156,764,766 person-years; women: 264,391,871). This implies that the fire-related mortality rate is 2.86 per 100,000 person-years among older adults in Europe. However, the country-specific rate ranges from 0.55 in Iceland to 14.65 in Latvia (figure 1).

Figure 1. Fire mortality rates (2005-2014) for men and women aged 75+ years for 31 European countries.



Sex-specific rates for each included country and the entire region are also available in Table 1, which includes data on living arrangements. As is seen, the most common living arrangement is living with others (excluding younger generations), followed by living alone and finally living with younger generations. Living with a younger generation and living alone is more common among women than men.

Table 1. Fire mortality rates for men and women aged 75+ years and covariate data for 31 European countries.

		Men				Women			
Country	**GDP per capita (current US$)**	**Fire mortality rate[a]**	**Living with others[b]**	**Living with younger generation**	**Living alone**	**Fire mortality rate[a]**	**Living with others**	**Living with younger generation**	**Living alone**
Average	36311	3.60	78.8	2.14	16.9	2.43	51.9	6.8	37.2
Austria	47479	2.39	77.3	1.7	18.7	1.91	48.0	6.4	40.0
Belgium	44429	3.14	76.6	1.7	19.0	1.57	49.5	5.2	38.1
Bulgaria	6602	7.95	79.7	2.1	17.7	5.29	59.4	5.5	34.4
Croatia	13381	7.62	80.6	3.6	14.0	4.55	53.9	11.8	30.8
Cyprus	29876	3.64	88.3	1.3	9.0	1.93	67.0	5.5	24.6
Czech Republic	19026	3.10	76.9	2.5	18.5	1.88	48.6	8.1	39.6
Denmark	58384	6.81	72.4	0.5	25.4	5.28	46.7	0.9	49.2
Estonia	16088	17.02	73.4	2.3	21.8	8.06	40.9	9.9	46.5
Finland	47285	4.47	72.3	1.3	23.4	1.85	44.5	3.7	46.4
France	41053	3.22	76.9	1.1	18.0	2.23	47.6	3.9	41.4
Germany	42763	1.75	80.0	1.3	16.5	1.71	51.6	4.0	39.6
Greece	25660	10.93	84.6	2.9	10.8	4.38	55.6	11.8	30.1
Hungary	13330	7.37	77.3	2.1	18.1	5.08	47.4	6.6	42.1
Iceland	51055	0.00	71.8	1.2	19.8	0.96	51.9	2.0	35.1
Ireland	53699	6.43	69.8	3.2	20.2	4.30	49.8	9.7	30.1
Italy	36045	2.80	80.9	2.9	15.4	1.51	53.7	8.6	35.6
Latvia	12944	19.85	75.7	3.6	18.8	12.77	48.8	13.6	35.9
Lithuania	12912	9.08	78.5	2.7	17.6	4.32	47.4	10.4	41.0
Luxembourg	105387	0.81	77.6	2.0	16.5	0.96	49.7	5.7	34.3
Malta	20996	4.87	78.5	3.2	14.3	0.00	54.8	9.4	26.6
Netherlands	50319	1.40	77.5	0.9	18.7	1.18	49.0	2.5	42.0
Norway	89355	6.42	73.5	1.1	23.3	4.84	47.9	2.6	45.1
Poland	12160	5.54	82.2	3.7	13.2	3.16	53.8	13.4	31.6
Portugal[c]	21928	4.17	83.7	2.4	11.1	2.89	59.3	8.6	26.8
Romania	8324	10.21	81.5	2.8	15.3	8.68	56.0	9.3	34.1
Slovakia[d]	16491	3.21	77.1	4.4	13.5	1.46	50.6	11.9	32.3

Slovenia	23239	3.22	77.1	3.9	16.1	2.26	46.5	12.3	35.3
Spain	30559	2.45	82.4	3.6	12.4	1.43	58.6	11.1	27.5
Sweden	53289	4.01	72.0	0.9	22.2	2.15	50.9	1.6	40.0
Switzerland	73678	1.36	79.1	0.9	19.3	1.74	51.3	3.2	45.1
United Kingdom	43275	2.43	73.6	2.1	22.0	1.86	50.2	5.4	39.5

a Mortality rate per 100.000 person-years based on number of deaths due to exposure to fire, smoke and flames (ICD-10 codes: X00-X09, source: WHO mortality database) and population size (converted to person-years, source: Eurostat) from 2005-2014.

b Excludes living with younger generations.

c Missing outcome data for 2005-2006. Mortality rate for Portugal was missing for the period 2007-2014.

d Missing outcome data in 2011. Mortality rate for Slovakia was calculated after excluding this year.

Notes: Mortality rates are for ages 75+, but living arrangement data was only available for ages 65+. Living arrangement estimates do not sum to 100% due to some individuals living in differing arrangements. For example, homeless, long-term hospital care, etc. The averages presented are weighted by population size, except for the mortality rate, which was calculated by taking the sum of deaths divided by the sum of person-years.

Fire mortality rates are negatively correlated with GDP per capita (Spearman's rho: -.45 for women; -.59 for men), and positively correlated with the share of older adults living alone (Spearman's rho: .31 for women; 0.53 for men). This suggests that GDP per capita is an important confounder. Table 2 therefore includes both unadjusted and GDP-adjusted estimates, presented in percentage change per percentage point increase in the share of each living arrangement variable. In fact, the unadjusted estimates are of the opposite sign than expected (e.g., living alone appears protective), whereas the GDP-adjusted estimates are consistent with the theory of an increased risk as a consequence of living alone.

The adjusted models (Adjusted I) predict that when the share of older adults living alone increases by one percentage point, the fire mortality rate increases by roughly 4 percent for both sexes. Increasing the share of individuals who live with others could therefore have a protective effect. Our final model (Adjusted II), which includes (i) the share of individuals who live with the same generation or (ii) the share who live with the younger generation, suggests that the expected reduction in fire mortality is approximately the same independently of which of the two shares increases.

Table 2. Unadjusted and adjusted estimates for the association between country-level share of older adults in various living arrangements and fire mortality rates based on Poisson regression models.

	Unadjusted	Adjusted I	Adjusted II
Men			
Living alone (%)	-3.68 (-4.45, -2.90)	3.76 (2.79, 4.47)	

Living with others, excl. younger generation (%)	3.29 (2.46, 4.13)		-3.38 (-4.32, -2.42)
Living with younger generation (%)	23.2 (19.94, 26.54)		-3.78 (-7.33, -1)
Women			
Living alone (%)	-.82 (-1.3, -.33)	4.36 (3.75, 4.99)	
Living with others, excl. younger generation (%)	.99 (.31, 1.66)		-2.52 (-3.24, -1.79)
Living with younger generation (%)	5.08 (4.33, 5.83)		-3.44 (-4.50, -2.38)

Notes: The estimates are derived from incidence rate ratios (IRR) from Poisson regression models using (IRR-1)*100, and can be interpreted as the expected percentage change in fire mortality per percentage point increase in each covariate. Confidence intervals (95%) are presented in parentheses.

In regards to the effect of future changes in living arrangements, four different hypothetical situations were tested; an increased share of older adults living alone (+5 and +10 percentage points), or a decreased share (-5 and -10 percentage points). As can be seen in table 3, the results suggest that if the number of older people living alone in Europe increases by 10 percentage points, twice as many will be killed in fires compared to if the number living alone decreases by 10 percentage points.

Table 3. Estimated fire mortality rates and annual number of deaths per year in Europe under different scenarios created by artificially increasing or decreasing the share of individuals living alone in each country.

Group/Scenario	**Fire mortality per 100.000 person-years**	**Estimated number of deaths per year[a]**
Men		
Base case	3.60 (2.56, 5.06)	653 (465, 918)
-5 pp	2.99 (1.97, 4.55)	543 (357, 825)
-10 pp	2.49 (1.36, 4.56)	451 (246, 828)
+5 pp	4.33 (2.79, 6.72)	786 (506, 1220)
+10 pp	5.21 (2.75, 9.88)	945 (498, 1792)
Women		

Base case	2.43 (1.74, 3.39)	698 (500, 975)
-5 pp	1.96 (1.33, 2.88)	564 (383, 830)
-10 pp	1.58 (.97, 2.59)	456 (278, 745)
+5 pp	3.00 (2.10, 4.30)	865 (605, 1236)
+10 pp	3.72 (2.38, 5.81)	1071 (685, 1673)

a Calculated from the mortality rate assuming a population size equal to the sex-specific population aged 75+ in 2014, summed over all included countries.

Notes: The estimates were computed from Poisson regression models (adjusting for GDP per capita); 95% confidence intervals are presented in parentheses.

Abbreviations: pp, percentage points.

4. Discussion

This study can show several important aspects regarding fire mortality amongst older adults in Europe. Firstly, mortality rates differ considerably between different countries and between men and women. As expected, GDP is a strong predictor of fire mortality rates, in similarity to previous studies showing the correlation between high GDP and low injury mortality rates (Moniruzzaman, 2006). However, when this aspect is controlled for, the results show that the share of an older population living alone in a country is significantly correlated with the overall risk of fire mortality in the older age group. Conversely, the share of older adults living with others, whether they are younger of the same age, is associated with lower fire mortality rates.

One of the common explanations in understanding the overrepresentation of fire mortality amongst elderly is the higher prevalence of physical and cognitive impairments that affect the ability to cope with a fire or evacuate, once a fire has started (Gilbert & Butry, 2017). Previous studies have also shown that the fires that have caused the death of an elderly person are often relatively contained fires that have been started by small ignition sources, e.g. cigarettes, candles, etc. These small ignition sources have then often lit clothing, bed linen or upholstery, thereby leading to death. For an able-bodied individual, these types of fires are relatively simple to extinguish, even without specific equipment. However, for an elderly person, although rarely intoxicated or asleep, their cognitive or physical impairments seem to prevent them from extinguish the fire or evacuating to safety (Jonsson et al., 2017; Runefors et al., 2016).

Although unable to extinguish or evacuate, theoretically, given the slow fire growth, it could be possible for the older person to raise the alarm and receive help. However, given that fires have to be attended to very rapidly in order to save lives (Jaldell, 2015), this help needs to be close by in order to succeed. Hypothetically, therefore, regardless of age, those individuals co-living with older people could significantly affect the risk of death by extinguishing the fire, calling for help or helping to evacuate. Given that this study has merely studied the issue from a national aggregate level, it is important to note that it is not possible to assess how co-

living protects, nor how living alone increases the risk of fire mortality. A number of studies have shown that known fire mortality risk factors, such as smoking, excessive alcohol consumption, and lower prevalence of fire prevention equipment are all correlated with living alone (Kharicha et al., 2007; Nilson & Bonander, 2019; Rosén et al., 1990). Whether these factors evolve due to living alone or whether they lead to individuals living alone, is not known. However, previous studies have shown increased risky behaviour amongst those widowed or divorced (Kharicha et al., 2007), indicating that there is some interaction between the risk factors. Therefore, although more studies are needed to assess how co-living prevents fire mortality on an individual level, the results from this study strengthen the hypothesis that co-living is an important factor in protecting against fire mortality on a national level.

Regardless of how co-living protects against fire mortality, it is clear that a strong correlation exists. As mentioned in the background, one of the main causes of countries encouraging elderly to continue to live at home and receive home care rather than live in institutional care, were the financial aspects and also the shift in ideology with an increased focus on the empowerment and responsibility of the older person. Stricter eligibility criteria in order to be placed in nursing home were also implemented, largely from a cost-cutting perspective and a general transition towards neoliberal solutions, increasing the accessibility to buy services from the market. As such, there has overall been an increasing emphasis on informal care for older people (Da Roit, 2010). However, parallel to this development, the norm of older generations living with their children has lessened (Iacovou, 2000), meaning that whilst the responsibility of care has shifted towards informal care, this has not led to an increased co-living with younger generations.

Although specific policy processes have affected the living arrangement across Europe, changes it is also a consequence of an ideological shift where increased focus is placed on the older persons autonomy and independency. Also, studies have shown that older individuals want to stay in their own home (De Jong Gierveld & Van Tilburg, 1999) and a decrease in multigenerational households (Fernandez-Carro, 2016). These parallel processes, in which the state strives after older people to continue to live at home rather than institutional care, a decrease in multigenerational households and older people wanting to be independent, indicates that the number of older people living alone will likely continue to increase. As a consequence, as this study shows, it is likely that European fire mortality rates will increase considerably, almost doubling with a ten percentage point increase in older adults living alone.

Although steps have been taken to ascertain a soundness of the results in this study, there are some limitations that need to be taken into consideration. Firstly, all data used for this study are from secondary sources. Whilst the data sources are commonly used in research and considerable steps have been taken to ensure reliability, the authors of this study have had no possibility of controlling the data collection. In cross-country comparisons, there is always a possibility that differences in data collection procedures and definitions between countries may explain part of the correlations that we observe. However, it seems implausible that this could explain the entirety of the country-level correlation given that living alone is one of the

strongest observed risk factors for fire mortality observed also in individual case-control studies (Jonsson & Jaldell, 2018).

Secondly, the living arrangement and mortality data differ slightly both in terms of time periods and age groups, which may introduce some bias into the estimates. The differing age groups were due to data availability issues, whereas the difference in time periods was a design choice on our part to increase the precision of the estimates by allowing for more years of outcome data (sensitivity analyses using outcome data for 2010-2014 produce similar results; available upon request). Another potential issue is that unmeasured confounders may explain the observed relationship, as discussed above. For instance, indoor smoking in combination with alcohol and drug abuse are strong risk factors for fatal fires, but we were unable to collect age-specific data on these factors for the included countries. Even so, these factors, along with other negative effects of loneliness on health, may actually explain part of the hypothesised causal relationship between living alone and fire mortality, so it is not clear whether they should be adjusted for, even if they could be measured. Finally, it is important to point out that the estimates presented are intended to be interpreted at the country-level, and not for making individual-level inferences. Whilst some may argue that this is a weakness, these ecological estimates, given that they are indeed valid, provide additional context to the public health implications of the problem that is hard to capture in individual-level case-control studies.

5. Conclusions

Our results indicate that the share of older people co-living is an important determinant for low fire mortality rates on a national, European level. These results are worrisome given the ongoing care system transformations in European countries, where older people increasingly live alone and receive homecare rather than institutional care, alongside a process of decreasing multigenerational living arrangements. If the percentage of individuals living alone continues to increase, it would seem likely that fire mortality rates amongst older people in Europe will increase in the future unless effective countermeasures are implemented.

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Appendix

Table A 1. Correlation matrix for covariates (n = 256 municipalities with complete data).

	Share living alone, 65+ years (%)	Fall injury incidence (hospital admissions per 100.000 person-years).	Share of applications with longer than 90 days wait time (nursing homes) (%)	Gross regional product (GRP) per capita	Dependency ratio (ratio of inhabitants 0-19 years and 65+ to 20-64 years, logged)	Share living in nursing homes, 65+ years (%)	Share with home care service, 65+ years (%)	Rescue service response time (median)	Share living in urban areas (%)	Population density (inhabitants per 1000 km^2, logged)
Share living alone, 65+ years (%)	1									
Fall injury incidence (hospital admissions per 100.000 person-years).	0.4665	1								
Share of applications with longer than 90 days wait time (nursing homes) (%)	-0.0688	-0.0507	1							
Gross regional product (GRP) per capita	0.3642	0.2714	-0.0264	1						
Dependency ratio (ratio of inhabitants 0-19 years and 65+ to 20-64 years, logged)	0.0355	-0.0262	-0.102	-0.4621	1					
Share living in nursing homes, 65+ years (%)	0.4506	0.2679	-0.1611	0.098	0.267	1				
Share with home care service, 65+ years (%)	0.4206	0.2346	-0.0238	0.1997	0.0504	0.1188	1			
Rescue service response time (median)	0.2253	0.1821	-0.1308	-0.1954	0.5039	0.3841	0.0444	1		
Share living in urban areas (%)	-0.1009	0.0712	0.2009	0.3214	-0.6052	-0.2838	-0.0536	-0.6255	1	
Population density (inhabitants per 1000 km^2, logged)	-0.2926	-0.1103	0.0958	0.215	-0.6561	-0.4606	-0.1039	-0.6936	0.7348	1

Bilaga 4.

RAPPORT

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Tekniska och digitala hjälpmedel som skyddsfaktorer för dödsfall i bostadsbränder

Problematiken med dödsbränder bland äldre är högaktuellt i dagens Sverige, men förutsatt att de demografiska framtidsscenarierna är korrekta, kommer problematiken öka i framtiden. Även om problematiken kring dödsfall i bostäder kan betraktas som ett symtom på en större samhällsproblematik som kräver samarbete mellan olika aktörer (hemtjänst, socialtjänst, räddningstjänst, m fl.) och ett helhetsperspektiv kan nyutvecklade tekniska och digitala hjälpmedel vara av stor vikt.

För att öka tryggheten generellt bland äldre används idag flertalet tekniska och digitala hjälpmedel. Ett exempel är Alvesta kommun som har satsat på att installera smart elektronik som trådlösa sensorer och kameror när de skulle bygga ut ett äldreboende. Flera andra kommuner använder sig av olika appar, larmtjänster och uppkopplade system för kommunikation och bevakning.

Bland äldre personer kan problem med demens eller nedsatt kognitiv förmåga medföra ett behov av påminnelsestöd av olika slag. Det kan handla om att se till att stänga av spis och kaffebryggare eller liknande rutiner i vardagen. Här finns t.ex. smart sensorteknik att ta till för att öka tryggheten i hemmet. Robotar spås användas allt mer som hjälpmedel i framtiden. Idag används robotar främst till repetitiva uppgifter i industrier men de kommer att ta allt mer plats i hemmet. Något som kan observeras idag är de allt mer avancerade robotdammsugare som kan scanna av rummet och precisera var dammsugning behövs. Robotar kommer att vara kopplade till begreppet IoT (Internet of Things) som beskriver teknik som kan uppfatta sin omvärld, kommunicera med den och situationsanpassa sitt beteende. Denna teknik kan öka möjligheten till att på riktigt individanpassa brandskyddet.

Artificiell Intelligens (AI) är en annan teknik på stark frammatch tack vare en ökning av tillgänglig beräkningskraft, stora datamängder och bättre algoritmer. Tekniken kan användas

för att övervaka en persons hälsa för att på ett tidigt stadie upptäcka till exempel minskat välmående eller förändringar i rörelsemönster och vardagliga rutiner.

Syfte och Metod

Denna rapport presenterar framtidsperspektivet i Brandforsk projektet (nr 202-171) ”Bostadsbränder och äldre personer – tvärvetenskapliga framgångsfaktorer för reducering av döda och svårt skadade”. Syftet med framtidsperspektivet är att genom en litteraturundersökning och omvärldsbevakning finna tekniska och digitala hjälpmedel som från en teoretisk ansats kan tänkas vara särskilt betydelsefulla som skyddsfaktorer för dödsfall i bostadsbränder.

En litteraturstudie har genomförts för att sammanställa områden där det i tidigare projekt observeras behov av skyddsfaktorer. Denna litteraturundersökning tillsammans med kunskap inhämtad från tidigare arbetspaket har bildat en grund för att genomföra omvärldsbevakningen.

Omvärldsbevakningen har utgått från RISE kompetensområden; E-hälsa, Digitalisering, Preventiv hälsa, Artificiell intelligens och Life science. Denna omvärldsbevakning har kompletterats genom att följa idé- och innovationstävling för framtidens brandsäkerhet ”Brinnovation”[2]. Forskaren har också deltagit på ett nätverksmöte mellan forskare, innovatörer och slutanvändare med fokus på ”Tekniken – människans bästa vän för färre olyckor” som anordnades av Winguard[3] samt sökt efter innovationer med sökmotorn Google.

Resultat och diskussion

Runefors (2016) beskriver hur olika skyddsbarriärer kan stoppa det händelseförlopp som leder till en dödsbrand. Författarna delar upp skyddsbarriärerna i fem olika kategorier. Omvärldsbevakningen har utgått från att hitta tekniska och digitala skyddsfaktorer kopplat till dessa olika kategorier. Inom projektet har samboende identifierats som ytterligare en kategori där skyddsfaktorer kan existera. De olika kategorierna är:

1. Förebygga ej önskad värmeutveckling.
2. Förebygga antändning.
3. Förebygga brandspridning.
4. Teknik som kan hjälpa personen att lyckats utrymma.
5. Teknik kopplat till skyddsfaktorn ”Samboende”.

[2] https://www.brinnovation.se/
[3] https://winguard.se/

1. Teknik som förbygger ej önskad värmeutveckling

Vält lampa har orsakat oönskad värmeutveckling och startat bränder som lett till dödsfall. Redan idag finns teknik som skyddar mot dessa typer av oönskad värmeutveckling. De traditionella glödlamporna är sedan 2012 förbjudna att använda och har istället ersatts av lågenergialternativ, t.ex. halogen och LED-lampor (Andersson P. , 2018).

Många dödsbränder uppstår också på grund av elfel, antingen i bostadens elsystem eller i elektriska produkter (Runefors, Johansson, & van Hees, 2016). På nybyggda hus från år 2000 är det krav på jordfelsbrytare. Brytaren känner av om strömmen går fel väg och bryter innan någon skadas eller brand uppstår. Hur pass vanligt det är att det inte finns en jordfelsbrytare installerad när brand uppstår på grund av elfel har inte undersökts. Däremot finns det fältstudier som visar hur vanligt det är att jordfelsbrytare inte fungerar i praktiken (Arvidson, Larsson, Bergstrand, & Franzon, 2015). Ett tävlingsbidrag i innovationstävling Brinnovation har tagit fram en prototyp på en, enligt honom, intelligent jordfelsbrytare (Andersson B. , 2019). Uppfinnaren hävdar att denna uppfinning medför att spänning inte släpps ut om den inte har en inkopplad belastning. Detta ska förhindra att läckström uppstår som kan orsaka värmeutveckling.

En jordfelsbrytare kan inte förhindra är att värmeutveckling uppstår i produkten på grund av glappkontakt. Detta har en annan uppfinnare tagit fasta på och skapat en innovation för att minska risken för glappkontakt och överhettning i t.ex. adaptrar och skarvsladdar. Innovationen ”Allemanspluggen” sätts i stickkontakten och bryter strömmen vid för hög temperatur (Eek, 2019).

Batteriutveckling har gått mot allt högre energitätheter och längre livslängd. Idag finns det gott om produkter i bostaden som innehåller olika former av batterier. Batterier finns i konsumentprodukter som telefoner, datorer och leksaker, men det blir också allt vanligare med större batterier som laddas i bostaden som t.ex. Hoverboards, elsparkcyklar och elcyklar. Ytterligare tillkommer det att uttjänta batterier från elfordon installeras i byggnader för att användas som energilagring (Lönnermark, 2018). Lönnermark har kartlagt risker och forskningsbehov kring bland annat batterier som energilagring och redovisar en rad kunskapsluckor och forskningsbehov. Speciellt nämner författaren att det idag saknas kunskap kring totalriskerna för speciellt stora batterisystem, hur riskerna förändras vid åldring, hur batterilagring ska designas och installeras i byggnader och kunskap kring släckning av batterier.

2. Teknik som förebygger antändning

Textilier och stoppade möbler antänds av t.ex. cigaretter, elektriska produkter och levande ljus. För att förbygga risken för antändning används idag olika typer av flamskyddsmedel (Runefors, Johansson, & van Hees, 2016). I USA och Storbritannien har antalet dödsbränder

sjunkit kraftigt när de införde högre krav på antändlighet av stoppade möbler och madrasser. I Sverige finns enbart dessa krav på möbler i hotell eller offentliga lokaler (Andersson P. , 2018). Då många dödsbränder sker i sovrummet är det dock viktigt att alla typer av textilier flamskyddas, som kläder, nattkläder, lakan etc. (Runefors, Johansson, & van Hees, 2016). Olika material har lättare eller svårare att antändas och ett examensarbete visade att en inblandning av 5 % elastan medför att bomullstyg inte antänds av en cigarett (Andersson P. , 2018). Många flamskyddsmedel innehåller dock giftiga kemikalier som påverkar både miljö som hälsa.

Inom innovationstävlingen Brinnovation beskrivs en produkt (Lundström, 2019) som genom en kemisk process ska göra textilier svårantändliga. Metoden påstås vara helt miljövänlig och kan genomföra storskaligt.

Sedan flera år är självslocknande cigaretter ett krav på den europiska marknaden, i USA och i flera andra länder för att minska risken för att en cigarett antänder kläder. Flera studier från olika marknader visar dock att införandet av självslocknande cigaretter haft mycket begränsad eller ingen påverkan på antal omkomna vid bränder (Arvidson, Larsson, Bergstrand, & Franzon, 2015). Bedfirefighter (Ågren, 2019) är en innovation som ska minska risken för att den glödande änden av cigaretten inte kommer i direkt kontakt med kläder etc. Det funkar så att cigaretten placeras i en slagsnätbur vilket skapar en distans till tyget. Den ökade användningen av e-cigaretter skulle kunna minska antalet dödsbränder men det finns inga studier inom området.

Antändning på grund av levande ljus kan minskas med val av ljusstake, placering av ljuset, så kallade ljussläckare samt självslocknande ljus. Självslocknade ljus innebär att veken inte räcker ända ner till botten. Detta förhindrar dock inte att ljuset antänder material i närheten som t.ex. gardiner, vilket är det vanligaste antändningssättet (Andersson P. , 2018). En övergång till batteridrivna ljus skulle kunna eliminera möjligheten för antändning.

En vanlig brandorsak är bortglömd kokkärl på spis, men detta leder ofta inte till en dödsbrand. Men för att minska risken för att spisen ska orsaka en brand finns system som larmar eller bryter strömmen till spisen om för hög värme uppstår, så kallade spisvakter. Påminnelsestöd kan användas på flera sätt. I ett boende har elektroniskt påminnelsestöd installerats precis vid lägenhetsdörren. Denna larmar som spis eller kaffebryggare inte är avstängda. Personalen på boendet får också information på sina smartphones eller datorer (RISE, Tryggare boende när sensorer och e-tillsyn kompletterar händer - pilotprojekt, 2019).

Risken för antändning kan också minskas genom att placera potentiella antändare så att risken för brandspridning minskar. Detta har LADDBOX (Kihlström, 2019) tagit fasta på och lyft fram i tävlingen Brinnovation. Det en produkt där mobiltelefoner och pekplattor kan förvaras brandsäkert vid laddning. Produkten är i dagsläget inte testad om den kan motstå energiutvecklingen som bildas om en mobiltelefon eller pekplatta skulle börja brinna.

3. Teknik som förebygger brandspridning

Om boendesprinkler skulle installeras i alla bostadshus så visar forskning att dödsfallen kan potentiellt minskas med 70 % (Andersson P. , 2018). Boendesprinkler är dock dyra att installera och i dagsläget är det inte samhällsekonomiskt hållbart att installera dessa i samtliga hushåll. Ett alternativ till boendesprinkler är mobila sprinklersystem som idag används för att öka brandsäkerheten för vissa riskgrupper. Dessa system är flyttbara och kan därför placeras i rummet med den största brandrisken, t.ex. i sovrummet.

För att utvärdera släckeffektiviteten för olika sorters sprinklersystem genomfördes försök med brand i en stoppad fåtölj (Arvidson, 2017) Sprinklersystem som användas i försöken var:

- Boendesprinkler där flödet varierades mellan 30,3 l/min och 60,6 l/min och aktiveringstemperatur varierades mellan 68 °C och 74 °C.
- Vattendimsystem där flödet varierades mellan 17,2 l/min till 36,7 l/min.
- Mobilt sprinklersystem med flöde 8,2 l/min.

Resultatet från försöken visade att vattendimsystem inklusive det mobila sprinklersystemet gav en mer dämpad brand och lägre gastemperatur jämfört med boendesprinkler. Resultaten antydde dock att placeringen av det mobila vattensprinklersystemet var mycket viktigt för resultatet, vilket är negativt ur praktisk användbarhet. Resultatet indikerade även att en person i direkt närhet av branden troligtvis in skulle överlevt, oavsett system.

Genom att ha stängda dörrar mellan rummen kan brandspridning fördröjas eller till och med förhindras. Om utrymmet där branden startar är tillslutet så kan syrereduktionen bli så pass kraftig att branden kvävs. Det finns dock inga garantier för att en stängd dörr i en brandcell förhindrar spridningen helt. Branden måste därför uppmärksammas så att utrymning kan ske i tid. Vidare hjälper inte en stängd dörr om branden startar i samma rum som personen befinner sig i.

4. Teknik som hjälp vid utrymning

Utrymning krävs om det inte går att förhindra brandspridning. För att lyckas utrymma behöver personen först och främst uppmärksamma branden. En fungerande brandvarnare räddar liv, men tyvärr är det alltför ofta så att batterierna inte byts. Nätanslutna brandvarnare är en potentiell lösning. Brandvarnare behöver också vara placerade så att de detekterar branden innan den hunnit växa sig alltför stor. Andersson (2018) argumenterar att brandvarnare bör placeras i varje sovrum och vardagsrum samt att de ska vara sammankopplade. Kvalitén på detektionsförmågan varierar också mellan olika fabrikat och en bättre marknadskontroll på brandvarnare rekommenderas (Andersson, o.a., 2018).

Det räcker inte med att brandvarnaren detekterar och varnar om personen inte har möjlighet att höra signalen. I många fall hör inte äldre personer den höga tonen. Forskning

kring hur olika personer uppmärksammar signaler finns, men kunskapen har inte implementerats i produktstandarden (Andersson P. , 2018). Det finns dock tillverkare som erbjuder brandvarnare med låg ton, blinkande ljud och vibratorplatta som placeras under huvudkudden. För äldre har forskning visat att enbart blinkande ljus inte uppmärksammas (NFPA, 2019).

Idag är det vanligt med dammsugarrobotar i hemmet, men i framtiden kommer robotar att lösa allt mer avancerade saker. Nästa generations robotar kommer vara mer självständiga, ha fler frihetsgrader och kunna kommunicera med omvärlden på ett annat sätt. Inom några år spås en kraftig ökning av kommersiella robotar i hemmet (Helge Aspnes, o.a., 2012). Dessa robotar skulle kunna vara programmerade för att väcka personerna i huset när brandvarnaren detekterar en brand.

Det räcker dock inte att personen uppmärksammar branden, den behöver också ha kapaciteten att utrymma. Tidigare forskning visar att både grannar, hemtjänst och räddningstjänsten räddar liv (Bilaga 1). Olika tekniska och digitala hjälpmedel som kan förkorta responstiderna för dessa grupper borde bidra till att minska risken för dödsfall på grund av brand. En innovation som var med i tävlingen Brinnovation har tagit fasta på att grannar kan hjälpa till med utrymning (Hubsch, Svehagen, & Bräne, 2019). Det handlar om ett brandlarm med digital grannsamverkan där grannar blir larmade via sin telefon när brandlarmet går. Tekniken finns redan, det är de juridiska och praktiska aspekterna som behöver lösas.

I vissa kommuner har hemtjänstpersonal en lösning med nyckelfria lås för att förenkla processen med nyckelhantering (Herlitz, 2019). Denna tekniken borde kunna användas av säkerhetsbolag eller räddningstjänst för att förkorta responstiden och inte behöva bryta upp dörren.

Detektions- och responstid kan idag också förkortas genom att installera ett kombinerat inbrotts- och brandlarm via ett säkerhetsbolag. Säkerhetsoperatören kan via övervakningskameror identifiera om det brinner i huset och kan då direkt larma räddningstjänst. Hemtjänsten använder också övervakningskameror för att kunna genomföra tillsyn på natten utan att behöva gå in och störa brukaren. Detta tillsammans med GPS-larm menar personalen ökar tryggheten hos de äldre (Socialstyrelsen, 2019). Så kallad välfärdsteknik är något som regeringen satsat på och delat ut 11 miljoner till kommuner i Norrbotten för att t.ex. installera trygghetskameror i sovrum (Ek, 2019). Övervaknings- eller trygghetskameror borde också kunna användas av hemtjänstpersonal för att uppmärksamma brand.

Äldreboendet Solsidan i Alvesta kommun har i ett projekt installerat trådlösa sensorer, kameror, påminnelsesystem, nätuppkopplade tv-skärmar etc. i ett antal boenderum. Förutom dessa system finns det också installerat en nattstig som aktiveras när brukaren

stiger upp ur sängen. En belysning tänds utmed golvet för att minska risken för fallolyckor (RISE, Tryggare boende när sensorer och e-tillsyn kompletterar händer - pilotprojekt, 2019). I ett brandriskperspektiv skulle denna nattstig kunna användas för att hjälpa personen även vid utrymning. Boenderummen har även madrasser utrustade med sensorer som känner av när brukaren går upp ur sängen. Dessa sensorer skulle kunna användas för att dels känna av värmeutveckling i madrassen eller uppmärksamma personen på brand.

Forskning har visat att det finns stor potential att komplettera räddningsaktörerna med semi-professionella aktörer som t.ex. väktare, hemtjänstpersonal, vaktmästare och personal som arbetar hos räddningstjänsten dagtid. Genom att använda denna personal kan responstiden minskas ytterligare. Resurser som behövs för att kunna nyttja denna personal är tillgång till första hjälpen utrustning, handbrandsläckare och IT support för att kunna ta emot larm. Vidare finns det behov av enklare träning i att genomföra riskbedömning, att släcka brand samt att ge första hjälpen. De största utmaningarna är organisatoriska, ekonomiska, juridiska och hur hantering av försäkringar ska ske (Yousefi Mojir, Pileman, & Andersson Granberg, 2018).

Ytterligare en idé som framkom under innovationstävlingen Brinnovation var att montera en lans på en handbrandsläckaren. På detta sätt görs det möjligt att släcka branden från utsidan och därmed minska risken för semi-professionella. Om detta skulle öka förutsättningarna för att snabbare kunna undsätta en drabbad är inte utrett.

5. Samboende

Det är inte utrett varför samboende är en positiv skyddsfaktor vid dödsbrand. Två eller fler personer borde dock öka förmågan att detektera och uppmärksamma brand. Personerna kan också hjälpa varandra att utrymma samt i det förebyggande arbetet öka chansen till att risker uppmärksammas. En äldre person har ofta nedsatt syn vilket medför att risksituationer blir svårare att uppfatta. Den reducerade rörligheten medför också långsammare reaktioner, svårt att få upp dörrar, minskad förmåga att använda handbrandsläckare och svårigheter att utrymma med rullator eller rullstol (Storesund, o.a., 2015). Att vara samboende ökar möjligheten till att få stöttning och hjälp med dessa saker. Nedan nämns tekniska och digitala hjälpmedel som skulle kunna vara jämförbar med de skyddsfaktorer som innefattas av att vara samboende.

En samboende kan i ett tidigt skede uppmärksamma ett avvikande beteende hos sin sambo. En digital lösning för detta kan hjälpa personen själv eller hemtjänstpersonal att uppmärksamma avvikande beteende. Ett mycket större problem än brand är antalet fallolyckor som medför att äldre skadar sig och till och med avlider har uppmärksammats av forskare på RISE. Forskarna har utvecklat en metod som tidigt kan upptäcka när en person löper risk att falla. Lösningen baseras på sensorer i kombination med en mobilapp och

utbildningsprogram för vårdpersonal (RISE, Färre fallolyckor med modern teknik, 2019). Skulle en likande app observera brandrelaterat riskbeteende?

Det finns även andra produkter kopplat till AI-teknik som kan registrera avvikande beteende. Produkten kan t.ex. lära sig när en person brukar gå och lägga sig, när denne äter eller borstar tänderna. När något avviker från de normala rutinerna varnar den per automatik (Wall & Domaradzki, 2019).

Att gå runt med sensorer kopplade till sin kropp kan väcka ett obehag och vara obekvämt. Projektet WEARITMED är ett pågående projekt som RISE driver tillsammans med Sahlgrenska Universitetssjukhuset och Borås Högskola och handlar om att samla in data om patienten genom att integrera sensorer i kläder. Patienterna upplever det mer positivt att gå runt med ett klädesplagg istället för att gå runt med flera olika sensorsystem som är fullt synliga. Vidare är det enklare att få kontroll över placeringen av sensorerna på kroppen (RISE, Sensortröjan håller koll på hälsan, 2019).

Ikeas materialutvecklare Linda Worbin berättar i podden ”Materialperspektivet (RISE p. , 2019)” om hur framtidens inredning ges liv genom att vara anpassningsbara till situationen, programmerbara och till och med visa känslor. Hon berättar om hur hon varit med och utvecklat två kuddar som kan prata med varandra. När hon kramade den ena kudden ändrade den andra kudden färg. Detta användas för att skicka meddelande till personen med den andra kudden att hon tänkte på denne. Kommer material och kläder i framtiden att kunna prata med oss och i tidigt upptäcka bränder?

Idag finns det en prototyp på en robot vars syfte är att hjälpa personer med demens (Adolfsson, 2019). Roboten är skapad av forskare vid Washington State University (WSU) och använder sensorer för att kunna avgöra var personen är, vad denne gör och när personen behöver hjälp. Roboten använder sig av videoinstruktioner för att till exempel påminna om medicinering eller mellanmål. Den kan också leda personen till olika ställen. Det är kombinationen av en rörlig robot och detekteringsteknik som är inbyggd i lägenheten som möjliggör detta. För att öka kunskapen kring hur vårdrobotar kan användas i vården pågår nu forskningsprojektet Orient. Projektet ska kartlägga vilken kunskap och inställning som olika grupper har till vårdrobotar (Ryltenius, 2019).

Att vara frisk, ha god hälsa och vara rörlig är skyddsfaktorer för att minska risken för att omkomma i brand. Virtual Reality (VR) har visat ge god effekt på äldres hälsa och olika studier och forskningsrapporter kring VR/AR har sammanställts av kunskapsportalen Immersivt[4]. Kopplat till äldresäkerhet har VR-tekniken visat sig vara ett sätt att motverka isolering genom att introducera nya upplevelser som t.ex. en lugn kanotfärd nedför en flod. Patienterna tycktes blommade upp efter upplevelsen. Ett annat sätt som visat sig kunna

[4] https://www.immersivt.se/vr-i-aldreomsorgen-aldrevarden/

bryta isolering och göra vardagen lite mer färggrann är att introducera nya appar som t.ex. Snapchat.

Att träna med VR har kan också minska risken för fallolyckor. I en studie finansierad av europeiska kommissionen fick 300 personer gå på löpband, tre gånger i veckan under sex månader. Hälften av de vuxna fick använda VR-utrustning och minskning av fallolyckor var mycket större än hos gruppen som enbart gick på löpband. VR-träningen bidrog med möjligheten att träna både rörlighet- och gåträning samt öva upp den kognitiva förmågan på samma gång (Lord, 2016).

Ett annat sätt att öka välmående är användning av robothusdjur, så kallade terapidjur. På Gotland har robotkatter köpts in till flera boenden och när patienten rör katten så kan den spinna, blinka med ögonen, vrida på huvudet, lägga sig på mage med mera. Katten har till och med ett konstgjort hjärta och har gjort stor succé på boenden (Sveds, 2019). Även några äldreboende i Höörs kommun har köpt in tekniken med positiva resultat (Fritsch Lärka, 2019).

Ytterligare sätt att hålla sig frisk är att röra på sig. Det finns en mängd olika träningsappar som kan användas för att öka motivationen till att träna. Försäkringsbolaget Länsförsäkringar har tillsammans med forskare från RISE tagit fram en app som fick fler människor att resa sig från soffan än utan appen (Sandberg, 2019).

Slutsats

De tre första kategorierna som diskuteras ovan handlar om att förebygga brand eller brandspridning. Inom detta område finns teknik som om den hade använts på ett optimalt sätt minskat dödsbränderna. Det handlar dels om att ha fungerande brandvarnare som har en signal som kan uppmärksammas av alla och dels om sprinklersystem som snabbt kan dämpa eller kontrollera branden. För att brand överhuvudtaget inte ska uppstå behöves hårdare kontroller så att produkterna som säljs på marknaden är tillräckligt säkra. Det kan också diskuteras om behovet av hårdare krav på vissa produkter som är särskilt viktiga som skyddsfaktorer. Adaptrar ska t.ex. redan idag ha inbyggda säkerhetssystem som gör att oönskad värmeutveckling inte ska kunna ske. Trots detta uppstår bränder på grund av dessa. Hårdare reglering så att elprodukter som inte uppfyller kraven kan släppas in på marknaden eller inbyggda säkerhetslösningar i eluttagen ses som en väg framåt. Nya brandrisker har dock tillkommit i form av att bostäderna kommer ha tillgång till allt fler produkter med batterier och energilagring i batterier. En helhetssyn kring vilka risker och hur dessa kan förebyggas krävs.

Flamskyddsmedel i textilier, kläder, möbler och madrasser skulle minska risken för antändning, men med tanke på miljö och hälsa är det frågan om detta är något som konsumenterna vill ha. I framtiden kommer kanske både kläder och möbler att ha inbyggda

sensorer som kan har multipla användningsområden. Sensorerna kan observera vår hälsa, säga till när de behöver tvättas samt göra det lättare att återvinna. Vidare skulle sensorerna kunna aktivera någon typ av larm eller sprinklersystem om oönskad värmeutveckling skulle uppstå.

De två senare kategorierna som diskuteras ovan, skyddsfaktorer kopplat till utrymning och samboende har flertalet tekniska och digitala hjälpmedel identifierats som t.ex. övervakningskameror, nyckelfria lås och digitala påminnelsestöd. Forskning behövs för att undersöka hur den teknik som idag används i olika områden kan nyttjas för att höja brandskyddet för individen. Det krävs ett holistiskt synsätt där tekniska och digitala hjälpmedel som används inom andra områden också kan vara en skyddsfaktor för brand. Grannar, hemtjänst och räddningstjänst räddar idag liv, men forskning behövs hur larm- och respons kan förbättras.

I framtiden kommer robotar bli allt vanligare i hemmen och i och med den utvecklingen är det viktigt att ta med hur dessa kan användas för att förebygga, varna eller till och med genomföra släckförsök om det börjar brinna. Vidare är det viktigt att arbeta med preventiva åtgärder där ny teknik kan vid ett tidigt stadie upptäcka avvikande hälsa eller vara en hjälp vid rehabilitering.

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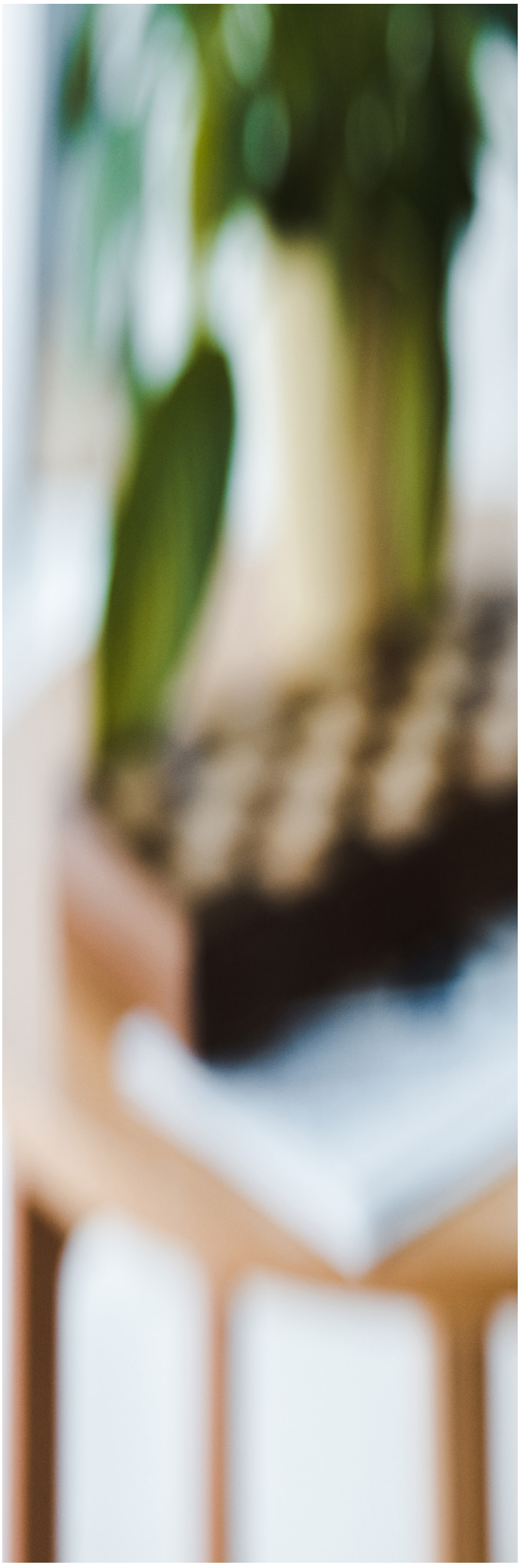

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