FINNISH PRETRIAL MALE FIRESETTERS: MORTALITY, SUICIDALITY, PSYCHOPATHY, AND MORBIDITY OF SCHIZOPHRENIA

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ACADEMIC DISSERTATION

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ABSTRACT

Objective: Fires cause extensive losses to society in terms of prematurely ended lives, burn injuries, and economic costs. Firesetters constitute a heterogeneous group, but some features have been found to be common, including a harsh childhood, frequent psychiatric and substance use disorder comorbidities, shyness, social incompetence, and impulsivity. Firesetters have also been described as more suicidal than other offenders. The mortality of firesetters has not earlier been compared with that of a matched control group from the general population. This study aimed to explore mortality rates and patterns among firesetters. Moreover, the study evaluated the number of those suicide attempts that were severe enough to require treatment in hospital. Psychopathy, a perilous disorder of personality, is common in criminal and forensic settings and is associated with crimes and violence. The study investigated whether firesetters engaging in different types of crime (versatile firesetters) or repeating their fire-setting behavior (fire-setting recidivists) show high rates of psychopathy. Violent behavior in youth has been described as part of a prodromal phase of schizophrenia, and the prevalence of schizophrenia spectrum disorders is high among firesetters. Therefore, the study also analyzed whether fire-setting among adolescents or young adults would predict onset of schizophrenia spectrum disorders.

Materials and methods: The firesetters were a consecutive sample of 441 pretrial men, who underwent a forensic psychiatric examination during 1973-1998 in Helsinki University Hospital. The control group consisted of date and place of birth- and gender-matched persons in a 4:1 relation to firesetters. The controls were obtained from the Population Information System. The follow-up began when the examination was completed and ended when the person died, moved abroad, or at the latest on 31.12.2012. The Causes of Death Register of Statistics Finland provided dates and causes of deaths. Information on treatment was obtained from the Care Register for Health Care of the National Institute for Health and Welfare. In one part of the study concerning psychopathy, a subgroup of firesetters that had been evaluated during 1989-1998 and comprised 135 men was used. Psychopathy traits were assessed
with PCL-R. In another part of the study, a subgroup consisting of 137 firesetters aged 15-25 years was used, excluding persons with past or current diagnoses of schizophrenia spectrum disorder. The study assessed how many had onset of schizophrenia spectrum disorder during follow-up.

**Results:** Nearly half, that is 48.0%, of firesetters and 22.0% of control subjects had died at the end of follow-up (OR 2.47, 95% CI 2.00-3.05, \( p < 0.001 \)). The firesetters died significantly younger, at an average age of 53.2 years, than the controls, whose average age at death was 61.6 years (\( t = 7.0350, p < 0.001 \)). Alcohol-related deaths due to somatic diseases or intoxications were more frequent among firesetters. Suicide was the cause of death among 8.0% of firesetters and 1.0% of controls (OR 8.87, 95% CI 4.91-15.99, \( p < 0.001 \)). Suicide attempts leading to hospital treatment were nearly 13 times more common among firesetters (OR 12.95, 95% CI 8.32-20.13, \( p < 0.001 \)). The suicide attempt method most often chosen in both groups was intentional self-poisoning or exposure to noxious substances. The versatile firesetters scored significantly higher on the PCL-R total and factor scores than the exclusive firesetters. No difference on PCL-R scores could be found between one-time and recidivist firesetters. In the last part of the study, 12.6% of firesetters and 1.1% of controls received a diagnosis of a schizophrenia spectrum disorder during follow-up (HR 12.5, 95% CI 4.49-35.65, \( p < 0.001 \)). The average delay of diagnosis from the fire-setting crime was 9.7 years (SD 7.9).

**Conclusions:** Fire-setting behavior was associated with a high mortality rate. Alcohol use causing drunkenness or somatic diseases contributed substantially to suicide attempts, completed suicides, and deaths overall. Antisocial pathways may be the motivator for versatile firesetters, showing significant traits of psychopathy. Fire-setting among youths should be taken seriously, as these individuals are prone to schizophrenia spectrum disorders and need long-term follow-up and evaluation for psychotic symptoms. Firesetters constitute a high-risk suicidal behavior group, which must be addressed when planning treatment and release.

esiintyvyyttä arvioitiin käyttäen PCL-R:ää. Toiseen osatutkimukseen valikoiti 137 mielentilatutkimuksen aikaan 15–25 vuotiasta, joilla ei ollut aikaisempaa tai senhetkistä skitsofreniaspektrin diagnoosia. Heidän osalta selvitettiin, kuinka suuri osa heistä sai skitsofreniaspektrin diagnoosin seurannan aikana.

**Tulokset:** Lähes puolet tuhopolttajista (48,0 %) ja 22,0 % verrokeista kuoli seurannan aikana (OR 2,47, 95 % CI 2,00–3,05, p<0,001). Tuhopolttajat kuolivat huomattavasti nuorempina, keskimäärin 53,2 vuotiaina, verrattuna verrokkeihin, jotka kuolivat keskimäärin 61,6 vuoden iässä (t=7,0350, p<0,001). Alkoholiin liittyvät somaattiset sairaudet tai myrkytystilat ja niistä johtuvat kuolemat olivat yleisempiä tuhopolttajilla. Kahdeksan prosenttia tuhopolttajista ja 1,0 % verrokeista kuoli itsemurhan kautta (OR 8,87, 95 % CI 4,91–15,99, p<0,001). Tuhopolttajat tekivät verrokkeihin nähden lähes 13 kertaa enemmän sairaalahoitoon johtavia itsemurhayrityksiä (OR 12,95, 95 % CI 8,32–20,13, p<0,001). Molemmissa ryhmissä tavallisin tapa yrittää itsemurhaa oli tahallinen itsensä vahingoittaminen myrkyllä tai muilla vahingollisilla aineilla. Monipuoliset rikolliset saivat pelkkiä tuhopolttoja tekeviin verrattuna merkittävästi enemmän kokonais- ja faktoripisteitä PCL-R:stä. Yhden tai useamman tulipalon sytyttäneet tuhopolttajat eivät merkittävästi eronneet toisistaan PCL-R pisteissä. Viimeisimmässä osatyössä 12,6 % tuhopolttajista ja 1,1 % verrokeista saivat skitsofreniaspektrin kuuluvan diagnoosin seurannan aikana (HR 12,5, 95 % CI 4,49–35,65, p<0,001). Keskimääräinen viive tulipalon sytyttämisestä diagnoosiin oli 9,7 vuotta (SD 7,9).

**Johtopäätökset:** Tulipalon syttyttäminen liittyi merkittävästi kokonneeseen kuolleisuuteen. Alkoholin aiheuttamilla humalatiloilla ja somaattisilla sairauksilla oli oleellinen vaikutus itsemurhayrityksiin, itsemurhiin ja yleiseen kuolleisuuteen. Niillä rikollisilla, jotka tuhopolttojen lisäksi tekevät muita rikoksia, oli merkittävästi enemmän psykopaattisia piirteitä ja heitä saattoi motivoiva antisosiaaliset syyt tulipalojen syttyämiseen. Nuorten tekemiin tuhopolttoihin on syytä suhtautua vakavasti ja nämä henkilöt tarvitsevat pitkän seurannan psykoottisten oireiden varalta. Tuhopolttajat ovat ryhmänä korkeassa itsemurhariskissä mikä on huomioitava hoitoa ja vapautusta suunnittelussa.
SAMMANDRAG


Institutet för hälsa och välfärd information angående vårdperioder. 

**Resultat:** Nästan hälften, 48,0 %, av brandanstiftarna och 22,0 % av kontrollpersonerna dog under uppföljningen (OR 2,47, 95 % CI 2,00–3,05, \( p<0,001 \)). Brandanstiftarna dog signifikant yngre, vid en ålder av 53,2 år, medan kontrollpersonerna dog i medeltal vid 61,6 års ålder (\( t=7,0350, p<0,001 \)). Alkoholrelaterade dödsfall pga somatiska sjukdomar eller förgiftningar, var mer allmänna bland brandanstiftarna. Hos 8,0 % av brandanstiftarna och 1,0 % av kontrollpersonerna var dödsorsaken självmord (OR 8,87, 95 % CI 4,91–15,99, \( p<0,001 \)). Brandanstiftarna var nästan 13 gånger mer benägna att göra självmordsförsök som ledde till sjukhusvård (OR 12,95, 95 % CI 8,32–20,13, \( p<0,001 \)). Den mest frekventa metoden för självmordsförsök i båda grupperna var en avsiktlig självdestructiv handling genom förgiftning eller exponering för skadliga substanser. De versatila brandanstiftarna hade signifikant högre PCL-R totala och faktorpoäng än de exklusiva. Studien visar ingen skillnad i PCL-R poäng mellan brandanstiftare som hade anlagt endast en brand och dem som anlagt flera bränder. I den sista delstudien fick 12,6 % av brandanstiftarna och 1,1 % av kontrollpersonerna en diagnos inom schizofrenispektrum under uppföljningen (HR 12,5, 95 % CI 4,49–35,65, \( p<0,001 \)). Diagnosen ställdes i medeltal 9,7 år (SD 7,9) efter branden ifråga.

**Slutsatser:** Anläggande av bränder var associerat till en hög mortalitet. Alkoholbruket bidrog till en betydande del av självmordsförsök, självmord och dödsfall överlag. Versatila brandanstiftare hade betydande drag av psykopati, vilket kan tyda på att deras motivation för att anlägga bränder har en antisocial grund. Ungdomar som anlägger bränder bör följas upp eftersom de har en förhöjd risk att insjukna i sjukdomar inom schizofrenispektrum. Uppföljningen bör vara långvarig och förekomsten av psykotiska symptom bör utvärderas kontinuerligt. Brandanstiftare utgör en grupp med hög självmordsrisk, vilket bör beaktas i vården och även då personen släpps fri.
The writing of this thesis has been very engaging and compelling. Luckily, the subject still feels as interesting and important as at the beginning. Performing this study has been rewarding in many ways, I have been acquainted with and learned about issues I would not have encountered otherwise and have met many talented and dedicated people. The study was conducted between 2012 and 2016 at the Doctoral School of Health Sciences of the University of Helsinki.

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Sipoo 20.7.2016

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LIST OF ORIGINAL PUBLICATIONS

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Some unpublished data are also presented.
# ABBREVIATIONS

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>5-HIAA</td>
<td>5-Hydroxyindoleacetic acid</td>
</tr>
<tr>
<td>ADHD</td>
<td>Attention deficit/hyperactivity disorder</td>
</tr>
<tr>
<td>AOR</td>
<td>Adjusted odds ratio</td>
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<tr>
<td>CBT</td>
<td>Cognitive behavioral therapy</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence interval</td>
</tr>
<tr>
<td>CNS</td>
<td>Central nervous system</td>
</tr>
<tr>
<td>DSM-I</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 1st edition</td>
</tr>
<tr>
<td>DSM-II</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 2nd edition</td>
</tr>
<tr>
<td>DSM-III</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 3rd edition</td>
</tr>
<tr>
<td>DSM-IIIR</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 3rd edition, revised</td>
</tr>
<tr>
<td>DSM-IV</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 4th edition</td>
</tr>
<tr>
<td>DSM-5</td>
<td>Diagnostic and Statistical Manual of Mental Disorders, 5th edition</td>
</tr>
<tr>
<td>FIPP</td>
<td>Firesetting Intervention Programme for Prisoners</td>
</tr>
<tr>
<td>FBI</td>
<td>Federal Bureau of Investigation</td>
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<tr>
<td>FSE</td>
<td>Fire safety education</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross domestic product</td>
</tr>
<tr>
<td>HR</td>
<td>Hazard ratio</td>
</tr>
<tr>
<td>HTR2B</td>
<td>5-Hydroxytryptophan receptor 2B</td>
</tr>
<tr>
<td>ICD-6</td>
<td>International Classification of Diseases, 6th revision</td>
</tr>
<tr>
<td>ICD-8</td>
<td>International Classification of Diseases, 8th revision</td>
</tr>
<tr>
<td>ICD-9</td>
<td>International Statistical Classification of Diseases and Related Health Problems, 9th revision</td>
</tr>
<tr>
<td>ICD-10</td>
<td>International Statistical Classification of Diseases and Related Health Problems, 10th revision</td>
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<tr>
<td>IQ</td>
<td>Intelligence quotient</td>
</tr>
<tr>
<td>MAOA</td>
<td>Monomamine oxidase A</td>
</tr>
<tr>
<td>M-TTAF</td>
<td>Multi-Trajectory Theory of Adult Firesetting</td>
</tr>
<tr>
<td>OR</td>
<td>Odds ratio</td>
</tr>
<tr>
<td>PCL-R</td>
<td>Psychopathy Checklist Revised</td>
</tr>
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Introduction

SCH  Broadly defined schizophrenia, including schizoaffective disorder
SD    Standard deviation
SSRI   Selective serotonin reuptake inhibitor
TAU   Treatment as usual
WHO  World Health Organization
1 INTRODUCTION

Fire is one of the classical elements described in early cultures. Historically, it has been an important part of human culture and religion. As humans learned to master fire, it made cooking, heating, and controlled combustion possible (Goudsblom 1986). Today, unwanted fire-setting behavior is very troublesome and expensive for society. Every year, thousands of humans are killed in fires and even more are injured. Additionally, all sorts of fires cause economic losses of about 1% of annual global gross domestic product (GDP) (The Geneva Association 2014).

When fire is loose and a building is burning, it is a spectacle that attracts attention. There are the flames, the heat, the alarm sounds of Rescue Services arriving, in short the chaos. Fires fascinate and scare us. Nowadays, we are dependent on combustion, but still, it represents a force that is difficult to control. Arson is a crime that attracts media and sells well. Behind the big sensational headlines is, however, often a human tragedy.

Children and adolescents light fires more commonly than adults. In 2012, minors in Finland lit about 400 fires requiring Rescue Services; about half of these fires were deliberate (Kekki 2014). The motivation is frequently curiosity or thrill seeking. In a Finnish thesis by Brita Somerkoski (2007), she assessed the occurrence of playing with fire among comprehensive school students. She found that until grade five, boys more often played with fire, but the difference between sexes decreased in puberty. Among eighth graders, 37% of boys and 25% of girls reported having played with fire. The derogatory attitudes of parents, the youngsters themselves, and authorities towards youngsters playing with fire and setting fires were worrying.

Studies show that a majority of teenaged boys have deliberately put something on fire, while girls do not seem to be involved in fire-setting to the same extent (Perrin-Wallqvist and Norlander 2003). Only a fraction continues starting fires later on, while the vast majority ceases these dangerous experiments
by late adolescence. Among adult firesetters, males dominate as well (Hoertel et al. 2011).

The incidence of arson in Finland increased nearly tenfold between 1965 and 1991 (Räsänen 1995). The increase appears to have continued over the last two decades. Mäkelä and Laitinen (2008) found that in 1999 about 15% of all fires were deliberate, and in 2005 they noted that about 18% of all fires belonged to this category. They elaborated on possible reasons and concluded that one explanation may be that figures produced by authorities have become more accurate. Another reason that people report fires to authorities more often may be that mobile phones have become common or ineptitude of people today with fires (Rescue Services have been alerted to fires that they have put out with half a bottle of water). Further, Mäkelä and Laitinen discussed political choices that may affect fire-setting frequencies. These include alcohol politics and making alcohol more easily accessible and decisions concerning mental health services and the significance of deinstitutionalization.

It is difficult to find statistics depicting the incidence of arson because the collection of statistics has differed over the years. Legally, arson is defined in The Criminal Code of Finland (39/1889) in Chapter 34 (578/1995), Endangerment, Section 1, Criminal mischief, together with causing an explosion or a flood (Ministry of Justice 2012). A firesetter can in addition to arson get sentenced for insurance fraud, murder, etc., depending on the nature and result of the fire. Hence, there is no distinct legal term to look for in criminal statistics when trying to define the commonness of fire-setting.

The act of fire-setting is easily performed, but the consequences can be unpredictable and devastating. It is, however, a matter that concerns society substantially and should be managed with attentiveness.
2 REVIEW OF THE LITERATURE

2.1 GENERAL ASPECTS OF FIRES

In 2014, there were about 14000 fires in Finland in which Rescue Services participated (Department for Rescue Services 2015). Human activity caused about half of these fires, which included building, wild, vehicle, and other fires (Ketola and Kokki 2015). Intentionally set fires constituted nearly 2000 fires, constituting 15% (building fires) to 67% (vehicle fires) of fires caused by human activity depending on the object set ablaze. An additional 600 fires were set where intent could not be determined (Ketola and Kokki 2015).

In Finland, the number of persons dying in fires has decreased in recent years, in part, due to legislative measures and improved fire safety (Kokki 2011). The average number of annual fire deaths for the last five years is 74 persons, the amount being 88 persons in 2014 (Ketola and Kokki 2015). This corresponds to 16 deaths per million inhabitants, which is a number lower than the world average, but still higher than for many Scandinavian and Western countries (Brushlinsky et al. 2015). Interestingly, Rescue Services in Finland have saved or evacuated most human lives from fires taking place early Saturday morning, between 2 and 6 am. The majority of the deceased were men and under the influence of alcohol (Ketola and Kokki 2015). Eighteen persons (20%) died in deliberate fires in Finland in 2014 (Nordstat 2015).

The number of persons injured in fires has been around 600 a year during the last years. On a global scale, it is estimated that in 2013, fire caused 73 000 – 146 000 deaths (Brushlinsky et al. 2015).

The direct economic losses due to fires in Finland have been estimated at 0.17% of GDP and indirect losses at 0.011% of GDP (Brushlinsky et al. 2015). Costs in addition to these include fire department services, maintaining fire codes in buildings, and fire insurance.
2.2 PYROMANIA AND FIRE-SETTING

Literature on fire-setting behavior in the 19th century has focused on descriptive case reports. Already at the beginning of the 1800s, Henke elaborated on the concept of “arson urge and pyromania” (Andrews 2010; Lewis and Yarnell 1951), and he was not the first. Platner, among others, had observed an “internal voice” among insane incendiaries and a delight in watching fires typical among imbeciles (Andrews 2010). Marc coined the phrase “monomanie incediere”, referring to pathological firesetters in 1833 (Geller 1992a). Esquirol described instinctive monomania as the expression of an irresistible impulse in 1838. Meckel and Prichard were among the first to suggest that fire-setting might be the main symptom of a distinct mental disorder and Prichard used the term “instinctive madness” (Prichard 1842; Andrews 2010). It was, at this time, generally thought that the typical person to start fires was a pubertal, mentally retarded girl with abnormal psychosexual development and menstrual problems (Lewis and Yarnell 1951).

In Europe and America, there was during the 19th century an intense debate whether the entity pyromania existed and what it implied. Some argued that pyromania was “a distinct type of impulsive or instinctive mania”, while others were of the opinion that it was “an artificial contrivance” (Geller 1992a). One argument for not accepting pyromania as a real psychiatric disorder was that it would allow criminals to get away with arson unpunished. Historically, arson had been harshly punished (Davis and Lauber 1999) so it was controversial to think that lighting fires was caused by a mental illness, making the perpetrator not fully or not at all answerable for his or her actions.

2.2.1 TERMINOLOGY
The terms pyromania, arson, and fire-setting have sometimes been used interchangeably. However, there are some distinctions; pyromania is a psychiatric diagnosis, which is nowadays classified among the habit and impulse disorders
(F63) within the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10) (World Health Organization 1992), which is used for diagnostics e.g. in Europe. These acts have, according to ICD-10, no clear rational motivation, generally harm the person’s own and other people’s interests, and are associated with impulses that the person experiences as uncontrollable. Pyromania, or pathological fire-setting (F63.1), is by definition characterized by “multiple acts of, or attempts at, setting fire to property or other objects, without apparent motive, and by a persistent preoccupation with subjects related to fire and burning”. The definition also states that the behavior is often associated with “feelings of increasing tension before the act and intense excitement immediately afterwards”. This definition excludes fire-setting in adults with antisocial personality disorder, alcohol or psychoactive substance intoxication, conduct disorders, organic mental disorders, or schizophrenia. An important aspect to assess is the absence of motive. Usual motives comprise financial reasons, strong emotions such as jealousy or hatred, crime concealment, making a personal or political statement, or curiosity (among children and adolescents).

Arson is a legal term and is often defined as an intentional destruction of property by fire for unlawful purposes. The legal definition of arson may vary somewhat depending on the country. For example, in the USA, the FBI’s Uniform Crime Reporting Program defines arson as “any willful or malicious burning or attempting to burn, with or without intent to defraud, a dwelling house, public building, motor vehicle or aircraft, personal property of another, etc.” (The Federal Bureau of Investigation 2013).

The term fire-setting does not necessarily imply criminal or malicious intent. In this thesis, I will use firesetter to describe a person setting objects intentionally on fire, not taking motive or other features of the person into account.

2.2.2 DIAGNOSIS OF PYROMANIA

In 1924, Wilhelm Stekel published a comprehensive study, where he provided a psychoanalytic interpretation of pyromania (Stekel
In 1924, Sigmund Freud elaborated on the psychoanalytic formulation focusing on a disordered psychosexual development to explain fire-setting behavior (Freud 1932). Freud theorized that fire had a symbolic relationship with the male sexual urge. He refined his theories by suggesting pyromaniacs to have a fixation on the phallic-urethral stage of psychosexual development. This, in turn, led some researchers to assume this was the reason for the behavior being more common among males. During the 20th century some researchers claimed that fire-setting was a substitute for masturbation (Horley and Bowlby 2011). The approach, which keeps pathological sexuality as the root of pyromania, has not been empirically verified (Hill et al. 1982; Quinsey et al. 1989).

Lewis and Yarnell (1951) were the first to depart from case reports by describing a larger group of firesetters and classifying them. They collected a sample consisting of 1626 firesetters, 1145 of whom were male aged 16 years or older. They found chiefly males committing arsons and concluded that the peak incidence was in late adolescence (17 years). As one of the groups lighting fires, they described the pyromaniacs, who did not have a clear motive, but the fire in itself was most important. In this group, they included tramps, persons working as volunteer firemen, and persons wanting to act as heroes discovering the fires. Persons describing “irresistible impulses” to set fires were also included in this group. However, Lewis and Yarnell cautioned the use and acceptance of pyromania for setting fires, as they pointed out that it is a term used too frequently and lightly by investigators, psychiatrists, and the offenders themselves as a convenient explanation for their behavior.

There are few studies during the last part of the 20th century or the 21st century where the diagnosis of pyromania has been explicitly made. In a Finnish study among 90 male arsonists, 12 fulfilled the diagnostic criteria for pyromania, but of these nine were intoxicated during the act of fire-setting, leaving three pure pyromaniacs (3.3%) (Lindberg et al. 2005). A Canadian study among 243 male firesetters in a secure psychiatric facility found one person (0.4%) fulfilling the diagnostic criteria of pyromania (Rice and Harris 1991). In a study in the UK among 38 female and 129 male firesetters, as many as 2.6-13.2% of the females and
20.9-32.6% of the males showed features of pyromania (Dickens et al. 2007), but diagnostic criteria of any kind were not applied.

Grant and Kim (2007) approached the subject from another point of view by studying specifically 21 subjects with lifetime pyromania. They found that the diagnosis resulted in profound distress and functional impairment. The slight majority of pyromaniacs had not committed arson, giving rise to the reflection that there are different levels of severity of pyromania, only some of which lead to arson. Consequently, the research on pyromania could benefit from being explored in settings other than prison or forensic, where the diagnosis is rare.

2.2.3 CLASSIFICATION OF PYROMANIA

The heated debates over the relevance of the term pyromania are reflected in how it has been classified in the Diagnostic and Statistical Manual of Mental Disorders (DSM), which is the main diagnostic tool in USA and often in research settings. In DSM-I (American Psychiatric Association 1952), pyromania was classified as an obsessive-compulsive reaction. The term disappeared altogether from DSM-II (American Psychiatric Association 1968). Pyromania was, however, re-introduced in DSM-III (American Psychiatric Association 1980) and DSM-III-R (American Psychiatric Association 1987) as “Disorders of Impulse, not elsewhere classified”. DSM-IV (American Psychiatric Association 1994) was developed in collaboration with ICD-10, and the diagnosis of pyromania was listed under “Impulse Control Disorders”. It was characterized as being preceded by a rise in tension before the behavior or when resisting the behavior and followed by pleasure, gratification, or relief of tension.

In the latest version, the DSM-5 (American Psychiatric Association 2013), pyromania is classified in the section “Disruptive, Impulse-Control, and Conduct Disorders”. In DSM-5, the emphasis of the disorder is on the impulsivity being related to the specific behavior of fire-setting that provides relief of inner tension. The inclusion of the diagnosis was not obvious, but was preceded by a debate whether sufficient evidence existed in
support of pyromania being a distinct disorder (Nanayakkara et al. 2015).

In the classification system of WHO, the ICD-6 (World Health Organization 1949) was the first version that had a section for mental disorders, but no mention of pyromania. The diagnosis of pyromania was introduced in ICD-9 (World Health Organization 1977), where it was located under “Disorders of Impulse Control, not elsewhere classified”. Accordingly, the diagnostic systems DSM and ICD have been rather uniform in their processing of pyromania, although it was recognized earlier in the DSM.

2.2.4 CHARACTERISTICS OF THE FIRESETTER

A typical firesetter does not exist, but some common features are described in the literature. They are often described as Caucasian (Ritchie and Huff 1999), male (Molnar et al. 1984; Räsänen et al. 1995), unemployed or having a low level of education (Ritchie and Huff 1999; Räsänen et al. 1996), and possessing a low intelligence quotient (IQ) (Rice and Harris 1991; Räsänen et al. 1994). Firesetters have been characterized by relationship problems with the opposite sex and other social problems (Dickens et al. 2007; Hurley and Monahan 1969; Ritchie and Huff 1999; Räsänen et al. 1996). Other common characteristics described are impulsivity (Dolan et al. 2002; Labree et al. 2010; Virkkunen et al. 1987), suicidality and engaging in self-harm (Räsänen et al. 1996), low socioeconomic background and unstable childhood (O’Sullivan and Kelleher 1987; Räsänen et al. 1995; Yesavage et al. 1983), and high prevalence of alcohol use disorders (O’Sullivan and Kelleher 1987; Puri et al. 1995; Repo et al. 1997a; Räsänen et al. 1995). Firesetters seem to have communicative problems and poor social skills, leading to attention-seeking acts (Fritzon et al. 2001). It is usual for firesetters to have experienced physical or sexual abuse (Hill et al. 1982; Jayaraman and Frazer 2006) and they often have histories of parental alcoholism or mental illness (Repo et al. 1997a; Repo and Virkkunen 1997a).

Mental disorders are generally prevalent as well, which I will describe further under Section 2.3 (Comorbidities). Compared with other mentally disordered offenders, mentally disordered
firesetters have been described to be more socially isolated, shyer, less likely to show physical aggressivity, and to have more extensive psychiatric and juvenile offending histories (Harris and Rice 1996). Yarnell (1940) studied 60 young firesetters and proposed an ego triad among juveniles, including fire-setting behavior, enuresis, and cruelty to animals. Later studies have linked this ego triad among youth to adult criminal behavior (Felthous and Bernard 1979; Wax and Haddox 1974), but some studies have not confirmed these findings (Faranda et al. 2007; Prentky and Carter 1984). Slavkin (2001) showed that young firesetters that were cruel towards animals were also more likely to engage in recidivistic fire-setting behavior. In that study, however, the presence of enuresis did not affect the recidivistic tendencies.

2.2.5 MOTIVES FOR FIRE-SETTING

Pyromania, as described in ICD-10, is rarely the only motivating factor behind arsons (Lindberg et al. 2005). In the classic study by Lewis and Yarnell (1951), they divided firesetters into five main groups: unintentional, delusional (e.g. psychosis), erotically motivated (traits of pyromania), revenge-motivated, and children who light fires. Inciardi (1970) suggested six categories motivating fire-setting: revenge, excitement, claiming insurance, vandalism, concealment of crime, and institutionalized firesetters. Jayaraman and Frazer (2006) concluded when studying 34 arsonists of both genders that the most common motives for younger ones were vandalism, a cry for help, and alcohol misuse. They concluded that alcohol could cause disinhibition, leading to anger and frustration, which in turn triggered arson. In their study, the most usual motive of fire-setting women was being rehoused, which differed from the most usual motive of men. A central motive for firesetters has constantly been shown to be revenge or jealousy (Coid et al. 1999; Ritchie and Huff 1999).

Harris and Rice (1996) examined 243 mentally disordered male firesetters and divided them into four groups. First, the psychotics, who were primarily motivated by delusions, second, the unassertives, whose motives were anger or vengeance. Third,
multi-firesetters, who were characterized by lengthy stays in institutions, where they most often lit their fires. The fourth group they named criminals and these persons were frequently diagnosed with a personality disorder.

The motives described for mentally disordered firesetters are quite similar as those for non-mentally disordered firesetters (Tyler and Gannon 2012), with some exceptions. Communicative arson, for example, was a preferred motive among mentally disordered (Geller 1992b) and vandalism among non-mentally disordered firesetters (Rix 1994) in two studies.

Burning churches is an attention-attracting phenomenon because of the status of churches as buildings of worship. Information on this subject is scarce. The motive can be ethnic conflicts or hatred (so-called hate crimes), where a whole community of people is attacked such as in the burning of black churches in USA (Soule and Van Dyke 1999). Other suggested motives are vandalism, burglary, crime concealment, insurance fraud, or delinquency (Bartkowski et al. 2002; Soule and Van Dyke 1999), i.e., the same motives as for other targets. No scientific studies have established devil worshipping to be a central motive. Still, for example, in Norway burning churches have been part of the black metal scene and appreciated by central figures in that music genre (Raudvere et al. 2015). In Finland, in March 2016 a fire had been set that consumed the church of Ylivieska. Before this, one of the most reputed arson cases of a church was that of the cathedral of Porvoo in 2006.

2.2.6 THEORIES OF FIRE-SETTING BEHAVIOR

The motive-based classifications of firesetters are somewhat troublesome since the perpetrators report their motives retrospectively, after being caught. Additionally, they might report several motives or none at all (Davis and Lauber 1999; O´Sullivan and Kelleher 1987). Therefore, other theoretical approaches have been developed for classifying firesetters.

Canter and Fritzon (1998) summarized four themes of arson: expressive arson aimed at a person (connected to anxiety and suicidality), expressive arson aimed at an object (connected to burning of symbolic buildings), instrumental arson aimed at a
person (connected to revenge), and instrumental arson directed at an object (connected to concealing a crime). This theoretical framework was tested among 189 Finnish (Häkkänen et al. 2004) and 65 British (Almond et al. 2005) firesetters and found to be useful in, for example, analyzing relationships between crime scene behaviors and personal offender characteristics.

Gannon et al. (2012) has outlined the latest theoretical framework for adult fire-setting in their Multi-Trajectory Theory of Adult Firesetting (M-TTAF). They outline some developmental circumstances that interact with psychological vulnerabilities, leading to critical risk factors predisposing to fire-setting behavior in response to a trigger. M-TTAF suggests five trajectories explaining fire-setting behavior:

1) Antisocial cognition is characterized by individuals not particularly interested in fire, but leading a criminal life, often exhibiting antisocial behaviors. This trajectory is dominated by males.

2) The grievance trajectory is driven by anger and aggression and a wish for revenge or retribution. These firesetters are not interested in the fire itself, but rather have discovered that fire is a powerful tool. Firesetters acting in this trajectory represent both genders equally.

3) Fire interest is the motivating factor for males and females genuinely interested in fire or the circumstances that fire causes. Fire can also be used as a coping mechanism to mask difficult external or internal problems.

4) The fourth trajectory is divided into two subgroups: emotionally expressive and need for recognition. Emotionally expressive firesetters are impulsive and have poor problem-solving skills, making fire-setting a means of communicating their needs. Among female firesetters with borderline personality disorder, fire can be used for self-harm or suicide. Firesetters driven by a need for recognition are theorized to have social skill problems, leading them to plan and set fires in order to play the hero and get noticed in a dramatic way.

5) The multi-faceted trajectory holds predominantly males; these men are interested in fires and have pro-criminal attitudes. They are likely to have problems with social skills and communication. This group consists of offenders likely to
commit many crimes, including multiple fire-settings. They differ from persons acting in the fire interest trajectory in that they use fire as a means for their antisocial goals.

M-TTAF need further evaluation in clinical practice and research, but offers at the moment the most comprehensive theoretical background to fire-setting behavior.

2.2.7 PREVALENCE OF PYROMANIA AND FIRE-SETTING

Most of the published studies have dealt with apprehended arsonists, among whom pyromania seems to be infrequent, so it is difficult to appreciate the prevalence of pyromania among all firesetters. Grant and Kim (2007) hypothesize that the frequency of pyromania might be higher among the general population as there appears to be different levels of severity of pyromania, only some of which cause arsons. In a study among 31 depressed inpatients, 9.7% were diagnosed with pyromania (Lejoyeux et al. 2002). Among 204 adult psychiatric inpatients, 5.9% had a lifetime diagnosis of pyromania (Grant et al. 2005) and in a similar study among 102 adolescent psychiatric inpatients, 6.9% had a current diagnosis of pyromania (Grant et al. 2007). Odlaug and Grant (2010) screened 791 college students for impulse control disorders and found that the lifetime rate of pyromania was 1% for both genders.

There are some estimates on the prevalence of fire-setting behavior in the general population. Blanco et al. (2010) studied over 43 000 persons from the general population and found an overall lifetime prevalence of 1.13% in the USA. When they excluded persons with a comorbid antisocial personality disorder, the prevalence decreased to 0.55%. Fire-setting was found to be significantly more common among males (OR 5.1, 95% CI 3.8-6.8). In a recent study from the UK (Barrowcliffe and Gannon 2015) among un-apprehended firesetters, the prevalence of fire-setting was found to be 17.8%, with females predominating (62.5%). This was an internet-based anonymous questionnaire, which might offer the participants more courage to reveal their fire-setting behavior, but at the same time the gender distribution was skewed with a much higher proportion of females (89%).
2.3 COMORBIDITIES

The frequency of comorbidities among firesetters is a complicated matter to resolve. Firstly, most firesetters are never apprehended. Secondly, research has often focused on prisoners or inpatients, who constitute a heterogeneous group and probably represent the most psychologically disturbed cases. Thirdly, the terminology varies between studies, hindering comparisons.

Generally, fire-setting has been associated with several psychiatric disorders such as psychotic disorders (Anwar et al. 2011; Ducat et al. 2013b; Geller 1987; Lindberg et al. 2005; O´Sullivan and Kelleher 1987; Ritchie and Huff 1999), antisocial or borderline personality disorders (Ciardha et al. 2015; Geller 1987; Lindberg et al. 2005; Vaughn et al. 2010), substance use disorders (Boden et al. 2013; Ducat et al. 2013b; Enayati et al. 2008; Jayaraman and Frazer 2006; Vaughn et al. 2010), bipolar disorder or mania (Geller 1987; Grant and Kim 2007), mood and anxiety disorders (Ducat et al. 2013b; Geller 1987; Grant and Kim 2007; Lindberg et al. 2005; Ritchie and Huff 1999), and impulsivity (Dolan et al. 2002; Labree et al. 2010; Virkkunen et al. 1987). Additionally, there are studies reporting correlations with medical conditions such as intellectual disability (Alexander et al. 2015; Dickens et al. 2008; Geller 1987; Lewis and Yarnell 1951; Räsänen et al. 1995), chromosomal disorders (Klinefelter’s and XYY syndrome (Bartlett et al. 1968; Stochholm et al. 2012)), head traumas or other brain conditions (Carpenter and King 1989; Volavka et al. 1992; Witzel et al. 2015), and reactive hypoglycemia measured with the glucose tolerance test (Virkkunen 1984).

Blanco et al. (2010) discovered that 95% of their sample of 407 firesetters had a lifetime history of at least one psychiatric diagnosis (Axis I or II), compared with 53.4% of the individuals not reporting a fire-setting history (n=41 552), corresponding to an adjusted odds ratio (AOR) of 12.8 (95% CI 7.3-22.4). In both groups, the most prevalent disorder was an alcohol use disorder.
Common genes can affect comorbidities among mental disorders and substance use disorders (Nurnberger Jr. et al. 2004; Pickens et al. 1995) and offer one explanation.

Because arson repeatedly has been associated with mental disorders (Vinkers et al. 2011), many suggest that apprehended arsonists should be, along with offenders accused of murder or other serious violent crimes, evaluated by a forensic psychiatrist either pretrial or in prison (Ducat and Ogloff 2011). I will present the findings for the most central comorbidities.

2.3.1 PSYCHOSIS

Arson or fire-setting has been associated with schizophrenia and other psychotic disorders in several studies as stated above. Psychotic delusions or hallucinations can be the trigger for carrying out these horrendous acts (Lewis and Yarnell 1951). Psychotic firesetters seem to express less general criminality, but more often light fires as a response to e.g. situational crises (Lindberg et al. 2005) and might use fire as a means of suicide (Green et al. 2014). The motives seem to be similar to those of other firesetters (Virkkunen 1974), but revenge might be less common among psychotic firesetters (O’Sullivan and Kelleher 1987). In some studies, schizophrenic firesetters often set fires under the influence of psychiatric symptoms in addition to a motive like revenge (Geller 1987; Koson and Dvoskin 1982). Psychotic firesetters, in contrast to non-psychotics, are less likely to be diagnosed with a substance use disorder (Harris and Rice 1996) and are less often intoxicated at the time of the fire-setting (Dalhuisen et al. 2015).

The fires lit by psychotic persons can, however, be considered to be more dangerous since they often set fire to their own home or habituated buildings, posing more danger to people (Dalhuisen et al. 2015; Rix 1994).

Anwar et al. (2011) compared the prevalence of psychotic disorders between firesetters and community controls and found 8.1% vs. 0.7% to have a diagnosis of a psychotic disorder. The odds for having a diagnosis of schizophrenia were 20 times higher for male firesetters and almost 40 times higher for female firesetters than for controls. In a similar study in Australia, the
figures were 6.9% and 1%, respectively, for firesetters and community controls to be diagnosed with a psychotic disorder (Ducat et al. 2013b). In one Finnish study, the prevalence of schizophrenia or psychosis was 18% among arsonists and 4% among homicide offenders (Räsänen et al. 1995), and in another study among recidivist arsonists, 20% were diagnosed with a psychotic disorder (Lindberg et al. 2005). Among the general population in Finland, the lifetime prevalence of schizophrenia is estimated to be 0.9% (Perälä et al. 2007).

2.3.2 PERSONALITY DISORDERS
Personality disorders, especially borderline and antisocial personality disorders, are among the most common disorders consistently found in firesetters (Dolan et al. 2002; Geller 1987; Lindberg et al. 2005). Rates as high as 50% have been reported (Rice and Harris 1991), but having a personality disorder seems to be equally frequent among other offenders as well (Labree et al. 2010).

In an American study, a mixed offender sample of 159 inpatients and 7383 outpatients was compared with 4502 civil inpatients and 23993 civil outpatients. Thirty-six percent of offender inpatients and 11% of civil inpatients had a diagnosis of personality disorder. The corresponding figures for outpatients were 21% and 7%. The differences were statistically significant. The differences were primarily due to the high prevalence of antisocial personality disorder among offenders (26% in inpatients and 14% in outpatients, in civil patients the numbers were 4.8% and 1.0%, respectively). The prevalence of borderline personality disorder was 3.1% among inpatient offenders and 2.1% among outpatient offenders, and for civilian patients 2.4% and 1.6%, respectively. (Rotter et al. 2002)

Firesetters show several traits that are characteristic of borderline personality disorder, such as instability in interpersonal relationships, poor impulse control, and affect regulation issues (Ciardha et al. 2015). Coid and colleagues (1999) observed a significant prevalence of borderline disorder among female firesetters. They noted a subgroup of females with self-mutilating behavior and fire-setting, who used these
pathological behaviors interchangeably. The firesetters experienced tension, dysphoria, and irritability before either one of the acts, and the pathological behavior eased their psychological discomfort. A similar finding was also reported by Miller and Fritzon (2007), who analyzed fire-setting and self-harm behaviors among female inpatients. Further research is, however, needed to settle whether these traits imply a borderline personality disorder or whether they should be considered risk factors for fire-setting behavior.

Firesetters have been shown to be more than 20 times more likely to have an antisocial personality than the general population (Blanco et al. 2010). The National Epidemiological Survey on Alcohol and Related Conditions found that fire-setting was associated with all antisocial behaviors and several lifetime psychiatric diagnoses (Vaughn et al. 2010). Especially staying out late without permission, cutting class and leaving without permission, and shoplifting were common behaviors among firesetters. Antisocial behaviors strongly associated with fire-setting behavior were destroying another’s property, robbing/mugging someone or snatching a purse, and rape (Vaughn et al. 2010). According to Hoertel et al. (2011), when comparing men with a lifetime history of fire-setting to men without fire-setting, the firesetters were more likely to show the following antisocial behaviors: leaving without permission, destroying another’s property, quitting a job, stealing, failing to pay off personal debts, hurting an animal or person on purpose, and shoplifting or doing something that may lead to an arrest.

The presence of a personality disorder does not differentiate firesetters from other offenders, but it is a matter that warrants consideration in designing a treatment plan. Several studies have observed that antisocial behavior, substance use, and impulsivity co-occur regularly, implying that fire-setting is a part of an externalizing spectrum and a broader impulse control disorder (Blanco et al. 2010; Kendler et al. 1997; Krueger 1999). Disinhibition and lack of constraint are traits that seem to be shared among impulsive persons such as those with the aforementioned personality disorders.
2.3.3 PSYCHOPATHY

Psychopathy does not equal antisocial personality disorder, although there are aspects of antisociality within the concept of psychopathy. Some consider the antisocial lifestyle of psychopaths to be more the consequence of the core characteristics: affective and interpersonal features (Cooke et al. 2004; Skeem and Cooke 2010). The core of psychopathy consists of traits like short-temperedness, callousness, absent or diminished feelings of remorse and guilt, inability to empathize, and failure to take responsibility (Hare 2006). The psychopath prototype can be described as glib and charming, with grandiose self-presentation and a deceitful and manipulative manner. In addition, he/she generally leads a socially deviant life, reflecting a need for stimulation, a lack of long-term goals, irresponsibility, impulsivity, parasitizing of others, and a tendency to violate social conventions (Hare 1991).

There are two variants of psychopathy described: primary and secondary. Primary psychopathy is characterized by low levels of anxiety and can be perceived as a heritable affective deficit. Secondary psychopathy is distinguished by high levels of anxiety and is theorized to evolve in response to environmental factors such as maltreatment or abuse (Karpman 1941). Karpman (1948) argued that primary psychopaths are less impulsive and better able to calculate and plan their actions cold-bloodedly, while secondary psychopaths act impulsively and hot-headedly in response to such feelings as anger or hatred. Primary psychopaths are described as inter-personally confident, dominant, and free of negative emotionality, while secondary psychopaths are hostile, withdrawn, and troubled with serious emotional difficulties (Skeem et al. 2007). Karpman’s theory has not been indisputably clinically verified, although there are studies supporting the discrimination of “low anxious” and “high anxious” psychopaths (Kosson and Newman 1995; Skeem et al. 2003) and the discrimination of primary and several secondary types of psychopathy (Skeem et al. 2003).

Childhood conduct disorders have been shown to persist into adulthood and to predict pervasive violent behavior (Söderström et al. 2004). Beaver and colleagues (2011) established that genetic factors are essential in the creation of psychopathy and
psychopathic traits. There is a strong correlation between psychopathy, violence, and crime (DeLisi 2009). Psychopathy, as measured by the Psychopathy Checklist, Revised (PCL-R), has in several studies been shown to predict general and violent recidivism among male offenders (Firestone et al. 1998; Grann et al. 1999; Hart et al. 1988; Hawes et al. 2013; Mokros et al. 2014; Olver et al. 2013; Rice and Harris 1992; Tengström et al. 2000).

The prevalence of psychopathy is estimated to be less than 1% in the general population (Coid et al. 2009a), but in prison settings the prevalence has been shown to be 7.7-15% among males (Coid et al. 2009b; Ogloff 2006). A study among Finnish male prisoners found a prevalence of 12-18% depending on the cut-off score on the PCL-R (Jüriloo et al. 2014). Among women, the prevalence and the level of psychopathy seem to be lower (Beryl et al. 2014; Nicholls et al. 2005). The manifestation of psychopathic traits is different depending on gender (Grann 2000; Strand and Belfrage 2005), making direct comparisons tricky.

Labree et al. (2010) compared arson offenders with other offenders using PCL-R scores, but did not find a difference in total scores. Arsonists did, however, score higher on item 14, reflecting impulsivity. They also scored lower on items 1 and 18, showing less superficial charm and juvenile delinquency. In a study among 12- to 18-year-old adolescents, the firesetters scored significantly higher on callousness scores than antisocial non-firesetters or school controls (Hoerold and Tranah 2014). So far, no studies have compared PCL-R scores within a group of firesetters, which could identify possible subgroups according to e.g. earlier behavior or recidivism.

2.3.4 SUBSTANCE USE DISORDERS
Fire-setting behavior is associated with comorbid substance use disorders, especially those of alcohol and cannabis (Blanco et al. 2010; Puri et al. 1995; Vaughn et al. 2010). The findings are similar among fire-setting adolescents, showing elevated rates of especially alcohol and cannabis use (MacKay et al. 2009). Offenders setting fires have been found to have an alcohol use disorder more often than offenders not setting fires. Among fire-
setting offenders, on the other hand, any substance use disorder is more common among versatile firesetters, i.e. firesetters who also commit other crimes (Ducat et al. 2013a).

In a Finnish study among 90 arsonists, 68% were intoxicated with alcohol during their index offense (Lindberg et al. 2005), and another Finnish study found that 84% of 98 arsonists had an alcohol abuse problem (Räsänen et al. 1995). In the United States, 64% of 283 arsonists were abusing alcohol or drugs at the time of their index offense (Ritchie and Huff 1999). So being intoxicated at the time of fire-setting or suffering from a substance use disorder is a common feature of firesetters. Alcohol abuse in itself can increase the risk of impulsive crimes including arson (Boden et al. 2013).

The presence of an alcohol use disorder is more frequent among fire-setting and other criminal recidivists (Jayaraman and Frazer 2006; Repo et al. 1997a), and this is essential to recognize in the treatment and in fire-setting prevention programs. In a Dutch study comparing inpatient arsonists with offenders of other serious crimes, the arsonists were found to more often have a history of severe alcohol abuse. No difference existed between the groups in overall substance use. (Labree et al. 2010)

Among mentally disordered firesetters, substance use disorders are among the most frequent diagnoses (Enayati et al. 2008). However, firesetters with diagnosed psychotic disorders are less likely to abuse alcohol than their mentally healthier counterparts (Dalhuisen et al. 2015; Virkkunen 1974). Dalhuisen et al. (2015) found that psychotic firesetters were more likely than non-psychotic firesetters to have a cannabis use disorder during their lifetime. The use of other illegal drugs was equally common in both groups, and a considerable portion of firesetters suffered from severe drug abuse problems. This is an interesting finding as it is also known that cannabis use can predispose to psychotic disorders (Casadio et al. 2011), which are likewise common among firesetters.
2.3.5 INTELLECTUAL DISABILITY

The link between fire-setting and intellectual disability is less clear than that between fire-setting and psychotic or substance use disorders. The varying definitions of intellectual disability and inconsistencies in criminal justice processes hinder estimations of prevalence among offenders, with figures ranging from 2% to 40% (Jones 2007).

In a Finnish study of 44 forensic patients with intellectual disability, arson was the most common offense (Männynsalo et al. 2009). However, if all types of violent offenses were put into the same category, the rate of violent offenses clearly exceeded that of arson (41% vs. 27%). This finding is in line with an earlier study, where 72 firesetters were compared with 56 homicide offenders, and no significant differences were noted in IQ scores between the two groups (Räsänen et al. 1994). In a Swedish study, firesetters had more learning disabilities than violent offenders (Enayati et al. 2008), but the definition of learning disability is different from that of intellectual disability, making the results not directly comparable.

So far, research does not imply that firesetters could be distinguished on the basis of a lower IQ, which seems to be equally prevalent in other (violent) offenders.

2.4 IMPULSIVITY

The International Society for Research on Impulsivity defines impulsivity as a “behaviour without adequate thought, the tendency to act with less forethought than do most individuals of equal ability and knowledge, or a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions” (International Society for Research on Impulsivity 2016). Impulsiveness can be thought of as an emphasis on living in the moment. Impulsivity has been connected to many psychiatric disorders, among others, attention deficit/hyperactivity disorder (ADHD), antisocial and borderline personality disorders, and suicidality. The ICD-10 lists five disorders in group F63 Impulse disorders: pathological gambling, pyromania, kleptomania,
trichotillomania, and other impulse disorders such as intermittent explosive disorder and unspecified impulse disorder (World Health Organization 1992).

Impulsive behavior can be measured in different ways and there are also different kinds of impulsivity. Research has been conducted to identify the determinants of different impulsive behaviors, and it is clear that not just one brain structure or region is involved. There are several genes affecting impulsivity and, moreover, the levels of different neurotransmitters matter (Goldman 2014). Serotonin is a substance associated with impulsive aggression among violent offenders and alcoholics (Linnoila et al. 1983; Virkkunen and Linnoila 1993). Low levels of serotonin in the central nervous system (CNS) have been associated with impulsivity (Lidberg et al. 2000; Virkkunen et al. 1987). Among arsonists with low cerebrospinal 5-hydroxyindoleacetic acid (5-HIAA, a metabolite of serotonin) levels, the most frequent diagnoses were borderline personality disorder or intermittent explosive disorder (Roy and Linnoila 1988). However, the connection between impulsivity and low cerebrospinal levels of 5-HIAA is not indisputable (Roggenbach et al. 2002). Especially earlier research has contained many confounding factors and the definition of impulsivity has been unclear. Furthermore, the neurotransmitter dopamine has been linked to impulsive behavior and addictions (Buckholtz et al. 2010).

Two genes have thus far been identified to modify impulsivity in humans: monoamine oxidase A (MAOA) and 5-hydroxytryptophan receptor 2B (HTR2B). MAOA alters the metabolism of monoamine neurotransmitters, such as serotonin, dopamine, adrenaline, and noradrenaline, and HTR2B blocks the expression of a serotonin receptor. Caspi et al. (2002) showed that interaction between the MAOA gene and the environment (maltreatment in childhood) produced an effect on children’s behavior, predicting later antisocial behavior. An imaging study has also shown the connection between low levels of MAOA in the brain and antisocial personality disorder and impulsive aggression (Kolla et al. 2015). Goldman et al. (2010) found a HTR2B serotonin receptor stop codon that led to impulsivity. The stop codon was identified among a sample of 96 Finnish
forensic patients exhibiting violent impulsive behavior and arson. The offenders were suicidal and had committed unpremeditated impulsive offenses mainly under the influence of alcohol. They were found to commonly fulfill the criteria for antisocial personality disorder or intermittent explosive disorder and alcohol use disorders. This gene finding was exclusive for Finns, as all carriers were of Finnish ancestry.

There is a strong correlation between addiction disorders and impulsivity (Dick et al. 2010; MacKillop et al. 2011). Also addictions other than substance misuse have been coupled to high impulsivity (Grant and Chamberlain 2014); gambling disorder, for instance, is highly comorbid with substance addiction (Chou and Afifi 2011). There are contradictory findings whether acute use of addictive substances affects impulsivity, but according to a meta-analysis chronic use is associated with elevated impulsivity (MacKillop et al. 2011).

Already Prichard (1842) and Lewis and Yarnell (1951) connected fire-setting to disturbed impulse control. Furthermore, this has generally been the accepted line of thinking. High impulsivity has been shown to increase the frequency of fire-setting among youth (Hoerold and Tranah 2014). Grant and Kim (2007) examined a sample of 21 adults with lifetime pyromania as defined in DSM-IV; 13 (61.9%) had a current mood disorder, 10 (47.6%) an impulse-control disorder, and 7 (33.3%) a substance use disorder. The majority of these persons reported that the symptoms of pyromania preceded the other disorders. Interestingly, all of the persons who had stopped setting fires and did not fulfill current diagnostic criteria for pyromania reported that symptoms of another impulse control or substance use disorder had appeared instead. Thus, they had substituted one impulsive pathological behavior for another.

2.5 SUICIDALITY

Suicide is considered a central global public health problem. In 2004, intentional injuries caused 3.8% of all deaths among males and 1.7% of all deaths among females worldwide. In total, this
means that about 800 000 lives were lost prematurely to suicide. (World Health Organization 2008)

Depression (Sokero et al. 2005), certain personality traits (Blüml et al. 2013), psychosis or schizophrenia (De Hert et al. 2001), non-suicidal self-injury (Whitlock et al. 2013), and substance use disorders (Arria et al. 2009; Dhossche et al. 2000) are known risk factors for suicidal ideation and suicidal behavior. Among persons with depressed mood, Liu et al. (2016) found six factors predicting suicide: age, feelings of emptiness, sudden mood changes, self-harm history, depressed mood, and interference with social activities in the last four weeks. Depression has been shown to be five times and bipolar disorder three times more common among firesetters than among community controls (Ducat et al. 2013b). Furthermore, firesetters have been described as being socially isolated, to have poor communication skills and low self-esteem, and to express a proneness to self-harm (O´Sullivan and Kelleher 1987). These are all known risk factors for subsequent suicide.

Suicide by fire, either self-burning or self-immolation, is not particularly typical for firesetters as a group. Rather, in the Western world this unusual behavior is connected to substance abuse and mental disorders (Makhlouf et al. 2011; Reiland et al. 2006). The attempters are usually male and in their thirties (Laloë 2004). One Finnish study showed, however, that for up to one-third of 98 firesetters, suicide was the motive for fire-setting (Räsänen et al. 1995). Self-inflicted burns constitute around 1% of burn admissions in Western countries (Mojarrad et al. 2007; Wasiak et al. 2009), but figures in low-income countries are higher. This behavior is a common means for attempting and completing suicide among women in their twenties in the Eastern Mediterranean region and in south and central Asia (Laloë 2004; Othman and Kendrick 2010). A Finnish group found in an 8-year retrospective study that 5.7% of patients admitted to a burn unit had self-inflicted burns, but no difference in gender was observed (Palmu et al. 2004). Self-inflicted burns often result in larger mean total body surface area burned and higher mortality than accidental burns (Mojarrad et al. 2007; Palmu et al. 2004). There are observations of a small group of mainly females with traits of borderline personality who engage
in recurrent self-burning (Henderson et al. 2013). This worrisome group should be identified as their pathological behavior is dangerous and damaging for themselves and their environment, potentially causing deadly burns and notable economic losses.

Sometimes persons engage in complex suicides, meaning that they apply more than one suicide method to ensure success in their attempt (Bohnert and Rothschild 2003). Self-burning is rarely combined with other suicide methods, but there are some case reports written about this rare behavior (Adair and Fisher 2006; Makhlouf et al. 2011). The fire itself or the fire extinguishing measures can destroy evidence and make the determination of manner of death laborious. It may, at times, be challenging for investigators to establish whether they are dealing with a case of suicide or a homicide.

Fazel et al. (2011) found in a study involving several countries that suicide rates among imprisoned men were three times those of the general populations. In another study (Fazel et al. 2005) performed in England and Wales, prisoners were observed to be five times more likely to die of suicide than the general population. Overall, prison inmates have lifetime suicide attempt rates of 14–27% (Larney et al. 2012; Roy et al. 2014; Sarchiapone et al. 2009). Often a suicide is preceded by a suicide attempt within one month of the suicide (Hawton et al. 2014). Offenders with fire-setting behavior are more likely to have suicidal ideation or to have attempted suicide than offenders not setting fires (Ducat et al. 2013a; Räsänen et al. 1995). So, in this respect also, firesetters constitute a high-risk group for completed suicide.

Several studies have shown that apprehended firesetters have high rates of self-harm and suicide attempts in their histories (Jayaraman and Frazer 2006; O’Sullivan and Kelleher 1987). Barrowcliffe and Gannon (2015) found a similar history of suicide attempts among un-apprehended firesetters as among non-firesetters living in the UK.

Some evidence has emerged that completed suicides and suicide attempts are not rare among firesetters. However, the causes from which firesetters die in general and whether these
causes of death differ from those in the general population remain unknown.

2.6 YOUNG FIRESETTERS

2.6.1 FIRE-SETTING AMONG CHILDREN

Child and youth fire-setting behavior is often driven by a curiosity towards fire in combination with a lack of understanding of the destructible potential of fires. Young firesetters constitute a heterogeneous group, but generally higher levels of need, lower functioning, and fewer strengths among children lighting fires have been noticed (Lyons et al. 2010). Fire-setting is one of the criteria for conduct disorder in DSM-5 (American Psychiatric Association 2013) and ICD-10 (World Health Organization 1992). ICD-10 defines conduct disorder (F91) as being characterized by “a repetitive and persistent pattern of dissocial, aggressive, or defiant conduct”. In addition to fire-setting, the disorder may include “excessive levels of fighting or bullying, cruelty to other people or animals, severe destructiveness to property, stealing, repeated lying, truancy from school and running away from home, unusually frequent and severe temper tantrums, and disobedience” (World Health Organization 1992).

There are reports of figures as high as one in three children lighting fires and boys more commonly than girls (Del Bove et al. 2008; Loeber 1987; MacKay et al. 2009). In one study by Perrin-Wallqvist and Norlander (2003), the prevalence for having played with fire during childhood was 70% among boys and 44% among girls, when the persons were interviewed at the age of 18-19 years. Dadds and Fraser (2006) collected 1359 children aged 4-9 years and found that 5% of the children were reported to have engaged in fire or match play. This behavior was clearly more common among boys and increased with age. Lyons et al. (2010) collected a sample of 4155 children and youth aged 0-17 years who had been brought into custody by child welfare authorities. They found an overall prevalence of fire-setting of 1.35%, with the
rate for boys being twice that of girls. The rate among children aged 10-17 years was 3.5%.

Fire-setting rarely occurs by itself, but rather together with e.g. a conduct disorder or antisocial tendencies. Among children setting fires, behaviors such as hyperactivity, thrill seeking, and cruelty to animals are common, and these are characteristics predicting chronic antisocial behaviors (Dadds and Fraser 2006).

### 2.6.2 FIRE-SETTING AMONG ADOLESCENTS

The majority of young firesetters stop setting fires as they mature. However, there appears to be a subgroup with a more serious psychopathology that is in need of treatment. This group can be identified by some common features such as expressing deliberate, planned, and persistent fire-setting (Moore Jr. et al. 1996; Sakheim and Osborn 1999). In addition, a heightened interest in fire (MacKay et al. 2006) and fireplay and fire-setting at an early age (Hoerold and Tranah 2014) should be taken as warning signs for fire-setting recidivism.

Adolescent firesetters, aged 12-18 years, showed, as did antisocial non-firesetters, a higher impulsivity than control juveniles (Hoerold and Tranah 2014). Additionally, these firesetters scored high on callous traits. According to Forehand et al. (1991), juvenile fire-setting represents a level of antisocial behavior. It has been estimated that about 7 in 10 adolescent firesetters have a comorbid conduct disorder (Sakheim and Osborn 1999).

There is some evidence that violent behavior in adolescence might be part of a prodromal phase of schizophrenia. In a Danish study, psychiatric admission before the age of 19 years or conviction for a violent crime (violence excluding murder, attempted murder, and particularly brutal assault) between the ages of 15 and 19 years predicted later hospitalization for schizophrenia (Gosden et al. 2005). The study did not show that arson was directly linked to schizophrenia, but the number of young arsonists was fairly low (n=31) and the follow-up period lasted only 8.7 years, and thus, the arsonist might have fallen ill with schizophrenia after the follow-up ended. This is an issue
warranting more research to clarify the risks of young firesetters getting a later diagnosis of schizophrenia.

The prevalence of fire-setting behavior among youth was 67.4% in an offender sample and 37.5% among non-offenders (Watt et al. 2015). About 20% in each group had lit more than 10 fires.

### 2.7 FEMALE FIRESETTERS

Female firesetters have been studied less than their male counterparts. However, among females committing crimes, arson is more usual than among males (Degl'Innocenti et al. 2014; de Vogel et al. 2015), although the total number of males convicted for arson is higher. Hollin et al. (2013) found arson to be nearly three times more prevalent among women when looking at hospital admissions within gender. Fire-setting females are often perceived as more psychologically challenged than their male counterparts. The schizophrenia rate for female arsonists has been noted to be more elevated than for men, consistent with findings among women committing violent crimes (Anwar et al. 2011). Comparing fire-setting women and men reveals that women more often have a lifetime diagnosis of alcohol abuse or antisocial or schizoid personality disorder (Hoertel et al. 2011). When comparing fire-setting women with non-fire-setting women, the firesetters were more likely to be diagnosed with any lifetime alcohol or cannabis use disorder, conduct disorder, antisocial, compulsive-obsessive, or schizoid personality disorder, or psychotic or bipolar disorder (Hoertel et al. 2011). A similar finding emerges when comparing fire-setting men with non-fire-setting men. Female firesetters seem to prefer setting fire to personal or residential targets (Dickens et al. 2007; Stewart 1993), and they often show more exclusive fire-setting offending behavior (Ducat et al. 2013a) than their male counterparts.

Females with both fire-setting and self-mutilating behavior represent the most psychologically damaged subgroup, often originating from families with social and emotional deprivation. They are generally criminally versatile and can be diagnosed with
an antisocial and/or borderline personality disorder (Coid et al. 1999). There is more frequently a history of child sexual abuse among female firesetters than among males (Dickens et al. 2007; Puri et al. 1995; Stewart 1993). Dickens et al. (2007) compared 129 males and 38 female adult arsonists. They found that men and women differed in several characteristics, e.g. women more often expressed attention seeking or parasuicide with their fire-setting and were typically older at their first conviction. In their sample, 61% of female and 38% of male arsonists had a psychiatric diagnosis. Jayaraman and Frazer (2006) studied 27 male and 7 female firesetters, and in their sample all (100%) of the women reported a history of sexual abuse and self-harm and six (85.7%) of the women reported having experienced physical abuse. The corresponding figures for the male firesetters were 8 (23.5%) and 17 (50%).

The lifetime prevalence of fire-setting in a general US population was 0.4% among women and 1.7% among men (Hoertel et al. 2011). When comparing women with lifetime fire-setting with men, four antisocial behaviors were associated with the women: cutting class and leaving without permission, getting three or more traffic tickets for reckless driving or causing accidents, having driver’s license suspended, and using a weapon in a fight. On the other hand, male firesetters were associated with behaviors like hurting an animal on purpose, failing to pay off personal debts, and shoplifting (Hoertel et al. 2011).

2.8 RECIDIVISM

Studies show that 4% (Barnett et al. 1999; Soothill and Pope 1973) to 60% (Repo and Virkkunen 1997a; Repo and Virkkunen 1997b; Rice and Harris 1991) of firesetters re-offend with fire-setting or other crimes during follow-up periods, which have lasted 6-20 years. The firesetters in these studies cannot be thought of as a homogeneous group, as some are hospitalized, others imprisoned. In addition, there are firesetters convicted but receiving only community service and those who do not get caught. In order to be able to accurately predict risk of fire-setting and other criminal recidivism, we need more information
regarding the character and motive of the firesetter. Findings consistently reveal certain risk factors and also that the fire-setting recidivism rate is clearly lower than the general re-offending rate (Ducat et al. 2015). Another important point is that not all re-offendings are recorded in the official statistics (Hollin et al. 2013).

Offenders with an antisocial personality disorder combined with a substance use disorder have a general recidivism rate that is two times higher than for antisocial offenders without a comorbid substance use disorder (Walter et al. 2011). This finding has been replicated in many studies, indicating that recidivism is strongly connected to a substance use disorder (Repo et al. 1997a), which should be addressed when aiming to prevent re-offendings. This is highly relevant for firesetters, as they, as stated earlier, commonly suffer from substance use disorders.

A study among 184 Finnish arsonists showed that 76% re-offended during follow-up, which lasted on average 6 years (Stoat et al. 2005). The delay between the arson and the re-offending was on average 428 days (SD 622.8, range 0-3073), which is longer than the delay noted in O’Sullivan’s and Kelleher’s study (1987). In the Finnish study, 11% of arsonists re-offended with fire-setting; other usual crimes were different crimes against property (Stoat et al. 2005). This is in line with the findings of Ducat et al. (2015).

Barnett et al. (1997) found that mentally disordered arsonists were more likely to light fires than their psychiatrically healthier counterparts, both before and after their index arson. Also, mentally disordered arsonists generally remained faithful to fire-settings, while psychiatrically healthier persons offended in a more versatile fashion. During a 10-year follow-up, the arson relapse rate was 9-10% among arsonists with diminished or no responsibility compared with 4% for fully responsible arsonists (Barnett et al. 1999). The exclusive arsonists with diminished responsibility lit the highest number of fires, so if one would like to analyze and explore pyromania, this group could offer the most subjects. In a study by O’Sullivan and Kelleher (1987), they noted that fire-setting recidivism was most likely to manifest itself within six months after release, but it could occur also many
years later. A long delay of recidivist fire-setting was also observed in the 20-year cohort study by Soothill and Pope (1973).

2.9 TREATMENT OF FIRE-SETTING BEHAVIOR

2.9.1 PSYCHOTHERAPY
Cognitive behavioral therapy (CBT) has proven effective in reducing general offending recidivism (Lipsey et al. 2001). Furthermore, treatment programs for fire-setting among adolescents have been effective (Franklin et al. 2002; Kolko 2001). The most common approaches are an educational intervention or a CBT intervention. Although most children playing with fire stop by themselves, the small group continuing to light fires is in need of treatment, otherwise their behavior might become chronic. Some persons appear to switch behavior from lighting fires to acting impulsively in other ways or to using illegal drugs or alcohol (Grant and Kim 2007). This might be due to an underlying similar neuropathology behind these disorders, as suggested by some biological evidence.

Kolko (2001) studied 38 children randomized to CBT or fire safety education (FSE) and compared their outcomes after one year with those of 16 children receiving a brief intervention (home visit from a firefighter). At follow-up, relative to the children in the brief intervention group, the children in both the CBT and FSE groups had lower frequencies of fire-setting, less playing with matches, and were less involved in fire-related acts and other deviant fire activities.

Firesetters are impulsive and commonly suffer from substance use disorders, which are also connected to impulsivity. These behaviors can be characterized by reward-seeking. Therefore, targeting impulsivity when planning treatment programs for firesetters is essential. Also, impulsivity is a central predisposing factor for fire-setting recidivism. Mindfulness or attentional training programs could prove effective for increasing
self-regulation of attention (Moore et al. 2012) and decreasing impulsivity (Murphy and MacKillop 2012; Peters et al. 2011).

When planning treatment for offenders with fire-setting behavior, not only the criminal act but also the function of their behavior within a broader context should be addressed (Fritzon et al. 2011). A person lighting fires for expressive reasons, e.g. the person wants to be a hero, should be aided in seeing alternative ways to gain the reward, i.e. be perceived a hero. If the fire itself is the reinforcer for the fire-setting behavior, treatment will be challenging. Among juvenile firesetters, there has been some success with treating a negative practice (repeatedly striking a match) with corrective consequences and token reinforcement (Kolko 1983), and this technique might be adapted to adults in a similar way as treatment for drug misuse. If a person lights fires as part of a criminal lifestyle, the treatment should focus on training general social skills and attempt to reduce the general criminality. These firesetters can have poor social skills and be hostile in general, conditions that if reduced may decrease the risk of recidivism (Hagenauw et al. 2015). Persons lighting fires on the spur of the moment, e.g. as an act of revenge, should receive training on problem solving and assertiveness. Firesetters acting out of inner, sometimes suicidal, needs may benefit from dialectical behavior therapy (Linehan et al. 1991), principles generally aimed at persons with recurrent suicidality and borderline personality disorder. Fritzon (2011) also suggests a narrative approach to treatment.

Social skills training, including communication training and problem solving, can help firesetters to use means other than lighting fires in response to negative life events or inner frustration. Both male and female firesetters experience social and relationship problems that predispose them to impulsive behaviors in times of trouble.

CBT has been used with mentally disordered firesetters, but the studies have been small and have not had any control groups, although the outcomes generally have been reported to be favorable (Swaffer et al. 2001; Taylor et al. 2002; Taylor et al. 2006). The first treatment report in a prison setting is by Gannon et al. (2015), where they evaluated the efficacy of a specialist group therapy: the Firesetting Intervention Programme for
Prisoners – FIPP. Firesetters in the 28-week FIPP group were compared with firesetters receiving treatment as usual (TAU), meaning no specific treatment for their fire-setting behavior. At three months after treatment, participants in the FIPP group had improved significantly with regard to their interest and approach towards fire. These individuals also showed diminished levels of violent and antisocial attitudes relative to the persons in the TAU group.

All in all, it is important to consider the firesetter at hand and plan interventions accordingly.

2.9.2 PHARMACOLOGICAL THERAPY
No controlled studies exist on pharmacological therapy for fire-setting and no medicines are registered for this purpose in Europe or in the USA. However, there is one case report in which CBT combined with topiramate has been effective in a case of pyromania (Grant 2006). Partial or full remission of pyromania has been reported for topiramate, escitalopram, sertraline, fluoxetine, and lithium (Grant and Kim 2007). In the same study, no effect on pyromania was reported for fluoxetine, valproic acid, lithium, sertraline, olanzapine, escitalopram, citalopram, and clonazepam.

Theoretically, serotonine reuptake inhibitors (SSRIs) or lithium might be effective for fire-setting as these drugs can decrease impulsivity. Clearly, however, more research is needed in this area.

It is important to treat possible comorbid disorders in an optimal way. For example, the use of antipsychotic medication for schizophrenia spectrum disorders reduces risk of aggression (Fazel et al. 2014; Buckley et al. 2011). Benzodiazepines, by contrast, having disinhibitory effects on behavior and impulse control, might even provoke impulsive acts, which can be accentuated by using benzodiazepines in high doses or combined with alcohol (Lundholm et al. 2013). Therefore, the last-mentioned group of medicines should be prescribed with particular caution for persons with impulse control disorders (Albrecht et al. 2016), like firesetters, especially if the person has a comorbid alcohol use disorder.
3 AIMS OF THE STUDY

This study aimed to achieve a better understanding of the comorbidity of schizophrenia spectrum disorders, substance use disorders, and mortality and suicidality in firesetters. Specific aims of the studies were to investigate the following in firesetters:

1. Rates and patterns of mortality (I).
2. Prevalence and nature of attempted suicides (II).
3. Prevalence and levels of psychopathic traits (III).
4. Fire-setting behavior in adolescents or young adults and association with a later schizophrenia spectrum disorder (IV).
4 MATERIALS AND METHODS

4.1 SUBJECTS AND CONTROLS

The study population comprised a consecutive sample of 441 male firefighters who had been subjected to a pretrial forensic psychiatric examination in 1973-1998 at the Helsinki University Hospital. They had all been charged with fire-setting offenses, mainly arson. A few persons had had two examinations during the time period in question and for these individuals only the first examination was included in the study.

The control group consisted of persons randomly selected from the Population Information System (Population Register Centre) who were matched to the study subjects with respect to date and place of birth and gender. If no match was found on the community level for place of birth, the search was extended to the regional level. The number of control subjects for each firefighter was four in order to improve statistical power.

4.1.1 STUDY I

The final number of firefighters included in the analysis was 435; six subjects were excluded since four had been born abroad and two had a security prohibition, and thus, could not be matched with control subjects. Firefighters who had moved abroad during follow-up were included because the majority moved to other Nordic countries, thus enabling the Causes of Death Statistics (Statistic Finland) to be updated with respect to potential deaths.

The number of control subjects was 1740.

4.1.2 STUDY II

The number of firefitters included in analysis was 426; altogether 15 firefighters could not be matched to control subjects due to their either moving abroad during follow-up (nine
persons) or being born abroad (four persons) or having a security prohibition (two persons).

The number of control subjects was 1704.

4.1.3 STUDY III
In this study, a subpopulation consisting of firesetters examined during 1989-1998 was used because the quality of the examinations was more homogeneous and suitable for PCL-R assessments during the last part of the study period. A total of 135 firesetters was recognized, six of whom were intellectually disabled (IQ $\leq$70) and excluded from analysis, leaving 129 participants. No control group was used.

4.1.4 STUDY IV
Among the 441 firesetters, there were 137 firesetters aged 15-25 years. Of these, 111 were included in analysis, after exclusion of those born abroad (two persons), having a security prohibition (two persons), or having a past or current diagnosis of a schizophrenia spectrum disorder (22 persons) (ICD-10: F2*).

The control group comprised 440 persons because four persons were excluded as they had been treated for a schizophrenia spectrum disorder (ICD-10: F2*) before the index day.

4.2 METHODS

4.2.1 FORENSIC PSYCHIATRIC EXAMINATION
In Finland, the court decides whether a person charged with a crime is submitted to a forensic psychiatric examination. The age of liability is 15 years. If an examination is deemed necessary, the court requests that arrangements be made by the National Institute for Health and Welfare. The examination is performed either in a state or municipal psychiatric hospital or in a psychiatric hospital for prisoners and lasts about two months.
Data are gathered from various sources such as surveys of family members and relatives as well as medical, criminal, school, and military records, psychiatric and physical evaluations, standardized psychological tests, interviews conducted by a multi-professional team, and continuous observation of the offender by hospital staff. Courts and scientists consider the overall quality and reliability of Finnish forensic psychiatric examinations to be good (Eronen et al. 2000). After the examination, the forensic psychiatrist or resident in forensic psychiatry submits a report to the National Institute for Health and Welfare. The report includes the offender’s general history, a summary of criminal records and observations made, and the results of psychological testing. At the end, the writer summarizes the examination and gives an opinion on the offender’s psychiatric status at the time of the offense and whether the person should be held responsible for his or her actions.

The court makes the final decision about the legal capacity of the person and gives its verdict. Some offenders serve their sentence in prison and others may be left without absolute discharge. If psychiatric treatment is needed, the offender might be transferred to a hospital offering forensic services.

For these studies, I collected the following information on subjects from the forensic psychiatric examination reports: name and personal identity code, age, place of birth, date of examination (index day), type of offense, possible earlier offenses, and all diagnoses.

In Finland, psychiatric classification according to the International Classification of Diseases, Eighth Revision (ICD-8) (World Health Organization 1965) was used in clinical practice between 1968 and 1986 and was replaced by ICD-9 (World Health Organization 1977), which was applied until 1995. However, between 1987 and 1995 the DSM-IIIR (American Psychiatric Association 1987) was used in clinical practice, but the diagnoses were converted into ICD-9 diagnoses, e.g. when reporting them to the Care Register for Health Care. Since 1996, ICD-10 (World Health Organization 1992) has been employed in clinical contexts.
4.2.2 THE REGISTERS

The following registers were used:

- The Population Information System is a register of all Finnish citizens and foreigners residing in Finland, maintained by the Population Register Centre and local register offices (Population Register Centre). It holds information on demographic variables of the population such as personal identity code, age, gender, marital status, place of birth and residence as well as information on dwellings and real estate. The current Finnish system of population registration is based on a combination of data from the domicile lists and the parish registers. The collection of the domicile lists began in the 16th century and that of the parish registers in the early 18th century. Especially for the development of vital statistics, the collection of the number of births and deaths from the parish registers has been central (Nieminén 1999).

- The Causes of Death Register is a register of Statistics Finland that produces statistics on causes of death and on the development of mortality since 1936 (Statistics Finland). The statistics on causes of death are compiled from data obtained from death certificates, which are supplemented with data from the Population Information System. The death certificates contain information on the primary cause of death and in some cases on secondary causes. All death certificates are verified by a physician at the regional level and by medical experts at Statistics Finland. The statistics on causes of death include persons who have died in Finland or abroad and who at the time of death were domiciled in Finland. The register has been scientifically validated (Lahti and Penttilä 2001).

- The Care Register for Health Care is a register of the National Institute for Health and Welfare operating since 1993 (National Institute for Health and Welfare). It was preceded by the Hospital Discharge Register, which was used in 1967-1993. The Care Register holds information on patients’ identity codes and patients discharged from
inpatient care and since 1998 also on specialized outpatient care and information on day surgeries and since 2010 on outpatient care in health centers. In addition, the register maintains a count of all inpatients in hospitals and health centers for December 31\textsuperscript{st} of each year. For every patient, it holds information on reason for seeking care, diagnoses, need for care on admission/discharge/count, procedures and interventions, whether the patient is a psychiatric patient or has an advanced cardiac condition, and so on (Gissler and Haukka 2004). Data in this register are of good quality and sufficient for research purposes (Aro et al. 1990).

4.2.3 SUICIDE ATTEMPTS
The statistics on treated suicide attempts contain complete information on outpatients from 2010 onwards. In this study, we had a long follow-up period, beginning in 1973, so in order to get meaningful results we focused on suicide attempts serious enough to warrant treatment in hospitals. Information on hospital treatment periods and reasons for treatment has been available since 1967 in the Care Register for Health Care.

ICD-8 and ICD-9 were used at the beginning of the follow-up period until 1995, and the diagnostic codes collected indicating suicide attempts were E950-E952 Suicide and self-inflicted injury by different substances, E953-E958 Suicide and self-inflicted injury by other defined means, and E959 Late effects of self-inflicted injury. Since 1996, ICD-10 has been used and the codes indicating suicide attempt were X60-X69 Intentional self-poisoning by different substances, X70-X84 Intentional self-harm by other defined means, Z72.8 Self-damaging behavior, and Z91.5 Personal history of self-harm (suicide).

4.2.4 PSYCHOPATHIC TRAITS
In Study III, the PCL-R (Hare 1991; Hare 2003) was used to assess the number of psychopathic personality traits. PCL-R consists of 20 items that assess the behavior and personality
characteristics considered fundamental to psychopathy. The items are rated from 0 (= absent) to 2 (= definitely present), summing up to a maximum total score of 40. The PCL-R measures two factors that appraise affective-interpersonal features (Factor 1 = glibness and superficial charm, grandiose sense of self-worth, pathological lying, manipulative behavior, lack of remorse or guilt, shallow affect, lack of empathy, failure to accept responsibility) and socially deviant lifestyle and behaviors (Factor 2 = proneness to boredom, parasitic lifestyle, poor behavioral controls, lack of realistic, long-term goals, impulsivity, irresponsibility, juvenile delinquency, revocation of conditional release).

The validity and reliability of PCL-R is considered high (Gacono and Hutton 1994; Grann et al. 1998; Hare et al. 2000), and the psychometric properties are similar across countries (Stone 1998) and ethnic origins (Skeem et al. 2004). A cut-off score of 30 points is generally diagnostic of psychopathy (Hare 2003), but a lower cut-off score of 25 has been recommended and used in European and Scandinavian samples (Cooke and Michie 1999; Grann et al. 1999; Rasmussen et al. 1999; Sullivan et al. 2006). For research purposes, the PCL-R assessment can be made solely upon sufficient file information (Alterman et al. 1993; Laurell and Dåderman 2007; Mossman 1994), although it is recommended that the assessment be based on an interview in addition to a file review.

In Study III, the firesetters’ forensic psychiatric examination reports were reviewed and scored by one trained forensic psychiatrist of the research team (Professor Nina Lindberg).

4.2.5 BROADLY DEFINED SCHIZOPHRENIA

I used the concept of broadly defined schizophrenia (SCH) in Study IV since the diagnoses of schizophrenia and schizoaffective disorder in research can be regarded as of similar clinical appearance (Kotov et al. 2013). Also, in an imaging study by Amann and colleagues (2016), they found that patients with schizoaffective disorder and schizophrenia had similar changes of gray matter brain abnormality, implying common features.
The numbers of persons treated during follow-up for schizophrenia, schizoaffective disorder, or any schizophrenia spectrum psychosis leading to any of the stated diagnoses (SCH) in the fire-setting and the control groups were counted. The onset of SCH was defined as the first hospitalization leading to one of the aforementioned diagnoses. Diagnoses of psychoses associated with affective, organic, or substance use disorders were not taken into account.

The diagnoses used in Study IV were during 1973-1995 from ICD-8 and ICD-9, being 295.0-6 and 295.8-9 Schizophrenic disorders and 295.7 Schizoaffective disorder. From 1996 onwards, ICD-10 codes were used, i.e. F20.0-9 Schizophrenia and F25.0-9 Schizoaffective disorders. This information was retrieved from the Care Register for Health Care.

### 4.2.6 SUBSTANCE USE DISORDERS

The diagnoses of substance use disorders were collected from the Care Register for Health Care. The diagnosis codes used during follow-up included alcohol- and drug-related diseases (somatic and psychiatric) and accidental poisoning by alcohol or drugs (Official Statistics of Finland 2005).

Treatment periods for substance use disorders could be due to the direct effect of the substance (e.g. alcohol or drug dependence) or due to somatic causes following use (e.g. alcoholic pancreatitis, drug-induced hepatitis).

### 4.2.7 RECIDIVISM

Information on earlier criminality in the forensic psychiatric examination report was used when dividing firesetters into exclusive or versatile ones. However, some persons described additional crimes during their examination, which were not included into the official criminal records. These crimes were taken into account and rated in the PCL-R.

Exclusive firesetters had only fire-setting crimes in their official criminal history, and versatile ones had other types of crime as well. Firesetters were classified as one-timers if the
index fire-setting was their first and as fire-setting recidivists if they had at least one earlier fire-setting.

4.2.8 FOLLOW-UP PERIOD (I, II, IV)
The follow-up period started when the firesetter’s forensic psychiatric examination was finished, called the index day. The period ended on 31.12.2012, except for Study I, where it ended on 31.1.2013. Also a person’s death ended the follow-up period. In Studies II and IV, a move abroad ended the follow-up as well. Thus, the length of the follow-up period varied depending on when the person had been examined. In Study IV, I retrieved the exact date of fire-setting, which was used when calculating the delay between fire-setting and receiving a diagnosis of broadly defined schizophrenia. The follow-up of the control subjects began on their respective firesetter’s index day.

The mean length of follow-up for Study I was 20.9 years (range 0-40, SD 6.4, median 22) and for Studies II and IV 20.3 years (range 0-39, SD 9.31, median 21 years). Study III had a cross-sectional design.

4.3 STATISTICS
The statistical analyses were performed using IBM SPSS Statistics versions 19 and 22. In Studies I-IV, the likelihood ratio Chi-square test ($\chi^2$) with Yates’ correction, and Fisher’s exact test were used for categorical variables and the paired $t$-test for continuous variables to compare the groups. In Study I, Kaplan-Meier analysis and in Study IV Cox regression analysis were used to compare firesetters with controls. Hazard ratios (HRs) with 95% confidence intervals (CIs) were presented in Study IV. In all studies, the odds ratio (OR) with its 95% CI was reported as a measure of the association between outcomes.

In Study III, the phi ($\phi$) coefficient was used as an effect size measure for the $\chi^2$ test and Fisher’s exact test and Cohen’s $d$ for the independent samples $t$-test. For the Mann-Whitney U-test, theta ($\Theta$) was used as the effect size measure. The magnitude of the $\phi$ coefficient was interpreted as follows: 0.1 small effect, 0.3
moderate effect, and 0.5 large effect. Respectively, the magnitude of Cohen’s $d$ was interpreted as follows: 0.2 small, 0.5 moderate, and 0.8 large effect (Cohen 1992). $\theta$ can be interpreted as follows: 0.56 small, 0.64 moderate, and 0.70 large effect (Acion et al. 2006).

In all statistical tests, findings were considered significant when two-tailed $p<0.05$.

4.4 ETHICAL QUESTIONS

Forensic examination reports are not regular case histories, but official legal documents that can be used for research purposes. However, they contain delicate personal material, which must be handled with care. Publication and presentation of results were done with sensitivity and in such a way that no person could be identified.

The ethics committee of the Helsinki and Uusimaa hospital district evaluated and approved the study plan (diary no. 372/13/03/03/2010). This was a register-based study, and thus, no personal contact was made with firesetters or control subjects.

4.4.1 PERSONAL INVOLVEMENT

I participated in planning the study, wrote the study plan, and applied for the permissions to use the different registers. I collected and extracted the data from the forensic psychiatric examination reports. I ordered the information regarding the persons in the control group and the information needed from the different registers described earlier for subjects and controls. I analyzed the data and performed the statistical tests under the supervision of Professor Jouko Miettunen. I was the first writer in all published and submitted articles.
5 RESULTS

5.1 CHARACTERISTICS OF THE FIRESETTERS

Among all 441 firesetters, 16 persons (3.6%) were diagnosed with pyromania. Of these, one was omitted from analyses due to a security prohibition. See Figure 1 for the distribution of all diagnoses made in the forensic psychiatric examinations. Most persons were assigned more than one diagnosis.

5.1.1 STUDY I

Among the 435 firesetters included in Study I, the principal psychiatric diagnosis in the forensic psychiatric examination was mental disability (IQ<70) in 18 (4.1%) and a schizophrenia spectrum disorder in 83 (19.1%). A personality disorder was diagnosed in 211 persons (48.5%) of whom 55 (12.6%) had a borderline and 39 (9.0%) an antisocial personality disorder. In addition, 59 offenders (13.6%) suffered from mood disorders (depression and bipolar disorder), 12 (2.8%) from anxiety disorders, and 49 (11.2%) from some other disorder such as conduct disorders, organic brain disease, or pyromania. Only three offenders (0.7%) were not diagnosed with any psychiatric or somatic disorder (Figure 2).

Of the 435 firesetters, 281 (64.6%) were diagnosed with alcohol use disorders (harmful use or dependence). The mean age of all firesetters included was 33.4 years (standard deviation (SD) 11.52, range 15.5–67.8) at the time of their examination. Nearly one-third, that is 124 (28.5%) offenders, were 15–24 years.

Of all firesetters, 124 (28.5%) were fire-setting recidivists (i.e. had committed at least one separate fire-setting in addition to the index one). Most of these fire-settings were included in the charges leading to this pretrial examination. However, only 32 (7.4%) had earlier convictions for exclusively fire-setting
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offenses, while 213 (49.0%) had convictions also for other types of crime. Altogether 190 firesetters (43.7%) had no convictions before their index crime.

![Figure 1. Distribution of all diagnoses made in the forensic psychiatric examinations transformed into ICD-10 diagnoses. Substance use disorders include all diagnoses beginning with F1*, schizophrenia spectrum disorders; F2*, mood disorders; F3*, neurotic disorders; F4*, other personality disorders; F60*, except F60.2 and F60.3, pyromania; F63.1, mental disability; F7*, somatic disorders include somatic diseases such as diseases of the circulatory system, XYY Klinefelter syndrome, diabetes, and cancer. The last column of other diagnoses includes ADHD, learning disabilities and psychological and behavioral disorders associated with sexual development and orientation. Comorbidities are common, and thus, the number of diagnoses exceeds the number of firesetters.]

5.1.2 STUDY II

The mean age of the 426 firesetters in Study II was 33.5 years (SD 11.54, range 15.5–67.8) at the time of their evaluation. The
distribution of principal psychiatric diagnoses was similar to that in Study I (Figure 2).

Figure 2. Distribution of principal diagnoses according to the pretrial forensic psychiatric examination in Studies I and II.

5.1.3 STUDY III
The final number of firesetters in Study III was 129, after exclusion of the intellectually disabled. The mean age was 32.3 years (SD 11.1, range 16–67). The principal psychiatric diagnosis was a schizophrenia spectrum disorder in 30 (22.2%), a personality disorder in 76 (56.3%), and some other psychiatric disorder (mood disorder, adjustment disorder, alcohol dependence, pyromania) in 22 (16.3%). One firesetter (0.7%) had no psychiatric diagnoses.

Forty-one subjects (30.4%) were fire-setting recidivists and 94 (69.6%) had a history of only one fire-setting.

Versatile firesetters differed significantly with respect to the distribution of psychiatric diagnoses compared with exclusive
ones. The versatile firesetters were more often diagnosed with a personality disorder (exclusive n=23 (46%), versatile n=53 (67%), χ²=5.626, p=0.03, φ=0.209, max=1.050).

5.1.4 STUDY IV
In this study, I focused on the age group of 15-25 years, and hence, the study population consisted of 111 firesetters with no history of past or current schizophrenia spectrum disorder. The mean age of these youths/men was 21.3 years (range 15.5-25.7, SD 2.50).

5.2 MORTALITY (I)

5.2.1 OVERALL MORTALITY
Firesetters were 2.5 times more likely to die during the follow-up than control subjects (OR 2.47, 95% CI 2.00-3.05, p<0.001). Thus, 209 firesetters (48.0%) and 383 controls (22.0%) passed away. The firesetters died at a significantly younger age as well, their mean age being 53 years compared with 62 years for the controls (t=7.0350, p<0.001).

The mortality rate was even higher for firesetters, being 15-24 years at the beginning of follow-up. In this group, 30 (24.2%) and 32 persons (6.5%), respectively, died (OR 3.95, 95% CI 2.37-6.59, p<0.001).

5.2.2 CAUSES OF DEATH
Firesetters died more often due to unnatural causes of death such as poisonings and traumas (Figure 3). This tendency was accentuated early in the follow-up, but as time passed more natural reasons caused the deaths. In the control group, natural deaths dominated throughout the follow-up period (Figure 4). A total of 35 firesetters (8.0%) and 17 controls (1.0%) committed suicide (OR 8.87, 95% CI 4.91–15.99, p<0.001).
Figure 3. Causes of death for firesetters and control subjects. The total number of firesetters was 435 and controls 1740, and the corresponding total numbers of deaths were 209 (48%) and 383 (22%).
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Of the 83 firesetters with a principal diagnosis of a schizophrenia spectrum disorder, 35 (42.2%) passed away during follow-up. The corresponding figure for the 211 personality-disordered firesetters was 93 (44.1%), for the 18 intellectually disabled 7 (38.9%), and for the 120 firesetters with other psychiatric diagnoses 74 (61.7%). None of the three persons without a psychiatric diagnosis had died.

For firesetters, alcohol was the primary cause in 26 (6.0%) of the 105 natural deaths and in 16 (3.7%) of the 45 deaths due to poisonings among the unnatural deaths. Among the controls, the
figures were 37 (2.1%) and 11 (0.6%), respectively. The differences were statistically significant. Other major groups of substances causing deaths in addition to alcohol were prescribed drugs, mainly antiepileptics or sedatives, and illegal drugs or poisonous substances. The figures for firesetters were 18 poisonings caused by drugs (4.9%) and 11 by combinations of alcohol and drugs or carbon monoxide (2.5%). The corresponding numbers for control subjects were 9 (0.5%) and 4 (0.2%) (OR 8.30, 95% CI 3.70-18.6, p<0.001 and OR 11.3, 95% CI 3.57-35.5, p<0.001, respectively).

Natural deaths were mostly caused by cardiovascular diseases, accounting for 39 (18.7%) and 102 (26.6%) deaths, respectively (OR 0.63, 95% CI 0.42-0.96, p=0.038). The second largest group was malignancies causing 17 (8.1%) and 92 (24.0%) deaths per group (OR 0.28, 95% CI 0.16-0.48, p<0.001).

Seven firesetters (3.3%) and two controls (0.5%) died in or due to fires because of carbon monoxide poisoning or burns (OR 6.60, 95% CI 1.36-32.07, p=0.011). All of these persons were under the influence of alcohol or drugs at the time of death. The intent of the deceased persons could not be established with certainty.

5.3 SUICIDALITY (II)

5.3.1 NUMBER OF SUICIDE ATTEMPTS

In Study II, 426 firesetters were compared with 1704 control subjects with respect to the number of hospital-treated suicide attempts. The focus was on suicide attempts serious enough to require treatment in hospital. There were 78 firesetters (18.3%) attempting suicide 191 times and 29 controls (1.7%) attempting suicide 48 times during follow-up. The firesetters were significantly more prone than controls to attempt suicide (OR 12.95, 95% CI 8.32-20.13, p<0.001).

The firesetters were more likely to have a single serious suicide attempt, but the OR for having multiple serious suicide attempts was even higher (OR 18.04, 95% CI 8.96-36.33, 67
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$p<0.001$). The mean number of suicide attempts was $2.5$ (SD 1.9) for firesetters and $1.7$ (SD 1.1) for controls ($t=3.18$, $p=0.004$).

5.3.2 METHODS OF SUICIDE ATTEMPTS

Intentional self-poisoning was the most frequently chosen method for attempting suicide in both groups. This method was used in 145 of 191 (75.9%) of the firesetters’ and in 39 of 48 (81.3%) of the controls’ attempts. Sedatives and hypnotics and psychotropic agents were the most common drugs in the poisonings.

The second most common method was by unspecified means in both groups, and least common were more violent means such as drowning, submersion, firearm discharge, sharp objects, or jumping from high places.

5.3.3 MORTALITY AND LENGTH OF STAY IN HOSPITAL

All in all, 37 (47.4%) of the firesetters and 11 (37.9%) of the controls attempting serious suicide later died. For nine (11.5%) and two (6.9%) subjects, respectively, the cause of death was suicide. The rest died of natural causes, accidents and poisonings, or under unclear circumstances in which intent could not be resolved. No significant differences were present between the groups in the above-mentioned parameters.

The median length of being an inpatient after a serious suicide attempt was two days in both groups (range of firesetters 1-291 days and of controls 1-18 days). The firesetters’ mean length of stay was 5.6 (SD 22.8) days and for controls 3.7 (SD 3.1) days. This difference was not significant ($t=0.754$, $p=0.453$).

5.4 PSYCHOPATHY (III)

5.4.1 PSYCHOPATHIC TRAITS ASSESSED BY PCL-R

When using a cut-off score on the PCL-R of $\geq 30$ points, two (1.6%, 95% CI 0.0-3.7) of the 129 individuals fulfilled the criteria
for psychopathy. When using the lower cut-off score of ≥ 25 points, 19 persons (14.7%, 95% CI 8.6-20.8) met the criteria.

The mean Factor 1 score was 5.0 (SD 3.41, range 0–13) and the mean Factor 2 score 9.9 (SD 3.86, range 1–18), while the mean PCL-R total score was 16.1 (SD 6.88, range 2–33).

5.4.2 PSYCHOPATHIC TRAITS AND FIRE-SETTING RECIDIVISM

One-time firesetters were compared with fire-setting recidivists, and no significant differences between PCL-R total, Factor 1, or Factor 2 scores were found. In the subgroup of 88 one-time firesetters, one person (1.1%) scored ≥ 30 points and 11 (12.5%) ≥ 25 points. In the subgroup of 41 recidivists, one person (2.4%) scored ≥ 30 points and eight (19.5%) ≥ 25 points.

The mean Factor 1 score was 4.8 (SD 3.01, range 0–12), the mean Factor 2 score 10.3 (SD 3.80, range 0–18), and the mean PCL-R total score 16.6 (SD 7.10, range 4–33). No significant differences were found between the items.

5.4.3 PSYCHOPATHIC TRAITS AND VERSATILE OFFENDING

Finally, exclusive firesetters were compared with persons showing versatile criminal behavior. Among the exclusive firesetters, only one (2.0%) had a PCL-R score ≥25 points, while the corresponding figure for the versatile firesetters was 18 (22.8%). Thus, the versatile firesetters were 14 times as likely as the exclusive firesetters to show significant psychopathy (OR 14.46, 95% CI 1.86-112.15, \( p=0.002 \)). The versatile firesetters had significantly higher mean total and factor scores as well. Among the different items of the PCL-R, the versatile firesetters scored significantly higher on items 6 (lack of remorse or guilt), 14 (impulsivity), 15 (irresponsibility), and 20 (criminal versatility). See Figure 5 for the distribution of PCL-R scores on the different items and in total.
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5.5 YOUNG FIRESETTERS AND SCHIZOPHRENIA (IV)

In Study IV, during follow-up, which lasted on average 25 years, 14 (12.6%) of the 111 firesetters aged 15-25 years were diagnosed with SCH. Respectively, of their 440 controls, 5 (1.1%) got a similar diagnosis. In other words, persons undergoing a forensic psychiatric examination because of a fire-setting crime, had a HR of 12.5 (95% CI 4.49-34.65, \( p < 0.001 \)) of falling ill with SCH after the offense. The delay between the index fire-setting crime and diagnosis with the disorder was on average 9.7 years (SD 7.9), ranging from 1.0 to 25.7 years. Less than half, or six (42.9%), of these persons were diagnosed with SCH within five years of the crime.

Persons falling ill with a schizophrenic disorder differed from persons not falling ill only with respect to having more often previous convictions for crimes in general (12 (85.7%) vs. 41 (42.3%) persons), and also violent crimes (6 (42.9%) vs. 11 (11.3%) persons). The persons later receiving a SCH diagnosis were eight (OR 8.20, 95% CI 1.74-38.62, \( p = 0.003 \)) times more likely to have previous crimes in their history and five (OR 5.86, 95% CI 1.71-20.07, \( p = 0.005 \)) times more likely to have convictions for violent crimes. No significant differences between the groups were found with respect to the number of earlier fire-settings, primary diagnoses, comorbid alcohol use disorders, or mortality rate during follow-up.
5.6 SUBSTANCE USE DISORDERS (UNPUBLISHED DATA)

5.6.1 PREVALENCE
When examining the firesetters of Study II (426 firesetters and 1704 controls) with respect to their substance use disorders, 277 (65.0%) had an alcohol and 17 (4.0%) another substance use disorder diagnosed in the forensic psychiatric examination. Most of the other drug use disorders were comorbid with an alcohol use disorder; only five subjects (1.2%) had a drug use disorder on its own.

During follow-up 317 firesetters (74.4%) and 189 controls (11.1%) were treated for alcohol use disorders, with altogether 2956 and 963 treatment periods, respectively. Additionally, eight firesetters (1.9%) and 12 controls (0.7%) received treatments for drug use disorders, resulting in 348 and 66 treatment periods per group.

The length of the follow-up period varied between individuals, so in order to get comparable figures, I present the numbers per 10 years of follow-up. Hence, the mean number of treatment periods per 10 years due to alcohol use disorders was for firesetters 6.3 (SD 11.1, median 2.6) and for controls 3.2 (SD 6.5, median 1.2). The Mann-Whitney U-test sum of ranks was 88461 ($p<0.0001$), indicating that firesetters had significantly more treatment periods per 10 years because of alcohol use disorders than controls.

5.6.2 EXCLUSIVE VERSUS VERSATILE FIRESETTERS
In this sample, there were 49 firesetters (11.5%) with earlier convictions for fire-setting crimes and 210 (49.3%) with convictions for versatile criminality before the index fire-setting.

In the forensic psychiatric examination, 32 exclusive firesetters (65.3%) were diagnosed with an alcohol and one (2.0%) with a comorbid drug use disorder. Among the versatile firesetters, 172 (81.9%) had an alcohol and 13 (6.2%) a drug use disorder; two persons did not have a comorbid alcohol disorder.
Versatile firesetters had significantly more alcohol use disorders than exclusive firesetters at the beginning of follow-up (OR 2.40, 95% CI 1.21-4.77, p=0.013).

During follow-up 41 exclusive (83.7%) and 187 versatile firesetters (89.0%) had at least one treatment period for alcohol abuse (OR 1.59, 95% CI 0.66-3.80, p=0.328). Drug abuse alone resulted in three exclusive (6.1%) and two versatile firesetters (1.0%) to undergo at least one treatment period.

In the forensic psychiatric examination, nine exclusive (22.0%) and 30 versatile firesetters (16.0%) with at least one treatment period for a substance use disorder were diagnosed with an antisocial personality disorder, and the same numbers of persons were found to have a borderline personality disorder (OR 0.68, 95% CI 0.29-1.57, p=0.493). Both personality disorders were diagnosed simultaneously in one exclusive and four versatile firesetters.
Discussion

6 DISCUSSION

This study included a consecutive sample of pretrial male firesetters who had undergone a forensic psychiatric examination during 1973-1998 in Helsinki University Hospital. The number of firesetters included in the different studies varied between 111 (IV) and 435 (I). The number of control subjects was four times that of the firesetters in each study. The follow-up period lasted up to 40 years.

6.1 MORTALITY OF FIRESETTERS (I, II)

In Study I, I compared the mortality rate of firesetters with that of age-, gender-, and place of birth-matched control subjects representing the general population. The mortality rate of firesetters was 2.5 times higher than that of controls. Firesetters died significantly younger and more often due to unnatural causes, especially early in follow-up. This is the first study to compare the mortality of firesetters with that of a matched control group. It is well known that persons with mental disorders have a higher mortality rate than the general population (Charlson et al. 2014), due to both unnatural and natural conditions (Crump et al. 2013; Lawrence et al. 2013). A higher mortality rate has also been associated with alcohol use disorders (Rehm et al. 2010).

6.1.1 OVERALL MORTALITY AND RISK FACTORS

Firesetters bear many risk factors associated with elevated premature death; for example, most firesetters in our study were diagnosed with some mental disorder. Studies have shown that persons with schizophrenia-related or other serious mental disorders have a mortality rate that is two to three times as high as that of the general population (Joukamaa et al. 2006; Tidemalm et al. 2008) and their life expectancy is 10-20 years.
shorter (Laursen et al. 2014; Nordentoft et al. 2013). Wahlbeck and colleagues (2011) showed in a large register-based study that the life-expectancy gap of about 20 years did not decrease intrinsically for mentally disordered men in Sweden during a 20-year follow-up, although a slight positive trend was noted in Finland and Denmark and among Swedish women.

Persons with mental disorders have a higher mortality rate due to the mental disorder itself, but furthermore due to somatic morbidity. The relationship is complicated. Persons with mental disorders do not only have a higher risk of suicide (Li et al. 2011; Page et al. 2014), which was accentuated in our findings as well, but also have numerous risk factors for somatic diseases. Mentally disordered persons smoke more often (Dickert et al. 2015), lead sedentary lives (Carpiniello et al. 2013), and sometimes use psychiatric medication, which can cause weight gain, diabetes, coronary disease, etc. (De Hert et al. 2011; De Hert et al. 2012; Young et al. 2015). By contrast, some studies have shown reduced mortality rates among the mentally disordered using medication (Crump et al. 2013; Tiihonen et al. 2009). It seems, however, that polypharmacy and high doses increase the risk of adverse effects (Correll et al. 2015), and polypharmacy and discontinuation of medication may increase all-cause mortality (Haukka et al. 2008b; Joukamaa et al. 2006). In this study, I did not take into account somatic illness or medication use and how these might have affected mortality.

Another important issue is social inequality in society, leading to persons in lower social classes not seeking help in time for different medical conditions. However, Nordic societies provide tax-funded healthcare services, which is generally thought to decrease social inequalities. Children from families with one or more mentally disordered parent are, however, at risk of receiving a worse beginning in life, living in families with unemployment, living with the stigma of an ill parent, and so on. Childhood and early family conditions affect future mortality (Elo et al. 2014). There are studies showing that social inequalities are associated with increased rates of psychotic illness (Kirkbride et al. 2014; Van Os et al. 2000; Zammit et al. 2010), which can lead to higher mental and somatic healthcare costs in the future. Firesetters are known to often derive from low
social status or troubled families. Whether the growing inequalities in Finnish society will further accelerate the increasing arson trend, e.g. through these mechanisms, remains to be seen.

This study found that over 60% of the firesetters received a diagnosis of an alcohol use disorder in the forensic psychiatric examination and nearly three-fourths had a treatment period due to alcohol use during follow-up. Earlier studies confirm the frequent occurrence of alcohol use disorders among firesetters (Rice 1996; Räsänen et al. 1995). According to the Global Burden of Disease 2010 study (Charlson et al. 2014), alcohol dependence was an underlying cause of more than 5 million deaths and causally attributed to more than 110 000 deaths in 2010 globally. Alcohol has been linked to an increased risk of death (Eaton et al. 2013; Timko et al. 2006) and morbidity of several somatic and mental disorders (Rehm et al. 2010). Among our sample of firesetters, alcohol was involved in nearly 10% of the deaths, as opposed to less than 3% of controls' deaths.

In 2014, Finns aged at least 15 years, consumed over 9 liters of 100% alcohol, which is far above the global consumption of about 6 liters per person (Säkkinen et al. 2015). In the same year, alcohol use was responsible for about 4% of all deaths in Finland, and additionally, alcohol contributed to a substantial proportion of accidental or violent deaths (Official Statistics of Finland 2015).

Charlson et al. (2014) estimated that illicit drug use caused over 700 000 excessive deaths indirectly and 44 000 directly in 2010. Among the firesetters in my study, drug use disorders were quite rare, which might in part reflect the substance abuse profile of the mentally ill in Finland. Another possible reason for drug use disorders being rare in my sample is that the firesetters may have lacked the social skills needed to acquire illegal drugs, whereas alcohol was easily bought from a liquor store.

In a recent Danish study among 41 470 persons with schizophrenia, 11 739 with bipolar disorder, and 88 270 with depression, it was established that the presence of a dual diagnosis, i.e. having both a mental disorder and a substance use disorder simultaneously, significantly increased the risk of all-cause mortality (Hjorthøj et al. 2015). The majority of firesetters
in my study had dual diagnoses. Risk factors for suicidal behavior and mortality in general accumulate in these individuals, who represent the most stigmatized segment of the population.

6.2 CAUSES OF DEATH (I, II)

6.2.1 NATURAL CAUSES
Natural causes of death constituted 50% and 80% of all deaths occurring among firesetters and control subjects, respectively, during follow-up. In controls, natural deaths dominated throughout the follow-up, while for firesetters natural deaths became the primary cause about halfway through the follow-up. Thus, natural deaths were largely responsible for lives ending prematurely, which is in accordance with other findings concerning mentally disordered persons.

In both groups of this study, the most usual reasons for natural deaths were cardiovascular diseases and malignancies. This was also the case for males of the general population in 2014 (Official Statistics of Finland 2015). Therefore, it is important that interventions aimed at the whole population also include institutionalized persons or persons living socially secluded lives. It is essential that these persons are reached by, for instance, cancer screenings and smoking cessation campaigns.

It has been speculated that undertreatment of physical disease is common among psychiatric patients. However, a Finnish study among long-term inpatients in a psychiatric hospital (Räsänen et al. 2007) concluded that physical diseases are recognized and treated, but challenges are present in dealing with unhealthy life habits and social isolation.

Smoking cessation support is of importance for reducing health inequalities and excess mortality in the mentally disordered since this population segment smokes more frequently. Smoking increases, among other things, the risks of cardiovascular disease and malignancies, both of which are common causes of death in this population. Wu et al. (2015) examined the economic incentives for smoking cessation among people with mental disorder in the UK and reported that by
reducing smoking in this group great sums of money could be saved.

Thornicroft (2013) calls for evidence-based interventions to reduce excess mortality among the mentally disordered in an editorial in the British Medical Journal. He points out that although 126 countries have ratified the United Nations Convention on the Rights of Persons with Disabilities little impact has been seen in persons suffering from mental illness. Mental illness is still badly undertreated in some countries (Wang et al. 2007). Some apprehended firesetters are in involuntary treatment in psychiatric hospitals, where they receive treatment, while other firesetters serve a prison sentence. In prison settings, all persons in need of psychiatric or somatic treatment are not necessarily recognized equally well. Moreover, not all firesetters using psychiatric services feel that they get help, so it is essential to develop interventions for fire-setting behavior in addition to treating the comorbidities.

There are indications that personality-disordered men do not seek help for somatic conditions, leading to higher mortality (Hoye et al. 2013). A considerable proportion of the men in this study belonged to the above-mentioned group, which probably had an impact on excessive mortality.

### 6.2.2 UNNATURAL CAUSES

Firesetters died of unnatural causes, such as different poisonings and traumatic incidents, more frequently than controls. A small proportion deceased in fires, but it is uncertain whether these deaths were intentional or not. As noted in the literature review, investigating fire scenes, and thereby discovering and differentiating between accidents and crimes, homicides, and suicides, is challenging. The process of investigating fires and their origins in Finland is described in detail in the book “Läpi tulen” by Päivi Mäkelä et al. (2013).

Impulsive and aggressive behaviors, e.g. suicides and attempts, violent traumas, or accidents, were ordinary among firesetters. These are also characteristic of borderline and antisocial personality disorders (Goodman and New 2000), the most typically diagnosed personality disorders in my sample
(12.6% borderline and 9.0% antisocial personality disorder). It is generally estimated that 1-2% of the general population (Torgersen et al. 2001) and about 15% of psychiatric inpatients (Widiger and Weissman 1991) can be diagnosed with borderline personality disorder. Wetterborg et al. (2015) found a prevalence rate of about one-fifth among male offenders on probation in Sweden. These probationers had high rates of comorbidities, generally known to affect re-offending. In a Finnish sample, Joukamaa et al. (2010) showed that 2-16% of male and 24% of female prisoners had a borderline personality disorder.

The prevalence of antisocial personality disorder is also 1-2% in the general population (Torgersen et al. 2001) and about 20% in prison populations (Watzke et al. 2006). However, a Finnish study among a prison population found antisocial personality disorder in 57-65% of male and 58% of female prisoners (Joukamaa et al. 2010). There are gender differences, borderline personality being more common among women, and the opposite being the case for antisocial personality disorder (Hoye et al. 2013; Watzke et al. 2006). In the Finnish study mentioned above among prisoners, female prisoners were significantly more often diagnosed with borderline personality disorder, while there was no significant difference between genders with respect to antisocial personality disorder (Joukamaa et al. 2010).

Eaton and colleagues (2013) noted that antisocial personality disorder was associated with premature death, both with and without a comorbid substance use disorder. The high prevalence of these disorders in our sample may, in part, explain the high mortality of the firesetters. Impulsive behavior leads to premature deaths in accidents and in self-inflicted harm.

In many countries, persons suffering from serious mental illness can be retired early for mental reasons if the prognosis of recovery is weak. This is often the case for firesetters suffering from chronic serious mental illness. However, it is unclear whether this possibility is a positive one or not. There is evidence of disability retirement due to mental reasons leading to excess mortality, especially in alcohol-related deaths and deaths from other unnatural causes such as suicide (Leinonen et al. 2014). An activating approach may be more beneficial for affected individuals.
6.2.3 SUICIDE

The findings of this study confirm earlier findings of firesetters attempting and completing suicide frequently (Repo et al. 1997b). Offenders are in general a high-risk population for self-harm and suicide (Clarke et al. 2011; Hawton et al. 2014), and my findings were similar. Suicide is not unusual among persons with schizophrenia-related disorders (Singhal et al. 2014) or personality disorders (Pompili et al. 2005), both of which were common in this study.

Impulsive aggression, as seen in borderline and antisocial personality disorders, is associated with self-disruptive behaviors, although it might be that aggression in borderline personality disorder is mediated primarily through emotional dysregulation and poor social cognition (Herpertz et al. 2014; Scott et al. 2014). In any case, the heightened risk of acting impulsively may lead to impulsive suicidal acts even in response to a minor burden (Kumar et al. 2013).

In this study, I focused on hospital-treated suicide attempts, not taking into account less lethal self-harm. In Hawton and colleagues’ (2014) study among prisoners, only 1% of suicide attempts were of high lethality. Some self-harm is probably overlooked by healthcare personnel, and some individuals engaging in self-harm do not seek help for their behavior. Compared with prisoners, it is, however, reasonable to assume that this subsample, consisting of pretrial firesetters subjected to a forensic psychiatric examination, was expressing higher levels of psychopathology, increasing the risk for suicidal behavior.

Tobacco use, common among the mentally disordered, is associated with a risk of suicide attempts (Berlin et al. 2015), another important reason to offer support to these offenders in tobacco cessation attempts. Unfortunately, I did not have data on tobacco smoking among my sample, but it can be assumed that the rate was high, as in other samples of persons with severe mental disorders (De Leon and Diaz 2005).

The most recurring suicide attempt method among firesetters and control subjects was poisoning, specifically drug poisoning with hypnotics, sedatives, and psychotropics. This finding is in line with a large general population-based study of more than 18,000 individuals in Finland (Haukkka et al. 2008a). In prison
populations, the same pattern concerning the self-harm method has been observed (Hawton et al. 2014). In a study in the general population, alcohol intoxication contributed to 42% of suicides (Mäki and Martikainen 2008).

Generally, knowledge about suicidal firesetters is based on apprehended firesetters. However, Barrowcliffe and Gannon (2015) found among a sample of un-apprehended firesetters that they, too, had significantly more suicide attempts than non-firesetters.

Another well-known risk for suicide is long-term unemployment (Mäki and Martikainen 2012), which is prevalent among firesetters (Dalhuisen et al. 2015; Räsänen et al. 1995). Low social class itself is associated with an elevated suicide risk, regardless of employment status (Mäki and Martikainen 2008).

Preventing suicides is essential in the general population, but also high-risk groups, such as firesetters, should have their own strategies for approaching this issue. A well-known risk factor for suicide is previous self-harm (Bolton et al. 2015; Hawton et al. 2014). In my study, one-fourth of the firesetters and one-fifth of the controls attempting suicide eventually succeeded in killing themselves. Prisoners may be reluctant to disclose suicidal thoughts or self-harming behavior (Way et al. 2013). Therefore, self-harming behavior should be assessed actively during institutionalization so that prompt measures can be undertaken. Support should also be offered when these individuals are released.

6.3 PSYCHOPATHIC TRAITS (III)

6.3.1 PSYCHOPATHIC TRAITS ASSESSED BY PCL-R

This study found that only 1.6% of the firesetters scored ≥30 points on the PCL-R, which is the original cut-off point (Hare 2003). When using a cut-off score of ≥25, about 15% of the sample had significant psychopathic traits. A study among Finnish prisoners found a prevalence of 12.3% when the cut-off score was ≥30 (Jüriloo et al. 2014). Their study reported that 17.7% scored at least 27 points. In this study, the firesetters
showing the highest number of psychopathic traits were the versatile firesetters (n=79), who presumably most resembled the prison population. Among the versatile firesetters, 18 (22.8%) scored ≥25 points on the PCL-R.

The mean PCL-R score of the prisoners in the study by Jüriloo et al. (2014) was 19.52 (SD 8.05). In this study, the mean score for the whole group of firesetters was 16.1 (SD 6.88) and for the versatile subgroup of firesetters 18.4 (SD 6.51). In a Dutch study comparing 25 arsonists with 50 other offenders of serious crime (Labree et al. 2010), the mean PCL-R score of the arsonists was 17.4 and of the other offenders 18.3 (no significant difference).

The PCL-R explains two factors, with Factor 1 depicting the way the person relates to other people and Factor 2 the lifestyle. The former is often thought of as describing a “true” psychopath (Cleckley 1976), while the latter better reflects antisocial behavior. For the whole group of firesetters, the mean Factor 1 score was 5.0 (SD 3.41) and Factor 2 score 9.9 (SD 3.86). In the Dutch study, the corresponding scores were 7.8 and 8.4 for arsonists and 8.1 and 8.5 for non-arsonists, with no significant differences between groups (Labree et al. 2010). The scores of the Finnish prisoners were 7.1 (SD 3.7) and 9.7 (SD 4.1), respectively (Jüriloo et al. 2014). The versatile firesetters in my study scored 5.8 (SD 3.44) for Factor 1 and 10.8 (SD 3.86) for Factor 2.

Looking at the separate items, I anticipated high scores on impulsivity, presuming that the theory of high impulsivity in firesetters is correct. On item 14 (impulsivity), the versatile firesetters scored 1.9 and the exclusive firesetters 1.4, thus showing a significant difference. The arsonists in the study by Labree et al. (2010) also scored significantly higher than other offenders on item 14, the mean being 1.7 vs. 1.3. Additionally, in Labrees and colleagues’ study, the arsonists scored significantly lower on items 1 (superficial charm) and 18 (juvenile delinquency), 0.3 vs. 0.7 and 0.2 vs. 0.6, respectively. In this study, I did not find significant differences between groups in the scores on item 1 or 18.

Among firesetters, there appears to be a subgroup bearing significant psychopathic traits, and in this study they were characterized by versatile offending. No difference emerged in the number of fire-settings between exclusive and versatile
firesetters, but for the latter group fire-setting was just one crime among others. The impulsivity scores were higher for this group within firesetters, and Labree et al. (2010) observed that firesetters scored higher than other offenders of serious crimes. Also, when comparing factor scores, firesetters scored higher on Factor 2, which measures inadequacy of managing impulses. This finding is in line with the theory of firesetters having difficulties in controlling impulses and showing impulsive behavior.

6.3.2 PSYCHOPATHIC TRAITS AND FIRE-SETTING RECIDIVISM

The hypothesis was that fire-setting recidivists would score higher on the PCL-R than one-time firesetters. However, no significant differences existed between these two groups in total scores or item scores. This study thus provides no support for fire-setting recidivism being associated with significant traits of psychopathy. Nevertheless, it is possible that persons with diagnoses of pyromania could be found among these recidivists, which would offer one explanation for the low score on the PCL-R. Also, it is possible that persons with high traits of psychopathy may be more skilled at concealing their crimes, thus avoiding being caught.

6.3.3 PSYCHOPATHIC TRAITS AND VERSATILE OFFENDING

I divided the firesetters into persons having only fire-setting in their official records and persons performing other crimes as well. I found significantly higher amounts of psychopathic traits among versatile firesetters when looking at PCL-R total scores, factor scores, and also several item scores. Other studies have reported similar findings in prison populations (Långström and Grann 2002; Mokros et al. 2014; Porter et al. 2001).

Ducat et al. (2013a) compared fire-setting offenders with non-fire-setting offenders and further exclusive firesetters with versatile ones. They stated that exclusive firesetters did not differ
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with respect to the number of lit fires, a finding supported here. Furthermore, they noted that versatile firesetters had significantly more prior offending and more often had a diagnosis of a personality disorder, which was also the case among our firesetters.

According to these results, we are most likely to find highly psychopathic individuals performing crimes without much selection among the versatile firesetters. However, not all offenders perform fire-settings, so these individuals are likely to have some preference for fire. One can only speculate whether the interest stems from early experiences, a habit picked up later, or a general indifference towards the lives or property of others. More research of this highly criminal subpopulation of firesetters is thus warranted.

6.4 YOUNG FIRESETTERS (IV)

The hypothesis was that fire-setting in adolescence or young adulthood would predict a later diagnosis of SCH. The general prevalence of schizophrenia is estimated to be 0.4-0.9% in the general population (Perälä et al. 2007; Saha et al. 2005), but nearly 13% of the firesetters in Study IV were treated for SCH during follow-up. Gosden et al. (2005) investigated 780 offenders aged 15-19 years convicted of violent crimes. They found that a conviction of a violent crime predicted a later hospitalization for schizophrenia. The prevalence of schizophrenia was 3.3% when the offenders were aged 23-29 years. In Gosden and colleagues’ (2005) study, arson did not predict future hospitalizations for schizophrenia, but the authors speculated that this result may be affected by the relatively small amount of arsonists (n=31) in their study or the follow-up period not being long enough. In our study, the delay in receiving a diagnosis of SCH was almost ten years. Less than half of the subjects were diagnosed within five years, which is estimated to be the average length of the prodromal phase of schizophrenia (Häfner 2015). Hence, a sufficiently long follow-up is important when investigating these issues.
Among the firesetters in our study, having a conviction of any crime or a violent crime was more common with those later afflicted with SCH. These groups did not differ in mortality, prevalence of substance use disorders, or earlier fire-settings.

Other studies have shown that youngsters in high-risk groups for psychosis have more criminal convictions (Purcell et al. 2014) and that one-fifth reported current violent thoughts or plans (Hutton et al. 2012). Another study among community adolescents reported an association between fire-setting and psychopathology (psychological distress, sensation seeking, delinquent behavior, suicidal intent) and substance use disorders (MacKay et al. 2009).

A recent study by Hoerold and Tranah (2014) comparing fire-setting and non-fire-setting antisocial adolescents with control adolescents in school reported that both the fire-setting and non-fire-setting antisocial adolescents showed high levels of uncaring traits and low cognitive empathy. Also, the fire-setting adolescents had elevated scores of impulsivity and a high degree of callous traits. In their study, the fire-setting frequency was best predicted by high impulsivity.

Thus, adolescents setting fires, especially those also carrying out other crimes, should be thoroughly assessed for psychiatric symptoms. Also, this group of young offenders needs long-term follow-up for psychotic symptoms. They constitute a high-risk group for future SCH, so when planning treatment a preventive approach may be valuable.

6.5 SUBSTANCE USE DISORDERS

Alcohol is the main substance abused by Finnish firesetters. Cannabis, which is the most widely used illegal drug in Finland (Säkkinen et al. 2015), did not seem to be used in larger amounts by the study population. Drug screening from urine samples was not routinely performed in forensic psychiatric examinations when this sample of firesetters was collected, so the use of cannabis or other drugs that can be detected in a urine sample cannot be completely ruled out. In the general population, about one-fifth of persons have sometime used cannabis, and when
focusing on 25- to 34-year-olds the amount is doubled. An estimated 0.55-0.9% of Finns aged 15-64 years use opioids or amphetamine in a problematic manner (Säkkinen et al. 2015).

Cannabis has been shown to be associated with psychosis (Casadio et al. 2011), but this could not be explored in our sample as hardly anyone had used cannabis according to the registers. Possibly, the sample being collected some time ago has an impact on this, as it is mostly young people that try cannabis, and back in the 1970s to 1990s cannabis use was not yet prevalent in Finland. According to statistics from 2010, the use of cannabis seems to double with each 10-year cohort (The National Institute for Health and Welfare 20.10.2014). Among persons born in 1945-1954, about 5% had at some point used cannabis, among persons born in 1955-1964 about 10%, among persons born in 1965-1974 about 20%, and among persons born in 1975-1984 about 35%. Cannabis use could also have been missed in my study if the personnel did not fill in all diagnoses in the Care Register for Health Care.

Also, according to the official records, diagnoses of benzodiazepine use disorders were rare. Prescription registers of pharmacies would likely have yielded more accurate information on benzodiazepine use. In any case, this finding applied to both firesetters and controls.

No significant differences emerged between exclusive and versatile firesetters with respect to amount of substance use in treatment periods during follow-up. At the time of the forensic psychiatric examination, versatile firesetters had, however, about two times more often a diagnosis of an alcohol use disorder. When comparing firesetters with controls, firesetters had significantly more treatment periods due to alcohol use. Substance use other than alcohol caused only eight (1.9%) and 12 (0.7%) treatment periods for firesetters and controls, respectively.

Among unapprehended firesetters, the rate of being intoxicated at the time of fire-setting or having a substance use disorder seems to be significantly smaller. Unapprehended firesetters reported that 2.5-12.5% were intoxicated when igniting their fires (Barrowcliffe and Gannon 2015). The authors speculate that maybe intoxicated firesetters cannot cover their
tracks and are therefore over-represented in the fire-setting population of many studies. Another hypothesis is that intoxicated firesetters, as a result of the disinhibitory effects of alcohol, may set fire to structures where it more easily gets out of hand, leading to an uncontrolled fire, garnering attention and leading to apprehension.

6.6 STRENGTHS AND LIMITATIONS OF THE STUDY

6.6.1 STRENGTHS OF THE STUDY
Strengths of this study were that I managed to collect a consecutive sample of firesetters from 1973-1998 and the long follow-up time. Also, the quality of the Finnish Register for Health Care (Aro et al. 1990) and the Causes of Death Register (Lahti and Penttilä 2001) is good. The Population Information System contains information on all citizens and their unique identification number, making the use of this register in research possible and valid.

In Study IV, the absence of cannabis use was positive since cannabis use would have increased the incidence of psychoses. However, because this was a register-based study we cannot be certain of the correctness of this missing diagnosis. Nevertheless, it is unlikely that psychoses directly linked to excessive cannabis use would have gone without mention of the substance in the registers.

6.6.2 LIMITATIONS OF THE STUDY
An estimated 10% of firesetters suspected by the Police undergo a forensic psychiatric examination (Räsänen 1995). Most likely, only the most severe cases that would result in harsh punishments are chosen for a forensic psychiatric examination. The assessment of whether an examination is needed is made by the court, without consulting medical experts, and hence, the decision could be arbitrary. At the time when my sample of
firesetters was examined, forensic psychiatric examinations were performed, in addition to at the Helsinki University Hospital, in state mental hospitals and on psychiatric wards of a prison. Generally, the last-mentioned location involved persons most likely to attempt an escape or showing the most antisocial features. A state mental hospital was preferred for persons obviously suffering from a serious psychiatric disorder. Thus, my sample constituted a highly selected group of firesetters, arising from pretrial forensic psychiatric examinations, where the first selection took place depending on the appearance of the fire-setting crime and the firesetter himself. The group of firesetters in this study is not representative of firesetters in general. In addition, the sample consisted only of males. Fire-setting is, however, known to be more prevalent among males than females (Hoertel et al. 2011).

There was a number of unclear deaths (n=13, 6%), and among these deaths there might have been suicides, leading to even greater suicide losses than those observed. However, there was also a number of unclear deaths among controls, so the groups were still comparable (n=11, 3%).

It is also possible and even likely that not all suicide attempts were recognized by healthcare personnel or that the discharge report was not filled in correctly, leading to underrecognition of self-harm as well. Since the follow-up period was long, it is also possible that the threshold for reporting suicides and suicide attempts had varied over the decades. However, these potential flaws in reporting are likely to be equal for both groups, and hence, would not have skewed the results markedly.

The substances used in suicide attempts could not be identified on a more specific level than that the majority belonged to hypnotics, sedatives, and psychotropics. Additionally, there were some organic compounds and carbon monoxide causing intoxications. The numbers were not large enough to divide into subgroups for analyses.

Sociodemographic background factors were not collected from the forensic psychiatric examination reports. Socioeconomic status and possible early traumas or maltreatment, which are known risk factors for psychiatric and somatic morbidity and mortality (Afifi et al. 2007; Muennig et al.
Firesetters are known to often have relationship problems (Dickens et al. 2007; Hurley and Monahan 1969), to be unemployed, and to have low levels of education (Ritchie and Huff 1999; Räsänen et al. 1996). All of these factors might have affected the results.

Information on responsibility could have been gathered and used in comparison within the whole group of firesetters with respect to, for example, psychiatric diagnoses and whether the firesetter was versatile or exclusive in re-offending behavior.

The forensic psychiatric reports contain one principal diagnosis and possibly also other diagnoses. We took only the principal diagnosis into account when dividing the firesetters into diagnostic groups. As described under each section’s heading, sometimes also comorbid diagnoses were taken into account, e.g. substance use or personality disorders, as appropriate.

Firesetters were divided into one-time, recidivist, exclusive, or versatile firesetters on the basis of the official criminal records presented in the forensic psychiatric examination. Occasionally, the firesetter described crimes that he was not convicted of in the interviews during the examination. These crimes were taken into account when rating the PCL-R, although they could not be officially verified. Moreover, it is possible that one-timers later set new fires, thus becoming recidivist firesetters, and that exclusive ones offended in ways other than fire-setting, becoming versatile firesetters.

In Study III, two firesetters were under the age of 18 years. They were nevertheless assessed using PCL-R instead of Psychopathy Checklist – Youth Version (Forth et al. 2003).
7 CONCLUSIONS

7.1 SUMMARY AND CONCLUSIONS

This register-linkage study dealt with pretrial male firesetters who had undergone a forensic psychiatric examination in the Helsinki University Hospital during 1973-1998. The sample was followed until the end of 2012. The focus was on mortality, suicidality, degree of psychopathy, and incidence of schizophrenia. The principal conclusions drawn were the following:

- Comparison of the mortality of 435 firesetters with that of 1740 controls revealed the total mortality of firesetters to be more than double that of control subjects. The firesetters died at an average age of 53.2 years, while the controls died at the significantly older average age of 61.6 years. Alcohol was involved in roughly 10% of the deaths of firesetters and in only 3% of the deaths of controls. Firesetters were eight times more likely to commit suicide. (Study I)

- The 426 firesetters were nearly 13 times as likely as the 1704 control subjects to have attempted suicide leading to hospital treatment. Also, making multiple suicide attempts leading to hospital treatment was more common among firesetters. The most frequently used method of attempting suicide was intentional self-poisoning and exposure to noxious substances. (Study II)

- Among a subgroup consisting of firesetters (n=129) subjected to a forensic psychiatric examination during 1989-1998, the versatile firesetters had the highest degree of psychopathic traits. This was assessed with the PCL-R. Recidivist firesetters did not differ from one-timers with regard to the degree of psychopathic traits. (Study III)
- Firesetters (n=111) with no current or past schizophrenia spectrum disorders who were aged 15-25 years at the time of their forensic psychiatric examinations were significantly more prone to receive a diagnosis of SCH than controls (n=440). The follow-up lasted over 20 years. The average delay of SCH diagnosis from the index fire-setting was nearly 10 years, and only about two-fifths received the diagnosis within five years. The youths later receiving a SCH diagnosis were more often convicted of crimes before the index fire-setting. (Study IV)

- Substance use disorders, mainly due to alcohol, were common among all firesetters. They had significantly more treatment periods due to alcohol use than control subjects.

These findings provide new information concerning the risk of excess mortality of firesetters. Study I is the first in which mortality of a large sample of firesetters was compared with that of a matched control group. The results support earlier studies that have found firesetters to show a proclivity for suicidal behavior and alcohol use disorders. By assessing firesetters with the PCL-R and dividing them into subgroups, one subgroup was identified that showed significant psychopathic traits. Also, fire-setting behavior among adolescents or young adults can predict presence of more severe psychopathology, leading to a schizophrenia spectrum disorder. This finding is in line with previous research among juveniles, but is the first such finding for young adults and with a long follow-up.

As anticipated, the diagnosis of pyromania was rare in the whole sample, although comorbidities and dual diagnoses were common. The most common diagnoses were substance use disorder and different personality and mood disorders.

The results of this study emphasize the importance of reducing the gap in life expectancy between different groups in society. The firesetters constitute a high-risk group in many ways, and the elevated mortality risk was clear. To prevent premature deaths, several issues should be addressed. Firstly,
persons being released from prison or hospital treatment should be offered sufficient support to prevent suicide; the risk is at its highest immediately after release. This group would benefit from an integrated mental health and addiction policy, where social aspects, such as employment, living conditions, etc., are taken into account. It is evident that treating especially alcohol but also other substance use disorders effectively is essential when attempting to reduce premature deaths and re-offending.

Secondly, the persons suffering from serious mental illness are prone to somatic illnesses as well, and therefore, a close-knit liaison between mental and somatic health experts is needed. It is a challenge to meet the needs of this often socially isolated group that will not necessarily seek help on its own.

Thirdly, the subgroup of firesetters characterized by psychopathic traits might need a different approach in treatment for reducing suicide and re-offending. It is necessary to acknowledge this because they are most likely motivated by an antisocial pathway and may not respond to the same treatments given to persons motivated by fire interests. The focus should be redirected to influencing impulsivity.

An effective treatment approach will have the potential to save not only the lives of firesetters but also other burn casualties.

7.2 FUTURE DIRECTIONS

In the future, similar studies should be carried out among firesetters outside the forensic settings. Much of the knowledge concerning firesetters has been acquired from forensic settings, although only a fraction of firesetters end up there. To increase our understanding of the events leading up to fire-settings, we should attempt to reach a more diverse population of firesetters. One way to approach this would be acquiring a national sample from various sources. Moreover, it would be essential to collect sociodemographic background factors and detailed comorbidities and adjust for these in the analyses.

We do not yet know the prevalence of fire-setting behavior in different age groups and in different parts of Finland. Collaborations with researchers investigating fires in Finland
could be developed and by combining different points of view we could extend our knowledge base.

This and other studies have shown that the prognosis of firesetters is not particularly rosy; often their lives end prematurely, sometimes even by suicide. Determining the rate of fire-setting and other offending recidivism is important. Here, one challenge for collecting information from registers on this topic is the diversity of charges a person can face when the crime is that of setting a deliberate fire.

Last, but not least, it is important to try to define different types of firesetters according to the newer theroretical frames. This would promote the development of much-needed effective interventions.
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Conclusions


Conclusions


Conclusions


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