Anniina Lahti

EPIDEMIOLOGICAL STUDY ON TRENDS AND CHARACTERISTICS OF SUICIDE AMONG CHILDREN AND ADOLESCENTS IN FINLAND
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Academic Dissertation to be presented with the assent of the Doctoral Training Committee of Health and Biosciences of the University of Oulu for public defence in Auditorium 1, Building PT1 of the Department of Psychiatry (Peltolantie 17), on 10 October 2014, at 12 noon.

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University of Oulu Graduate School; University of Oulu, Faculty of Medicine, Institute of Clinical Medicine, Department of Psychiatry; Oulu University Hospital, Department of Psychiatry; Helsinki University Central Hospital, Department of Psychiatry, Division of Adolescent Psychiatry

University of Oulu, P.O. Box 8000, FI-90014 University of Oulu, Finland

Abstract

Finnish youth suicide mortality is exceptionally high in international comparisons. This study investigated the epidemiology of child and adolescent (< 18 years) suicides in Finland, with a special focus on gender differences.

Two data sets were employed. Data from the national Finnish Cause of Death Register was used to examine trends in the rates and methods of child and adolescent suicides in Finland in 1969–2012. The characteristics of 58 child and adolescent suicides, which occurred in the province of Oulu in Northern Finland between 1988 and 2012, were explored based on individual-level data extracted from documents pertaining to establishment of the cause of death in medicolegal autopsy investigations. The primary source of data was death certificates. Other sources included documents such as police investigation reports and the results of toxicological investigations. In addition, the suicide data was linked with the Finnish Hospital Discharge Register.

After 1990, suicide rates generally decreased for males, but increased for females. Among females, hanging exceeded poisoning as the most common suicide method after 1990, whereas firearms were the most common method among males, until traffic suicides took the leading position for both genders during 2008–2012. Violent suicide methods of all types increased among females after 1990. Male firearm suicide rates were nearly three times higher in Northern Finland than in Southern Finland, while there was no regional difference in rates of suicide by other methods.

15% of male and 17% of female suicide victims in the province of Oulu had a history of previous psychiatric hospitalization. The discharge diagnoses were heterogeneous. Previous suicidality and self-cutting were more common among females than males. Half of all adolescents were under the influence of alcohol at the time of their death. The majority of the intoxicated adolescents committed suicide at night, during descending blood alcohol concentrations. A notable fall peak was observed in male firearm suicides.

The increase in violent, i.e. more lethal, suicide methods among females is alarming, as females are known to have high rates of attempted suicide. The special characteristics of male firearm suicides in Northern Finland suggest the need for region-specific preventive measures. The high frequency of acute alcohol use in child and adolescent suicides warrants attention.

Keywords: adolescent, alcohol, epidemiologic studies, firearms, gender, mental disorders, seasonality, suicide
Lahti, Anniina, Epidemiologinen tutkimus lasten ja nuorten itsemurhien erityispiirteistä Suomessa. Oulun yliopiston tutkijakoulu; Oulun yliopisto, Lääketieteellinen tiedekunta, Kliininon lääketieteen laitos, Psykiatria; Oulun yliopistollinen sairaala, Psykiatrian klinikka; HYKS, Psykiatrian tulosyksikkö, Nuorisopsykiatrian klinikkaryhmä

Oulun yliopisto, PL 8000, 90014 Oulun yliopisto

Tiivistelmä
Suomalaisnuorten itsemurhakuolleisuus on kansainvälisessä vertailussa korkea. Tässä epidemiologisessa tutkimuksessa selvitettiin alle 18-vuotiaiden suomalaislasten ja -nuorten itsemurhien erityispiirteitä.


Asiastaan: alkoholi, aseet, epidemiologiset tutkimukset, itsemurha, mielenterveyshäiriöt, nuoret, sukupuoli, vuodenaiaksaisvaihtelu
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Oulu, August 2014

Anniina Lahti
Abbreviations

APC Annual percent change
BAC Blood alcohol concentration
BMI Body mass index
CI Confidence interval
FHDR Finnish Hospital Discharge Register
SD Standard deviation
UAC Urine alcohol concentration
WHO World Health Organization
List of original publications

This thesis is based on the following publications, which are referred throughout the text by their Roman numerals:


Some unpublished data are also presented in this thesis.
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1 Introduction

Suicide in a child or adolescent is a painful and devastating event that has a widespread effect on families, friends, and the community. To many, the very idea of young people dying by their own hands is incomprehensible. Yet, it is estimated that global annual suicide fatalities among children and adolescents may approach 100,000 (Greydanus & Calles 2007), making suicide one of the major causes of adolescent mortality throughout the world (Patton et al. 2009).

Suicidal behavior in the young population has long been recognized as a serious public health issue. Completed suicide in children and adolescents is the tip of the iceberg considering the large continuum of suicidality. According to some estimates, there are more than 100 suicide attempts to every completed suicide among adolescents (Maris 2002). Approximately 2–10% of adolescents report having attempted suicide, females more often than males (Bridge et al. 2006, Evans et al. 2005). Thoughts about death and suicide are common in adolescence. Around 10% to 30% of adolescents have had suicidal thoughts at some point in their lives (Evans et al. 2005, Nock et al. 2013).

Finnish adolescent suicide mortality is among the highest in Europe (European Detailed Mortality Database 2014). In early 21st century Finland, suicide has been the second leading cause of death among 15–19-year-old adolescent males and the third for females of the same age (Statistics Finland 2014a). The United Nations Committee on the Rights of the Child has recently expressed its concern about the high rate of depression and high number of suicides among children in Finland, and about inadequate access to mental health services (United Nations Committee on the Rights of the Child 2011). The committee recommended the strengthening of mental health services for children and the intensification of suicide prevention measures.

Gender is an important factor in child and adolescent suicides. Whereas the rate of attempted suicides is higher among females, males predominate in completed suicides, particularly in Western societies (Hawton et al. 2012b). Further, specific psychiatric disorders, a history of previous suicidality, and the distribution of different suicide methods among adolescent suicide victims have all been shown to vary by gender (Brent et al. 1999, Grøholt et al. 1999, Marttunen 1994, Shaffer et al. 1996). Despite the clinical importance of these differences, not all child and adolescent suicide studies have reported their findings for males and females separately, which may reduce the utilizability of the results.
The ultimate aim of suicide research is to increase our knowledge of suicidal behaviors in order to form a basis for effective preventive measures. Epidemiological studies have an important contribution to make to the field of suicidology, as they provide insights regarding the different determinants of suicide. Accordingly, this study sought to investigate the epidemiology of child and adolescent suicides in Finland, with a special focus on gender differences. Finland’s reliable national registers and cause-of-death certification practices form a good basis for performing such research.
2 Review of the literature

2.1 Terms and definitions

2.1.1 Suicide

The concept of suicide is much more complex than is conveyed by the words “killing oneself”, which originate in the Latin terms “sui” (of oneself) and “caedere” (to kill). In defining suicide, it has been emphasized that suicide is a behavior – not a disease, disorder or diagnosis – and that all behavior is multidimensional and determined by multiple factors (Silverman et al. 2007). Numerous definitions of suicide have been proposed, a selection of which is presented in Table 1.

Table 1. A selection of definitions of suicide.

<table>
<thead>
<tr>
<th>Definition of suicide</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>The act of killing oneself deliberately initiated and performed by the person concerned in the full knowledge, or expectation, of its fatal outcome.</td>
<td>World Health Organization 1998</td>
</tr>
<tr>
<td>Self-inflicted death with evidence (either explicit or implicit) that the person intended to die.</td>
<td>American Psychiatric Association 2003</td>
</tr>
<tr>
<td>An act with a fatal outcome, which the deceased, knowing or expecting a potentially fatal outcome, has initiated and carried out with the purpose of bringing about wanted changes.</td>
<td>De Leo et al. 2006</td>
</tr>
<tr>
<td>Self-injurious behavior that resulted in a fatality and was associated with at least some intent to die as a result of the act.</td>
<td>Posner et al. 2007</td>
</tr>
<tr>
<td>Death caused by self-directed injurious behavior with any intent to die as a result of the behavior.</td>
<td>Crosby et al. 2011</td>
</tr>
</tbody>
</table>

Death, i.e. a fatal outcome, is the most easily agreed element between different definitions. Other key aspects include the agency of the act (self-inflicted), the intention to die or stop living, and consciousness/awareness of the outcome (De Leo et al. 2006, Silverman 2006). With regard to the intention to die, because of the generally ambivalent attitude towards living or dying in the case of an individual contemplating suicide, post mortem determination of the presence and degree of suicidal intent is often difficult (Silverman 2006). A central question posed by De Leo et al. (2006) is, “how much more must the suicidal subject wish for death rather than life, in order for their death to be classified as a suicide”. Establishing intent and consciousness/awareness of the outcome can be
particularly problematic regarding suicide in children and young adolescents. According to Mishara (1999), coroners and medical examiners may not classify a pediatric death as suicide due to the commonly held view that children have an insufficient understanding of the finality and irreversibility of death. However, Mishara (1999) found that most 5–7-year-olds and almost all children aged 8–12 know that suicide results in death and understand that death is permanent and final.

For the purposes of this thesis, suicide is defined as deaths that have been officially classified as suicides by medical examiners, based on a medicolegal death investigation practice.

2.1.2 Suicidal and nonsuicidal self-injury, self-harm and suicidality

Not only the concept of suicide itself, but the overall terminology, nomenclature and classification systems of suicidology are complex and have been a topic of considerable international debate (De Leo et al. 2006, Skegg 2005). From one viewpoint, death is not always the aim of self-injurious behaviors, i.e. there is no intent to die. The presence or absence of the intent to die can therefore be used as a premise for dichotomizing self-injurious behaviors into suicidal (when there is evidence of suicidal intent) and nonsuicidal (no evidence of suicidal intent) behavior (Crosby et al. 2011, Kapur et al. 2013). On the other hand, “self-harm” is a term used to encompass all self-injurious behaviors regardless of suicidal intent (Hawton et al. 2012b, Skegg 2005). The reasoning behind the latter view is that suicidal intent is fluid, it exists on a continuum rather than being a categorical construct, and its evaluation is difficult and unreliable (Brunner et al. 2014, Ougrin 2012). Furthermore, multiple motivations for self-harm may exist simultaneously, and even the persons themselves may be equivocal as to the underlying reasons of their self-harming behavior (Kapur et al. 2013).

The term “suicidality” is a broad concept that refers to all suicide-related thoughts and behaviors, including suicidal ideation, suicide attempts and completed suicides (Bridge et al. 2006). Suicidal ideation has been defined as thoughts about suicide that may include the planning of suicide attempts (Waldvogel et al. 2008), a wish to or threat to die (Pelkonen & Marttunen 2003), or thoughts of harming or killing oneself (Bridge et al. 2006). According to a definition provided by Crosby et al. (2011), a suicide attempt is a non-fatal self-directed potentially injurious behavior, with any intent to die as a result of such behavior. However, in common language “suicide attempt” is often used as an
umbrella term for any self-injurious behaviors regardless of intent, a view also shared by some investigators (Kerkhof 2000).

Differences of opinion also exist as to the term “nonsuicidal self-injury” (NSSI), defined as intentional self-inflicted damage to the surface of the body without conscious suicidal intent (American Psychiatric Association 2013). Here, the focus of controversy again rests on the question of whether a clear-cut distinction can be made between “non-suicidal” and “suicidal” self-injury – especially given the strong association that exists between NSSI and suicidal behavior (Kapur et al. 2013). Nevertheless, it is of importance in terms of this thesis that the most common method of NSSI is cutting or carving oneself with a sharp implement (Nock 2010). In the research literature, “self-mutilation” and “self-cutting” are some of the terms used to refer to such behavior (although often with no precise definition regarding the suicidal intent of the individual). In this thesis, the term “self-cutting” will be used to describe the above-mentioned behavior, regardless of the suicidal intent.

2.1.3 Childhood and adolescence

One dictionary definition of childhood refers to it as the period of life before puberty (HarperCollins 2014). In the Convention on the Rights of the Child, children are defined as persons up to the age of eighteen years (United Nations 1989). In legal terms, children are referred to as those under the age of majority, the limit for which is 18 years in many countries, including Finland. The World Health Organization (WHO) defines adolescence as the period in human growth and development that occurs after childhood and before adulthood, from the ages of 10 to 19 years (World Health Organization 1986). Some other definitions of adolescence are not based solely on chronological age. For example, it has been stated that adolescence begins with the onset of physiologically normal puberty, and ends when an adult identity and behavior are accepted (Sacks et al. 2003).

As a consequence of the various definitions of childhood and adolescence, studies of child and adolescent suicides tend to be marked by high variability in age groupings. Numerous suicide research papers focus on “young people” (individuals aged 15–24 years), thereby including adolescents in this broader age group and excluding children and younger adolescents. Since the developmental and sociodemographic characteristics of children and adolescents are in many ways different from those of young adults, the main emphasis of this literature
review is on studies investigating suicides in children and adolescents under 20 years of age.

In this thesis, children and adolescents are defined as those under 18 years of age. In addition to being the age of majority, this age limit is of importance in child and adolescent mental health services and social services in Finland. The Finnish Child Welfare Act (2007) refers to children as anyone under 18 years of age. The Finnish Mental Health Act (1990) requires that patients under 18 years of age – referred to as “minors” – in need of inpatient psychiatric treatment must be treated separately from adults. Further, regarding involuntary commitment, the conditions for ordering treatment are broader for minors than for adults (Mental Health Act 1990). It is also worth noting that the Finnish law defines the time limits within which patients must be given access to health care services, and regarding access to mental health care the treatment of children and young people (<23 years of age) must begin within three months, while the limit is six months for adults (Health Care Act 2010).

2.2 Suicide research methodology

Suicide is a complex research subject. By definition, the first obstacle concerns the unavailability of the people who it is most important to understand – the deceased themselves (Berman et al. 2006). Another challenge is the relative rarity (low base rate) of completed suicide amongst the population. This means that in prospective studies, the generally preferred research strategy, very large sample sizes would be required in order to obtain meaningful results (Nock 2009, Robins & Kulbok 1986). In addition to clinical and methodological difficulties, potential ethical restraints are of importance (Berman et al. 2006). It is therefore not surprising that studies of adolescent suicidality have to a great extent focused on living suicidal individuals, such as suicide attempters and individuals with a history of self-harm. However, although adolescent suicide attempters and completers share many characteristics, they also differ from each other in many important ways (Moskos et al. 2004). Results obtained from studies on the former group may not therefore directly apply to the latter.

As outlined by Berman et al. (2006), there are two main methodological strategies for studying completed suicides. The “macro approach” makes use of large samples of aggregate data to study the characteristics of population groups. The “micro approach”, on the other hand, investigates individual suicide cases with the aim of identifying more specific clinical characteristics and risk
variables. In both approaches, suicide data may be linked to various registers, such as national health registers, in order to obtain additional relevant information.

### 2.2.1 Macro approach

The macro approach, i.e. the ecological research method, is based on population data rather than focusing on the characteristics of individual suicides (Stack 1987). Suicide counts and rates are compared between regions, genders, or age groups, for example. Temporal trends in the suicide mortality of different populations can also be examined. (Robins & Kulbok 1986)

### 2.2.2 Micro approach

In the micro approach, i.e. case study strategy, individuals serve as units of analysis (Stack 1987). Sources of data include existing records, and/or interview data (of relatives, physicians, etc.) generated for research purposes. Compared with the macro approach, case studies involve the prospect of finding more specific predictors for suicide. (Berman et al. 2006) Two main types of micro approach strategies, i.e. psychological autopsies and record review studies, account for most of our current knowledge of the clinical characteristics and risk factors of adolescent suicides.

### Psychological autopsies

In psychological autopsy studies, interviews of family members, other close intimates and health professionals are used in conjunction with different kinds of record data to reconstruct the social and psychological features of deaths by suicide (Marttunen et al. 1993). This technique has been regarded as particularly useful when studying suicides among young people, because many informants, such as parents and other family members, friends, and teachers, are available in most cases (Marttunen et al. 1993). Nevertheless, there are surprisingly few psychological autopsy studies on child and adolescent suicides. Since the 1980s, only around ten research groups have published results of psychological autopsies conducted on children and adolescents under 20 years of age (Brent et al. 1999, Eisele et al. 1987, Freuchen et al. 2012, Marttunen et al. 1991, Portzky et al. 2009, Renaud et al. 2008, Rich et al. 1990, Shaffer et al. 1996, Shafii et al. 1985).
Record review studies

Record review (case series) studies make use of the available record data. Such information is typically extracted from suicide case files compiled by medical examiners or other relevant authorities responsible for establishing the cause of death. Case files usually include death certificates in combination with investigatory records containing more detailed information (Berman et al. 2006).

2.3 Epidemiology of child and adolescent suicides

2.3.1 General characteristics

There is a great deal of international variability in adolescent suicide rates (Wasserman et al. 2005). A universal characteristic of suicide epidemiology, however, is the rarity of completed suicide before puberty and the subsequent increase in frequency throughout adolescence (Gould et al. 2003). Explanations proffered for the low rates of suicide in children and young adolescents as compared to older adolescents include fewer risk factors, lower suicide intent and cognitive immaturity in the planning and execution of a lethal act (Brent et al. 1999, Groholt et al. 1998).

The male-female disparity in rates of completed suicides is another almost universal pattern in adolescent suicide epidemiology, with higher rates among adolescent males than females being identified throughout Western countries (Wasserman et al. 2005). In contrast, rates of self-harm, suicide attempts, suicidal ideation and self-cutting are generally more common among female than male adolescents (Brunner et al. 2014, Laukkanen et al. 2009, Lewinsohn et al. 1996, Lewinsohn et al. 2001, Moran et al. 2012, Wunderlich et al. 2001). This discrepancy between males and females has been called the “gender paradox of suicidal behavior” (Canetto & Sakinofsky 1998, Schrijvers et al. 2012). The reasons for the phenomenon are by no means clear. Suggested explanations include gender differences in accuracy and honesty in the reporting of suicidal behavior (Canetto & Sakinofsky 1998, Lewinsohn et al. 2001), the influence of cultural factors (suicide being regarded as a masculine and attempting suicide as feminine behavior) (Canetto 1997), disparity in help-seeking behaviors (Beautrais 2002) and differences in methods of suicide (Beautrais 2003) and psychopathology (Kaess et al. 2011, Schrijvers et al. 2012).
2.3.2 Suicide rates and secular trends

The age groupings most commonly utilized when reporting rates of child and adolescent suicides are those of 10–14 years and 15–19 years, which is likely due to the statistical practices of the World Health Organization. As regards the younger group, worldwide suicide rates (per 100,000 population) among 10–14-year-olds range between 0.0 and 8.5 for males and between 0.0 and 6.5 for females (Dervic et al. 2008, Kolves & De Leo 2014). Recent reports on secular trends in suicide rates in this age group are scarce, and where published data exists, the findings are inconsistent. Decreasing suicide trends in 10–14-year-old males in Austria between 1970–2001 (Dervic et al. 2006) and a sporadic increase among females in Canada from the 1980s until 2008 (Skinner & McFaull 2012) have been reported. At the same time, no significant changes in suicide rates occurred among Austrian females (Dervic et al. 2006), Canadian males (Skinner & McFaull 2012), or among either gender in England and Wales in the first decade of the 21st century (Windfuhr et al. 2013).

Table 2 presents the rates of suicide (per 100,000 population) among 15–19-year-old adolescents by gender in selected European countries. Eastern European countries, Finland and Ireland lead the rates among male adolescents, and the situation is largely similar among females.
Table 2. Suicide death rate (per 100,000 population) among 15–19-year-old males and females in selected European countries. (European Detailed Mortality Database 2014)

<table>
<thead>
<tr>
<th>Country and year ¹</th>
<th>Males Suicide death rate</th>
<th>Females Suicide death rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Russian Federation 2010</td>
<td>24.7</td>
<td>Russian Federation 2010</td>
</tr>
<tr>
<td>Belarus 2009</td>
<td>21.3</td>
<td>Lithuania 2010</td>
</tr>
<tr>
<td>Lithuania 2010</td>
<td>20.2</td>
<td>Belarus 2009</td>
</tr>
<tr>
<td>Finland 2011</td>
<td>20.2</td>
<td>Norway 2012</td>
</tr>
<tr>
<td>Ukraine 2012</td>
<td>18.1</td>
<td>Finland 2011</td>
</tr>
<tr>
<td>Ireland 2010</td>
<td>17.6</td>
<td>Austria 2011</td>
</tr>
<tr>
<td>Latvia 2012</td>
<td>14.8</td>
<td>Ukraine 2012</td>
</tr>
<tr>
<td>Poland 2011</td>
<td>13.4</td>
<td>Sweden 2010</td>
</tr>
<tr>
<td>Czech Republic 2012</td>
<td>10.4</td>
<td>Belgium 2010</td>
</tr>
<tr>
<td>Sweden 2010</td>
<td>9.6</td>
<td>Ireland 2010</td>
</tr>
<tr>
<td>Estonia 2012</td>
<td>8.8</td>
<td>Switzerland 2010</td>
</tr>
<tr>
<td>Hungary 2012</td>
<td>8.4</td>
<td>Netherlands 2011</td>
</tr>
<tr>
<td>Belgium 2010</td>
<td>8.4</td>
<td>Poland 2011</td>
</tr>
<tr>
<td>Iceland 2009</td>
<td>8.2</td>
<td>Denmark 2011</td>
</tr>
<tr>
<td>Norway 2012</td>
<td>7.7</td>
<td>France 2010</td>
</tr>
<tr>
<td>France 2010</td>
<td>7.2</td>
<td>Germany 2012</td>
</tr>
<tr>
<td>Austria 2011</td>
<td>7.1</td>
<td>United Kingdom 2010</td>
</tr>
<tr>
<td>Switzerland 2010</td>
<td>6.9</td>
<td>Greece 2011</td>
</tr>
<tr>
<td>Germany 2012</td>
<td>6.6</td>
<td>Hungary 2012</td>
</tr>
<tr>
<td>Netherland 2011</td>
<td>5.1</td>
<td>Czech Republic 2012</td>
</tr>
<tr>
<td>Denmark 2011</td>
<td>4.9</td>
<td>Portugal 2011</td>
</tr>
<tr>
<td>United Kingdom 2010</td>
<td>4.4</td>
<td>Spain 2011</td>
</tr>
<tr>
<td>Spain 2011</td>
<td>2.9</td>
<td>Italy 2010</td>
</tr>
<tr>
<td>Italy 2010</td>
<td>2.8</td>
<td>Estonia 2012</td>
</tr>
<tr>
<td>Greece 2011</td>
<td>2.1</td>
<td>Iceland 2009</td>
</tr>
<tr>
<td>Portugal 2011</td>
<td>1.4</td>
<td>Latvia 2012</td>
</tr>
</tbody>
</table>

¹ Latest year available.

With regard to changes over time, an upward trend in suicides among males aged 15–19 years was reported in many countries between the 1960s and 1990s (Rutz & Wasserman 2004, Wasserman et al. 2005). More recently, declining trends in male adolescent suicides have been reported in the United States (US) (Bridge et al. 2008), Canada (Skinner & McFaul 2012) and the United Kingdom (UK) (Windfuhr et al. 2008, Windfuhr et al. 2013), for example. Opposing trends have also emerged, for example in South Korea (Park et al. 2014). Among 15–19-year-old females, suicide rates have generally remained more stable in many countries (Madge 1999, Rutz & Wasserman 2004, Wasserman et al. 2005). In recent times,
it has been reported that adolescent female suicide rates are stable in the UK (Windfuhr et al. 2013), and decreasing in the US (Bridge et al. 2008), but are increasing in Canada (Skinner & McFaull 2012). To conclude, secular trends in adolescent suicides have been diverse between different countries and genders.

2.3.3 Methods of suicide

As well as suicide rates and trends, the distribution of suicide methods among adolescents varies between nations and genders. Use of firearms is the leading method of suicide among 15–19-year-old males in Finland (Statistics Finland 2014a) and the US (Lubell et al. 2007), as well as in Switzerland for all <20-year-old males (Hepp et al. 2012). Firearms have also been the most common suicide method among 15–19-year-old males in Canada, but hanging surpassed firearms at the beginning of the 1990s (Skinner & McFaull 2012). At the same time, in Canada the distribution of suicide methods also changed among adolescent females, with hanging overtaking poisoning as the leading method of suicide (Skinner & McFaull 2012). In a similar manner, in the US at the beginning of the 2000s hanging surpassed firearms as the most common suicide method among adolescent females (Lubell et al. 2007).

In contrast to the use of firearms among adolescent males, hanging is the most common method of suicide among 15–19-year-old females in Finland (Statistics Finland 2014a), while traffic (railway suicides) is the most common method among Swiss female adolescents (Hepp et al. 2012). In Italy, hanging is the leading method among males, whereas jumping from a high place accounts for most female adolescent suicides (Pompili et al. 2009). Otherwise, recent reports on the distribution of suicide methods among European adolescents (<20 years) are scarce. However, a study of 15 European countries examined suicide rates in young people (15–24 years) and found that hanging was the most common method of suicide among males in 12 countries and among females in all but one country (Värnik et al. 2009).

2.4 Risk factors for child and adolescent suicides

Suicide is a highly complex and multidetermined outcome. No single cause can be shown to underlie any individual suicide, and no single path leads to this end. Nevertheless, research from several previous decades has consistently identified
factors that are associated with an increased likelihood of completed suicide in adolescence – that is, risk factors for adolescent suicides.

### 2.4.1 Mental disorders, substance abuse and alcohol intoxication

Psychological autopsy studies have identified at least one psychiatric disorder in approximately 90% of adolescent suicide victims (Brent et al. 1993b, Marttunen et al. 1991, Portzky et al. 2005, Renaud et al. 2008, Shaffer et al. 1996). However, Brent et al. (1999) found that only 60% of under 16-year-old suicide victims had a diagnosable psychiatric disorder, and similar results have also been found in other studies (Groholt et al. 1998, Shaffer et al. 1996).

In psychological autopsy studies, mood disorder has been the most prevalent mental disorder among adolescent suicide victims (Brent et al. 1993b, Groholt et al. 1999, Renaud et al. 2008, Shaffer et al. 1996, Shafii et al. 1988). Gender difference is a consistent finding across studies: more female (approximately 70%) than male (approximately 40–60%) adolescent suicide victims have suffered from a mood disorder (Brent et al. 1999, Marttunen et al. 1991, Shaffer et al. 1996). Substance abuse or dependence (alcohol or drugs) is another important risk factor (Brent et al. 1999, Marttunen et al. 1991, Portzky et al. 2005, Renaud et al. 2008, Shaffer et al. 1996). As regards gender differences, one study from the US (Shaffer et al. 1996) found higher rates of substance abuse among male adolescents (42% in males vs. 12% in females), whereas another (Brent et al. 1999) reported fairly similar rates (35% vs. 24%) between genders. In a Finnish study (Marttunen et al. 1991), the rates of alcohol abuse/dependence were higher among females (23% vs. 44%), although note should be taken of the small number of adolescent females (n=9) in that study. Findings regarding age differences in terms of the prevalence of substance abuse among adolescent suicide victims are more consistent, the rates being significantly higher among older adolescents (Brent et al. 1999, Groholt et al. 1998, Shaffer et al. 1996). Substance abuse is often comorbid with mood disorders (Brent et al. 1993b, Shaffer et al. 1996), and psychiatric comorbidity is common in adolescent suicides in general, as up to 70% of adolescent suicide victims have had more than one psychiatric disorder (Bridge et al. 2006). Apart from mood disorders and substance abuse, disruptive disorders (such as oppositional disorder) are among the mental disorders that have been shown to increase the risk of adolescent suicide, especially among males (Brent et al. 1999, Renaud et al. 2008, Shaffer et al. 1996).
Whereas alcohol abuse, i.e. chronic alcohol use has consistently been shown to be a risk factor in adolescent suicide, empirical research on the role of acute alcohol use in increasing the risk of suicide among adolescents is scarce. On a general level, it has been suggested that acute alcohol consumption is a potent risk factor for completed suicides (Lamis & Malone 2012). Proposed mechanisms include increased psychological distress (particularly, it is suggested, during descending blood alcohol concentration, which is often associated with depressed and sedative-like effects (Holdstock & de Wit 1998)), increased aggressiveness, and the impairment of cognitive processes (Hufford 2001). In relation to cognitive functioning, Hufford (2001) argues that alcohol use impedes alternative coping strategies and narrows the range of options that the individual perceives as being available. It is also well-known that alcohol impairs inhibitory control (Field et al. 2010) and that there is a strong association between impulsivity and alcohol use (Lamis & Malone 2012).

Table 3 presents results from previous studies that included data, based on the results of forensic toxicology examinations, on adolescent suicide victims who were under the influence of alcohol at the time of their death. Where information is available, the results are shown by gender. The overall figures for acute alcohol use among adolescent suicide victims fall between 10% and 50%, between 20% and 50% for males and between 10% and 40% for females, although an exceptionally high proportion (56%) of intoxicated female adolescent suicide victims was reported in a Finnish study by Marttunen et al. (1992). In addition to the information provided in Table 3, a study from Belgium (Portzky et al. 2005) reported that 37% of adolescent suicide victims were known, based on informant interviews, to have consumed alcohol during the day of their death (no results of toxicology examinations were available). Regarding age differences, studies have shown that being under the influence of alcohol at the time of death is rare among <15-year-old adolescents (Brent et al. 1999, Freuchen et al. 2012, Grøholt et al. 1998).
Table 3. Adolescent victims under the influence of alcohol at the time of death, based on forensic toxicology examinations.

<table>
<thead>
<tr>
<th>Study</th>
<th>Country, time span</th>
<th>Age group (years)</th>
<th>Total n (males %)</th>
<th>Alcohol toxicology screens, %</th>
<th>Under the influence of alcohol (positive cases among those tested)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total, % Mare, %</td>
</tr>
<tr>
<td>Eisele et al. 1987</td>
<td>US, 1983–1984</td>
<td>13–19</td>
<td>25 (76%)</td>
<td>88%</td>
<td>18% 1 not reported</td>
</tr>
<tr>
<td>Hoberman &amp; Garfinkel 1988</td>
<td>US, 1975–1985</td>
<td>&lt;20</td>
<td>229 (80%)</td>
<td>not reported</td>
<td>28% 1 not reported 2</td>
</tr>
<tr>
<td>Aldridge &amp; St John 1991</td>
<td>Canada, 1977–1988</td>
<td>10–19</td>
<td>63 (84%)</td>
<td>not reported</td>
<td>21% 1 not reported</td>
</tr>
<tr>
<td>Marttunen et al. 1992</td>
<td>Finland, 1987–1988</td>
<td>13–19</td>
<td>53 (83%)</td>
<td>94%</td>
<td>51% 50% 56%</td>
</tr>
<tr>
<td>Grøholt et al. 1997, 1999</td>
<td>Norway, 1990–1992</td>
<td>8–19</td>
<td>129 (77%)</td>
<td>79%</td>
<td>45% appr. 45% appr. 40%</td>
</tr>
<tr>
<td>Brent et al. 1999</td>
<td>US, 1984–1994</td>
<td>13–19</td>
<td>140 (85%)</td>
<td>not reported</td>
<td>29% 3 32% 15%</td>
</tr>
<tr>
<td>Weinberger et al. 2001</td>
<td>US, 1996–1997</td>
<td>11–16</td>
<td>46 (74%)</td>
<td>100%</td>
<td>11% not reported</td>
</tr>
<tr>
<td>Johansson et al. 2005</td>
<td>Sweden, 1981–2000</td>
<td>13–19</td>
<td>88 (75%)</td>
<td>appr. 97%</td>
<td>35% appr. 40% appr. 20%</td>
</tr>
<tr>
<td>Shields et al. 2006</td>
<td>US, 1993–2002</td>
<td>11–17</td>
<td>108 (89%)</td>
<td>94%</td>
<td>17% not reported</td>
</tr>
<tr>
<td>Singh &amp; Lathrop 2008</td>
<td>US, 1979–2005</td>
<td>9–17</td>
<td>433 (79%)</td>
<td>not reported</td>
<td>20% 23% 9%</td>
</tr>
<tr>
<td>Karch et al. 2013</td>
<td>US, 2005–2008</td>
<td>10–17</td>
<td>1046 (not reported)</td>
<td>appr. 75%</td>
<td>appr. 10% not reported</td>
</tr>
</tbody>
</table>

1 Evidence of probable alcohol consumption (based on observers’ reports) in another 17%.
2 Males and females equally likely to have been under the influence of alcohol; figures not provided.
3 Figures calculated based on information in the article text.
2.4.2 Previous suicide attempt and self-harm

A history involving a prior suicide attempt has consistently been shown to be one of the strongest risk factors in adolescent completed suicide (Brent et al. 1999, Grøholt et al. 1997, Shaffer et al. 1996). More female (36–67%) than male (12–37%) adolescent suicide victims have previously attempted suicide (Brent et al. 1999, Groholt et al. 1999, Hoberman & Garfinkel 1988, Karch et al. 2013, Marttunen et al. 1992, Marttunen et al. 1995, Shaffer et al. 1996, Soor et al. 2012, Weinberger et al. 2001), which is similar to the situation amongst the general adolescent population (Evans et al. 2005, Hultén et al. 2001, Lewinsohn et al. 2001). It has been suggested that a previous suicide attempt increases the risk of suicide among male adolescents in particular, the predictive value being less important in females (American Academy of Child and Adolescent Psychiatry 2001, Gould et al. 2003), but this interpretation does not seem justifiable when we examine original data from case-control studies that employ the psychological autopsy method (Brent et al. 1999, Shaffer et al. 1996).

Self-cutting in adolescents is often regarded as low-risk behavior. However, a study from the United Kingdom explored the long-term outcomes of self-harm among <19-year-old children and adolescents and found that self-cutting was strongly associated with the risk of suicide. Importantly, the study showed that self-cutting conveyed a greater risk of suicide than self-poisoning. (Hawton et al. 2012a)

2.4.3 Familial and psychosocial risk factors

Parental psychopathology (most commonly, depression and substance use) and a family history of suicidal behavior are risk factors in adolescent suicide (Brent et al. 1996, Gould et al. 1996). Case-control studies have shown that parental divorce/separation is more common in the families of suicide victims than in those of controls, but the association decreases when parental psychopathology is accounted for (Gould et al. 2003).

Both in the longer term and shortly before a suicide, stressful life events, such as interpersonal losses and conflicts, discord, and legal and disciplinary problems are more common among adolescent suicide victims than among controls (Bridge et al. 2006, Gould et al. 2003). In the latter case, the stressors are referred to as precipitating factors or precipitants. Marttunen et al. (1993) described a precipitant as a stressor that occurred during the month preceding the suicide and
that is believed to have directly contributed to it. An argument with one’s parents is more common among child and young adolescent suicide victims, while arguments or end of a relationship with a boy/girlfriend is associated with suicides among older adolescents (Brent et al. 1999, Grøholt et al. 1998). A precipitating factor was reported in 45% of male and 50% of female adolescent suicides in a Norwegian study (Grøholt et al. 1999) and in 70% and 64% of all adolescent suicide cases in studies conducted in Finland and the US, respectively (Marttunen et al. 1993, Rich et al. 1990). One study from the US reported that a precipitating event occurred on the day of the suicide in the case of 33% of suicide victims under 18 years old (Barber 2005).

2.4.4 Availability of lethal methods

Much of the literature on the association between adolescent suicides and the availability of lethal methods focuses on the use of firearms and largely originates in the US, where use of firearms is the leading method of suicide among adolescent males (Lubell et al. 2007). Results of ecological studies have suggested that areas with a higher availability of firearms have higher rates of suicide (Birckmayer & Hemenway 2001, Miller & Hemenway 1999, Miller et al. 2002, Miller et al. 2007). Further, studies indicate that this association is relatively more important in suicides among adolescents and young people than in the adult population (Birckmayer & Hemenway 2001, Miller et al. 2002, Miller et al. 2007, Sloan et al. 1990). More robust empirical evidence concerning the association between firearms availability and adolescent suicide can be found in case-control studies (Miller & Hemenway 1999). Such studies have shown that the presence of a firearm in the home is associated with a higher risk of adolescent suicide (Brent et al. 1988, Brent et al. 1991, Brent et al. 1993c, Shah et al. 2000). With regard to age differences, Brent et al. (1999) have suggested that availability of lethal means may play a greater role among younger than older adolescents. Furthermore, there is some evidence that a firearm in the home is associated with a particularly high risk of suicide among adolescents with no discernible psychopathology (Brent et al. 1999). The role of impulsivity has been emphasized in this respect (Brent & Bridge 2003).
2.4.5 Suicide contagion and clusters

It is recognized that some suicides occur in clusters, supporting the view that suicide can be contagious behavior (Niedzwiedz et al. 2014). There are two main patterns of suicide clusters: point clusters (localized in space and time, therefore also known as space-time clusters) and mass clusters (media related, localized in time only) (Haw et al. 2013, Joiner 1999, Mesoudi 2009). Regarding mass clusters, the evidence indicates that the number of suicides increases following mass media reporting of suicide – so-called copycat behavior or the Werther effect (Mesoudi 2009, Niederkrotenthaler et al. 2010). Mesoudi (2009) defines point cluster as a temporary increase in the frequency of suicides within a small community or institution, relative to both the baseline suicide rate before and after the point cluster and the suicide rate in neighboring areas. According to a recent systematic review study, the evidence suggests a greater risk of point suicide clustering among adolescents compared with older age groups (Niedzwiedz et al. 2014). However, point clustering has been reported as being a factor in less than 5% of suicides among adolescents and young people (Gould et al. 1990, Jones et al. 2013b).

The internet’s role in adolescent suicide contagion is currently a subject of interest (Olson 2013, Robertson et al. 2012), but little research has been done on the topic. A systematic review concluded that internet use may have both positive effects, such as functioning as a support network, and negative effects, such as normalizing self-harm and increasing suicidal ideation and hopelessness, on young people who are at risk of self-harm or suicide (Daine et al. 2013).

2.5 Seasonal and other temporal patterns of suicide

Seasonal variation in suicide occurrence is a classic subject of interest in psychiatric research. Conventionally, seasonality is defined as a “cyclical change related to seasons of the year”, although nowadays the term is sometimes used to refer to periodic fluctuations of any kind (Ajdacic-Gross et al. 2010a). Apart from seasonal patterns, shorter-term temporal variations have been reported in accordance with the day of the week and time of day (Law & De Leo 2013).

Seasonal variation in suicides among the general population, with peaks during the spring and early summer, has been well documented in the medical literature (Ajdacic-Gross et al. 2010a, Christodoulou et al. 2012). This general pattern is known to vary between subpopulations according to the suicide method,
gender, and age (Ajdacic-Gross et al. 2010a, Christodoulou et al. 2012). However, seasonality of suicides among adolescents is a poorly studied area, the current, inconsistent findings being based on just a few published reports. Studies from the US (Hoberman & Garfinkel 1988), Canada (Aldridge & St John 1991) and Turkey (Uzun et al. 2009) identified no seasonality in <20-year-old adolescent suicides. Another study from Canada (Thompson 1987) revealed a fall peak among <21-year-old males. In the US, a September peak has been demonstrated among 11–17-year-old children and adolescents (Shields et al. 2006) and fall and winter peaks among <16-year-old males (McCleary et al. 1991). Dervic et al. (2006) identified discrete suicide peaks in the spring and fall, i.e. a bimodal seasonal trend, for <15-year-old Austrian children and adolescents. In Norway, 63% of <16-year-old males and 75% of females of the same age who committed suicide, did so “during the dark season”, i.e. between September and February (Freuchen et al. 2012).

With regard to shorter-term fluctuations in the occurrence of suicide, an excess of suicides on Mondays amongst the general population has been reported (Maldonado & Kraus 1991, Miller et al. 2012), although an increased risk over the weekend days was observed in a Finnish study (Partonen et al. 2004). Findings from adolescent suicides have rarely been reported. In one study, a peak on Saturday (30% of all suicides) was observed (Aldridge & St John 1991). Another study found that 44% of adolescent suicide-related deaths occurred between Friday and Sunday (Johansson et al. 2005) – a figure very close to what would be expected if the suicides were distributed evenly throughout the days of the week. 55% of suicides among <16-year-old Norwegian females were committed on Monday, and only 17% of male suicides occurred between Friday and Sunday (Freuchen et al. 2012). In terms of the time of day, a peak in suicides during the late morning hours has been demonstrated amongst the general population (Gallerani et al. 1996, Preti & Miotto 2001), whereas the peak for younger people (14–24 years) occurred in the late afternoon (Preti & Miotto 2001). Similarly, a preponderance of suicides in the afternoon or evening has been reported among <20-year-old (Hoberman & Garfinkel 1988) and <16-year-old (Freuchen et al. 2012) suicide victims.

2.6 Child and adolescent suicide prevention

It is a widely accepted view that, in order to be effective, suicide prevention efforts need to be comprehensive, multimodal and integrated (Lönnqvist et al. 1997).
Suicide prevention strategies can be conceptualized using a model based on Universal, Selected and Indicated preventive approaches (the USI model) (Dumon & Portzky 2013a). While universal strategies target the entire population (or large subgroups such as adolescents), selective strategies address subgroups of the total population that have an above average risk of suicide. Indicated prevention strategies target individuals who are at specifically high risk of suicidal behaviors, such as those with suicidal thoughts. (Dumon & Portzky 2013a, Nordentoft 2011, U.S. Department of Health and Human Services (HHS) Office of the Surgeon General and National Action Alliance for Suicide Prevention 2012)

The low base rate of suicides entails methodological problems in demonstrating the efficacy of various suicide prevention measures, since very large studies with long follow-up periods would be needed in order to conduct research with completed suicide as an outcome (Robinson et al. 2011). Due to these practical considerations, not to mention ethical ones, in this field it is practically impossible to perform randomized controlled trials, with ecological or individually based naturalistic studies being carried out instead (Nordentoft 2011). Robust scientific evidence on the efficacy of most suicide prevention approaches is therefore largely lacking. The evidence used in suicide prevention may be imperfect from the scientific perspective, but given the significance of suicide as a serious public health concern preventive acts and recommendations must rely on the best available knowledge (Campo 2009, Nordentoft 2011).

In the following review of suicide prevention approaches, the emphasis is on the strategies considered most relevant to adolescents.

### 2.6.1 Universal suicide prevention

**School-based programs**

Compared to suicide prevention measures amongst the general population, a specific dimension of child and adolescent suicide prevention lies in the fact that most young people attend school. A school setting therefore seems a natural standpoint from which to target virtually all individuals in this age group.

Suicide awareness programs number among the most commonly applied adolescent suicide prevention programs (Portzky & van Heeringen 2006). Among the main goals of these programs are enhancing help-seeking behavior and
providing adolescents with the information they need to identify at-risk peers, followed by confiding in responsible adults (since suicidal adolescents are much less likely to talk to adults than to peers in times of distress) (Berman et al. 2006, Brown et al. 2007, Gould et al. 2003). However, no firm evidence exists on the positive impact of these programs on reducing suicidal behavior (van der Feltz-Cornelis et al. 2011). As reviewed by Gould et al. (2003), Mann et al. (2005) and Pelkonen and Marttunen (2003), whereas positive effects have sometimes been observed, indifferent and even unfavorable effects have been reported, such as negative reactions among suicidal adolescents and a decreased likelihood of recommending mental health evaluations to a suicidal peer. It is also acknowledged that changes in behavior are not necessarily brought about by changes in knowledge and attitudes (Berman et al. 2006). The emphasis has therefore been shifted toward other school-based strategies, including skills training programs focusing e.g. on the problem-solving and cognitive skills of the adolescents in question (Bridge et al. 2006, Gould et al. 2003). Although no direct causal relationship can be established between skills training programs and reduced suicide rates, improvements in other factors such as distress coping skills are regarded as being of importance in general.

**Media education**

Since considerable evidence exists of suicide contagion, a plausible intervention option would involve influencing media reporting on suicides. Accordingly, media guidelines have been published (Dumon & Portzky 2013b, World Health Organization 2008), including descriptions of factors that should be avoided (such as portraying suicides in a glamorizing or romanticizing manner, or disclosing the method and location of suicide) and suggestions for enhancing the positive role played by the media in suicide prevention efforts (such as providing information on the help available and stressing the multifactorial nature of suicidal acts).

**Method restriction**

Restricting access to lethal means of suicide is a key and evidence-based suicide prevention strategy at the population level (Florentine & Crane 2010, Mann et al. 2005, Yip et al. 2012). The background rationale for this approach lies in the idea that ambivalence about life and death is common among suicidal individuals, the suicidal intent “waxes and wanes”, and periods of high risk are often of short
duration. Restricting access to suicide methods during this short period may therefore have the potential to prevent suicides (Florentine & Crane 2010). At the same time, it is acknowledged that such a suicide prevention approach does not address the underlying causes of suicide (Hawton 2005).

The substitution hypothesis constitutes a potential dilemma in relation to the method restriction approach. This hypothesis states that if access to one method of suicide is restricted, another will be used instead (Florentine & Crane 2010). However, there is some evidence that suicidal individuals have a preference for a specific method of suicide and tend not to switch easily from one to the other (Daigle 2005).

One of the most intensely studied areas of the method restriction strategy is controlling access to firearms. Not only has it been shown that the availability of firearms increases the risk of adolescent suicide by such means, but several studies have also concluded that adolescent firearm suicide rates fall following stricter regulation of such access (Beautrais et al. 2006, Cheung & Dewa 2005, Lubin et al. 2010, Niederkrotenthaler et al. 2010, Webster et al. 2004). Examples of other method restriction approaches shown to reduce suicide rates among the general population include packing analgesics in blister packets and limiting packet size, detoxification of domestic gas, restrictions on pesticides, and the construction of barriers at jumping sites (Nordentoft 2011, van der Feltz-Cornelis et al. 2011).

### 2.6.2 Selected suicide prevention

The aim of this approach is to prevent the onset of suicidal behaviors among specific above-average risk subpopulations (Dumon & Portzky 2013a). Since psychiatric disorder is a salient risk factor in adolescent suicides, those with mental illnesses are the most important risk group with respect to prospective use of the selected suicide prevention approach.

**Screening and gatekeeper education**

A screening strategy involves the use of self-report and individual interviews to identify at-risk adolescents, with subsequent referral for treatment (Gould et al. 2006). A potential problem in this approach is the relatively high rate of false positives. Although even non-suicidal adolescents would probably benefit from interventions, the downside is the large burden imposed on limited mental health
resources (Horowitz et al. 2009). Suicide screening programs in schools are popular in the US, yet a review study concluded that, given the weak evidence base demonstrating the effect of this approach in reducing suicidal behaviors, “efforts to use such programs should be regarded as investigational in nature” (Peña & Caine 2006).

The rationale for gatekeeper education is that by educating adults (such as school personnel) who meet adolescents on an everyday basis about suicide risk factors, the identification of at-risk adolescents could be improved. In their review, Gould et al. (2003) concluded that the research findings are encouraging, pointing to improvements in e.g. knowledge, attitudes and referral practices among school personnel, while the amount of research is limited.

**Treatment of psychiatric disorders**

In reducing suicidal behaviors, the effectiveness of treatment of adolescent psychiatric disorders provides the fundamental grounds for high-risk suicide prevention strategies. Because mood disorders are the most common diagnostic risk factors involved in adolescent suicide, most research has focused on the treatment of depression (Pelkonen & Marttunen 2003). A review of adolescent depression treatment approaches would be beyond the scope of this literature review, but it should be mentioned that psychotherapy and use of antidepressants are commonly accepted evidence-based treatments (Thapar et al. 2010).

Regarding antidepressant treatment and suicidal behavior in children and adolescents, during the first decade of the 21st century concerns emerged about the possible adverse effect of antidepressants in provoking suicidal behavior among adolescents (Hammad et al. 2006). Subsequently, “black box warnings” were issued by the US Food and Drug Administration (FDA) (Leslie et al. 2005). However, the subject remains controversial (Cooper et al. 2014, Isacsson & Rich 2014).

**2.6.3 Indicated suicide prevention**

The indicated suicide prevention approach focuses on the high-risk group of adolescents who have already attempted suicide, or who are at specifically high risk of suicidal behaviors, such as those with suicidal thoughts (Dumon & Portzky 2013a). As previously noted, a history of prior suicide attempts is one of the most potent risk factors in terms of adolescent suicides. It should be noted, however,
that only a minority of adolescents who engage in self-harm and attempt suicide seek treatment or present to hospitals (Bridge et al. 2006, Hawton et al. 2012b). A large proportion of these high-risk individuals may therefore remain unknown to health care professionals.

In cases of suicidal crisis, guidelines commonly recommend that adolescents be referred to inpatient care (American Academy of Child and Adolescent Psychiatry 2001). Although intensive treatment based on skilled observation and support are offered in hospital settings, no empirical evidence exists on the effectiveness of this treatment in reducing rates of completed suicides (Gould et al. 2003).

A recent review (Robinson et al. 2011) studied randomized, controlled trials testing interventions in the case of adolescents and young adults who had attended a clinical setting due to suicidal behavior or deliberate self-harm. The outcome measures were suicidal behavior, ideation, and/or deliberate self-harm. The review concluded that no differences were found between treatment and control groups, except for one study in which favorable outcomes emerged in an individual cognitive therapy group compared to treatment as usual (i.e. standard treatment used in clinical practice) received by a control group. The authors of the review remarked that the sample sizes were far too small to enable a study of the effectiveness of treatments in preventing completed suicides.
3 Aims of the study

The purpose of this work was to investigate the epidemiology of child and adolescent suicides in Finland, with a special focus on gender differences. The specific aims were:

2. To analyze the regional difference between Northern and Southern Finland in rates of firearm suicides among male children and adolescents in 1972–2009 (II).
3. To explore the characteristics of child and adolescent suicides, including demographic, psychosocial and situational factors, use of alcohol, previous suicidality and the psychiatric inpatient treatment histories of the suicide victims, and seasonal pattern of the suicides in the province of Oulu between the years 1988–2012 (III, IV).

Hereafter, the Roman numerals I–IV refer to the original publications.
4 Material and methods

4.1 Suicide data

The data presented in this thesis are based on information from official documents concerning deaths classified as suicides by medical examiners. Regarding death certification practices, Finnish law requires that the police conduct an investigation into the cause of death and request a medicolegal autopsy 1) when a person's death is due or is suspected of being due to a criminal offence, an accident, suicide, intoxication, an occupational disease or medical treatment, 2) when a person has died from an unknown disease or did not receive medical treatment during their last illness, and 3) when the death was otherwise unexpected (Act on the Inquest into the Cause of Death 1973).

As stated above, in Finland medicolegal autopsy is performed in every case in which the actual or suspected cause of death was suicide. Medicolegal autopsies are performed by official medical examiners who are forensic pathologists. They make the final decision on the cause and manner of the death and issue the death certificate once the information acquired from the autopsy is complete and the necessary background information, such as medical history and recent life events, has been gathered on the deceased. The data included in this thesis refer only to deaths classified as suicides, whereas deaths classified as being of undetermined cause did not qualify for the study.

4.1.1 Macro approach (I, II)

The data for the macro-level studies (I, II) were obtained from the Finnish Cause of Death register, which is produced by Statistics Finland (Statistics Finland 2013). Statistics on the cause of death cover persons who have died in Finland or abroad and were permanently resident in Finland at the time of their death. The Cause of Death Register is based on data from death certificates and includes information on the cause and manner of death, the date and place of death, and the person’s exact birth date, personal identity code, age, gender and place of residence. Since 1996, causes of death have been coded according to the 10th revision of the International Statistical Classification of Diseases and Related Health Problems (ICD-10). In 1969–1986, such statistics were compiled according to ICD-8, and ICD-9 was used in 1987–1995.
For the purposes of this study, deaths classified as suicides were extracted from the Causes of Death Register. The diagnostic codes used for suicides were E950–959 of ICD-8 and ICD-9 in 1969–1995, and codes X60–X84 and Y87.0 of ICD-10 since 1996. The classification of specific suicide methods in various revisions of ICD is illustrated in Table 4.

### Table 4. Classification of suicide methods in ICD-8, ICD-9 and ICD-10.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>Poisoning</td>
<td>E950</td>
<td>E950</td>
<td>X60–X65, X68–X69</td>
</tr>
<tr>
<td>Gassing</td>
<td>E952</td>
<td>E951–E952</td>
<td>X66–X67</td>
</tr>
<tr>
<td>Hanging</td>
<td>E953</td>
<td>E953</td>
<td>X70</td>
</tr>
<tr>
<td>Drowning</td>
<td>E954</td>
<td>E954</td>
<td>X71</td>
</tr>
<tr>
<td>Use of firearms</td>
<td>E955</td>
<td>E955</td>
<td>X72–X75</td>
</tr>
<tr>
<td>Jumping from a high place</td>
<td>E957</td>
<td>E957</td>
<td>X80</td>
</tr>
<tr>
<td>Other methods</td>
<td>E956, E958–E959</td>
<td>E956, E959</td>
<td>X76–X79, X81–X84, Y87.0</td>
</tr>
<tr>
<td>Traffic suicides</td>
<td>not specified</td>
<td>E959A–E959B</td>
<td>X81–X82</td>
</tr>
<tr>
<td>Other/Unspecified</td>
<td>E956, E958–E959</td>
<td>E956, E959</td>
<td>X76–X79, X83–X84, Y87.0</td>
</tr>
</tbody>
</table>

Year-end population estimates for specific age groups were also obtained from Statistics Finland, in order to calculate age-standardized suicide mortality rates, i.e. annual suicide rates per 100,000 population. An age limit of 12–17 years was chosen for the adolescent population, because suicides among persons younger than 12 years of age are extremely rare.

**Adolescent suicide trends in Finland (I)**

The data derived from the original publication I cover all suicides committed by under 18-year-old children and adolescents (hereafter referred to as “adolescents”) between 1st January 1969 and 31st December 2008 in Finland. In this study, trends in overall and method-specific suicide rates among male and female adolescents were investigated. The suicide methods presented in Table 4 were further classified into violent methods (use of firearms, hanging, jumping from a high place, drowning), non-violent ones (poisoning and gassing) and others.

At the time the data was purchased, Statistics Finland classified suicide methods according to ICD-9 (from 1987 until 1997). Nowadays, the causes of
death classification follows the year limits used in the official classification of diseases described in Table 4.

This thesis also includes unpublished results for updated suicide trends. The updated data includes the years 2009–2012.

**Adolescent male firearm suicides in Northern and Southern Finland (II)**

Data derived from the original publication II cover all male adolescent suicides committed with firearms in Northern and Southern Finland between 1st January 1972 and 31st December 2009. As reference groups, the data also includes firearm suicides by males aged 18–24 years (hereafter referred to as “young adults”) and 25–44 years (“adults”). Rates of adolescent male firearm suicides in Northern Finland and Southern Finland are compared. The study regions are illustrated in Figure 1.
Fig. 1. Study regions: Northern and Southern Finland and the province of Oulu.

In ICD-8 and ICD-9, only one diagnostic code (E955) was used for firearm and explosive suicides. In ICD-10, firearm suicides were classified as follows: handgun discharge (X72); rifle, shotgun and larger firearm discharge (X73); other and unspecified firearm discharge (X74); explosive material (X75). Since information on specific types of firearm was not recorded before 1996, typespecific firearm results can only be reported from that year onwards.

The characteristics of Northern and Southern Finland are presented in Table 1 of the original publication II. A major difference between the study regions lies in the greater number of firearms per person in the north (50/100 persons in
Northern Finland vs. 27/100 persons in Southern Finland) (The Finnish Police, unpublished data).

4.1.2 Micro approach (III, IV)

Data from the “Suicides in the province of Oulu” research project

Data on micro-level studies originate in the “Suicides in the province of Oulu” research project, which was initiated in 1988. This includes all suicides committed in the province of Oulu since 1st April 1988. Such data is collected by the Department of Psychiatry, University of Oulu, in collaboration with the competent authority in charge of forensic medicine. In the province of Oulu, this competent authority was the Department of Forensic Medicine of Oulu University until 2009 and the National Institute for Health and Welfare from 2010.

The province of Oulu, situated in Northern Finland, is shown in Figure 1. The area will be referred to under that name in this thesis, although as of the beginning of 2010 the Finnish provinces were abolished and the former area of the province of Oulu is now administered by the Regional State Administrative Agency for Northern Finland. The province of Oulu is a geographically extensive area covering 19% of Finland’s land area, while the population accounted for 9% (n=480 000) of the total population of Finland in 2014 (Statistics Finland 2014b).

The data used in the “Suicides in the province of Oulu” research project are based on documentation related to establishing the cause of death during medicolegal autopsy investigations. Related sources of information are illustrated in Table 5. Primary source of data consists of death certificates in which suicide has been classified as the manner of death by official medical examiners. Data extracted from death certificates include age, gender, method of suicide, date and place of death, contributory cause(s) of death (defined as reasons adversely affecting the development of the condition leading to death and hence contributing to it) (Statistics Finland 2013), and the presence of alcohol in the blood at the time of death (use of alcohol coded as the contributory cause of death). In addition to their structured data fields, the death certificates include a blank text field for event description, i.e. a short case history written in the form of free text (Lahti & Penttilä 2001). Such a case history usually includes background information on issues such as the previous suicidality of the deceased, or critical life events prior to suicide. The type of firearm used in
firearm suicides is always noted in the event description. Appendix 1 presents a copy of the Finnish death certificate form.

Table 5. Sources of information for the “Suicides in the province of Oulu” research project.

<table>
<thead>
<tr>
<th>Information source</th>
<th>Specific information source</th>
<th>Original publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents pertaining to establishing the cause of death</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Primary source</td>
<td>Death certificates</td>
<td>III, IV</td>
</tr>
<tr>
<td>Other sources</td>
<td>Autopsy referrals</td>
<td>III</td>
</tr>
<tr>
<td></td>
<td>Police investigation reports</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Findings of the external and internal examinations of the medicolegal autopsies</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Microscopic examinations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Toxicological examinations</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Final medicolegal autopsy reports</td>
<td></td>
</tr>
<tr>
<td>Register linkage data</td>
<td>Finnish Hospital Discharge Register</td>
<td>III</td>
</tr>
</tbody>
</table>

Other sources of information are also presented in Table 5. Autopsy referrals are written by primary care physicians and often include information on the deceased’s prior state of health. Most police investigation reports include information based on interviews with next-of-kin or others who knew the deceased, and copies or mentions of possible suicide notes. Detailed external and internal examinations of the body are conducted by official medical examiners, who also take tissue samples for microscopic examination. Toxicological examinations include, for example, the determination of alcohol and drug concentrations in the blood and urine. All toxicological analyses are performed in the Forensic Toxicology Laboratory at the Department of Forensic Medicine Hjelt Institute of the University of Helsinki. Final medicolegal autopsy reports are written by medical examiners based on all of the above information.

National health care register information was also used as a source of data. In Finland, it is possible to make register linkages using the personal identity codes with which every Finnish citizen is provided. The suicide data was linked to the Finnish Hospital Discharge Register (FHDR, renamed as the Care Register for Health Care in 1994), a nationwide health register covering all inpatient hospital admissions at primary and specialized level care in Finland since 1969 (Sund 2012). The FHDR data contain primary diagnoses and comorbidities upon
discharge, as well as the length of stay and discharge dates for all treatment episodes. Such data is provided by the National Institute for Health and Welfare.

Adolescent suicide data (III, IV)

The study sample in the original publication III comprised all 58 adolescents below 18 years of age who committed suicide in the province of Oulu between 1st April 1988 and 31st December 2012. Among the documents pertaining to establishing the cause of death, death certificates were available for all subjects. In terms of other documents, these were available for 54 (93%) adolescents and, due to administrative obstacles, unavailable for four male subjects. Among the 54 suicide victims, the medical examiners’ suicide case files included documents of all other kinds, except for autopsy referrals (or equivalent documents) which were available for 56% of the subjects. In addition, while the content of toxicological examinations varied, the blood alcohol concentration (BAC) was available for all subjects.

For the purpose of this research, besides data derived from the death certificates, information extracted primarily from the other documents included blood and urine alcohol concentrations, the presence and concentrations of substances other than alcohol in the blood and urine, the time of suicide, the presence of a suicide note, the family circumstances and living arrangements of the adolescents, precipitating factors (defined as a recent stressor believed to have directly contributed to the suicide), the psychological and behavioral characteristics of the adolescent, previous suicidality (expression of suicidal ideas or a suicide attempt) and self-cutting. Self-cutting was defined as distinctive scars detected by a medical examiner in an external examination of the body. A previous suicide attempt was considered to be present if “suicide attempt” was mentioned in any of the documents. As described in section 4.1.1., suicide methods were categorized as violent or non-violent.

Blood alcohol concentrations are reported in line with the Finnish standards on the issue, i.e. as mass of alcohol per mass of blood (1 mg/g, indicating 1 per mil (%)), in contrast to many other countries which use mass of alcohol per volume of blood (e.g. 1 g/L) as the unit of measurement (Jones 2006). A cut-off concentration of 0.20 g/L (i.e. 0.19 mg/g, or 0.19‰) was used when reporting positive blood alcohol results (Jones et al. 2013a), due to the risk of small amounts of alcohol being generated in the body after death.
In the original publication IV, the seasonal distribution of adolescent suicides (n=42) was examined for the period 1988–2005. Adult suicides (≥18 years) were used as a comparison group. Since the seasonality of suicide differs by method and the use of firearms was the most common suicide method among the adolescents studied, only the seasonality of firearm suicides was investigated. Seasonal patterns among adolescent and adult firearm suicides were compared with one another and with the uniform distribution of suicide cases over the year. Additionally, the seasonal pattern of firearm suicides within a subgroup of young adults aged 18–23 years was compared with that of the rest of the adult population (≥24 years).

The distribution of suicides was investigated by both month and season. The seasons were defined as follows: winter (November to January), spring (February to April), summer (May to July) and fall (August to October). As such, they follow the occurrence of solstices and equinoxes and are based on the amount of light, which in Northern Finland peaks in June and troughs in December. Monthly mean sunshine hours during the period 1971–2000 in the province of Oulu were obtained from official publications by the Finnish Meteorological Institute (2004).

This thesis also includes unpublished results based on updated suicide seasonality data related to adolescent suicides up to the year 2012. For male adolescents, the updated results are presented as overall data, and separately for firearm suicides and for suicides by all other methods. With respect to adolescent females, due to the small number of cases the updated results are presented for total data only.

Further, this thesis presents unpublished data based on the results of forensic toxicology examinations, which include results related to alcohol concentrations in the blood (BAC) and urine (UAC). The stage of alcohol metabolism in suicide victims at the time of death, i.e. whether they committed suicide during the ascending or descending phase of blood alcohol concentration, can be assessed by calculating the ratio of UAC and BAC. The UAC/BAC ratio also serves as an indicator of the time which elapsed between the point at which drinking ended and death (Jones 2006).

As regards alcohol metabolism, alcohol is absorbed into the circulatory system from the stomach and gut, whereby the BAC begins to increase. The alcohol is then distributed throughout the body (Kugelberg & Jones 2007). The UAC begins to increase, although at a lower rate than the BAC, when alcohol passes into the kidneys from blood carried by the renal artery (Jones 2006). During the initial 60–120 minutes after alcohol consumption, the UAC is less
than or equal to the BAC during the absorptive phase, as the BAC increases (ascending phase of the blood alcohol concentration), and slightly higher than the BAC during the plateau phase (an “intermediate period” denoting that alcohol is still being absorbed, but no increase in BAC is occurring due to the elimination process simultaneously occurring in the liver). In the post-absorptive phase, i.e. approximately >120 minutes after drinking, as the BAC is decreasing due to alcohol metabolism in the liver (the descending phase of the blood alcohol concentration), the UAC is higher than the BAC due to the higher water content of the urine (~100%) compared with that of the blood (~80%). (Jones 2006, Jones & Kugelberg 2010) Following alcohol consumption, the UAC/BAC ratio therefore changes as a function of time. A relatively low UAC/BAC ratio (<1.0) suggests that the absorptive phase was under way at the time of death, indicating that the individual had been drinking alcohol fairly recently, around one hour before death. A UAC/BAC ratio between 1.0 and 1.2 suggests that the decedent was in the plateau phase, while a ratio greater than 1.2 is indicative of the complete absorption and distribution of alcohol (post-absorptive phase), implying that most of the alcohol was consumed several hours before death. (Jones 2006, Kugelberg & Jones 2007, Levine & Smialek 2000)

UAC/BAC ratios were calculated for all adolescent suicide victims who were under the influence of alcohol at the time of their death, except for one subject whose forensic toxicology results were not available (but use of alcohol was recorded on the death certificate). The proportion of adolescents in the ascending phase (UAC/BAC ratio ≤1.2) and in the descending phase (UAC/BAC ratio >1.2) of blood alcohol concentrations at the time of suicide was determined. To calculate the UAC/BAC ratios, BAC units of 1 mg/g were converted into 1 g/L to enable use of the aforementioned cut-off value of 1.2, which is based on mass per volume measurements (Levine & Smialek 2000). Since the water content of urine is close to 100%, i.e. its density is almost 1.0, conversion of units is not required for UAC values (Jones 2006).

4.2 Statistical methods

The statistical significances of the group differences in categorical variables were assessed using Pearson’s chi-squared test or Fisher’s exact test, and in continuous variables using Student’s t-test. In addition, the specific statistical analyses used in the original publications are presented below.
**Original publication I.** For the analysis of suicide trends, a Joinpoint regression model was employed in order to identify changes in suicide rates over time. A grid-search model was used to fit the regression function to unknown joinpoints. In addition, the annual percent change (APC) was used to characterize trends in suicide rates over time and the model suggested by the Joinpoint regression analysis (Kim et al. 2000) was used as the best fit for the adolescent suicide rate data per 100,000 population. The Joinpoint regression Program, version 3.4.2 (http://srab.cancer.gov/joinpoint/) served as the software. Owing to the relatively small number of adolescent suicides, three-year moving averages were used for statistical modeling.

In analyzing trends in specific suicide methods, trends from the year 1975 onwards were examined. This was because during the time of study completion method-specific suicide data were unavailable for 1969–1974. Since it is well established that the year 1990 marked a notable turning point in overall suicide rates in Finland, i.e. the rising trend turned to a decrease (Hiltunen et al. 2009), these method-specific trends were examined separately for the years 1975–1989 and 1990–2008. From 1987, the “other methods” were split between traffic suicides and other/unspecified methods, since due to a change in the statistical practices used within Statistics Finland, a separate code was assigned to traffic suicides (E959; X81–X82). When calculating the trend in violent suicides for the period 1990–2008, traffic suicides were included in violent suicide methods.

**Original publication II.** Suicide rates were visualized as 3-year moving average rates. Differences in suicide rates between Northern and Southern Finland were analyzed using the Independent Samples t-test. Regression analysis was used to test the linear trend in suicides.

**Original publication III.** Because this study was descriptive in nature, no sophisticated analyses were performed. The data were analyzed by gender and age group (<15 years and 15–17 years), where such an approach was considered relevant.

**Original publication IV.** Overall seasonality was assessed using the chi-square test for multinomials and the ratio of the observed to the expected number of suicides was calculated with 95% confidence intervals (Wonnacott & Wonnacott 1990). Expected numbers of suicides were calculated based on the uniform distribution of suicide cases over the year. Adjustment for equal month length was performed and account was taken of the effect of leap years.
All statistical tests were two-tailed, and a limit for statistical significance was set at $p<0.05$. The statistical software used in the analyses was SPSS Statistics (IBM Corp. 2013).

4.3 Ethical considerations and personal involvement

The research plan for the “Suicides in the province of Oulu” project, of which the micro approach section of the present research forms part, was approved by the Ethics committee of the Faculty of Medicine, University of Oulu on 8th November 1999, and by the Ministry of Social Affairs and Health on 22nd May 2000 (Dnro 14/07/2000). The data used in this study are solely based on administrative documents and information culled from Finnish national registers. The topic of this doctoral thesis was approved by the Postgraduate Research Committee of the Faculty of Medicine at the University of Oulu on 16th December 2008.

Suicide in children and adolescents is a particularly sensitive topic, and careful consideration must be given to the publication and presentation of study results related to this subject. The results of this study have therefore been reported while maintaining the confidentiality of deceased children and adolescents. Individual cases cannot be identified in any of the published results. No family members or other people close to the suicide victims were contacted and no interviews were performed at any stage of the research.

The author of this thesis has been participating as a researcher in the “Suicides in the province of Oulu” study project since 2004. In addition, the author has made a major contribution to all of the original publications, is named as the first author in each of them, and was the corresponding author of manuscripts I–III. She was involved in designing the study, collecting and analyzing the data and reporting the results. Also, in consultation with a professional statistician, she participated in the statistical analyses of all of the original studies. She wrote the first draft of each manuscript and was responsible for the final form of each paper as it was submitted.
5 Results

5.1 Macro approach (I, II)

5.1.1 Child and adolescent suicide trends in Finland (I)

In the original publication I, trends in overall and method-specific suicide rates among Finnish male and female adolescents were explored. Over a period of 40 years between 1969 and 2008, there were 901 suicides among children and adolescents under the age of 18 years in Finland. Of the suicide victims, 78% (n=701) were male and 22% (n=200) female, giving a male-to-female ratio of 3.6:1.

Analysis based on the updated data showed that, over the period 1969–2012, the number of adolescent suicides increased to 964, 77% of which (n=746) were male and 23% (n=218) female suicides (unpublished data). In the additional period 2009–2012, there were 45 (71%) male and 18 (29%) female suicides. The male-to-female ratio for the years 2009–2012 was thus 2.5:1.

Overall trends in adolescent suicides

Figure 1 of the original publication I shows gender-specific adolescent suicide trends between the years 1969 and 2008. Male adolescent suicide rates increased significantly (p<0.001) in 1969–1989 and decreased after 1990 (p<0.001). Rates among females were inconsistent during the earlier period, turning into a significant increase (p<0.001) in the latter period.

Adolescent suicide trends were recalculated with updated data covering the period up to the end of 2012 (unpublished data). As shown in Figure 2, the results remained the same among adolescent males, except for the turn from a decreasing trend towards an increase during the most recent years (change p=0.013). Female adolescents also show similar results for the earlier years, but the rate has begun to decrease slightly in more recent times (change p=0.007).
Fig. 2. Child and adolescent suicide trends in Finland in 1969–2012.

**Trends in methods of suicide**

Among male adolescents, use of firearms was the most common method of suicide, as it was involved in 49% of all suicides in 1975–1989 and in 49% of all suicides in 1990–2008 (I: Figure 2). The second most common suicide method was hanging (35% in the earlier period and 26% in the latter period). The proportion of all non-violent suicide methods among adolescent males was low throughout the study period, as they accounted for 3% of all suicides in the earlier period and 5% in the latter. As shown in Table 1 of the original publication I, no significant changes occurred in rates of different methods of suicide among male adolescents in the period 1975–1989. In 1990–2008, a significant decrease was observed in suicides by the use of firearms, by poisoning and by all violent methods. The decrease in suicides by all violent methods including traffic suicides was likewise significant. There was no significant change in the rate of all non-violent methods.

For female adolescents, the most common method of suicide was poisoning (26%) in 1969–1989 and hanging (32%) in 1990–2008 (I: Figure 2). Hanging was the second most common method (22%) in the earlier period, while other
methods (25%) were in the latter. Traffic suicides accounted for 96% of the other methods. Among females, poisoning was the only non-violent method of suicide, accounting for 26% of all suicides in the earlier period and 21% in the latter. As presented in Table 2 in the original publication I, no significant changes in the rates of any specific female suicide methods were observed during the period 1975–1989. In 1990–2008, a significant increase was observed in suicides by “other methods”, especially traffic suicides. A significant increase was also observed in violent suicides when traffic suicides were included. Rates of non-violent suicides remained unchanged.

In a further analysis using updated data, the distribution of adolescent suicide methods was examined for the most recent 5-year period (2008–2012) (unpublished results). During this period, traffic suicides were the most common method of suicide among both genders, as they accounted for 34% of all suicides among males and for 35% among females. For males, the second and third most common suicide methods were hanging (28%) and use of firearms (26%), and for females hanging (27%) and jumping (19%). Non-violent methods accounted for 2% of all male and 12% of all female adolescent suicides.

5.1.2 Child and adolescent male firearm suicides (II)

In the original publication II, the regional difference in the rates of male adolescent firearm suicides between Northern and Southern Finland was examined. Of the total of 654 adolescent (<18 years) male suicides in Finland between 1972 and 2009, 47% (n=305) were committed through the use of firearms. In the reference groups of young adult (18–24 years) and adult (25–44 years) males, 36% (n=1,530) of the 4,252 young adult male suicides and 25% (n=3,588) of the 14,674 adult male suicides were committed using firearms.

Regional differences in firearm suicide rates

Throughout the study period, 1972–2009, the mean rate of Finnish adolescent male firearm suicides (per 100,000 population aged 12–17 years) was significantly higher in Northern Finland than in Southern Finland (8.7 vs. 3.1, p<0.001) (II: Figure 3a). The difference in rates between these regions was 2.8-fold. A similar regional difference in firearm suicides was also observed among young adult males, as the regional difference was 2.6-fold (33.8 vs. 13.2,
p>0.001) (II: Figure 3b) and, in adult males, firearm suicide rates involved a 1.9-fold (22.0 vs. 11.4, p<0.001) difference between regions (II: Figure 3c).

Regarding the rates of suicide by other methods, no regional differences were observed among adolescent males (4.8 vs. 4.3, p=0.176) or young adult males (26.8 vs. 28.7, p=0.086). A significant difference was observed among adult males (43.2 vs. 38.7, p=0.004).

Proportion of suicides involving firearms

Among adolescent males, the proportion of suicides involving firearms was significantly higher in Northern Finland than Southern Finland (64% vs. 41%, p<0.001) (II: Figure 4). A similar regional difference was also found among young adult males (55% vs. 31%, p<0.001) and adult males (34% vs. 23%, p<0.001). The highest proportion of suicides involving firearms was observed among adolescent males in Northern Finland (64%) and the lowest among adult males in Southern Finland (23%).

Types of firearms

The exact type of firearm involved was included in the diagnostic codes for suicides from the year 1996, when ICD-10 was implemented in Finland. Type-specific firearm results are therefore reported only for the years 1996–2009. A shotgun or rifle (i.e. a hunting gun) was the most commonly used weapon in male firearm suicides in all three age groups, both in Northern and Southern Finland (II: Table 2). Among adolescent males, a hunting gun was involved in 88% of all firearm suicides in Northern Finland, whereas the proportion was 67% in Southern Finland (p=0.060). The regional difference was similar among young adults (85% vs. 67%, p<0.001) and adult males (79% vs. 56%, p<0.001).

5.2 Micro approach (III, IV)

5.2.1 Demographic features of child and adolescent suicides (III)

The original publication III presented the characteristics of child and adolescent suicides, with a special focus on gender differences. Of the total of 58 adolescent suicide victims in the province of Oulu during 1988–2012, 79% (n=46) were male
and 21% (n=12) female. The male-to-female ratio was thus 3.8:1. Approximately one fifth of both male (n=9) and female (n=2) suicide victims were under 15 years of age (III: Table 1) and the youngest suicide victim was 11 years of age. In our sample, 17-year-old adolescents comprised almost half of all suicide victims, the proportions being 43% (n=20) among males and 58% among females (n=7) in (p=0.518).

With regard to the family circumstances and living arrangements of these adolescents at the time of suicide, most had been living with at least one biological parent (III: Table 1). Approximately one in ten of the males were housed by child welfare services (institutions, relatives, foster family). Of the adolescents living with at least one biological parent, at least half of the males and two thirds of the females were living with both biological parents.

5.2.2 Suicide methods (III)

Use of firearms was the most common method of suicide in both genders, with 63% (n=29) of males and 33% (n=4) of females employing this method (III: Table 1). Hanging was the second most common suicide method among the males, accounting for 20% (n=9) of all male adolescent suicides. In addition, 9% (n=4) of the males jumped from a height, 7% (n=3) committed suicide in traffic, and 2% (n=1) committed suicide using exhaust gas. Of the adolescent females, 25% (n=3) committed suicide in traffic (railway suicides in all cases), 17% (n=2) took a drug overdose, and hanging, a jump from a height and drowning were each employed by one female. There was a significant difference in the distribution of suicide methods between males and females (p=0.009).

In regard to violent and non-violent methods of suicide, with the exception of one gassing suicide all male adolescent suicides were committed employing a violent method (98%, n=45). Two females committed suicide by drug overdose, meaning that the majority (83%, n=10) of adolescent females had used violent suicide methods. No significant difference was observed in the choice between violent and non-violent methods of suicide between the genders (p=0.106).

5.2.3 Mental health (III)

Table 6 summarizes the findings concerning the mental health status of adolescent suicide victims. Evidence of mental health problems – defined as lifetime inpatient hospital care due to a mental disorder or self-poisoning, a mental
disorder as a contributory cause of death in the death certificate, previous suicidality (expression of suicidal ideas or a suicide attempt), self-cutting, or nonspecific symptoms of mental health problems – was found in the majority of adolescent suicide victims in both genders: 63% of males and 83% of females.

Table 6. Evidence of mental health problems among adolescent suicide victims, by gender.

<table>
<thead>
<tr>
<th>Evidence of mental health problems</th>
<th>Males</th>
<th>Females</th>
<th>p-value¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>History of inpatient psychiatric hospitalization</td>
<td>7</td>
<td>2</td>
<td>1.000</td>
</tr>
<tr>
<td>History of inpatient somatic hospitalization due to self-poisoning</td>
<td>–</td>
<td>2</td>
<td>0.040</td>
</tr>
<tr>
<td>Mental disorder as a contributory cause of death in the death certificate</td>
<td>4</td>
<td>3</td>
<td>0.147</td>
</tr>
<tr>
<td>Previous suicidality</td>
<td>14</td>
<td>9</td>
<td>0.020</td>
</tr>
<tr>
<td>Expression of suicidal ideas</td>
<td>13</td>
<td>7</td>
<td>0.086</td>
</tr>
<tr>
<td>Suicide attempt</td>
<td>2</td>
<td>3</td>
<td>0.055</td>
</tr>
<tr>
<td>Self-cutting</td>
<td>3</td>
<td>4</td>
<td>0.028</td>
</tr>
<tr>
<td>None of the above, but nonspecific symptoms of mental health problems</td>
<td>7</td>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>Any of the above</td>
<td>29</td>
<td>10</td>
<td>0.302</td>
</tr>
<tr>
<td>No mental health problems by parental report</td>
<td>6</td>
<td>–</td>
<td>0.328</td>
</tr>
<tr>
<td>Not reported</td>
<td>11</td>
<td>2</td>
<td>0.716</td>
</tr>
</tbody>
</table>

¹ Fisher’s exact test, two-tailed significance

Lifetime inpatient psychiatric care

A history of inpatient psychiatric hospitalization was infrequent, with only seven males and two females having been admitted to hospital during their lifetime. Of these adolescents, five males and one female had only one treatment episode with one discharge diagnosis. One male had three different discharge diagnoses within one treatment episode and another had several long treatment episodes due to autism, whereas one female had six discharge diagnoses within five inpatient treatment periods. Self-poisoning was diagnosed in two males and one female. Depression was diagnosed in one male and one female. Similarly, a substance abuse diagnosis was given in the case of one male and one female. The remaining discharge diagnoses were diverse and each occurred only once. Examples include conduct disorder, adjustment disorder and eating disorder. Child psychiatric diagnoses, such as autism and encopresis, were seen only among males.
The duration of previous psychiatric inpatient treatment periods varied from 1 day to 3 months (median 4 days, excluding one male subject with autism). Of seven males with a history of psychiatric hospitalization, three had been discharged within 6 months to 1 year before committing suicide, one within 1–2 years, and three more than two years before their suicide. One female subject was on home leave from a psychiatric hospital at the time of her suicide, and another had been discharged within 1–2 years before her suicide. Of the two females with a history of admission to medical wards due to self-poisoning (i.e. a suicide attempt), one had been discharged within 6 months and another within 1–2 years before committing suicide. None of the adolescents with a history of lifetime inpatient hospitalization due to mental disorder or self-poisoning were under the age of 15 at the time of their deaths.

**Mental disorder as a contributory cause of death**

A psychiatric diagnosis, depression in all cases, was recorded on the death certificates by the official medical examiners for four male and three female suicides. Two males and two females had previously been hospitalized because of a psychiatric disorder.

**Previous suicidality and self-cutting**

A significantly greater proportion of female than male adolescents (75% vs. 30%) had shown evidence of previous suicidality, defined as the expression of suicidal ideas or suicide attempts (Table 6). In a separate analysis of the expression of suicidal ideas and previous suicide attempts, gender differences were shown to be marginally significant. Significantly more of the female than male adolescents had a history of self-cutting (33% of females vs. 7% of males).

**Nonspecific symptoms of mental health problems**

15% of the males and 8% of the females had shown nonspecific symptoms of mental health problems, but did not have a history of inpatient hospitalization due to a mental disorder or self-poisoning, previous suicidality, self-cutting, or a mental disorder as a contributory cause of death. Information on nonspecific symptoms of mental health problems was based on parental reports, which described the recent behavioral and psychological characteristics of the
adolescent, for example signs of being depressed, withdrawn, nervous, or uncommunicative. Evidence of mental health problems was also found in sources such as the adolescents’ diary entries and suicide notes, revealing that they had been contemplating suicide for a long period.

**Other mental health related information**

Information on the adolescents’ previous mental health treatment in outpatient settings was rarely found among the documents establishing the cause of death. A known history of outpatient psychiatric treatment was reported for only one male and one female, and at the time of suicide, one female was currently receiving such treatment.

Information concerning the mental health of the suicide victims was absent for 24% of the males and 17% of the females. In 13% of the male suicides, the documents stated explicitly that, according to parental reports (and in some cases the primary care physician), the adolescent was physically and mentally healthy and his behavior had been normal prior to the suicide. No precipitating events were reported for these male adolescents. The method of suicide was firearm use in all such cases, one of which involved a boy under 15 years of age.

**5.2.4 Circumstances of the suicides (III, IV)**

An adolescent’s home and its surroundings provided the most common location for suicides among adolescents. A total of 59% (n=27) of the males and 50% (n=6) of the females committed suicide in the home, in an outbuilding next to their home, or outside in the near vicinity of their home (p=0.746). In terms of suicide notes, 37% (n=17) of the males and 40% (n=5) of the females left a written or recorded note (p=0.752). A precipitating event was reported in 24% (n=11) of the males and 17% (n=2) of the females (p=0.716). The reported precipitating events among males were an argument or the end of a relationship with a girlfriend (45%, n=5), an argument with their parents (27%, n=3), an argument with friends (9%, n=1), an argument with a girlfriend and friends (9%, n=1) and shoplifting (9%, n=1). Among the females, the precipitating events were an argument with friends in one case, and a recent abortion in another.
In the original publication IV, an analysis of seasonal variation was performed for 25 adolescent firearm suicides that had occurred in the province of Oulu in 1988–2005. Adult (≥18 years) firearm suicides, n=554, committed in the province of Oulu during the same time period were used as a comparison group. A significant seasonal pattern (p<0.001) with a notable peak in the fall (ratio 2.70, 95% CI: 1.97–3.42) was found in adolescent firearm suicides (IV: Figure 1). 68% of these firearm suicides occurred in the fall (August–October), 14% in the winter (November–January), 21% in the spring (February–April) and none in the summer (May–July). Among adults, however, firearm suicides peaked in the late spring/early summer (p=0.05; ratio 1.19, 95% CI: 1.05–1.35). The seasonal pattern of firearm suicides differed significantly between these two age groups (p<0.001). In addition, the seasonal pattern of firearm suicides involving the subgroup of young adults aged 18–23 years was similar to that of adult victims (p=0.140).

By using updated data, this thesis presents unpublished results on adolescent suicide seasonality by gender, up to the year 2012. Figure 3 shows the seasonal distributions of adolescent male suicides within the updated data (1988–2012). There was a significant fall peak (p=0.004; ratio 1.81, 95% CI 1.24–2.38) in all male adolescent suicides, which was accounted for by the fall peak in firearm suicides (p<0.001; ratio 2.60, 95% CI 1.91–3.29). In suicides by other methods, there was a nonsignificant peak in the winter (p=0.188; ratio 1.87, 95% CI 0.93–2.81). Very few male adolescent suicides were committed in the summer.
Due to the small number of female cases, the seasonal distribution of adolescent female suicides was investigated for total data only. There was no discernible seasonal pattern in the suicides of female adolescents, as 25% occurred in the spring and 25% in the summer, 33% in the fall, and 17% in the winter ($p=0.882$).

In the original publication III, regarding the day of the week and time of day, the exact time of death was known for 89% ($n=41$) of the male and 92% ($n=11$) of the female adolescents (III: Figure 2). The variation in suicides in terms of days of the week was rather small, with 48% of male suicides and 33% of female suicides occurring on the weekends between Friday and Sunday. Among the males, half of the suicides were committed during the day (between 06.00 and 18.00) and half at night (between 18.00 and 06.00) (III: Figure 2). Among the females, one third of the suicides were committed in daytime and two thirds during the night.

Fig. 3. Seasonal distribution of all suicides, firearm suicides and suicides by all other methods among male adolescents in the province of Oulu, 1988–2012.

Due to the small number of female cases, the seasonal distribution of adolescent female suicides was investigated for total data only. There was no discernible seasonal pattern in the suicides of female adolescents, as 25% occurred in the spring and 25% in the summer, 33% in the fall, and 17% in the winter ($p=0.882$).
5.2.5 Toxicology findings (III)

Alcohol

48% (n=22) of the males and 58% (n=7) of the females were under the influence of alcohol at the time of their suicide (p=0.747). Among the males, 11% (n=1) of those under 15 years of age and 57% (n=21) of those aged 15–17 years were under the influence of alcohol at their time of death (p=0.023). The corresponding figures for the females were 0% and 70% (n=7) (p=0.152).

Blood alcohol concentration (BAC) data were available for 95% (n=21) of the males and 100% (n=7) of the females. For the males, the mean (±SD; min–max) BAC value was 1.34‰ (±0.47; 0.45–2.1) and for the females it was 1.19‰ (±0.52; 0.52–2.0) (p=0.476). Urine alcohol concentration (UAC) data (unpublished results) were available for all of these adolescents. The mean UAC value for the males was 1.96‰ (±0.72; 0.38–3.1) and for the females it was 1.71‰ (±0.64; 1.20–2.8) (p=0.419).

Figure 4 presents the UAC/BAC ratios of 21 male and 7 female adolescents who were under the influence of alcohol at the time of suicide (unpublished results). The reference line is the UAC/BAC ratio of 1.2, which indicates the beginning of the post-absorptive phase of the BAC, i.e. descending blood alcohol concentration. A total of 90% (n=19) of the males and 86% (n=6) of the females were in the post-absorptive phase (UAC/BAC ratio >1.2) at the time of their deaths. The mean (±SD; min–max) UAC/BAC ratio was 1.37 (±0.19; 0.79–1.59) for the males and 1.45 (±0.37; 1.03–2.18) for the females (p=0.497).
Fig. 4. The UAC/BAC ratio of adolescents who were under the influence of alcohol at the time of their suicide, by gender.

Males who committed suicide during the night were significantly more often under the influence of alcohol at their time of death than males who committed suicide in the daytime (86% (18/21) vs. 15% (3/20), p<0.001) (III: Figure 2). Among females, 86% (6/7) of those who committed suicide at night were under the influence of alcohol, compared with 25% (1/4) of those who committed suicide during the day, and a trend towards statistical significance was found (p=0.088).

Substances other than alcohol

Toxicology screens for substances other than alcohol had been performed for 79% (n=33) of the 42 males for whom information on toxicological investigations was available and for 92% (n=11) of the females. Among them, 21% (7/33) of the males and 36% (4/11) of the females tested positive for the presence of illegal or
prescription drugs. Among the females, a drug overdose was the method of suicide in two such deaths. The specific substances found in the toxicology screens are shown in Table 7. Benzodiazepines and benzodiazepine-like drugs (diazepam, temazepam, unspecified benzodiazepine and zolpidem) and antidepressants (mianserin, doxepin, mirtazapine and paroxetine) were the most commonly detected prescription drugs. Antidepressants had been prescribed for the two females who screened positive for such medication, but in other cases there was no indication that the drugs had been prescribed for the adolescents. Cannabis was found in one male. No positive results were found in cases where subjects were tested for the presence of so-called hard drugs such as amphetamine, cocaine or buprenorphine. Four males and three females were also under the influence of alcohol at the time of death. None of the adolescents who tested positive for the presence of illegal or prescription drugs were under 15 years of age at the time of their death.

Table 7. Substances other than alcohol detected in the blood or urine of adolescent suicide victims.

<table>
<thead>
<tr>
<th>Cases</th>
<th>Substances in blood</th>
<th>Substances in urine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Males</td>
<td>Alcohol present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case 1</td>
<td>diazepam &lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Case 2</td>
<td>zolpidem &lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Case 3</td>
<td>benzodiazepine (unspecified)</td>
</tr>
<tr>
<td></td>
<td>Case 4</td>
<td>codein, salicylates</td>
</tr>
<tr>
<td></td>
<td>No alcohol present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case 1</td>
<td>mianserin &lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>Case 2</td>
<td>methyl tert-butyl ether &lt;sup&gt;2&lt;/sup&gt; doxepin</td>
</tr>
<tr>
<td></td>
<td>Case 3</td>
<td>cannabis &lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td>Females</td>
<td>Alcohol present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case 1</td>
<td>mirtazapine, ibuprofen</td>
</tr>
<tr>
<td></td>
<td>Case 2</td>
<td>temazepam</td>
</tr>
<tr>
<td></td>
<td>Case 3 &lt;sup&gt;4&lt;/sup&gt;</td>
<td>codein, paracetamol, ibuprofen</td>
</tr>
<tr>
<td></td>
<td>No alcohol present</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Case 1 &lt;sup&gt;4&lt;/sup&gt;</td>
<td>paroxetine, levomepromazine</td>
</tr>
</tbody>
</table>

<sup>1</sup> Recorded as contributing cause of death in death certificate.
<sup>2</sup> Had drunk gasoline.
<sup>3</sup> Also detected in hair.
<sup>4</sup> Drug overdose as a method of suicide.
5.2.6 Somatic findings from the medicolegal autopsies (III)

Below are presented unpublished findings, based on data from external and internal examinations and microscopic examinations conducted during the medicolegal autopsies of adolescent suicide victims. In relation to the somatic diseases observed during the autopsies, there were early signs of atherosclerosis in 33% (n=15) of the males and in 25% (n=3) of the females, mild fatty degeneration of the liver in three cases, one case of gastritis, one case of mild pneumonia, and one case of thyroid cancer.

Information on the body mass index (BMI) was available for 89% (n=41) of the males and 100% (n=12) of the females. The average BMI was 22.7 kg/m² for the males and 21.2 kg/m² for the females. 13% (n=6) of the males and none of the females were overweight or obese (BMI >25 kg/m²). 2% (n=1) of the males and 8% (n=1) of the females were underweight (BMI <18.5 kg/m²).

Of the three males with self-cutting scars, the scars were located on the thighs in the case of two males and the thighs and arms in the case of one male. Among females, the location of the scars was the arms for all four suicide victims.
6 Discussion

6.1 Overview of the results

Following the continuously increasing trend in male adolescent suicides in Finland from the late 1960s onwards, rates began to decline after the early 1990s. However, this favorable development has not continued in recent years, as slight increases in suicide rates have been observed among male adolescents. Among adolescent females, following earlier inconsistent trends suicide rates began to increase in the early 1990s. This alarming upward trend was followed by a slightly decreasing trend from the early 2000s.

From the 1970s, use of firearms was the most common suicide method among Finnish male adolescents, until traffic suicides took the lead position in recent years. Among females, poisoning used to be the most common suicide method before 1990, but hanging surpassed poisoning after that time. In line with the situation for males, traffic suicides have recently exceeded hanging to become the most common method of suicide among female adolescents. On a more general level, there has been a decrease in the use of all violent methods among males, and an increase for females since the early 1990s.

Between the years 1972–2009, the adolescent male firearm suicide rate in Northern Finland was almost three times higher than that observed in Southern Finland, while there was no difference in rates of suicide by other methods. A northern excess in firearm suicide rates was also found among young adult and adult males. Hunting guns were the most common type of firearms employed in the case of young male suicides, and their use was particularly common in Northern Finland.

In a comprehensive sample of adolescent suicides that occurred in the province of Oulu during a period of 25 years, only a minority of the suicide victims had a previous history of psychiatric hospitalization. The discharge diagnoses were heterogeneous. A higher proportion of females than males had a known history of previous suicidality. Half of the adolescents were under the influence of alcohol at the time of death. Of these, the vast majority committed suicide during the night and during the descending phase of the blood alcohol concentration. One fifth of adolescents screened positive for substances other than alcohol. Violent methods of suicide predominated (males 98%, females 83%). Use of firearms was the most common suicide method among both genders. A
significant seasonal pattern was discernible among male adolescent firearm suicides, with a peak occurring in the fall.

6.2 Discussion of the findings

6.2.1 Trends in child and adolescent suicides (I)

The results of the study of trends in the suicide rates of Finnish adolescents aged less than 18 years showed that male adolescent suicide rates increased from 1969 to 1989, while there were no consistent changes in the rates for adolescent females during that period. The transition from the 1980s to the 1990s marked a turning point in adolescent suicides, since from that time onwards the adolescent male suicide rate began to decline, while the female suicide rate followed an upward trend. It is worth noting that more recent data up to the year 2012 again revealed shifts in suicide trends among both genders. The previous favorable decline in male adolescent suicides gave way to a slight increase in the mid-2000s, while the previous increase in female adolescent suicide rates has ceased and a slightly declining trend has emerged since the early 2000s. However, despite these trend changes, current male adolescent suicide rates are still remarkably lower, and the corresponding rates in females higher, compared to the rates in the early 1990s.

The general decreasing trend in suicide rates among adolescent males from the 1990s is in line with the decline reported in the general Finnish male population, whose suicide rate fell by half between 1990 and 2012. Whereas the rate was as high as 50.1 per 100,000 male population in 1990, it had fallen to 23.6 by 2012 (Statistics Finland 2014a). As regards females in the general population, a declining suicide trend has also been observed in their rates of suicide between 1990 and 2012 (from 12.1 to 7.5 per 100,000 population). Therefore, during the 1990s the rising suicide trend among adolescent females was the opposite to that among Finland’s general female population.

It is remarkable that, despite the long history of suicide research, explanations of changing trends in suicide rates have remained largely speculative. In Finland, it has been suggested that decreasing suicide rates among the general Finnish population are related to better depression treatments, with special regard being paid to the increased use of SSRI antidepressants (Korkeila et al. 2007, Lönnqvist 2009, Partonen 2012). In addition, the multidimensional effects of the national
suicide prevention project in Finland, established in the late 1980s (Lönnqvist et al. 1993), and positive advances in society in a broader sense, have been proposed as possible contributors to this decreasing trend (Hiltunen et al. 2009, Lönnqvist 2007). With regard to the use of adolescent outpatient psychiatric services in Finland, the number of 13–22-year-old patients has increased by two thirds in the 2000s and it has been suggested that the previously hidden need for psychiatric services has given way to active demand (Pylkkänen 2013). Also researchers from various other countries have suggested that improvements in antidepressant treatment and government suicide prevention strategies may underlie decreasing suicide rates among young people (Bridge et al. 2005, McKeown et al. 2006, Morrell et al. 2007). Other authors seeking explanations for changes in adolescent suicide rates have focused on factors such as rates of alcohol consumption, access to lethal means and the influence of the internet (Biddle et al. 2008, Brent et al. 1987, Bridge et al. 2008, McClure 2001). On the other hand, it has been suggested that a combination of socio-economic and clinical factors accounts for the changes (Windfuhr et al. 2008), which is consistent with the view that suicide is a multidetermined event.

Better treatment of depression and the favorable societal changes that have occurred in Finland may play a role in explaining the decrease in adolescent male suicides since 1990, but the important question arises of why the rate for adolescent females has followed the opposite trend at the same time. Notably, the increase has specifically occurred in the rates (and proportion) of violent suicide methods, whereas the rate of non-violent methods has remained unchanged. Similarly to the present findings, a shift towards the use of more violent suicide methods among young (20–24 years) females had been observed in Finland before the 1990s (Öhberg et al. 1996), and more recently in several other European countries (Värnik et al. 2009). It has been suggested that converging gender roles, i.e. as more similar roles have begun to replace traditional masculine/feminine roles, are contributing to this phenomenon (Grøholt et al. 1999, Pompili et al. 2009, Värnik et al. 2009). This is alarming, since females are known to have higher rates of attempted suicide than males and the use of violent suicide methods is more likely to end in a fatal outcome.

It is also of interest to compare the distributions of violent and non-violent suicide methods among Finnish adolescents to those among the adult population in Finland. Between 1998 and 2012, violent methods were employed in 76% of male and 46% of female adult (≥25 years) suicides (Statistics Finland 2014a), which illustrates the traditional gender difference in the choice of violent and non-
violent methods among adult suicide victims. As the results of the present study show, the proportions of violent suicide methods among adolescents of both genders are notably higher than the corresponding proportions for adults. Correspondingly, Hepp et al. (2012) have reported that suicides by intoxication are less frequent among Swiss adolescents than among adults. They suggest that this may be due to adolescents having more difficulty accessing potentially lethal drugs and lacking sufficient knowledge of the toxicity and lethal doses involved. Apart from considerations of method availability, another possible explanation for the large proportion of violent suicide methods among adolescents is related to the sociocultural acceptability of different suicide methods, with norms and traditions having an effect on the choice of suicide method (Cantor & Baume 1998).

Recent changes in the types of suicide methods among adolescents in Finland also merit consideration. Use of firearms has been the predominant method for Finnish adolescent males – accounting for half of all suicides – since at least the 1970s. The most recent suicide statistics from the years 2008–2012 showed, however, that traffic suicides have overtaken the use of firearms and hanging to become the leading suicide method among male adolescents. Similarly, traffic suicides have assumed the leading position in suicide methods among adolescent females and the shift towards the increasing use of this method had already begun among females in the 1990s. Again, this suggests that sociocultural acceptability may be of importance to the choice of method and that traditional patterns of suicide among adolescents are subject to change.

### 6.2.2 Regional differences in child and adolescent male firearm suicides (II)

The results of this study demonstrated a marked regional difference in firearm suicide rates among adolescent males, with significantly higher rates in Northern Finland compared to Southern Finland. By contrast, rates of suicide by all other methods did not show such a regional difference. Use of firearms evidently accounts for a major part of the northern excess in suicide rates among Finnish male adolescents.

In Finland, particularly in the northern areas of the country, hunting is a traditional sport among males of all age groups, including young adolescents. The prevalence of firearms in general, and hunting guns in particular, is substantially higher in Northern Finland compared to Southern Finland (The Finnish Police,
unpublished data). The association between a greater number of firearms and higher rate of firearm suicides within any specific region has been demonstrated in several studies (Ajdacic-Gross et al. 2010b, Johnson et al. 2000, Miller et al. 2007). The results of the present study showed that a regional difference in rates of firearm suicide was present among all <45-year-old Finnish males, but that the difference in rates was more prominent among adolescent and young adult males (2.8- and 2.6-fold differences, respectively) than in adult males (1.9-fold difference). Earlier studies have reported that the association between greater availability of firearms and higher rates of firearm suicides is more evident in young people than adult populations (Birckmayer & Hemenway 2001, Sloan et al. 1990). It has been suggested that this is because young persons are more impulsive. This impulsiveness when combined with easy access to a highly lethal method then leads to greater susceptibility to suicide among younger people, compared to older people (Miller et al. 2007).

With regard to suicide prevention, the evidence strongly suggests that means restriction is among the most effective available policies (Mann et al. 2005, Yip et al. 2012). Correspondingly, stricter firearm control as a means of suicide prevention has been emphasized in Finland (Wahlbeck 2011). Finland actually implemented stricter firearms legislation back in 1998 and again in 2011 (Firearms Act 1998), and a legislative proposal has very recently been presented to the Finnish Parliament proposing the further restriction of e.g. firearm storage practices (HE 20/2014). Further, from 2011 physicians have been duty-bound to notify the police of any persons they consider unfit to possess a firearm on the basis of the person’s health or behavior, as stated in amendment 11.2.2011/124 of the Firearms Act (1998). Physicians’ duty to notify the police is further specified in the ongoing legislative proposal (HE 20/2014). Those opposed to means restriction strategies argue that, according to the substitution hypothesis, if one method of suicide becomes unavailable, a suicidal person will seek an alternative method. However, it has been suggested that individuals have a preference for a specific means of suicide, which makes method substitution unlikely (Daigle 2005). To conclude, the findings of this study underscore the importance of further research on relations between firearm availability and suicide, and adolescents should be included in these studies.
Various characteristics of adolescent suicides were scrutinized in order to broaden the understanding of what may lie behind suicides among adolescents from the province of Oulu in Northern Finland. The basic demographic characteristics of adolescent suicide victims in this case series study are in line with previous research, as the number of male suicides was almost four times that of females, and suicide rates increased with age among both genders. Violent methods of suicide were almost always used (in 98% of cases) by adolescent males, and also predominated among females (83%); this is in accordance with the distribution of violent and non-violent suicide methods among Finnish adolescents in the country as a whole. The present study reveals that use of firearms was the most common method of suicide among both genders. This contrasts with the method distribution among adolescent females in the whole of Finland, since less than 10% of these suicides were committed using firearms during 1990–2008. As discussed earlier, cultural factors may play a role in the choice of specific suicide methods, which may also be of importance in explaining the present finding on the relatively greater use of firearms among adolescent females in the province of Oulu.

A minority of the suicide victims (15% of males and 17% of females) had a lifetime history of psychiatric inpatient hospitalization, which coheres with previous findings based on international studies. Brent et al. (1999) reported that 15% of adolescent suicide victims had received inpatient care, and other researchers have reported figures as low as between 2–5% (Groholt et al. 1997, Portzky et al. 2005). The figures reported for lifetime mental health care contacts among adolescent suicide victims have varied between 20 and 50% (Groholt et al. 1999, Karch et al. 2013, Marttunen et al. 1992, Portzky et al. 2005, Shaffer et al. 1996). In the present study, explicit information on psychiatric outpatient treatment was scarce. Only one male and two females were known to have received such care in their lifetimes. However, the clinical impression which emerged based on all of the available information suggested that the majority of the adolescent suicide victims had never been in contact with mental health services. Current psychiatric treatment (at the time of death of the adolescent) was also rare in this study, again a finding consistent with previous studies (Brent et al. 1988, Groholt et al. 1997, Rich et al. 1990, Shaffie et al. 1988, Windfuhr et al. 2008).
The infrequency of psychiatric care among adolescent suicide victims may have several explanations. Outward signs of mental health problems among adolescents may not be sufficiently severe to be recognized by others, and the adolescents may conceal or deny the extent of their problems. Further, even where problems are recognized, there may be reluctance on the part of the family, friends and the adolescents themselves to seek help from health care professionals, possibly due to the stigma associated with mental illness (Moskos et al. 2007). Young people’s reluctance to seek professional help for mental health problems is a well-known phenomenon and applies to young males in particular (Rickwood et al. 2007).

It is also possible that some of these adolescents had no need of psychiatric care since mental health problems were not involved. Based on the parental reports, 13% of the male adolescents covered in this study had been healthy, normally behaving adolescents whose suicides were completely unexpected. This finding seems consistent with the results of psychological autopsy studies, which have reported that approximately 10% of adolescent suicide victims (usually male) had no diagnosable psychiatric disorder (Brent et al. 1993a, Marttunen et al. 1991, Renaud et al. 2008, Shaffer et al. 1996). Suicides of this kind have often been explained in terms of impulsiveness. However, Brent et al. (1993b) found that adolescent suicide victims without an apparent psychiatric disorder were more likely to have some psychiatric risk factors, such as familial psychiatric disorders, compared to community controls. With regard to the present study, data on the mental health characteristics of the adolescents in question lacked sufficient detail for firm conclusions to be drawn in this respect.

In the present study, 25% of the females and just 4% of males were known to have previously attempted suicide, or the reverse, with 75% of the females and 96% of the males having died in their first suicide attempt. Previous studies have shown that a prior suicide attempt is a key risk factor in completed suicides among adolescents of both genders (Brent et al. 1999, Grøholt et al. 1997, Shaffer et al. 1996). However, in the current study a history of previous suicide attempt(s) seemed to serve as a potential predictor of suicide among females, but not among males.

The results of the present study showed that self-cutting scars were much more prevalent in adolescent female than male suicide victims (33% vs. 7%). Compared with these results, the life-time prevalence of self-cutting amongst the general Finnish adolescent population aged between 13 and 18 years is lower (17%) for females and the same (7%) among males (Laukkanen et al. 2009).
From a predictive viewpoint, self-cutting may therefore be an indicator of a potential suicide risk among female, but not male, adolescents. On the other hand, Laukkanen et al. (2013) have shown that adolescents who cut themselves on parts of the body other than just the arms present with psychiatric problems of greater severity, such as being more likely to have suicidal thoughts and attempt suicide, than those with self-cutting on the arms alone. Interestingly, in the present study self-cutting scars were located only on the arms among all four females, while all three males had cut themselves on the thighs (and also on the arms in one case). In the normal population study by Laukkanen et al. (2013) 11% of male adolescents who had a history of self-cutting had cut themselves on parts of the body other than the arms, compared with 100% of male suicide victims with self-cutting in the present study. The question therefore remains whether the location of self-cutting elsewhere than only in the arms serves as an indicator of suicide risk among male adolescents.

It is of great importance that this study found that 48% of male and 58% of female adolescent suicide victims had committed suicide while under the influence of alcohol. These figures, especially with respect to females, are notably high compared to findings from other countries. In the US, approximately 20–30% of adolescent male and 10–15% of adolescent female suicide victims were intoxicated with alcohol at their time of death (Brent et al. 1999, Singh & Lathrop 2008). The corresponding figures were approximately 45% and 40% in Norway (Groholt et al. 1999) and 40% and 20% in Sweden (Johansson et al. 2005). Compared with previous findings from Finland, in agreement with the present results a study by Marttunen et al. (1992) reported that 50% of male and 56% of female adolescents had been intoxicated at the time of suicide. However, a recent report on all deaths among Finnish children in 2009–2011 found a substantially lower proportion, 25%, of intoxicated <18 year-old suicide victims (Onnettomuustutkintakeskus 2014). No gender-specific results were presented.

An intriguing finding arising from the present study concerns the stage of alcohol metabolism among intoxicated adolescent suicides. Alcohol has a well-known biphasic effect: stimulation and elation are typical of the phase during which the level of blood alcohol concentration (BAC) is still increasing, whereas sedation and feelings of depression characterize the declining phase of the BAC (Jung 2009). In the present study, most intoxicated suicide victims were in the declining phase of BAC at the time of death. Similar findings have been reported in studies on adult suicides (Hayward et al. 1992, James 1966), with the majority of suicide victims having died during the descending phase of BAC. Both studies
concluded that acute alcohol use seems to lower the threshold for suicidal behavior, probably through its depressant and disinhibiting effects, rather than functioning as “Dutch courage” (i.e. first deciding to commit suicide and then drinking alcohol to gain sufficient determination to complete the act). The current study also found that being under the influence of alcohol was related to committing suicide at night. Whereas 86% of both male and female adolescents who committed suicide during the night were intoxicated, in the daytime the proportion of suicides committed while under the influence of alcohol was only 15% among males and 25% among females. It may be that tiredness-related adverse psychological changes, such as loss of inhibitions and impairment of judgment, further intensify the similar adverse effects of acute alcohol use – especially during the BAC’s descending phase, when the depressant action of alcohol prevails.

The results of toxicological analyses revealed that, with regard to substances other than alcohol, only one suicide victim tested positive for cannabis. No positive findings presented in cases where so-called hard drugs, such as amphetamine and cocaine, were tested. Prescription drugs were detected in just under one fifth of the cases in which toxicology screens had been performed, excluding victims who had used drug overdose as the method of suicide. The most commonly detected drugs were anxiolytes. With two exceptions (two females taking antidepressants), there was no indication that the prescription drugs detected had been prescribed to the adolescents, so these drugs seemed to have been used for intoxication purposes.

Unfortunately, no information on previous alcohol or drug use patterns among the adolescent suicide victims was available within the study data. This precluded an elucidation of the possible role played by more chronic substance abuse. Previously, Pirkola et al. (1999) have shown that, compared with other adolescent suicide victims, Finnish adolescent (13–22 years) suicide victims who misuse alcohol suffered from more severe and long-standing psychiatric morbidity. They also had a greater tendency to be intoxicated at the time of suicide.

Analysis of seasonal distributions in adolescent suicides revealed a noteworthy finding of the present study, i.e. that male adolescent firearm suicides show a peak incidence in the fall. The seasonal pattern was remarkably different to that in the adult population, which showed a traditional spring/early summer peak. It was of note that the seasonal pattern of firearm suicides among young adults (18–23 years) was similar to that observed in other adults, which indicates
that the fall peak is a specific phenomenon among the youngest age group. Other authors who have observed a fall peak in young people’s suicides have suggested that the intensification of social life after the summer vacations exposes young people to stressful situations and increases the risk of suicide (Chew & McCleary 1994, Näyhä 1982, Shields et al. 2006). Notably, in the present study the fall peak was found only in firearm suicides among adolescent males, whereas no specific pattern could be found among suicides by all other methods among males and all methods among females. This suggests that firearms play a specific role in explaining the seasonal distribution. One explanation for this may be easy access to hunting guns in homes in the fall, due to the beginning of the hunting season.

6.3 Strengths and limitations

6.3.1 Strengths of the study

The national register of causes of death, from which the data for the macro-level studies in this thesis were drawn, has proven a reliable source of information for scientific purposes (Lahti & Penttilä 2001). In Finland, the effort is to apply methods of medicolegal death investigation in all cases in which the cause of death may be other than a disease, and therefore the proportion of autopsies is high among such cases (Ministry of Social Affairs and Health 2007). Overall, the rate of medicolegal autopsies is high in this country. For example, in the year 2012 a medicolegal autopsy was performed in 19% of all deaths (Statistics Finland 2014a). Further, the suicide statistics cover the entire country with equal reliability. It is unlikely that determination of death as suicide differs between medical examiners from different regions.

The study sample in micro-level studies was comprehensive, including all consecutive child and adolescent suicides committed in the province of Oulu during the 25 study years. The completeness and accuracy of the nationwide health register (FHDR), which was used as one source of information, is generally good (Sund 2012). Information collected from FHDR and the death certificates was systematically available for all adolescent suicide victims. In addition, police investigation reports, findings from external and internal examinations of the medicolegal autopsies, and the final medicolegal autopsy reports were systematically present in all 93% of cases in which the suicide case files were
available. Blood alcohol concentrations had been investigated in all cases and other toxicological examinations had been performed in most.

6.3.2 Limitations of the study

A number of limitations in this study should be acknowledged. Regarding macro-level studies, as the data consist of suicide counts, it was not possible to analyze any biopsychosocial factors, such as the psychiatric histories of individual victims. Some suicides may have been misclassified as accidental or undetermined deaths (Öhberg & Lönnqvist 1998). However, the proportion of undetermined deaths has remained stable and it is unlikely that changes in suicide rates can be attributed to misclassification (Chishti et al. 2003).

In the micro-level studies involved in this thesis, the documents used to obtain the data were not compiled for research purposes, but in order to establish the cause of death. Information was not therefore systematically and consistently available on every variable in every case. In particular, information on psychiatric symptoms and mental health status recorded in the documents was either scarce or had simply not been documented in any form. Conclusions on this issue must therefore be drawn with great caution. Furthermore, unlike psychological autopsy studies, record review studies such as the present one do not allow for psychiatric diagnostic assessment. Gender comparisons may be biased and underpowered due to missing data. Although all self-cutting scars identified in external examinations were reported, in some cases there may have been a history of superficial self-cutting which leaves no permanent scarring on the skin. When seeking potential predictors for suicide, case-control design would allow the calculation of the suicide risk in relation to the various background and clinical characteristics of suicide victims. However, no meaningful controls were available for the purposes of this study.

The small numbers of cases may have caused a lack of statistical power in the analyses of subgroups, particularly in the micro-level studies. Some potential findings may therefore have remained statistically non-significant (type II error). Although the main findings are statistically robust, several comparisons have been performed and the risk of spurious findings (i.e. type I errors) cannot be discounted.
7 Conclusions

7.1 Main conclusions

Both favorable and unfavorable changes have occurred in suicide rates among children and adolescents in Finland, with those of males decreasing since the beginning of 1990s, while rates among females have increased. Although indications of opposite trends have been observed more recently in both genders, on a general level rates of male suicides are still lower, and those of females higher, than they used to be two decades ago. The Finnish male adolescent suicide rate was higher than that of females throughout the 44-year study period covered in this research. However, the gender difference in overall suicide rates has narrowed following the changes in suicide rates.

Finnish female adolescents now have a greater tendency to choose a violent suicide method. The increase in overall suicide rates among female adolescents stems specifically from the increase in violent methods of suicide, the rate of nonviolent methods having remained unchanged. This phenomenon is of particular concern, as females are known to make a large number of suicide attempts, and the use of violent suicide methods is more likely to end in death. With further regard to suicide methods, use of firearms has predominated among Finnish adolescent males since the 1970s. In female adolescents, hanging has exceeded poisoning as the leading method of suicide since 1990. In recent years, however, traffic suicides have taken the leading position as the most common method of suicide for both genders, which may indicate that the sociocultural acceptability of this method of suicide has increased among Finland’s young population.

Between 1972–2009, the adolescent male firearm suicide rate was almost three times higher in Northern Finland than in Southern Finland, while no such regional difference appeared in rates of suicide by all other methods. This suggests that, compared with Southern Finland, use of firearms plays a major role in explaining the higher male child and adolescent suicide rate in Northern Finland. Although a causal relationship cannot be inferred from this, it is proposed that the greater prevalence of firearms in Northern Finland compared to Southern Finland is a contributing factor.

As regards the similarities and differences in adolescent male and female suicides, apart from those observed in the rates and methods of suicide, the
empirically based study from the province of Oulu investigated more specific characteristics associated with the suicide victims. Regardless of gender, evidence of mental health problems was common, but only a minority had a history of psychiatric hospitalization. Previous suicidality and self-cutting were more common in female than male adolescents. Whereas being under the influence of alcohol at the time of death was infrequent among child and young adolescent suicide victims, more than half of the 15–17-year-old male and female adolescents had been intoxicated with alcohol at the time of their death, which highlights the role of acute alcohol use in adolescent suicides in both genders. Most of the intoxicated adolescents were in the descending phase of blood alcohol concentration at the time of their suicide, which suggests that the depressant effect of alcohol use may have contributed to the decision to commit suicide. This study also found that two thirds of all adolescent male firearm suicides were committed between August and October, indicating that the fall is a high-risk period for such suicides.

7.2 Implications of the study

The general upward trend in Finnish female adolescent suicide rates warrants attention. As suicide is a multifactorial process, no conclusive explanations can be offered for the changes in suicide trends, but the increase in violent methods of suicide seems to contribute to the phenomenon. In terms of suicide prevention efforts, method restriction is considered one of the most effective preventive strategies. The predominance of hanging suicides and, in recent times, traffic suicides in particular, impose limitations on the potential for employing the method restriction strategy, since both of these methods are difficult to restrict.

The rate of adolescent male firearm suicides was substantially higher in Northern than Southern Finland. Another special characteristic of firearm suicides among adolescent males in Northern Finland was the notable seasonal pattern, with a peak incidence of firearm suicides occurring in the fall. These findings emphasize the need to develop suicide prevention in line with specific regional characteristics.

Acute alcohol use was shown to play a central role in adolescent suicides, regardless of gender. Although no information on patterns of previous alcohol use among adolescents was available for the present study, previous research has shown that alcohol abuse is an important risk factor in adolescent suicide.
Reducing alcohol use and drunkenness-oriented drinking among underage adolescents is highly important from a preventative viewpoint.

Psychiatric disorders are thought to be present in the majority of adolescent suicides, but these disorders have often gone unrecognized and untreated. Many adolescents, especially males, tend not to seek help for their mental health problems. However, the role of health care professionals in suicide prevention (most importantly, identifying and treating psychiatric disorders) is limited to individuals who come into contact with health services. The role of family, friends, and other close people can therefore be vital in recognizing possible signs of distress in adolescents. Nevertheless, when an adolescent presents to the health care system and his or her general health is being evaluated, consideration should always be taken of the patient’s mental health status. Finally, functioning, low-threshold mental health services providing easy access to care, preferably integrated with the school health care system, and a reduction in the stigma associated with mental health problems, could be helpful in encouraging vulnerable children and adolescents to seek and obtain help.

7.3 Implications for further research

This epidemiological study on the trends and characteristics of suicide among children and adolescents in Finland provides the following insights for future research. Firstly, the increased use of violent suicide methods among female adolescents is alarming. Further studies are needed in order to investigate the possible underlying factors at individual level and to explore whether the phenomenon is universal amongst this young age group. Secondly, studies on the seasonality of child and adolescent suicides are rare and the findings are heterogeneous. Additional studies are therefore needed, which should also take account of the effect of biopsychosocial factors in order to identify their putative influences on seasonal variations in suicides. Thirdly, it remains to be seen whether the novel finding on the descending phase of blood alcohol concentrations at the time of suicide among children and adolescents can be confirmed in future studies.
References


Appendix 1. The Finnish death certificate form

![Finnish death certificate form image]
Original publications


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The original articles are not included in the electronic version of the thesis.


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1244. Honkavuori-Toivola, Maria (2014) The prognostic role of matrix metalloproteinase-2 and -9 and their tissue inhibitor-1 and -2 in endometrial carcinoma

1245. Pienimäki, Tuula (2014) Factors, complications and health-related quality of life associated with diabetes mellitus developed after midlife in men


1247. Haanpää, Maria (2014) Hereditary predisposition to breast cancer – with a focus on AATF, MRG15, PALB2, and three Fanconi anaemia genes


1250. Prunskaite-Hyyryläinen, Renata (2014) Role of Wnt4 signaling in mammalian sex determination, ovariogenesis and female sex duct differentiation


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EPIDEMIOLOGICAL STUDY ON TRENDS AND CHARACTERISTICS OF SUICIDE AMONG CHILDREN AND ADOLESCENTS IN FINLAND