

the Faculty of Health Sciences

Adolescents and self-harm

A study of factors associated with suicide and use of health care services following self-harm in national representative populations of Norwegian adolescents

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Preface

My motivation for entering suicidology as a researcher can be traced to my time as a volunteer at a suicide preventive hotline in Oslo. My conversations with people who were balanced precariously between life and death were to me a true demonstration of people's incredible strength and courage. I cannot properly express how grateful I am to these people, who were willing to share their wisdom and insight on life with me. Their stories and their voices remain in my heart.

Later, I joined the University of Oslo to study interventions for suicide prevention. One of the first things I learned was that, although suicide can be prevented, such prevention is difficult to document empirically. Suicide is an irreversible tragedy and the most important predictor is unbearable pain. However, people who walk on this earth leave their personal footprint. I believe that if we seek out and collect all these footprints, draw them as accurately as possible, and compare them, it can be easier to make custom shoes for those who tread the same ground thereafter. Everybody knows how well-designed footwear can relieve pain when walking long distances. This is the best analogy I have to describe what suicide research is about for me.

During my work on this thesis, I have tried to learn as much as possible about the complex structures underlying self-harm, help-seeking behaviors, and health care systems. My studies began with a focus on structural facilitators and barriers to accessing health care, and led me to investigate the characteristics of those who do seek and receive health care following self-harm. Since I began this work, my supervisors have changed, as have my employment contracts. This gave me the unique opportunity to learn from several experts in the field, who contributed with complementary professions, interests, and skills. However, it also meant that each paper included in this thesis was developed in separate periods and in different academic settings, which has made it challenging to structure this thesis in a manner that is both cohesive and comprehensive.

This thesis is composed of the footprints of more than half a million adolescents who were in contact with health professionals during mandatory medical examinations carried out prior to military service, or during visits in which they needed help for self-inflicted injuries. The observational design of the individual studies hinders causal associations, but the findings may assist policy makers and clinicians to more precisely reach adolescents who self-harm.

Hopefully this doctoral thesis, and the future research that builds on it, can contribute to the further development of health care services that fit the feet of those in pain.

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This thesis is dedicated to all those who left their footprints in this material. My deepest gratitude goes to all the skilled, marvelous people who helped in my efforts to collect and analyze the data and to all those who encouraged me and had faith in the work:

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Summary

This thesis uses data recorded in Norwegian governmental health registers, as well as data collected in a nationwide school survey carried out in Norway, to study risk factors for suicide and factors associated with the use of health services following self-harm in adolescents.

Paper I examined suicide in a population of half a million men with physician-diagnosed minor or major mental health impairment in adolescence. The main finding was that risk of suicide was elevated both in apparently well-functioning young men with minor mental health impairment and in young men with major mental health impairment.

Paper II examined the characteristics of adolescents who were admitted to hospital for self-poisoning with medications and identified factors associated with hospital readmission for subsequent self-poisoning with medications. This study demonstrated significant differences between the sexes in hospital admissions and in treatment for this condition. Moreover, the study showed that nearly 20% of the adolescents who were hospitalized for self-poisoning with medications were subsequently readmitted for the same reason. Female gender and secondary psychiatric diagnosis had a strong predictive effect on hospital readmission.

Paper III examined self-reported use of health care services in adolescents who reported self-harm with or without suicide intent and lived in areas with different geographic proximity to the hospital. The study found that adolescents who self-harmed with suicide intent reported more help and treatment compared to those who self-harmed without suicide intent.

Adolescents who attended school in urban municipalities (in which a hospital was located) were more likely than those who lived outside these areas to report using health services following self-harm, but this association was only present among adolescents who self-harmed without suicide intent.

The papers included in this thesis identify groups of adolescents who have a high risk of suicide, hospital readmission, or of not utilizing health care services following self-harm. These results have implications for policy makers, clinicians, and future research. On the other hand, although the data were rich and included a range of independent variables, misclassification may have occurred, and some important information was not available. Future studies should include more detailed information on things like the methods of and

intent behind self-harm, psychiatric diagnoses, and procedures for treatment in order to provide insight into the mechanisms behind the differentials and risks that were demonstrated in this thesis.

List of papers

Paper I:

Fadum EA, Fønnebø V, Borud EK.

Presence of minor and major mental health impairment in adolescence and death from suicide and unintentional injuries/accidents in males. A national longitudinal cohort study.

J Epidemiol Community Health. 2017;**71**:19-24 doi:10.1136/jech-2016-207656.

Paper II

Fadum EA, Stanley B, Qin P, Diep LM, Mehlum L.

Self-poisoning with medications in adolescents: a national register study of hospital admissions and readmissions

Gen Hosp Psychiatry. 2014 Nov-Dec;**36**(6):709-15.

Paper III

Fadum EA, Stanley B, Rossow I, Mork E, Törmoen AJ, Mehlum L.

Use of health services following self-harm in urban versus suburban and rural areas: a national cross-sectional study.

BMJ Open. 2013 Jul 26;**3**(7).

1. INTRODUCTION

Each year there are 800,000 deaths from suicide. Non-fatal self-harm is far more frequent than suicide, although there are no concrete prevalence estimates or hospitalization rates for this behavior. Non-fatal self-harm most commonly occurs during adolescence. About half of the adolescents who self-harm repeat this behavior, sometimes frequently, with an increasing risk of severe psychiatric morbidity and mortality with each subsequent event. Clinical manifestations or symptoms of psychiatric disorders are common in this population, and it has often been claimed that (repeated) self-harm and suicide could be prevented through the early assessment and management of the associated mental disorders. However, a large number of those who self-harm, with or without suicide intent, are out of reach of such interventions because they do not report these issues to their health care providers. For this reason, self-harm is often illustrated as an iceberg; in this parallel, those who die from suicide or use health care services following self-harm constitute the smaller, visible tip, and those who do not reveal their self-harming behavior to their health care providers represent the largest part, which cannot be seen below the surface of the water.

This thesis used recorded information on health, self-harm, and suicide in more than half a million adolescents in Norway. The first study used health information collected during mandatory medical examinations carried out prior to military service among male adolescents in 1980-1999. The mental health assessment at these examinations was used to categorize the participants according to their degree of mental health impairment at adolescence, and subsequent suicide incidence was compared across these groups. Paper I also reported death from unintentional injuries, but as these deaths fall outside the scope of this thesis, they are not discussed in this document. The second study used information on all adolescents admitted to Norwegian hospitals for self-poisoning with medications between 2008 and 2011. The aim of this study was to examine the characteristics of these adolescents and identify factors associated with hospital readmission for self-poisoning with medications. The last paper included in this thesis used self-reported information collected in a nationwide school survey conducted in 2002, in order to study factors associated with the use of health care services following self-harm in adolescents from different geographic areas.

1.1. Terminology

1.1.1. Injuries

An injury is defined as “damage to the body resulting from acute exposure to thermal, mechanical, electrical, or chemical energy or from the absence of such essentials as heat or oxygen” (The National Committee for Injury Prevention and Control 1989). However, this definition usually includes a psychological component of intent. This intent is used to separate injuries into one of two broad categories: unintentional or intentional. Unintentional injuries are commonly understood as “injuries not caused by a person’s intent to harm” while intentional injuries can be broadly defined as “the use of physical force with the intent to inflict injury or death upon oneself or another” (The National Committee for Injury Prevention and Control 1989). However, the assessment of intent is one of the most difficult parts of any investigation into the true nature of injuries, leading to substantial debate and divergent definitions and classifications (Silverman, Berman et al. 2007, Tollefsen, Helweg-Larsen et al. 2015).

1.1.2. Suicide

Intentional injuries with fatal outcome are commonly understood as suicide or the act of deliberately killing oneself (the World Health Organization 2014). However, several different definitions of suicide exist in the literature (Silverman, Berman et al. 2007); some definitions presuppose that death was a known and desired outcome of the deceased, such as the definitions used by the World Health Organization (WHO): “The act of killing oneself deliberately initiated and performed by the person concerned in the full knowledge, or expectation, of its fatal outcome” (The World Health Organization 1998) and the Centers for Disease Control and Prevention: “Death from injury, poisoning, or suffocation where there is evidence (either explicit or implicit) that the injury was self-inflicted and that the decedent intended to kill himself/herself” (O’Carroll 1988).

Other definitions do not mention the intention to cause death as a premise for suicide, but define suicide as a death that is caused by an injury that was both self-inflicted and intentional (Silverman 2006). One commonly used definition in Norway is as follows (translated from Norwegian)¹: “Suicide is a conscious and deliberate act, during which the individual undertakes to injure him/herself, and where the injuries lead to death” (Retterstøl and Øivind Ekeberg 2002).

¹ «Selvmord er en bevisst og villet handling som individet har foretatt for å skade seg selv, og hvor skaden har ført til døden»

Although it is less common, suicide can also be defined as death resulting from a self-inflicted act without taking into account the intent of the person to die or self-injure: “Death from injury, poisoning, or suffocation where there is evidence that a self-inflicted act led to the person’s death” (Goldsmith 2002).

1.1.3. Suicide attempt and non-suicidal self-injury

A suicide attempt is commonly understood as non-fatal self-inflicted injury with intent to kill oneself (Silverman 2006). Non-suicidal self-injury is defined as the direct and deliberate destruction of body tissue in the absence of an intent to die (Nock 2010). However, there is a lack of clear separation and diagnostic clarity between suicidal and non-suicidal self-injury (Nock, Joiner et al. 2006, Kapur, Cooper et al. 2013). The term suicide attempt is sometimes used for self-injury without a known or specified intent to die (Skegg 2005).

1.1.4. Self-harm

The broad concept of self-harm has gained widespread use in Europe and Australia as an overarching term for non-fatal self-inflicted injuries of all methods and intentions. This concept has been adopted in favor of the previously common terms “parasuicide” and “deliberate self-harm” (Silverman 2006). Self-harm is defined as “An act of intentional self-poisoning or injury irrespective of the apparent purpose of the act” (NHS Centre for Reviews and Dissemination 1998). Self-poisoning is further defined as the deliberate ingestion of an amount of a substance (whether it be for human consumption or not) or the ingestion of more than the prescribed dose of any drug, whether or not there is evidence that the act was intended to cause self-harm (Hawton, Fagg et al. 1997). However, because the most serious forms of self-harm relate closely to suicide, and because self-harming behaviors at the milder end of the spectrum merge with emotional pain far from death, most researchers further distinguish self-harm based on the presence or absence of any intent to die as a result of the behavior. To describe the behavior first and clarify intent later is probably a realistic strategy, which mirrors the way in which clinicians tend to refer to self-harm (Skegg 2005). The International Statistical Classification of Diseases and Related Health Problems (ICD) provides a standard diagnostic tool with detailed definitions and instructions for the classification of morbidity and mortality. In the 10th and current revision of the ICD (ICD-10), suicide (attempted) is classified as “intentional self-harm” (ICD code X60-X84), including self-poisoning or self-inflicted injury (The World Health Organization 2015).

1.1.5. Terms used in this thesis

Self-harm is used in this thesis to refer to non-fatal self-injuries according to the definition: “An act of intentional self-poisoning or self-inflicted injury irrespective of the apparent purpose of the act” (NHS Centre for Reviews and Dissemination 1998). However, when referring to the literature, emphasis has been placed on using the terms that the authors of the respective studies used whenever possible.

In Paper I, the term suicide corresponds to the classification of suicide provided by the Norwegian Institute of Public Health, which is based on the ICD criteria in place at the time of death.

In Paper II, self-poisoning is defined as “poisoning by drugs, medicaments and biological substances”, according to the Norwegian version of the ICD-10 (The Norwegian Directorate of Health 2011).

In Paper III, a suicide attempt is defined as self-harm with suicide intent, while self-harm without suicide intent refers to a deliberate overdose of a substance or other attempts at self-harm without the intent to die.

1.2. Models of self-harm and the use of health care services

1.2.1. The Causal Pie Model

Suicide is never the result of one single cause or stressor; it is always the consequence of a complex interplay between various factors. Similarly, aspects relating to the use of health care services show a very complex pattern. Several models have been suggested to account for the multifactorial nature of causation in many non-infectious diseases or events. One such model was proposed by Rothman in 1976, and is known as “the Causal Pie Model”. In this model the individual factors that contribute to disease are called component causes and are shown as one of many pieces of a pie. After all the pieces fall into place, the pie is complete and the disease/event occurs. The complete pie, which might be considered a causal pathway, is called a sufficient cause. A disease may have more than one sufficient cause, with each sufficient cause being composed of several component causes that may or may not overlap (Rothman 1976).

1.2.2. The stress-diathesis model

The stress-diathesis model is often conceptualized as a multicausal developmental model, which proposes that over the course of development, multiple risk factors interact with stressors and protective factors and contribute to normal development or psychopathology (Monroe and Simons 1991). Many authors have proposed models on suicide and self-harm within this tradition, distinguishing between vulnerability or distal factors that predispose some people to be at high risk for suicide/self-harm and stressors or proximal factors that trigger self-harm among those who are vulnerable (Bridge, Goldstein et al. 2006, van Heeringen 2012, Nock, Deming et al. 2013, Haw, Hawton et al. 2014).

1.2.3. The social cognition model

Social cognition is an approach in social psychology that focuses on how cognition is affected by wider and more immediate social contexts and how cognition affects our social behavior. Most models of social cognition assume that behavior and decisions are based on an elaborate, but subjective, cost-benefit analysis of the likely outcomes of differing courses of action (Conner 2007). When it comes to the use of health care services, these cost-benefit analyses will balance the perceived susceptibility to illness, the anticipated severity of the consequences of the illness, self-efficacy in coping, and beliefs concerning the benefits of and barriers to treatment (Conner 2007).

The behavioral model of health service use was initially developed by Andersen over 45 years ago. This model suggests that the use of health care services is a function of a person's predisposition to this use, factors which enable or impede use, and the need for care (Andersen 1995). Predisposing factors include demographic characteristics like age and gender. However, use of health care services might also be influenced by social relationships and other resources that might help some people overcome normative or practical barriers. Thus, characteristics such as marital status, education, occupation, ethnicity, social networks, personal and family income level, insurance coverage, awareness of services, access to transportation, and distance to services are important to consider. Need must also be taken into consideration, as people are usually more willing to seek health care if their medical condition is perceived as more serious (Andersen and Newman 2005).

Based on traditional stage process models, use of health care services in adolescents has been described as a process comprising five main stages: 1) the perception of the problem, 2) the perception that something can be done about the problem, 3) the motivation to act, 4) the decision to act, and finally 5) the choice of a particular source of help (Murray 2005). Such models are applicable to adolescents who self-harm (Fortune et al. 2008).

1.3. Suicide

1.3.1. The epidemiology of suicide worldwide

Most industrialized countries recorded their highest suicide rates in the early 1900s, with a new peak around 1930 that coincided with the Great Depression. Post-World War II, suicide rates leveled off and gradually decreased. However, the 1970s marked the beginning of a new era, during which most countries experienced a near epidemic rise in suicides, particularly among young males (15 to 34 years). Suicide rates continued to rise through the 1980s and into the 1990s (Liu 2009). After the mid-1990s, the overall global age-standardized suicide rate deflated and decreased, but country-specific changes in suicide rates differed greatly, ranging from a decline of 60% to an increase in 270% during the latest decade (the World Health Organization 2014).

Currently, an estimated 800,000 people die from suicide annually, representing an annual global age-standardized suicide rate of 11.4 per 100,000 (15.0 for males and 8.0 for females). However, age-standardized suicide rates vary greatly between countries, ranging from less than 1 per 100,000 in countries like Kuwait and Lebanon, to about 30-40 per 100,000 in countries like the Democratic People's Republic of Korea and Lithuania. Suicide rates among

males have an even greater range: i.e., from 0.6 per 100,000 in Saudi Arabia to 51 per 100,000 in Lithuania. In general, suicide rates are highest in low- and middle-income countries in South-East Asia and in Eastern Europe, while the lowest suicide rates are seen in low- and middle-income countries of the Americas and in the Eastern Mediterranean (the World Health Organization 2014).

However, it is important to bear in mind that definitive data do not exist on worldwide suicide mortality and comparisons by country are hampered by variations in the reporting and classification of suicide (Tollefsen, Hem et al. 2012). Indeed, the number of registered suicides is probably too low, partly due to difficulties in differentiating suicides from deaths from unintentional injuries (Tollefsen, Helweg-Larsen et al. 2015).

1.3.2. Suicide in Norway

In Norway, from the end of the 1960s to the end of the 1980s the suicide rate doubled to 24 per 100,000 inhabitants in males and 9 per 100,000 in females. During the same period there was a 3-to-4-fold increase in registered suicide among people under 30 years, of age. From 1991 to 2005, the suicide rate among Norwegian males fell steadily before flattening out. The suicide rate among Norwegian females has been constant over the last 20 years. The 5-year age- and sex-standardized suicide rate in Norway has remained steady at around 11 per 100,000 people since 2004: 16-17 per 100,000 in males and 6-7 per 100,000 in females (The Norwegian Institute of Public Health 2014). In 2014, the number of males and females who died from suicide in Norway was 401 and 147, respectively (The Norwegian Institute of Public Health 2014).

1.3.3. Suicide in adolescents

Although suicide is among the leading causes of death in the 10-19-year-old age group (Patton, Coffey et al. 2009), suicide is still a rare event in adolescents in most countries of the World. Though adolescent suicide is critical in some countries (i.e., Russia) and some countries may note disturbing peaks, suicide rates in adolescents have been considered as stable or slightly decreasing since the 1990s in most European countries and in the United States (Kolves and De Leo 2014, Kolves and De Leo 2016). Based on numbers from the WHO mortality database, the worldwide suicide rate in 2009 among boys aged 10-14 years was 1.52 per 100,000, and it was 9.51 per 100,000 in males aged 15-19 years. In female adolescents, corresponding rates were 0.94 per 100,000 and 4.18 per 100,000 (Kolves and De Leo 2014, Kolves and De Leo 2016). In both genders, the highest adolescent suicide rates

were observed in Eastern European countries, Kazakhstan, Lithuania, and the Russian Federation (Kolves and De Leo 2014, Kolves and De Leo 2016). In males aged 15-19 years, suicide rates in the 2000s in these three countries exceeded 30 per 100,000 and were above 7 per 100,000 in females aged 15-19 years (Kolves and De Leo 2016). In comparison, average suicide rates among 15-19-year-olds in Northern Europe were 12.43 per 100,000 for males and 3.88 for females in this period (Kolves and De Leo 2016).

Suicide rates for adolescents aged 15-19 years in Norway were 13.72 per 100,000 and 5.79 per 100,000 in males and females, respectively, during the years 2000-2009 (Kolves and De Leo 2016). In the past 5 years (2010-14), 120 male and female children and adolescents (0-19 years) died due to suicide in Norway (The Norwegian Institute of Public Health 2014).

However, death resulting from unintentional injuries in adolescents may wrongly be classified as suicide and vice versa (Groholt and Ekeberg 2003). Many countries do not present child suicide in their statistics, and changes in mortality registration may impact on trends. With small numbers, trends can be over- or under-inflated by a few cases, so suicide statistics in adolescents need to be interpreted cautiously.

1.3.4. The gender paradox –suicide among males and self-harm among females

“The gender paradox” in suicide and self-harm refers to the fact that in nearly all cultures of the world (with the exception of China and a few other Asian countries), suicide rates are significantly higher among males than females. In most Western countries the male:female ratio is 3-4:1 (the World Health Organization 2014). On the other hand, a significantly higher number of females than males attempt suicide or engage in self-harm (Weissman, Bland et al. 1999, Nock, Borges et al. 2008).

Males more often tend to die in their first suicide attempt, possibly because they usually use more fatal methods, such as hanging, shooting, or poisoning with highly toxic pesticides. Among females, the most predominant suicide method is self-poisoning, and in Western countries usually such poisoning is often done with analgesics or other drugs with low lethality (Ajdacic-Gross, Weiss et al. 2008). Another possible explanation for the differences in suicide rates between the genders is that males receive less treatment than females for mental health problems such as depression (Moller-Leimkuhler 2003). Compared to females, suicide among males seems to be more closely related to indicators of social insecurity, such as unemployment or financial difficulties, or the break-up of an intimate relationship (Qin,

Agerbo et al. 2003, Qin 2005). Being confronted with such life situations can generate negative emotions that cannot be controlled by the individual, which may result in identity problems and feelings of shame, humiliation, hopelessness, and vital exhaustion (Tornblom, Werbart et al. 2013, Rasmussen, Haavind et al. 2014, Kiamanesh, Dieserud et al. 2015). Unfortunately, males often respond to such feelings by consuming high quantities of alcohol, or by becoming aggressive, impulsive, and antisocial rather than by seeking help and treatment (Walinder and Rutz 2001, Azorin, Belzeaux et al. 2014).

1.4. Self-harm in adolescents

1.4.1. Prevalence

In previous community household surveys, about 2-5% of the adult population reported that they had attempted suicide at some time in their life (Bernal, Haro et al. 2007, Nock, Borges et al. 2008). But, because most countries lack national data collection mechanisms on self-harm, we do not have reliable prevalence estimates on this phenomenon. It is assumed that suicide attempts occur more than 20 times as often as suicide in a population (the World Health Organization 2014). However, when deliberate self-harm is included in this ratio the figures vary markedly across age groups, increasing from less than 10 in persons aged 60 years or more, to more than 200 in adolescents (Hawton and Harriss 2008).

Self-harm is considered rare before puberty. Although there are few community surveys that included individuals younger than 13 years old, hospital admission for self-harm is rare in those aged 10-12 years. The most consistently reported pattern of self-harm is that the risk of onset increases significantly from age 12-13 years, peaks at age 15-16 years, remains elevated into late adolescence and early adulthood, and then resolves (Olfson, Gameroff et al. 2005, Nock, Borges et al. 2008, Moran, Coffey et al. 2012, Griffin 2014). Surveys conducted in European countries and the United States have indicated that on average 10% of teenagers report suicide attempt and about 15-30% report deliberate self-harm or self-injurious behavior (Evans, Hawton et al. 2005, Jacobson and Gould 2007, Kokkevi, Rotsika et al. 2012, Muehlenkamp, Claes et al. 2012, Brunner, Kaess et al. 2014, Morey, Mellon et al. 2016).

Adolescent females are 2-4 times more likely to report self-harm than adolescent males (Evans, Hawton et al. 2005, Madge, Hewitt et al. 2008, Kokkevi, Rotsika et al. 2012). One example comes from the Child & Adolescent Self-harm in Europe study, which included over 30,000 school students from seven countries, most of whom were aged 15-16 years. Of these students, 13% of the females (range 5.7%–17% across countries) and 4% of the males (2.4%–

6.5%) reported self-harm. The self-reported lifetime prevalence of self-harm among the Norwegian participants was about 10% in females and nearly 5% in males (Madge, Hewitt et al. 2008).

1.4.2. Hospitalization rates

In the United States, annual rates of emergency room visits for self-harm among people aged 7-24 years was been estimated at 225.3 per 100,000 (Olfson, Gameroff et al. 2005). In 2013, the National Registry of Deliberate Self-harm in Ireland recorded hospitalization rates for self-harm of 619 per 100,000 in females aged 15-19 years and about 350 per 100,000 in males of this same age group. In girls and boys aged 10-14 years, the rates were about 150 and 25 per 100,000, respectively (Griffin 2014). In a multicenter study in the United Kingdom, annual rates of hospital-treated self-harm in 2000-2007 were 302 and 67 per 100,000, respectively, in girls and boys aged 10-14 years, and 1423 and 466 per 100,000, respectively, in females and males aged 15-18 years (Hawton, Bergen et al. 2012).

In Norway, national hospitalization rates for self-harm are lacking. In one county of Norway, incidence rates of hospital-treated suicide attempt among adolescents aged 15-19 in 1989-1994 were 250 per 100,000 in females and 110 per 100,000 in males (Hawton, Arensman et al. 1998). In Oslo, hospitalization rates for acute poisoning in 2003-2004 were about 380 and 210 per 100,000 person-years, respectively, in females and males aged 16-19 years (Hovda, Bjornaas et al. 2008). However, differences in inclusion criteria between studies and the variation in hospital or emergency room/department presentations between geographic regions makes it difficult to compare hospitalization rates across studies (Kopjar, Dieserud et al. 2005, Hawton, Bergen et al. 2012, Griffin, Corcoran et al. 2014).

1.4.3. Methods

Methods of self-harm are heterogeneous and include cutting, poisoning, jumping from heights, and several forms of self-battery. In community surveys, the most commonly reported methods of self-harm among adolescents were cutting (60%) and overdose (30%), though females reported cutting more often than males (Madge, Hewitt et al. 2008). Contrary to self-reports, in the majority (70-90%) of adolescents who are hospitalized for self-harm, this hospitalization is the result of an overdose (Olfson, Gameroff et al. 2005, Ystgaard, Arensman et al. 2009, Hawton, Bergen et al. 2012). Paracetamol is the most common drug used for self-poisoning, but benzodiazepines, antidepressants, and antipsychotics are also used (Rhodes, Bethell et al. 2008, Hawton, Bergen et al. 2012). However, significant gender

differences exist, as hospitalization following self-poisoning is more frequent in adolescent females, whereas adolescent males who are hospitalized following self-harm more often cut themselves, or suffer from a self-inflicted gunshot wound or hanging attempt (Hawton, Bergen et al. 2012).

1.4.4. Associated risk factors

Risk factors are biological or psychological hazards that increase the likelihood of a negative outcome in a group of people (Werner and Smith 1992). In this thesis, the term risk factor refers to a factor that is associated with an increased risk of suicide or self-harm.

Although there are huge variations in suicide rates across geographic, cultural, and ethnic groups, the key risk factors for suicide are remarkably consistent cross cultures. Among the most commonly reported individual risk factors are male gender, increasing age, mental illness, unemployment, low income, single marital status, a family history of suicide, indigenous origin or being an ethnic minority, homosexuality, rural or remote residence, physical illness, and media influence (Skegg 2005, Hawton and van Heeringen 2009, Pitman, Krysinska et al. 2012).

Suicide and self-harm share many individual risk factors, though differences exist, i.e., by sex, patterning of psychiatric diagnosis, and severity of mental illness (Beautrais 2001). The factors most associated with adolescent self-harm include a range of psychosocial stressors and psychological problems, such as family break-up, maladaptive parenting, child and adolescent sexual and physical abuse, interpersonal difficulties, and self-harm among friends (Hawton, Rodham et al. 2002, Webb 2002, Evans, Hawton et al. 2004, Bridge, Goldstein et al. 2006, Geulayov, Gunnell et al. 2012, Crepeau-Hobson and Leech 2014). Psychiatric disorders and their symptoms, including depression, anxiety, eating disorders, bipolar spectrum disorders, antisocial behavior, and alcohol/drug abuse, are common both in those who self-harm and in those who die from suicide (Groholt, Ekeberg et al. 1997, Agerbo, Nordentoft et al. 2002, Hawton, Rodham et al. 2002, Pelkonen and Marttunen 2003, Olfson, Gameroff et al. 2005, Nock, Joiner et al. 2006, Hawton, Saunders et al. 2012, Moran, Coffey et al. 2012). Personality disorders have been reported in more than a quarter of young people who died from suicide (15-24 years old), with a further quarter having substantial trait accentuation that did not reach the level of diagnosis (Houston, Hawton et al. 2001). In young males, conduct, hyperkinetic, and emotional problems from the age of 8 years have been found to be associated with suicide (Sourander, Klomek et al. 2009). Longitudinal studies

found that the presence of such mental health impairment in late adolescence predicted death from suicide in males up to 36 years later (Osler, Nybo Andersen et al. 2008, Gravseth, Mehlum et al. 2010, Lundin, Lundberg et al. 2011).

1.4.5. Repetition

In community surveys, about half of all adolescents who reported self-harm also said that they repeated this behavior (Madge, Hewitt et al. 2008, Stallard, Spears et al. 2013). In the United Kingdom and Ireland, among adolescents who had registered hospital stays due to self-harm one-third re-presented to hospital with self-harm (at least one repeat) (Hawton, Bergen et al. 2012, Perry, Corcoran et al. 2012, Griffin 2014). There is wide variation in the frequency of hospital readmission for self-harm, ranging from one or two to more than 50 hospital readmissions in 1 or 2 years (Hawton, Bergen et al. 2012). When focusing on those who self-poisoned (including alcohol and gas intoxications), about 15-20% were readmitted within 6-12 months for subsequent self-poisoning(s) (Hawton, Kingsbury et al. 1999, Reith, Whyte et al. 2003). When self-poisoning was defined as those who overdosed by medications, 1-year hospital readmission rates were around 15% (Griffin, Corcoran et al. 2014). However, it is difficult to compare hospital readmission rates between studies because of differences in factors like inclusion criteria and follow-up time (Kapur, House et al. 2003, Mehlum, Jorgensen et al. 2010). It seems that cutting, when compared to self-poisoning, is associated with more repetition (Hawton, Bergen et al. 2012). Furthermore, compared to those who do not repeat self-harm, those who do are characterized by more hopelessness, less problem solving skills, and more psychiatric disorders and treatment (Hawton, Kingsbury et al. 1999, Vajda and Steinbeck 2000, Hawton, Bergen et al. 2012).

One to 3% of the adolescent males who were hospitalized for self-harm and about 1% of their female peers repeated self-harm with a fatal outcome, which represents a substantially increased suicide risk compared to the general population (Hawton and Harriss 2008, Tidemalm, Beckman et al. 2015). One recent study on adolescents who were hospitalized for self-poisoning in Ontario, Canada found that the 1-year risk of suicide was more than 30-fold higher than that among reference individuals, corresponding to a suicide rate of 89.6 (95% CI 75.2-106.7) per 100,000 person-years (Finkelstein, Macdonald et al. 2015). The greatest risk of fatal repetition was found among those who cut themselves or attempted hanging, compared to those who overdosed, and was further associated with male gender and a history of psychiatric treatment (Hawton, Bergen et al. 2012, Stenbacka and Jokinen 2015, Tidemalm, Beckman et al. 2015).

1.4.6. Use of health care services

Use of health care services is defined as “any activity undertaken for the purpose of preventing or detecting disease or for improving health and well-being” (Conner 2007).

It has been suggested that the strong association between psychopathology and self-harm can be used to prevent repeated self-harm and suicide through early assessment and management of mental disorders (the World Health Organization 2014). However, most adolescents who self-harm are out of reach of such interventions because they do not contact health care services before or after this behavior. In community surveys, only 10-25% of the adolescents who engaged in self-harm reported that they had received help or treatment in health care services after an episode of self-harm (Michelmore and Hindley 2012, Rowe, French et al. 2014). In Norway, this proportion was about 20% when all self-harming methods were considered, ranging from 15% in those who used cutting to nearly 40% of those who overdosed (Ystgaard, Arensman et al. 2009, Rossow and Wichstrom 2010). Seventy-five percent of adolescent males who attempted or died from suicide had no registered health care contacts prior to this act (Allebeck and Allgulander 1990, Groholt, Ekeberg et al. 1997, Stanistreet, Gabbay et al. 2004, Suominen, Isometsa et al. 2004).

In community surveys, family and psychosocial factors such as being a victim of bullying at school, physical abuse, deliberate self-harm among family members, and having parents who were separated or divorced were further independently associated with the use of health care services following self-harm (Ystgaard, Arensman et al. 2009). Help from parents is associated with an increased use of health care services following self-harm, and a large proportion (about 70%) of those who presented to the accident and emergency department were accompanied by immediate family (Nadkarni, Parkin et al. 2000). Other correlates of increased use of health care services following self-harm are older age (late compared to early adolescence), previous self-harm and increased frequency of self-harm (Hawton, Rokach et al. 2009, Michelmore and Hindley 2012, Rowe, French et al. 2014). Adolescent females are in general more likely than males to receive some kind of formal or informal help following self-harm, but findings of gender differences are unclear when it comes to use of hospital and emergency room/department services (Nada-Raja, Morrison et al. 2003, Ystgaard, Arensman et al. 2009). Findings are mixed on whether or not mental health problems increase the likelihood of using health care services after self-harm in adolescents (Michelmore and Hindley 2012, Rowe, French et al. 2014). Those who contact health care services following self-harm tend to be characterized by increased alcohol and drug use, presence of suicide

intent and of psychiatric disorders when compared to those who do not use such services (Michelmores and Hindley 2012). On the other hand, many adolescents tend to alternate between self-harm with and without suicide intent (Nock, Joiner et al. 2006), and the presence of depression, anxiety, and suicidal ideation might sometimes act as an intrapsychic barrier to care (Rotheram-Borus, Piacentini et al. 1996, Carlton and Deane 2000, Nada-Raja, Morrison et al. 2003, Gould, Velting et al. 2004, Rowe, French et al. 2014). In addition adolescents may not know whom to ask or where to go for help, and they may also have restricted access to transportation, all of which can hamper their decision to use health care services following self-harm (Moskos, Olson et al. 2007, Fortune, Sinclair et al. 2008). Hospital admissions for self-harm are more than twice as common in residents of urban versus rural areas. This phenomenon was first discovered in the early 1970s (Morgan, Pocock et al. 1975, Rhodes, Bethell et al. 2008, Harris and Hawton 2011) and is, among others, linked to an individual's geographic proximity to a hospital (Cotter, Kaess et al. 2015, O'Farrell, Corcoran et al. 2015). Lack of health care services in rural districts has often been suggested as a contributing factor to the elevated suicide rates in rural males, but few studies have been devoted to this hypothesis, and it needs to be tested in empirical studies that consider individual factors, the location of health care services, and area of residence (Judd, Cooper et al. 2006).

1.5. Data sources for epidemiologic studies of suicide and self-harm

Epidemiology is defined as “the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to control of health problems” (Last, Abramson et al. 2001).

Epidemiologic studies analyzing the risk factors for suicide and/or self-harm commonly use a cross-sectional, case-control, or cohort-design (Christiansen, Larsen et al. 2014). The data used in such observational studies can be derived from clinical practice, but may also be based on data from screening, hospital records, or cross-sectional surveys (Figure 1).

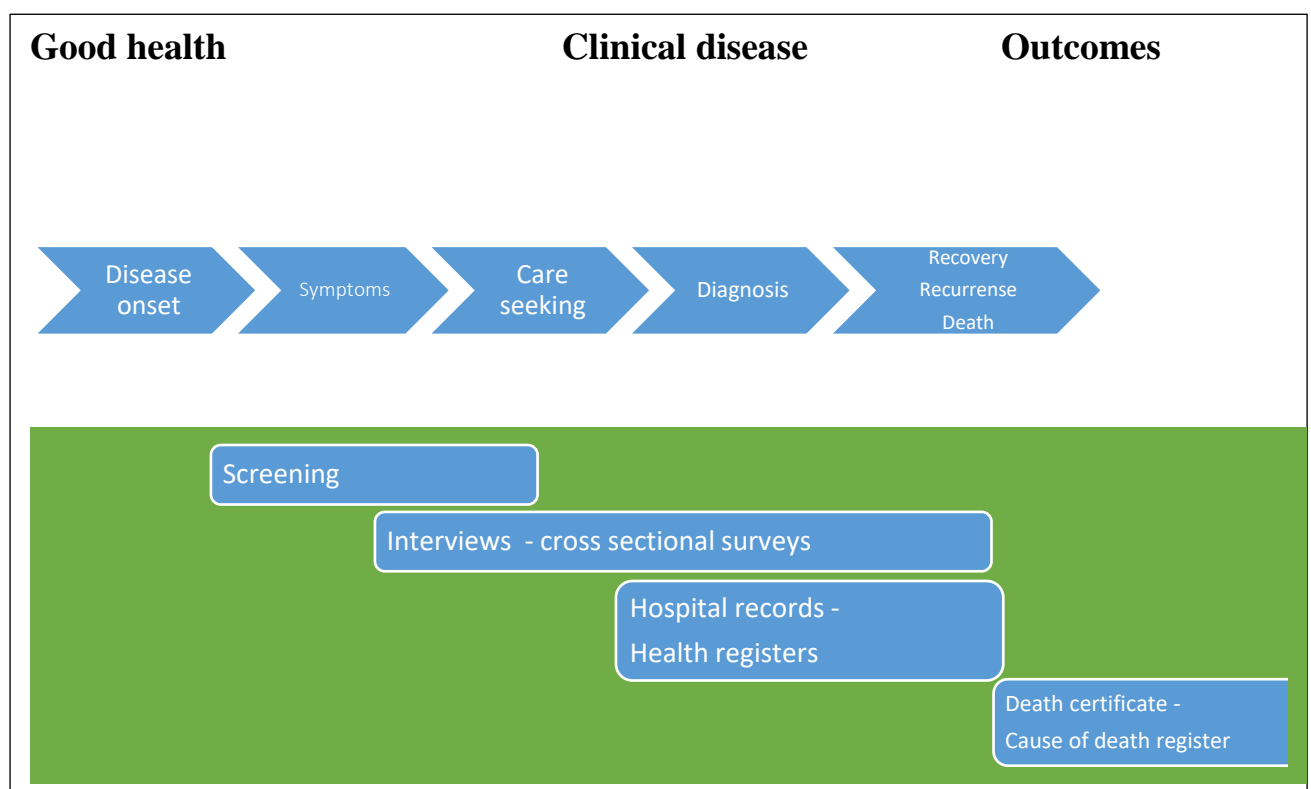


Figure 1. The course and outcome of diseases and selected sources of information.

1.5.1. Screening

Screening is the process by which unrecognized diseases or defects are identified by tests that can be applied rapidly on a large scale (Beaglehole 1993). However, most definitions of medical screening have an aim of treatment. Wald says: “Screening is the systematic application of a test or inquiry, to identify individuals at sufficient risk of a specific disorder to benefit from further investigation or direct preventive action, among persons who have not sought medical attention on account of symptoms of that disorder” (Wald 2008). In addition,

Wilson stated that "... the presumptive identification of unrecognized disease or defect by the application of tests, examinations, or other procedures which can be applied rapidly."

Screening tests sort out apparently well persons who probably have a disease from those who probably do not. A screening test is not intended to be diagnostic. Persons with positive or suspicious findings must be referred to their physicians for diagnosis and necessary treatment (Wilson 1968). (According to this definition, a physical examination can also be called screening as long as it is rapid).

Initiating screening of any disease or condition is appropriate and recommended if the condition causes significant morbidity or mortality, can be effectively treated, if the prevalence is not too rare, and if early detection is critical and beneficial for the individual (Ogden 2012). Self-harm is common in adolescents, though it often goes undetected by health providers. Assuming that effective treatment exists for depression, self-harm and/or risk of suicide in adolescents, meet the requirements for screening initiatives. Validated screening tools do exist to detect the risk of self-harm and/or suicide in adolescents, and these tools can be utilized in schools, primary care, and hospital emergency rooms/departments (Horowitz, Ballard et al. 2009, King, O'Mara et al. 2009, Wintersteen 2010, Horowitz, Bridge et al. 2012, Ballard, Horowitz et al. 2013, Cotter, Kaess et al. 2015). However, though screening instruments may be able to identify groups at high-risk for suicide, the number of false-positive cases is usually high, and adequate management and follow-up procedures among positive cases can represent a severe challenge (Cotter, Kaess et al. 2015). It is not known if systematic screening for suicide risk in adolescents improves outcomes, and the cost and potential harm of screening in various settings are unclear and need to be assessed further (O'Connor, Gaynes et al. 2013). However, such data provide a potential source for epidemiologic research on prevalence, correlates, and use of health care services in unselected populations (Brunner, Kaess et al. 2014, Cotter, Kaess et al. 2015).

Military screening

In several countries, targeted screening is conducted prior to military service, before officer training programs, and before and after peacekeeping operations. In Norway, every man and woman with Norwegian citizenship between the ages of 19 and 44 years may be called for military service (Ministry of Defense 2015). (From 2015, conscription is mandatory for all males and females born after 1997. Between 2007 and 2015, all females could register with the military, but service was voluntary.) All candidates for military service must undergo a mandatory medical examination prior to service, which is usually conducted at age 18 years.

For males, the data collection on these examinations dates back to individuals born in the 1950s, thus including nearly the entire male population born post-World War II. These data have been used extensively to study intellectual performance, height and body weight over time, and in relation to a range of factors related to birth, family, and social life (Table 1a). But research from neighboring countries indicates that these data are also suitable for epidemiologic studies of factors associated with suicide (Table 1b).

Table 1a. Norwegian longitudinal cohort studies based on data collected from military screening tests

First author (year)	Birth cohort	Measures from military screening tests	Associated factors or outcomes/main findings
Ariansen (2015)	1949-1959	Cognitive ability	The educational gradient in midlife coronary heart disease
Eriksen (2015)	1967-1984	Body mass index↑	Birth weight↑
Sjölund (2015)	1949-1951	Cognitive ability↓	Alcohol↑
Kristensen (2014)	1967-1976	Cognitive ability↑	Birth weight↑
Eriksen (2013)	1967-1984	Body mass index↑	Paternal age at birth↑
Eriksen (2013)	1967-1984	Body height↑	Singletons > twins
Eriksen (2013)	1967-1984	Cognitive ability↑	Stepfather's educational level↑
Eriksen (2012)	1967-1984	Cognitive ability↑	Singletons > twins
Gravseth (2010)	1967-1976	Mental health impairment	Suicide↑
Eriksen (2010)	1967-1984	Body mass index↑	Birth weight↑
Eriksen (2009)	1967-1973	Cognitive ability↓	Prenatal exposure to the Hong Kong flu
Sundet (2008)	1967-1976	Cognitive ability Body height	Difference between brothers
Gravseth (2008)	1967-1976	Cognitive ability↓ Mental health impairment Body height and weight	Disability pension↑
Øyen (2007)	1967-1979	Cognitive ability↓ Body height↓	Maternal epilepsy
Kristensen (2007)	1967-1976	Cognitive ability↑	Family social rank↑
Eide (2007)	1967-1979	Cognitive ability↑	Birth weight↑
Bjerkedal (2007)	1967-1998	Cognitive ability↑	Differences between brothers
Eide (2006)	1967-1979	Cognitive ability↓	Heart defects and cleft palate at birth
Sundet (2005)	1967-1979	Cognitive ability Height	Genetic and environmental sources of the covariation between height and IQ
Kristensen (2005)	1967-1971	Cognitive ability	Mediating factor between birth weight and unemployment
Eide (2005)	1967-1979	Body height and weight↑	Birth weight↑ and gestational age
Eide (2005)	1967-1979	Cognitive ability↑	No association with birth delivery
Sundet (2004)	1935-1984	Cognitive ability	Secular trends
Kristensen (2004)	1967-1976	Cognitive ability↓	Parental disability
Bjerkedal (2001)	1967-1980	Body mass index	Geographic variation
Bjerkedal (2001)	1967-1980	Body mass index	Temporal trends
Rossow (1995)	1932	Alcohol abuse	Suicide↑

Table 1b. Nordic longitudinal cohort studies on suicide and/or suicide attempt based on data collected from military screening tests

First author (year)	Birth cohort	Measures from military screening tests	Association
Stenbacka (2015)	1949-1951	Mental health problems	Suicide attempt↑
Sörberg (2014)	1949-1951	Body mass index↓	Suicide attempt↑
Åberg (2014)	1950-1987	Cardiovascular fitness↓	Suicide attempt/suicide↑
Sörberg (2013)	1949-1951	Cognitive ability↓	Suicide↑ Suicide attempt↑
Lundin (2011)	1949-1951	Psychiatric diagnoses (neurosis and personality)	Suicide attempt↑ Suicide↑
Gravseth (2010)	1967-1976	Mental health impairment	Suicide↑
Batty (2010)	1950-1976	Cognitive ability↓ Body mass index↓	Suicide attempt↑
Månsdotter (2009)	1949-1951	Masculinity rank↓	Mortality↑ (including suicide↑)
Price (2009)	1949-1951	Cannabis use↑	Suicide↑
Osler (2008)	1953	Body mass index↓ Cognitive performance↓ Mental health impairment↓	Suicide attempt↑ Suicide↑
Magnusson (2006)	1950-1981	Body mass index↑	Suicide↓
Gunnel (2005)	1950-1976	Cognitive ability↑	Suicide↓
Hemmingson (2003)	1949-1951	Smoking↑	Suicide↑ (explained by alcohol and low mental well-being among smokers)
Jiang (1999)	1973-1975	Body height↑ Military performance↑ Cognitive ability↑	Suicide attempt↓ (hospitalized)
Allebeck (1990)	1949-1951	Psychiatric diagnosis (neurotic, personality, drug dependence)	Suicide↑
Allebeck (1990)	1949-1951	Deviant behavior and substance abuse	Suicide↑
Andreassen (1988)	1949-1951	Alcohol↑	Mortality↑ including suicide
Rossow (1995)	1932	Alcohol abuse	Suicide↑

1.5.2. Hospital records

Data collected in hospitals and emergency rooms/departments are an important tool for epidemiologic and clinical research, and research on self-harm is no exception. Data on individuals who present to the hospital following self-harm have been utilized to explore rates of self-harm over time (Bergen, Hawton et al. 2010), to increase our understanding of associated factors (Hawton, Bergen et al. 2012), to compare outcomes such as repetition and mortality between regions and periods (Hawton, Bergen et al. 2012, Hiles, Bergen et al. 2015), and to evaluate the impact of treatment initiatives and political interventions (Kapur, House et al. 2003). However, there is a lack of comparable data on hospital admissions in persons who self-harm with or without suicide intent. Only one country, the Republic of Ireland, has a national monitoring system of all hospital admissions for self-harm that has existed since 2006. A few other well-known systems have been operating in Oxford, Leeds, Manchester, and Newcastle New South of Wales, Australia. We have compiled the cohort studies based on data collected in hospitals and emergency rooms/departments on adolescents who self-harmed using any methods and using self-poisoning specifically (Tables 2a and 2b).

Table 2a. Hospital-based cohort studies of adolescents who self-harmed using any method

First author (year)	Inclusion criteria	Study period	Data source	Incidence rates and/or main results
Cutler (2015)	ICD-9 codes E959-959	2009-2012	The National Trauma Databank, United States	Age 10-18 years: Increasing trend, associated with: female, older age, comorbidity, ethnicity, insurance category, firearms in males and cutting in females
Rhodes (2014)	ICD-10 codes X60-X84	2002-2011	National Ambulatory Care Reporting System, Ontario, Canada	Age 12-17 years: Time trend males: 125-75/100,000 population Time trend females: 310-225/100,000 population Self-poisoning most common 25% presented with mental illness
Sulyman (2013)	ICD-9 codes E959-959	2007	United States Emergency Department Database	Age <18 years: Average age 15.7 years Poisoning 70% of the cases More males than females died in the emergency department
Perry (2012)	ICD-10 codes X60-X84	2003-2009	The Irish National Registry of Deliberate Self-Harm.	Males 10-14 years: about 25/100,000 population Females 10-14 years: about 110/100,000 population Males 15-19 years: 336/100,000 population Females 15-19 years: 620/100,000 population
Ting (2012)	ICD-9 E950-959	1993-2008	the National Hospital Ambulatory Medical Care Survey database, United States	Males 15-19 years: 296/100,000 population Females 15-19 years: 449/100,000 population
Hawton (2012)	Self-harm	2000-2007	The Multicenter Study of Self-Harm in England (Oxford, Manchester, Derby)	Males 10-14 years: 67/100,000 population Females 10-14 years: 302/100,000 population Males 15-18 years: 466/100,000 population Females 15-18 years: 1,423/100,000 population Self-poisoning most common method
Dieserud (2010)	Suicide attempt	1984-2006	The Bærum surveillance system for Self-Harm	Females > males Relational difficulties, 23% mental health problems
Hawton (2008)	Deliberate self-harm	1978-2003	The Oxford Monitoring System for Self-Harm	Age <15 years: Most overdosed, related to life problems
Olfson (2005)	ICD-9 codes E950.0-959.9	1997-2002	The National Hospital Ambulatory Medical Care Survey database, United States	7-14 years: 102/100,000 population 15-19 years: 342/100,000 population 56% diagnosed with a mental disorder
Hawton (2003)	Deliberate self-harm	1990-2000	The Oxford Monitoring System for Self-Harm	The majority of deliberate self-harm involved self-poisoning (paracetamol)

Tab 2a. continue

First author (year)	Inclusion criteria	Study period	Data source	Re-presentation
Hu (2016)	ICD-10 codes X60-X84, Y10-Y34	2000-2011	The Emergency Department Data Collection, Western Australia	6% within the first 7 days. Associated with previous self-harm and psychiatry, gender differences
Perry (2012)	ICD-10 codes X60-X84	2003-2009	The Irish National Registry of Deliberate Self-Harm.	Age <15 years: 18% (one year)
Hawton (2012)	Self-harm	2000-2007	The Multicenter Study of Self-Harm in England (Oxford, Manchester, Derby)	Age 10-18 years: 18% (one year), 27% (up to 2 years of follow-up). Associated with being male, increasing age, cutting, psychiatry
Hawton (2008)	Deliberate self-harm	1978-2003	The Oxford Monitoring System for Self-Harm	Age <15 years: ¼ had a history of previous deliberate self-harm
Hawton (2003)	Deliberate self-harm	1990-2000	The Oxford Monitoring System for Self-Harm	Age 12-18 years: 15% (1 year), 1/3 had a history of previous deliberate self-harm
Vajda (2000)	ICD-9 codes E950-E959	1994-1995	The Royal Prince Alfred Hospital, Australia	Age 13-20 years: males 31% and females 25% (1 year), 39% had prior suicide attempts, associated with medical conditions, psychiatry, drug abuse and sexual abuse

Table 2b. Hospital-based cohort studies of adolescents who self-poisoned

First author (year)	Inclusion criteria	Study period	Data source and location	Incidence rates and/or main results
Finkelstein (2015)	ICD-10 codes X60-X69	2001-2012	The National Ambulatory Case Reporting System and the Canadian Institute for Health Information Discharge Abstract Database, Ontario, Canada	Age 10-19 years: 1% died (7 year follow-up) Increased risk of suicide and death from other causes
Tidemalm (2015)	ICD-9 codes E950-9 and E980-9 ICD-10 codes X60-84 and Y10-34	1990-1999	Four linked Swedish longitudinal population registers.	Age 10-19 years: In males (not in females) increased risk of suicide was associated with mental disorder and violent method
Xiang (2012)	ICD-9 codes 960-979	2007	Nationwide Emergency Department Sample, United States	Males 12-17 years: about 160/100,000 population Females 12-17 years: 350/100,000 population Males 18-20 years: about 305/100,000 population Females 18-20 years: about 410/100,000 population Suicide intent: females > males
Lipnik-Stangelj (2010)	poisoning by medication, drugs, and biological substances	2001-2005	The Register of Institute of Public Health Slovenia	Age 10-14 years: about 125/100,000 population Age 15-19 years: about 475/100,000 population
Rhodes (2008)	ICD-9 codes 960-979	2001-2002	National Ambulatory Care Reporting System, Ontario, Canada	Males 15-20 years: about 220/100,000 population Females 15-20 years: about 620/100,000 population Deliberate: females > males
Borna (2001)	Deliberate self-poisoning with drugs	1991-1995	Lund University Hospital	Age 12-18 years: males 20/100,000 female population 156/100,000 population Females 17-18 years highest rates: 310/100,000 population 20% had previously self-poisoned

Tab 2b.continue First author (year)	Inclusion criteria	Study period	Data source and location	Re-presentation
Reith (2003)	Self-poisoning	1991-1995	The Hunter Area Toxicology Service Database, Australia	Age 10-19 years: 12% (5 year), associated with psychiatric disorders
Hawton (1999)	Self-poisoning	-	The Oxford Monitoring System for Self-Harm	Age 12-18 years: 20% (1 year), 1/3 had a previous overdose
Sellar (1990)	ICD9 960-977	1980-1985	The Oxford Monitoring System for Self-Harm	Age 10-20 years: 7% (1 year), 10% (mean follow-up 3.6 years)

1.5.3. Norwegian governmental health registers

In Norway, some local hospitals have developed systems to monitor patients who self-harm, which have provided useful data for research (Dieserud, Gerhardsen et al. 2010, Mehlum, Jorgensen et al. 2010, Johannessen, Dieserud et al. 2011). As previously mentioned, data have been systematically collected on patients treated for poisoning in hospitals and emergency rooms/departments in Oslo over the last decades, resulting in research on patterns of poisoning, repetition, and mortality in the capital of Norway (Ekeberg, Ellingsen et al. 1994, Hovda, Bjornaas et al. 2008, Ekeberg 2009, Heyerdahl, Bjornaas et al. 2009, Bjornaas, Hovda et al. 2010, Kolvik, Heyerdahl et al. 2011). But, similar to most other countries, Norway lacks a national system for the specific purpose of monitoring or collecting data on self-harm. However, in Norway there are several governmental health registers that provide current, reliable, secure information about the population's health (Ministry of Health and Care 2014). The data in these health registers are structured into variables with different values and stored in such a way that individual information can be retrieved and updated (Ministry of Health and Care 2014). The structure and purpose of health registers is expressed in the following definition: “a patient registry is an organized system that uses observational study methods to collect uniform data (clinical and other) to evaluate specific outcomes for a population defined by a particular disease, condition, or exposure, and that serves one or more predetermined scientific, clinical, or policy purposes.” (Gliklich 2014).

Most of the health care services in Norway are publicly funded and all Norwegian citizens are covered by public health insurance, which provides access to free medical treatment. The regional health authorities, hospitals, and health care services are obligated to report patient data to the governmental health registers. As a result of this policy, several of these registers are considered to have complete coverage of an entire target population (Larsen, Smastuen et

al. 2009). The health information included in these registers may contain a broad range of demographic information and personal characteristics that are related to health, treatment, and health risks; furthermore, the information can often be linked to other public registries or surveys (Bakken, Suren et al. 2014). Secondary use of such public health register data are therefore often characterized as a “goldmine” for clinical and epidemiologic research, with the potential to provide important contributions to public health (Langhoff-Roos, Krebs et al. 2014, Lloyd, McGregor et al. 2015). Among the main strengths of register-based research is the potential to construct cohort studies with a high level of evidence (Christiansen, Larsen et al. 2014) and to produce exposure and risk estimates in the entire population in a prompt and inexpensive manner. In the Nordic countries there have been many excellent studies on suicide and self-harm that utilized information recorded in governmental health registers. Some of these studies focused on young people (10-21 years), most used a nested case-control or (matched) cohort design and included data collected in general and psychiatric hospitals that were linked to several population and administrative registers (Agerbo, Nordentoft et al. 2002, Christiansen, Goldney et al. 2011, Christiansen, Larsen et al. 2013, Christiansen, Agerbo et al. 2015, Guldin, Li et al. 2015, Tidemalm, Beckman et al. 2015).

1.5.4. Cross-sectional surveys

Unlike medical screening, where the goal is to bring patients to treatment, the principal aim of cross-sectional surveys is to elucidate the prevalence, incidence, and natural history of the variable or variables under study (Wilson 1968). Cross-sectional surveys can be easy and economical to conduct, and are often conducted on a regular basis on representative samples of a population focusing on personal and demographic characteristics, illnesses, and health-related behavior. The results of these studies are helpful in assessing the health care needs of populations. We have listed cross-sectional surveys that examined self-reported use of health care services following self-harm and associated factors in adolescent populations (Table 3). Cross-national surveys are listed first.

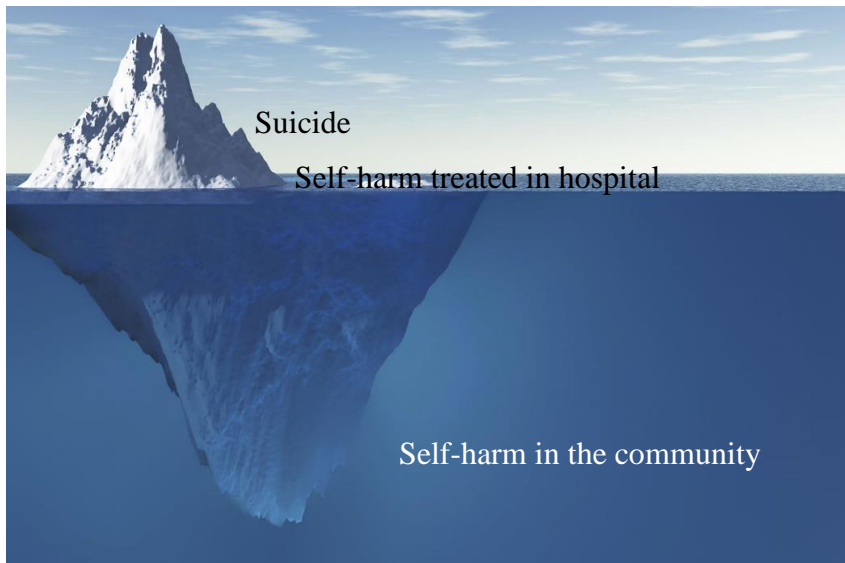
Table 3. Cross-sectional surveys on use of health care services in adolescents who self-harm

Study and definitions of self-harm and health services	Study period	Country	Number of participants	Use of health care services
<p>SEYLE</p> <p>Saving and empowering young lives in Europe:</p> <p>direct self-injurious behavior</p> <p>Clinical interview after school-based screening for direct self-injurious behavior</p>	2009-2012	Austria, Estonia, France, Germany, Hungary, Ireland, Israel, Italy, Romania, Slovenia, and Spain (Brunner, Kaess et al. 2014, Cotter, Kaess et al. 2015)	12,395 Age 14-16 years	<p>2% reported medical attention (more males than females)</p> <p>37% of referred adolescents attended the clinical interview (international variation between 6% and 97%). Attendance was associated with female gender, depressive symptoms, recent suicide attempt, and time and location for the interview</p>
<p>CASE</p> <p>The Child & Adolescent Self-Harm in Europe study:</p> <p>self-harm and self-harm thoughts</p> <p>Help from 'health services' including help from hospital, psychologist/psychiatrist, general practitioner, social worker, and drop-in center</p>	2000-2004	Australia, Belgium, England, Hungary, Ireland, the Netherlands, and Norway (Madge, Hewitt et al. 2008, Ystgaard, Arensman et al. 2009)	30,532 15-17 years	<p>18% had received help from health services of whom 12.4% had presented to hospital (more males than females)</p> <p>Self-cutting: 6.9%</p> <p>Overdose: 18.1%</p> <p>Associated factors: a wish to die, lethal methods, alcohol/drug problems and deliberate self-harm in the family</p>
	2000-2001	England (Hawton, Rodham et al. 2002, Fortune, Sinclair et al. 2008, Hawton, Rokach et al. 2009)	6020	<p>13% presented to hospital after self-harm</p> <p>Before and after self-harm respectively:</p> <p>Psychologist/psychiatrist: 5% and 8%</p> <p>General practitioner: 4% and 8%</p> <p>Associated factors: methods other than self-cutting and help-seeking before the act</p>
	2003-2004	Ireland (Morey, Corcoran et al. 2008)	3830	<p>11.3% had presented to clinical services</p> <p>Before and after self-harm respectively:</p> <p>Psychologist/psychiatrist: 4% and 9.2%</p> <p>General practitioner: 1.8% and 7.7%</p>
	2002	Australia (De Leo and Heller 2004)	3757	<p>Before and after self-harm respectively:</p> <p>Psychologist/psychiatrist: 9.5% and 6.1%</p> <p>General practitioner: 1.9% and 1.0%</p>

Table 3 continue

Study and definitions of self-harm and health services	Study period	Country	Number of participants	Use of health care services
Non-suicidal (NSSI) and suicidal (SSI) self-injurious behavior Psychological help and medical care in a hospital	2009	Belgia (Baetens, Claes et al. 2011)	1417 12-18 years	NSSI and SSI respectively: Psychological: 17% and 26% Hospital: 4% and 19%
PROMISE Self-harm General practitioner or another professional contact for anxiety or depression over the previous 6 months.		England (Stallard, Spears et al. 2013, Sayal, Yates et al. 2014)	3744 12-16 years	11% had contacted their general practitioner for problems of anxiety or depression, rising to 18% when other professionals were included. 0.9% had contacted specialized mental health services. Associated factors: depression
The European Study Project on alcohol and other drugs Suicide attempt Hospitalization		France (Pagès, Arvers et al. 2004)	12113 14-19 years	Hospitalization associated with problem behavior and living conditions
The Young in Norway Study Deliberate self-harm "help or treatment" from hospital/doctor/psychologist/psychiatrist	1994 and 2002	Norway (Rossow and Wichstrom 2010)	7446 (1994) /11678 (2002) 13-19 years	In 1994 and 2002 respectively: Hospital/doctor: 6% and 10% Psychologist/psychiatrist: 16% and 21%. Associated factors: female gender and parental attachment.
The Young in Oslo study Non-suicidal self-harm and suicide attempt Help from child and adolescent outpatient psychiatric services		Norway (Tormoen, Rossow et al. 2014)	11440 14-17 years	In those with either Non-suicidal self-harm or suicide attempt versus those with both behaviors respectively: 18% and 34% Associated factors: drug and psychiatric disorders.
Self-harm Help from 'health services' including help from hospital, psychologist/psychiatrist, general practitioner, social worker, and drop-in center		Ireland (Doyle, Treacy et al. 2015)	856 15-17 years	7% presented to hospital after self-harm

1.6. Summary of the introduction - The tip of the iceberg



- Suicide is a rare event in adolescents, but self-harm is considered to occur up to 200 times as often as suicide in the adolescent population.
- About 80% of those who die from suicide are males, but two to four times as many females than males report a suicide attempt or self-harm during adolescence. Many studies point to psychiatric disorders or mental distress as the most powerful predictor for suicide and (repeated) self-harm.
- Despite the strong association between self-harm, psychiatric morbidity, and suicide mortality, research indicates that about 75% of adolescents who self-harm do not receive treatment for this behavior.
- Most hospital admissions for self-harm involve self-poisoning. Hospital admissions for self-harm are more common among females than males, in urban compared to rural residents, in those with the highest degree of psychological distress/severity of mental health problems, and in those who self-harm with suicide intent.
- Monitoring systems for self-harm are not widespread. Existing systems include only those individuals who go to the hospital after the event and are limited to the catchment area of individual hospitals.
- In Norway, several governmental health registers exist. Secondary use of data from these registers provides an opportunity to conduct cohort studies with a high level of evidence and to produce risk estimates for suicide, hospital admission, and readmission for self-harm on a national level. Additionally, community surveys at the national level are necessary to include adolescents who engage in self-harm without going to the hospital.

2. AIMS OF THIS THESIS

The overall aim of this thesis is to examine factors associated with suicide, repeated hospital admissions and self-reported use of health care services following self-harm in adolescents.

The specific aims of the three papers included in this thesis were:

- Paper I: to examine the risk of suicide in different groups of males who had minor or major mental health impairments as adolescents.
- Paper II: to examine the characteristics of hospital admissions for self-poisoning with medications in adolescents and investigate factors associated with hospital readmission for self-poisoning with medications.
- Paper III: to examine self-reported use of health services following self-harm in adolescents who self-harm with and without suicide intent and who lived/attended school in municipalities with or without a hospital.

3. MATERIAL AND METHODS

3.1. Data sources and measures

Paper I and II use information recorded in the Norwegian Armed Forces Health Registry (NAFHR), the Norwegian Cause of Death Registry (NCoDR), and the Norwegian Patient Registry (NPR). The Paper III comprises information collected in a nationwide cross-sectional school survey (the Young in Norway Study).

The Norwegian Armed Forces Health Registry

The NAFHR was established as a personnel register in 2005, and includes the personal identification number assigned to all Norwegian residents and citizens. The register is run by the Ministry of Defense and the Norwegian Armed Forces Medical Services. The purpose of the NAFHR is: a) to monitor the health of personnel in the Armed Forces and to identify potential health risks associated with the various branches of the military, b) to promote and to provide a basis for research and statistics, c) to contribute to the improvement and development of military health services, and d) to contribute to the discovery of occupational injuries and ailments (Ministry of Defense 2005). The NAFHR contains personal-, service-, and health-related information for Armed Forces personnel and for every person who attends screening for military service. The NAFHR also contains information on emigration, and

dates and causes of death, all of which are updated annually through linkage to the NCoDR (Ministry of Defense 2005).

Up to the year 2009, military medical screening was mandatory for all Norwegian males. Only about 1.5% of the Norwegian male birth cohorts were exempt due to permanent disability that occurred before the age of 18 years. Another 3% of the Norwegian male birth cohort died or emigrated before the age of 18 years, and 6-7% did not present themselves for military screening because at that time they were abroad, ill, imprisoned, or for some other reason could not be traced by the Norwegian Conscription Board (Oyen, Vollset et al. 2007). From 2010, only a portion of eligible Norwegian citizens are called for military screening (each year about 20,000), depending on the Armed Forces military staff requirements. The military screening tests aim to determine any functional mental or physical impairment that might influence the person's ability to learn and perform military routines and operations. The examinations include a review of personal statements of health, any medical documentation of disease, a general clinical examination and interview, a visual acuity test, a test of color vision, audiometry, and observations and evaluations of the behavior and reactions during the clinical interview and examinations. All screened individuals must also take a validated group of intelligence tests that cover number series (calculation), verbal analogues, and geometric figures (the Norwegian Armed Forces Joint Medical Services 2013). The physical and mental health assessments are performed by medical doctors trained in military medicine and selection procedures. The doctors assign any relevant diagnoses in accordance with the International Statistical Classification of Diseases and Related Health Problems, 10th Revision (ICD-10), and detailed written procedures from the Norwegian Armed Forces Medical Services (the Norwegian Armed Forces Joint Medical Services 2013, The World Health Organization 2015). The results of the mental and physical examinations are recorded in the NAFHR as "no impairment", "minor impairment", "major impairment", and "unfit for military service". No impairment is used if no factors are revealed that can negatively affect the screened individual's ability to learn and perform military routines and operations. Minor impairment is used if current or previous disorders can potentially reduce stress tolerance and/or to a lesser extent negatively affect the ability to perform military routines and operations. Major impairment is used for physical and mental disorders that will require treatment during military service. Finally, screened individuals are classified as unfit for military service if their physical or mental condition is considered to be incompatible with learning and performing military routines and operations.

In the mental health assessment, conditions such as minor depression, minor neurotic symptoms, stress-related or behavioral disorders, or a mild degree of developmental disorders are classified as minor mental health impairment if the screened individual is still fully capable of learning and performing military routines and operations without treatment or special follow-up during military service. Major mental health impairment, on the other hand, includes psychiatric conditions that are incompatible with military service, including episodes of psychosis or mania, phobic anxiety disorders, dissociative disorders, eating disorders, mental retardation, pervasive development disorders, hyperkinetic disorders, conduct disorders, and Tourette's syndrome (the Norwegian Armed Forces Joint Medical Services 2013). Individuals with manifest drug addiction or drug abuse, specific personality disorders, severe mental retardation, or behavioral disorders with a significant degree of disability, or any mental disorder for which they had received prolonged treatment/hospitalization are classified as unfit for military service due to mental health impairment. However, an overall evaluation of psychosocial stress factors, emotional problems, and functional impairment is essential to this classification. Some people can also be classified as unfit for military service due to mental health impairment because they have adjustment disorders of undefined severity, or because they appear so severely unmotivated or unwilling to pursue military service that their mental health status is impossible to assess.

The Norwegian Cause of Death Registry

The NCoDR covers virtually all deaths in Norway since 1951 and is updated annually. Deaths of Norwegians who die abroad are also registered. All deaths (about 40,000 each year) are reported by doctors who are required to complete a death certificate. The official cause of death statistics are based on these death certificates and are prepared in accordance with the ICD Revision in effect at the time (World Health Organization). ICD-8 was used in 1980-1985; ICD-9 in 1986-1995; and ICD-10 in 1996-present, and causes of death are grouped according to the European Union (EU) Shortlist for causes of death. The EU-Shortlist is a list of 65 groups of causes of death and allows for the conversion of codes from ICD-10, ICD-9, and ICD-8 (Eurostat 1998).

The Norwegian Patient Registry

The NPR collects patient administrative data from all specialized health care services in Norway and includes information on patient's age, sex, residence, hospital and department, diagnosis(es) and surgical procedure(s), dates of admission and discharge, and date of

procedure. The NPR was established in 1997 and is run by the Ministry of Health and Care Services and a defined organizational unit within the Department of Health. The NPR is considered to have complete coverage on all hospital admissions and outpatient consultations in Norway. An encrypted version of the unique personal identification number has been included since 2008 (Ministry of Health and Care Services 2007). Diagnostic coding is done locally by each hospital and entered into the NPR. The primary diagnosis describes the main condition for which health care was provided during the hospital stay or consultation. If more than one condition is topical, the one that required the largest proportion of medical resources is recorded as the primary diagnosis. Secondary diagnoses describe conditions that exist simultaneously with the main condition or that develop during the treatment period (The Norwegian Directorate of Health 2011).

The Young in Norway Study

The Young in Norway Study is a nationwide cross-sectional survey conducted in 2002. It was financed by the Research Council of Norway and was conducted by Norwegian Social Research (NOVA).

A stratified sample of Norwegian schools was drawn by Statistics Norway. Schools were stratified based on five geographic regions and by number of pupils. Thirteen thousand adolescents from 73 Norwegian junior and senior high schools (grades 7-12) were eligible to participate (N=12,923) and were asked to complete a study questionnaire at school. Adolescents who were absent were given the opportunity to participate on another day. In total 11,406 adolescents (92.3%) completed questionnaires. The distribution by sex, age group, urban/rural residential area, single-parent household, and ethnicity among these adolescents correlated well with the distribution of these variables in the general population of Norway (available from Statistics Norway) (Rossow and Bø 2003).

3.2. Participants, outcomes, and independent variables

3.2.1. Paper I

Participants

All male citizens who attended military screening at ages 17-19 years in the period 1980-1999 (563,354) were eligible for the study. We excluded those who had a date of entry into military service or a date of death that was prior to the date of military screening, those who did not have any registration of mental health status (0.2%), and those who were categorized as unfit for military service due to mental health impairment (0.5%). This yielded a final study sample of 558,949 males.

Outcome

The outcome variable in this study was death from suicide (ICD-10 codes X60-X84, Y87.0).

Independent variables

Based on a literature review of the factors associated with suicide, the following information was collected from the NAFHR:

- mental health impairment, which was separated into none (reference), minor, and major
- age (17/18/19 years old)
- decade of examination (1980-89/1990-99)
- general health impairment (yes/no)
- motor system impairment (yes/no)
- visual impairment (yes/no)
- intellectual performance (average (reference)/below average/above average)

3.2.2. Paper II

Participants

The NPR was used to retrieve all cases of acute hospital admissions with a primary diagnosis of self-poisoning with medications for individuals aged 10-19 years in the period 2008 to 2011.

Outcome

The main outcome was hospital readmission for self-poisoning with medications. In the Norwegian classification system, these poisonings are coded as “T4n”, a generic code covering about 125 specific codes of poisonings including T36–T40, T42–T49 and T50. For each adolescent, the first recorded hospital admission with a principal diagnosis of acute self-poisoning with medications during the study period was set as the index hospital admission. The encrypted version of the patient’s personal identification number was then used to capture all subsequent hospital admissions for acute self-poisoning with medications during the study period. Hospital admissions that occurred within 1 day of a previous hospital admission were excluded to avoid counting transfers between hospital departments as new hospital admissions. Patients who had two or more hospital admissions for self-poisoning with medications during the study period were classified as repeaters.

Independent variables

We examined factors related to index hospital admission and the risk of hospital readmission for self-poisoning with medications in relation to:

- sex
- age group (10-14 years/15-19 years)
- secondary psychiatric diagnoses
- E-code (external cause of injury) for intentional self-harm
- length of hospital stay (0 days versus 1 day or more)
- discharge to the home versus further treatment (hospital psychiatric department, hospital department for treatment of drug addiction, or “other” unspecified health care institution)

3.2.3. Paper III

Participants

Of all the participants in the Young in Norway Study, 980 (8.7%) reported self-harm, among whom 959 provided valid responses to a follow-up question on any subsequent help or treatment they received. These 959 adolescents were included in the analyses. Girls represented 51.2% of the sample. The mean age for both genders was 15.7 years (standard deviation, SD=1.8).

Outcome

The main outcome was use of health services following self-harm. Respondents who confirmed having received help or treatment from a hospital /general practitioner/psychologist/psychiatrist following self-harm were categorized as having used health services following self-harm.

Independent variables

The question on self-harm in the survey read as follows: ‘Have you ever deliberately taken an overdose of pills or otherwise tried to harm yourself?’ and had the following answer alternatives: yes, less than a year ago; yes, more than a year ago; no, never. Suicide intent was assessed by a question on history of suicide attempt: ‘Have you ever tried to take your own life?’ (yes/no). Those who responded yes to the question on self-harm and the question on suicide attempt were classified as self-harm with suicide intent. Those who responded ‘yes’ to the question on self-harm and ‘no’ to the question on suicide attempt were classified as self-harm without suicide intent.

The residential area variable (urban versus suburban and rural areas) was determined in two ways: by school municipality, i.e., the municipalities where the adolescents attended school, which were classified according to the municipalities function in previously defined residential and labor market regions (Amdam 2007), and by adolescents’ self-report of where they lived. As few adolescents attended school in rural municipalities, suburban and rural school municipalities were combined. This dichotomization of municipalities matched the location of specialized health services, as a general hospital was located in 23 of the 26 urban municipalities in the sample (89%) versus in only two of the 29 (7%) suburban and rural municipalities.

The following variables that have been previously associated with use of health services among adolescents who self-harm were included in the analyses:

- help from parents or friends
- age
- living in a single-parent household
- parental education (university degree/no university degree)
- problem behavior (school truancy, theft, violence, conflicts with teachers, and use of illicit drugs in the past year).

3.3. Statistical methods

Bivariate associations between covariates and outcome variables were tested by cross tabulations using Pearson's χ^2 test and bivariate regression analyses. Variables achieving a statistical significance of $p < 0.05$ were entered into the multivariate models.

In Paper I, Cox proportional hazard models were used to evaluate the influence of different factors on the risk of suicide and to account for differences in the length of follow-up. Participants were followed from the date of their medical and psychological examination until the date of death, emigration, or the end of the observation period (31 December 2013), whichever came first. Analyses were conducted using SPSS version 23.0 (Inc. S. SPSS statistics 23.0, Chicago).

In Paper II, complementary log-log regression was used to fit discrete-time intervals for hospital readmission for self-poisoning with medications in the period 2008-2011, estimating hazard ratios (HR) with 95% confidence intervals (CIs) for covariates having an effect on hospital readmission. Differences in hospitalization rates between the sexes and age groups were tested by Poisson regression. The analyses were carried out in STATA/IC version 13 for Windows.

To assess the association between urban versus suburban and rural area and use of health services following self-harm and potential covariates (Study III), we used bivariate and multivariate logistic regression with unadjusted odds ratios (OR) and Wald tests. The adjusted association was estimated in a multivariate logistic regression model, applying a stepwise procedure based on model-fit criteria (log likelihood ratio). A multiplicative interaction term

‘area’ x ‘suicide intent’ entered in the second step of the multivariate analysis was statistically significant ($p < 0.001$), both when school municipality and residential area was used. Therefore, the bivariate and multivariate logistic regression analyses were conducted separately for those who reported self-harm with and without suicide intent. Statistical analyses were performed using SPSS version 17 (SPSS Inc., Chicago, Illinois, USA). More detailed descriptions of the statistical analysis used in the studies are presented in the three papers.

Table 4. Outcomes, independent variables, and statistical analysis used in the thesis.

	Paper I	Paper II	Paper III
	Suicide	Hospital readmission for self-poisoning	Self-reported use of health services following self-harm
Predisposing characteristics			
Sex		X	X
Age	X	X	X
Parents (education and household)			X
Need/proximal risk factors			
Mental health problems			
Mental health impairment	X		
Psychiatric disorders		X	
Problem behavior			X
Suicide intent		X	X
Intellectual performance	X		
Physical impairment	X		
Enabling resources			
Help from parents or friends			X
Service area			X
Treatment (length of hospital stay/referral to further treatment)		X	
Statistical analyses			
Comparison between groups	Pearson’s χ^2 test	Pearson’s χ^2 test Poisson regression	Pearson’s χ^2 test
Association between variables and adjustment for confounders	Cox proportional hazard models	Complementary log-log regression	Logistic regression

3.4. Literature search

A series of searches of the relevant literature in PubMed were performed. These included searches of studies published in English in peer-reviewed journals in the three decades prior to December 2015. The search terms were suicide, and self-injurious behavior, along with category-specific terms relevant to the subsections of this thesis, including epidemiology, trends, prevention and control, health services/utilization, hospitalization, military personnel, and risk factors. The searches were conducted with no age-limitation and were limited to adolescents (13-18 years). Titles and abstracts of search results were read to assess eligibility of the article for inclusion. When looking for articles on the use of health care services, the focus was placed on studies conducted in Europe. Studies that focused on particular groups such as psychiatric patients or alcohol abusers, and studies that included people older than 19 years were excluded from the review on the use of health care services. It should be noted that although the search procedures were thorough, these are not systematic reviews and some studies may have been omitted.

3.5. Ethical considerations

The four principles of autonomy, non-maleficence, beneficence, and justice, are considered by many as the standard theoretical framework from which to analyze ethical situations in research that involves human subjects (Beauchamp TL 2001). In summary, these four principles state that in biomedical research, the risk of harm related to research must be weighed against possible benefits for the patients, other subjects, and public health. In this thesis, the collection of the data involved no potentially harmful interventions, invasive procedures, or manipulation of the individuals. The studies that led to the papers included in this thesis are considered to be beneficial to public health, mainly because of their high external validity. However, the secondary use of personal data collected by the health services, and research on minors that involves sensitive issues such as self-harming behavior, raises some ethical concerns about autonomy and privacy (the World Medical Association 2013, Ludvigsson, Haberg et al. 2015).

In Papers I and II we used personal health data collected by Norwegian health services without obtaining informed consent from the subjects. In general, participation in biomedical research must be based on voluntary, informed consent that is linked to a specific research project (Ministry of Health and Care Services 2008). However, when sample sizes are large it

may prove impractical or impossible to obtain explicit consent from each individual for access to routinely-collected medical information (Gliklich 2014). Obtaining informed consent can further undermine many of the important attributes of register-based research, for example by introducing selection bias or by reducing originally large sample sizes (Kho, Duffett et al. 2009, Thygesen and Ersboll 2014). So, if societal benefits outweigh the potential risk to the study subject, individual consent can be waived (Gliklich 2014, Ministry of Health and Care 2014). However, people have different opinions on when informed consent should be obtained in health register-based research, and these opinions further vary according to the scenario under investigation, which underscores the complexity of this question (Clerkin, Buckley et al. 2013, Eloranta and Auvinen 2015, Xafis 2015). It is important to bear in mind that the information stored in Norwegian health registers was originally derived from sensitive and confidential information from patient journals. The flow of data into the registers is often incredibly complex and sometimes based on manual procedures and/or papers sent by mail, which clearly implies less privacy protection. Improper disclosure of such sensitive information may lead to things like social discomfort and stigmatization, or feelings of insecurity, fright, or embarrassment. Some people are concerned about data security and the threats to privacy that may stem from a lack of security, i.e., wider sharing of information, commercial exploitation, lack of accountability, and data inaccuracies (Clerkin, Buckley et al. 2013, Eloranta and Auvinen 2015, Papoutsis, Reed et al. 2015). But at the same time, people are usually inclined to grant the utilization of personal health data in research and are willing to compromise on personal privacy concerns for the sake of “the greater good” (Clerkin, Buckley et al. 2013, Eloranta and Auvinen 2015).

In this thesis, the risk of harming those who were included in Papers I and II by accidental leakage of information or breach of confidentiality was considered to be minimal for several reasons. Inclusion criteria were held to a minimum, and the data files comprised a broad part of the population. Data was strictly structured in codes and consisted of no qualitative information or any personally-identifiable information. An *à priori* requirement for obtaining permission to use these data is to follow prudent practice, including adhering to strict data protection procedures, as well as a legal framework that ensures confidentiality and protection from unauthorized access to data. All data were collected, stored, and analyzed in accordance with the Act on Medical and Health Research (Ministry of Health and Care Services 2008), the Health Register Act (Ministry of Health and Care 2014), and the regulations for the following registers: the NPR (Ministry of Health and Care Services 2007), the NAFHR

(Ministry of Defense 2005), and the NCoDR (Ministry of Health and Care Services 2001). Paper I was authorized by the Health Register Act to produce statistics in anonymous form without consent from the data subjects (Ministry of Defense 2005, Ministry of Health and Care 2014). The data collected in Study II were with no personal-identifiable information. Submission to the Regional Committees for Medical and Health Research Ethics (REK) and a license from the Data Inspectorate to process sensitive personal data was therefore not required.

In Paper III we used data on a range of social and behavioral aspects among adolescents aged 13-19 years. Research on minors that touches on sensitive issues such as use of illicit drugs, sexuality, violence, or self-harm poses specific challenges to research ethics, i.e., management and confidentiality of the data, and the capacity of a minor to consent to participate in a study. Any adolescent enrolled in research who is identified as at-risk due to drug use, a history of suicide attempts, or a mental health disorder (e.g., depression) is entitled to special protection and assistance (the World Medical Association 2013), and reporting to the parents or authorities could be necessary and ethical. On the other hand, breaching confidentiality towards minors by disclosing data might harm the minor socially or psychologically. Disclosure of information concerning the data of adolescents should therefore be given special attention in accordance with the ethical principle of “do no harm”. Despite the lack of empirical evidence (Gould, Marrocco et al. 2005, Biddle, Cooper et al. 2013), there is a widespread concern that exposure to suicide-related content could have an iatrogenic effect on adolescents.

When the Young in Norway Study questionnaire was developed, the researchers discussed their ethical concerns with experts in the field of suicidology, who found it ethical to include questions about self-harm in the survey. A pilot version of the questionnaire was tested among adolescents in junior and senior high schools. Interviews conducted after the pilot version of the questionnaire was completed revealed that the adolescents felt that the questions were easy to understand and the topics felt relevant. But the adolescents feared that some of the questions could provoke discomfort and should be made optional. Therefore, the adolescents who participated in the final survey were explicitly informed about their opportunity to refrain from answering any questions with which they were uncomfortable. Furthermore, they were given a card with an emergency telephone number and the contact information of the researchers at NOVA who were responsible for the study. The study protocol was approved by

the Ministry of Research and Education, the local school authorities, and the school boards. Written consent to participate in the survey was obtained from every adolescent and parental consent was also required (Rossow and Bø 2003).

4. RESULTS

4.1. Paper I

Fadum EA., Fønnebø V, Borud EK.

Presence of minor and major mental health impairment in adolescence and death from suicide and unintentional injuries/accidents in males. A national longitudinal cohort study.

J Epidemiol Community Health. 2017;**71**:19-24 doi:10.1136/jech-2016-207656

This paper presents the results from a national longitudinal cohort study of males aged 17-19 years old who attended mandatory medical and psychological examinations prior to military service between 1980 and 1999. The aim of the study was to examine the association between minor and major mental health impairment in late adolescence and death from suicide.

We included 558,949 males and followed them for suicide until the end of 2013. Compared to males with no mental health impairment, minor mental health impairment was associated with an increased risk of suicide (adjusted HR=1.63, 95% CI 1.39-1.92). In males with major mental health impairment, the risk of suicide was twice as high (adjusted HR=2.29, 95% CI 1.85-2.85).

4.2. Paper II

Fadum EA, Stanley B, Qin P, Diep LM, Mehlum L.

Self-poisoning with medications in adolescents: a national register study of hospital admissions and readmissions.

Gen Hosp Psychiatry. 2014 Nov-Dec;**36**(6):709-15.

This paper presents the results of a national cohort study of adolescents who were admitted to hospital for self-poisoning with medications between 2008 and 2011. The aims of the study were to examine the characteristics of adolescents who were admitted to hospital for self-poisoning with medications and identify factors associated with hospital readmission.

Among 1,497 included adolescents, 76.4% were females and 89.8% were aged 15-19 years. At their first hospital admission, about one-third received a secondary psychiatric diagnosis. Females (47.5%) were registered with an E-code for intentional self-harm more often than males (33.7%); however, when looking at index hospital admissions, 51.2% of females and 63.5% of males had no E-code for suicide intent. Females were discharged to further treatment more often than males (27.8% versus 21.5%). Nearly three-quarters of the females in our study sample (74%) stayed in the hospital for one day or more, compared to 62% of the males. Among our study sample, 18.4% had at least one hospital readmission for self-poisoning with medications (21.4% of the females and 8.9% of the males). Significant predictors for hospital readmission were female sex (HR=2.4, 95% CI 1.7-3.6), discharge to further treatment (HR=2.3, 95% CI 1.8-2.9) and secondary psychiatric diagnoses (HR=1.5, 95% CI 1.2-1.9).

4.3. Paper III

Fadum EA, Stanley B, Rossow I, Mork E, Törmoen AJ, Mehlum L.

Use of health services following self-harm in urban versus suburban and rural areas: a national cross-sectional study

BMJ Open. 2013 Jul 26;3(7).

This paper presents the results of a nationally representative school-based cross-sectional study conducted among adolescents. The aim of the paper was to examine factors associated with use of health care services in adolescents who self-harm with or without suicide intent and lived/attended school in municipalities with or without a hospital.

Overall, one in four adolescents reported using health care services following self-harm. In multivariate models, the sociodemographic factors cannabis use and help from parents predicted the use of health care services following self-harm. One-third (29.2%) of adolescents who reported self-harm with suicide intent used health care services afterwards, compared with 13.7% of those who reported self-harm without suicide intent (χ^2 [1, n=930] =26.01, $p<0.001$). Adolescents who reported self-harm with suicide intent were also more likely to report that they had received help from their parents or family members (22.9%) than those who reported self-harm without suicide intent (12.0%); χ^2 (1, n=930) =14.49, $p<0.001$.

Among those who reported self-harm without suicide intent, use of health care services was four times higher in those who attended school in an urban municipality with a hospital compared to those who lived outside such areas (respectively 16.4% versus 4.5%). This difference was not present in those who reported self-harm with suicide intent, neither in bivariate or in multivariate analyses.

5. DISCUSSION

5.1. Main findings

This thesis used three sets of nationwide data on adolescents to examine factors associated with suicide, hospital readmission, and self-reported use of health care services following self-harm. The main findings of this thesis were:

- In males, minor and major mental health impairment in late adolescence was associated with elevated risk of suicide.
- Females were more likely than males to be hospitalized for self-poisoning with medications. Nearly 20% of the adolescents were readmitted to hospital for a subsequent episode of self-poisoning. The risk of readmission was associated with being female, psychiatric diagnoses, and discharge to further treatment.
- Few adolescents reported that they had used health care services following self-harm. The proportion that did so was higher among those who reported self-harm with suicide intent compared to those who reported self-harm without suicide intent. Urban residence/school municipality was associated with increased likelihood of using health care services following self-harm without suicide intent, but this association was not present among adolescents who reported self-harm with suicide intent.

5.1.1. Mental health impairment in late adolescence and suicide in males

Though our estimates are broadly consistent with previous findings, comparisons with other cohort studies of male conscripts is limited due to, among other things, differences in mental health classification. In a cohort of 50,465 Swedish conscripts, Allebeck and Allgulander (1990) found that the relative risk for suicide was three times higher (95% CI 2.3-4.0) among those who received a psychiatric diagnosis (ICD-8) at conscription (13-year follow-up). Lundin et al. (2011) expanded on this work by following the same cohort for an additional 23 years. Among those who received a psychiatric diagnosis at conscription, the risk of suicide

was elevated 2.7 times (95% CI 2.2-3.2) (Lundin et al. 2011). Neurosis, personality disorders, and drug abuse were the psychiatric conditions associated with suicide (Allebeck and Allgulander 1990, Lundin et al. 2011). In two previous studies, a dichotomized version of the mental health assessment at conscription was used (no/any mental health impairment). In these two studies, “any mental health impairment” at conscription was associated with about a two-fold increase in suicide risk (Osler et al. 2008, Gravseth et al. 2010). Our study adds to this research by examining suicide in different groups of males who had minor or major mental health impairment. Suicide in those who suffer from minor mental health impairment has received little attention in the scientific literature, but measures of low emotional control and conduct problems at school has been found to be associated with suicide in a Swedish cohort of conscripts (Stenbacka and Jokinen 2015).

Drawing on cohort studies comprised of adolescents from the general population, one study from the United Kingdom found that suicide between the ages of 16 and 50 years was associated with self-rated emotional instability at age 13 years (Neeleman, Wessely et al. 1998). Other research has indicated that subthreshold-depression and subthreshold-anxiety are associated with an increased burden of disease and suicidal thoughts (Balazs, Miklosi et al. 2013). It is likely that symptoms such as fatigue, impaired problem-solving, or lack of emotional control, which may occur in persons with even minor mental health impairment, may increase the risk of suicide either directly or indirectly through things like problem drinking, risk-taking, or self-harm (Mattila, Parkkari et al. 2008). Greater symptom severity and/or availability of psychiatric medication could explain our finding of even higher risks for suicide in those with major mental health impairment (Robinson, Harris et al. 2010).

5.1.2. Hospital admission and readmission for self-poisoning with medications

Our reported hospitalization rates are somewhat lower than the estimates on adolescent self-poisonings from other countries, e.g., the United States (Xiang, Zhao et al. 2012). This was to be expected since our study only included adolescents with a primary diagnosis of self-poisoning and hence did not consider the contribution of secondary diagnoses of self-poisoning. However, we found that females outnumbered males in hospital admissions for self-poisoning, and the highest rate was in females aged 15-19 years (166.5/100,000 population 95% CI 156.4-176.7). Furthermore, females were more likely than males to receive the E-code for intentional self-harm, and females received more treatment. This age and sex distribution is consistent with data from the United States (Xiang, Zhao et al. 2012),

as well as with findings from regions in Australia (Reith, Whyte et al. 2003), Canada (Rhodes, Bethell et al. 2008), and the United Kingdom (Sellar, Hawton et al. 1990, Hawton and Fagg 1992).

It is important to note that between-study comparisons on this subject are limited, but repetition rates have been reported in a small number of publications and are mentioned here. Using prospectively-recorded hospitalization data on poisoned patients in Newcastle, New South Wales of Australia (the Hunter Area Toxicology Service Database (HATS)), Reith et al. (2003) found that 12.4% of adolescents (patient-based rate) came back to HATS with self-poisoning during the study period (1991-1995). The probability of a patient re-presenting to HATS within 1 year of their index presentation was 0.09 (95% CI 0.07-0.12) (Reith et al. 2003). In a study conducted on adolescent deliberate self-poisoning in the Oxford region, one-third had overdosed prior to their first hospitalization in the study period, and 20% had a repeated overdose within 1 year (Hawton, Kingsbury et al. 1999). However, these two studies included more poisonous agents than did our study. Another study from the Oxford region examined re-hospitalization in adolescents who had a main discharge diagnose of poisoning with drugs (ICD-9 960-977) between 1980 and 1985, and reported a 1-year readmission rate of 6.6%. In those who had 48 or more months of follow-up, the proportion re-hospitalized for a subsequent medication overdose was 15.6% (Sellar, Hawton et al. 1990). Based on data from the National Registry of Deliberate Self-Harm in Ireland (2007-2012), Griffin et al. (2014) reported that, among people younger than 15 years old who were admitted to hospital after deliberate overdose with drugs or medications (ICD-10 X60-X64), 16.7% were readmitted within 12 months, and rates of re-hospitalization were 14.9% in those who were 15-24 years old. In this study, an increased risk of re-hospitalization (all ages) was associated with admittance to a psychiatric ward at the index overdose (Griffin, Corcoran et al. 2014).

Our study found a significantly higher rate of hospital readmission among females compared to males, in those who received secondary psychiatric diagnoses, and in those who were discharged to further treatment compared to those who were discharged to their homes. In the previously mentioned Australian cohort of adolescents from HATS, personality disorders and non-affective psychoses were associated with an increased risk of re-hospitalization (Reith et al. 2003). Differences between the sexes on the perceived necessity and beneficial value of treatment, social support, and self-concept might explain some of the observed sex differences in our study (Moskos et al. 2007, Fortune, Sinclair et al. 2008). However, whether or not our

findings reflect a true difference between the sexes in the rate of self-poisoning and the intention to self-poison, a difference in hospitalization for this condition, differences in medical or psychiatric severity, or a combination of these sources of variation, remains a question for further studies.

5.1.3. Use of health services following self-harm with and without suicide intent in urban versus suburban and rural areas

No previous population-based studies on the use of health services following self-harm have differentiated between self-harm with and without suicide intent or between geographic areas in a way that reflected the location of health services. However, one investigation from 1996 reported that specialist utilization in the Nordic countries was higher among children in towns than in rural areas (Groholt et al. 2003). Rossow and Wichstrøm found the same pattern of health service use among Norwegian adolescents who had deliberately harmed themselves (Rossow and Wichstrom 1997). Similar findings have been reported in the research on adults' use of health care services after deliberate self-harm. In Ireland, the use of health and emergency services following self-harm was found to be primarily an urban phenomenon (Corcoran, Arensman et al. 2007), which in a recent study was largely explained by geographic proximity to a hospital (O'Farrell, Corcoran et al. 2015). Norway is characterized by a highly dispersed settlement. Due to a publicly-funded insurance scheme that provides health care services to all, it is likely that individuals place a larger value on the time needed to travel instead of the monetary cost of treatment. Therefore longer distances may have a negative effect on the use of health care services in adolescents who self-harm (Cauley 1987, Vistnes and Hamilton 1995, Goodman, Fisher et al. 1997, Roováli and Kiivet 2006, Moskos, Olson et al. 2007). On the other hand, one could expect that people with a more severe health condition, such as self-harm with suicide intent versus self-harm without suicide intent, are willing to pay a higher price and thus overcome any obstacles, i.e., long traveling distances, fear of stigma, etc., to gain access to treatment.

5.2. Methods discussion

5.2.1. Strengths and limitations

The main strength of this thesis is the use of nationwide data that included almost, or more than, 90% of all adolescents who were eligible for inclusion. Paper I and II in this thesis were designed as high-powered cohort studies, which are considered to have a high level of evidence (Christiansen, Larsen et al. 2014). Inclusion criteria and outcomes were well-defined and were based on ICD-10 diagnoses. Surveys (Paper III) usually have a low ranking for level of evidence. On the other hand, the inclusion of the survey material into this thesis may have strengthened the design by including information on adolescents who did not use health care services following self-harm and by including information on family characteristics and area that was not available in Papers I and II. The survey had a high response rate and included a nationally representative sample of adolescents from various geographic areas of Norway.

Some limitations need to be mentioned. All the studies were observational, which inhibits any inference of causality. Although we adjusted for possible confounding factors, it is impossible to rule out residual confounding from unmeasured characteristics of the adolescents. Though the data in this thesis were rich and included a range of independent variables, some important information was not available. For example, in Paper I, the specific ICD diagnoses underlying the mental health impairment classifications would have improved the internal validity of our study and comparability to the literature. Unfortunately, this information was not available. The long follow-up in Paper I was a strength because it increased study power. On the other hand, the study lacked information about potential changes in mental health during the long follow-up period between mental health assessment and outcome. In Paper II, we used a generic diagnostic code for self-poisoning by medication, which covered a range of different substances (T4n). For reasons of patient anonymity, the study lacked information on detailed codes of comorbid psychiatric disorders, the exact dates of hospital admissions, which medications the adolescents took, and their municipality of residence. The inclusion of such information into our analyses could have provided insight into both readmission risk and the sex differentials we found in our study. In Paper III, for example, unmeasured fear of stigma might have impacted the use of health services in urban versus suburban and rural settings to varying degrees (Rost, Smith et al. 1993).

5.2.2. External validity

The thesis included large sample sizes obtained from the national population (Papers I and II) and used a nationally representative sample of adolescents from various geographic areas (Paper III). The use of national data routinely collected by physicians (Paper I and II) further ensured representativeness and measures of associations in a real world setting. Paper I was conducted in a period when military medical screening was compulsory for all Norwegian males, which helped to avoid selection bias. However, Gravseth et al. (2010) found the highest risk of suicide in males who did not attend military screening. To refuse military screening is a crime, which makes it tempting to speculate whether the mental health status of males who refuse differs systematically from those who are willing to attend. However, we do not suspect that these numbers have the power to alter our estimates substantially. Information on mental health and suicide in females was not included in this study because military conscription was not mandatory for females during the study period, thus the study can only be generalized to men.

Regarding Paper II, since all Norwegian citizens are covered by a publicly-funded universal health care system, it is likely that all discovered cases of self-poisoning are admitted to hospital for acute treatment. However, we do not know how many cases do not go to hospital. We included only patients with a principal diagnosis of acute self-poisoning, which could lead to an underestimation of the contribution of self-poisoning listed as a secondary diagnosis. On the other hand, our main aim was to study repeated self-poisoning. Thus the inclusion of patients with other main conditions resulting from self-poisoning, such as respiratory or cardiac distress, could have introduced bias because most of these patients would have their clinical course affected by their primary medical condition. Although self-poisoning with non-medicinal agents, i.e., with pesticides, glue, or other liquid substances, has been reported in adolescents, we did not include these agents (Sulyman, Kim et al. 2013). Indeed, in Western countries most adolescents who are treated in hospitals or emergency rooms/departments overdose on medications; only a small fraction ingest non-medicinal substances (Hawton, Hall et al. 2003). Further, in the ICD-10, self-poisonings with non-medicinal substances and self-poisonings with medications fall into different categories with different coding instructions. Therefore, we limited our analyses to the group of adolescents who were most similar in terms of the substance they ingested, which still constituted the vast majority of adolescent self-poisonings in Norway (and most other Western countries). Paper II cannot be generalized to adolescents who self-harm by methods other than medication

overdose. Nor can it be generalized to adolescents who (repeatedly) ingest medications and do not go to hospital.

In Paper III, efforts were made to avoid selection by using a stratified sample of schools and by providing an opportunity for adolescents who were absent from school the day of the survey to participate at a later date. School truancy has been associated with a range of problematic behaviors and injuries (Buckley, Chapman et al. 2012). However, it is possible that those who had long or frequent absences still missed the survey. This survey likely does not represent adolescents who dropped out of school, had internships, were in vocational training programs, or had other such commitments. Secular trends in mental problems and use of health care services following self-harm among adolescents have been found (Rossow and Wichstrom 2010, von Soest and Wichstrom 2014). Finally, the data in Paper III were collected in 2002, which might limit the representativeness of the youth of 2016.

5.2.3. Validity of the measurements

Suicide

The NCoDR is a virtually complete and accurate register for epidemiologic purposes (Pedersen and Ellingsen 2015), which minimizes the effects of loss to follow-up. However, misclassifications in suicide do occur (Tollefsen, Helweg-Larsen et al. 2015), and a history of a mental disorder might impact on the classification (Palmer, Bennewith et al. 2015).

Mental health assessment

Mental health impairment recorded in the NAFHR was assessed and classified by highly qualified medical doctors, which ensures a high degree of validity in the classification. Recall bias was unlikely. On the other hand, the examination was designed to classify a person's suitability for military training; not to provide a diagnosis for treatment or research. Thus it is possible that assessments of mental health impairment were inaccurate or under-diagnosed (Gale, Batty et al. 2012). If this is the case, the group of males with no mental health impairment might have been spuriously more similar to the groups with minor and major mental health impairment with respect to the outcome.

Self-poisoning

We defined overdose with medications (ICD-10 T4n) as “self-poisoning”. However, from the available data we could not rule out that some cases of poisoning could have been inflicted by other people though the number of such cases was most likely too small to bias our estimates (Hovda, Bjornaas et al. 2008). Furthermore, we included a few cases (n=25) who were coded as accidental poisonings, two of which were later readmitted. More than half of the individuals we included did not receive an E-code for intentionality, thus less than half of the cases were actually denoted as intentional by clinicians. Consequently, we might have included cases of poisoning that did not fit the definition of self-poisoning as the *intentional* ingestion of more than the prescribed dose of any drug. However, we did not find any differences in readmission rates between those who received an E-code for intentional self-harm and those who did not. Results from the United Kingdom suggest that nearly all teenage cases coded as self-poisoning in the ICD-10 system are actually episodes of intentional self-harm whether or not the corresponding E-code is present (Sellar, Goldacre et al. 1990).

Repeated self-poisoning

Patients who had two or more hospital admissions for self-poisoning between 2008 and 2011 were classified as repeaters. We excluded admissions that occurred within the same day or the day after the previous hospital admission, but we cannot rule out the possibility that a small number of patients who were transferred between hospital departments were counted as repeaters. Our figures covered a variable follow-up period of between 1 day and 4 years. An unknown number of patients could have been admitted for self-poisoning before 2008 or repeated self-poisoning after our observation period. Individuals who died or moved out of the country were lost to follow-up. Our figures undoubtedly underestimate the true number of repeaters in this population.

Self-reported use of health care services following self-harm with and without suicide intent

Internal validity was strengthened by similar findings from two measurements of urban versus suburban and rural areas. However, information from self-reports may be subject to inaccuracy, recall bias, and hence misclassification of self-harm with or without suicide intent. We do not know how the responding adolescents may have interpreted the question of whether they had received any help or treatment following self-harm, which may have inflated false-negative and false-positive responses. However, even though the respondents may have under-reported or over-reported the type of self-harm and their subsequent use of

health services, there is no reason to assume that any such bias would differ systematically between adolescents in urban versus suburban and rural areas and thereby contribute to a biased association.

5.3. Implications

This thesis is an empirical observation of adolescents who were in contact with health care services, hence no causal associations can be drawn and all results must be interpreted with caution. However, the three papers in this thesis identify groups of adolescents who are at risk of suicide, recurrent hospitalization, and less service use following self-harm. The findings of these studies can assist policy makers in designing targeted interventions for different groups of self-harming adolescents and may aid clinicians to reach adolescents who are at risk of suicide and repeated self-harm. Future cohort studies, including more detailed clinical information on psychological/behavioral risk factors, psychiatry, and procedures for treatment will be useful to elucidate the mechanisms underlying the risks observed in these studies. Studies that include information on things like the methods and intentions for self-harm, psychiatric diagnoses, and procedures for treatment and measures of accessibility to services in multilevel models will be highly valuable to better understand how the interplay between predisposing characteristics, enabling resources, and need influence the use of health care services following self-harm among adolescents.

6. CONCLUSION

This thesis found that minor and mental health impairment at age 17-19 was associated with an elevated risk of suicide in males. In adolescents who were hospitalized for self-poisoning with medications, the majority was female and most was aged 15-19 years. One-third received a secondary psychiatric diagnosis, and less than half were registered as intentional self-harm. Significant predictors for hospital readmission were female gender, secondary psychiatric diagnoses, and discharge to further treatment. When questioned about the use of health care services following self-harm, few adolescents responded affirmatively. The proportion that did so was higher among those who had reported self-harm with suicide intent than in those who reported self-harm without suicide intent. Among those who reported self-harm without suicide intent, living in rural areas in which there was no hospital was associated with even less service use. These findings may have implications for policy makers, clinicians, and future research.

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