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The role of traumatic life events and macroeconomic fluctuations

Hildur Guðný Ásgeirsdóttir

Thesis for the degree of Philosophiae Doctor

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Sjálfsskaðandi hegðun og sjálfsvíg

Áhrif efnahagssveiflna og annarra streituvaldandi atburða

Hildur Guðný Ásgeirsdóttir

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To all individuals who are fighting through dysphoria to find their will to live, to their support system who strive to help them along the way, and in memory of those, we did not manage to save.

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Ágrip

Bakgrunnur og markmið: Meirihluti einstaklinga upplifir streitu og áföll á ævinni. Streita og áföll hafa í för með sér aukna áhættu á geðröskunum sem geta leitt til alvarlegri útkoma, eins og aukinnar áhættu á sjálfsvígshugsum sjálfsskaða, sjálfsvígstilraunum og sjálfsvígum. Markmið þessarar rannsóknar var að kanna tengsl milli ýmissa persónulegra áfalla á lífsleiðinni og sjálfsskaðandi hegðunar meðal karla og kvenna (rannsókn I). Enn fremur var markmiðið að skoða áhrif samfélagslegs áfalls, nánar tiltekið áhrif efnahagshrunsins á Íslandi árið 2008, á sjálfsskaðandi hegðun og sjálfsvíg (rannsókn II og III).

Efniviður og aðferðir: Rannsókn I byggði á spurningalista úr forrannsókn rannsóknarinnar Heilsusögu Íslendinga (N=1398). Tíðni áfalla voru metin með Life Stressor Checklist-Revised og skilgreiningarviðmið samkvæmt DSM-5 notuð til að skilgreina tegundir áfalla. Tíðni sjálfsskaðandi hegðunar (sjálfsvígshugsun, sjálfsskaði eða sjálfsvígstilraun) var metin og Poisson aðhvarfsgreining notuð til að meta tengsl milli áfalla og sjálfsvígshegðunar. Í rannsóknum II og III voru notaðar upplýsingar um komur á bráðamóttöku og innlagnir á Landspítala vegna sjálfsvígshegðunar (ICD-10: X60-84, X40-49, Y10-34, T36-50, Z91.5) á árunum 2003-2012, auk upplýsinga frá Dánarmeinskrá Embættis Landlæknis um sjálfsvíg á árunum 2002-2014 (ICD-10: X60-84 og Y 84.0). Þá voru upplýsingar um efnahagsvísa á landsvísu fengnar frá Hagstofu Íslands til að meta möguleg áhrif þeirra á sjálfsvígshegðun. Efnahagshrunið var skilgreint út frá dagsetningunni 6.október 2008. Poisson aðhvarfsgreining var notuð til að meta breytingu á tíðni sjálfsvígshegðunar eftir efnahagshrun samanborið við árin fyrir hrun.

Niðurstöður: Alls höfðu 76% þátttakenda upplifað einhvers konar áfall á lífsleiðinni í rannsókn I og 16% karla og 11% kvenna höfðu sögu um sjálfsskaðandi hegðun. Þátttakendur sem höfðu orðið fyrir persónulegum áföllum voru líklegri til að hafa skaðað sig á lífsleiðinni (RR 2.05, 95% CI 1.21-3.75). Þessi tengsl voru sérstaklega sterk meðal karla (RR 3.14, 95% CI 1.25-7.89) en ekki tölfræðilega marktæk meðal kvenna (RR 1.45, 95% CI 0.70-2.99). Þegar áföll sem fólu í sér ofbeldi voru metin, fundust tengsl við sjálfsskaðandi hegðun meðal kvenna og karla, (RR 2.97; 95% CI 1.67-5.67), og þegar áföll sem fólu ekki í sér ofbeldi voru metin, fundust tengsl við sjálfsskaðandi hegðun meðal karla (RR 3.27, 95% CI 1.30-8.25), en ekki kvenna. Rannsóknir II og III sýndu enga breytingu á sjálfsskaðandi hegðun

(RR 0.95, 95% CI 0.90–1.01) eða sjálfsvígum (RR 0.96, 95% CI 0.67- 1.38) eftir efnahagshrun samanborið við fyrir efnahaghrun. Hins vegar sýndu niðurstöður að komur karla vegna sjálfsskaða á Landspítala hefðu náð hápunkti stuttu fyrir efnahagshrun, í hápunkti góðæris. Tengsl voru milli hækkunar á atvinnuleysi og viðskiptajöfnuði eftir efnahagshrun og fækkun koma á Landspítala vegna sjálfsskaðandi hegðunar. Þótt heildaraukning hafi ekki orðið á sjálfsvígum eftir efnahagshrun, sýndi nánari greining að tíðni á sjálfsvígum ógiftra karla (RR 1.31, 95% CI 1.03-1.67) og karla eldri en 65 ára (RR 2.31, 95% CI 1.24-4.57) jókst. Þessi aukning átti sér þó stað þegar liðið var frá efnahagshruninu og var aukningin hjá eldri körlum tengd aukningu vergrar landsframleiðslu og auknum viðskiptajöfnuði.

Ályktun: Niðurstöður styðja fyrri rannsóknir sem sýnt hafa að áföll geti aukið hættu á sjálfsskaðandi hegðun og gefa auk þess til kynna að áhrifin geti verið sterkari fyrir karla en konur. Niðurstöðurnar gefa einnig til kynna að með batnandi efnahag, og aukinni vergri landsframleiðslu, geti áhætta á sjálfsskaðandi hegðun og sjálfvígum aukist, sérstaklega meðal karla. Ólíkt því sem sést hefur í kjölfar efnahagshruna af þeirri stærðargráðu sem Íslendingar upplifðu 2008, þá jókst ekki heildartíðni sjálfsskaðandi hegðunar og sjálfsvíga í kjölfar hrunsins. Hugsanlega hefur félagsleg samheldni og seigla í samfélaginu auk aðgerðaráætlana í sterku velferðarkerfi á Íslandi haft áhrif á þær niðurstöður.

Lykilorð: Áföll, efnhagssveiflur, sjálfsskaði, sjálfsvígstilraunir, sjálfsvíg.

Abstract

Background and aims: Most people experience stressful and traumatic life events during their lifetime. These events increase risks of psychiatric morbidities and disorders which may result in enhanced suicidal risk in vulnerable populations. The overall aim with this study was to explore the association between traumatic and other stressful life events and suicidal behavior among men and women (Study I). As an example of a significant societal stressor, we further aimed to study the potential influence of the 2008 economic collapse in Iceland on population rates of self-harm, suicide attempts (Study II), as well as completed suicides (Study III).

Methods and materials: Study I was built on a pilot phase of the SAGA Cohort (N=1398). Life events were assessed with the Life Stressor Checklist-Revised, and the DSM-5 criterion was used to classify traumatic life events. Reports of lifetime suicidal thoughts, self-harm and suicide attempts were considered as lifetime suicidality. We used Poisson regression and adjusted for demographic factors to calculate relative risks as a measure of the association between traumatic events and suicidal behavior. In studies II and III we used data from two different registries: hospital attendances due to self-harm and suicide attempts during 2003-2012, (containing ICD-10: X60-84, X40-49, Y10-34, T36-50, Z91.5), and data on all suicides from the National Causes of Death Registry in Iceland during 2002-2014 (ICD-10: X60-84 and Y 84.0). With the pre-collapse period as a reference, Poisson regression models were used to compare attendance rates and age-adjusted suicide rates before and after the economic collapse. We furthermore used information from Statistics Iceland on macroeconomic factors including unemployment rate, gross domestic product (GDP) and balance of trade (BoT) during the study period, to evaluate whether the risk of hospital attendances or suicide was associated with changes in the national economy.

Results: In study I, the lifetime prevalence of any traumatic event was 76% and lifetime suicidal behavior was 16% for men and 11% for women. An overall association was observed between having experienced traumatic life events and suicidal behavior (RR 2.05, 95% CI 1.21-3.75): these differences were only statistically significant for men (RR 3.14, 95% CI 1.25-7.89), but not women (RR 1.45, 95% CI 0.70-2.99). Interpersonal trauma was associated with suicidal behavior among both men and women (RR 2.97,

95% CI 1.67-5.67), while non-interpersonal trauma was only associated with suicidal behavior among men (RR 3.27, 95% CI 1.30-8.25). In study II and III, no overall differences were observed in pre-to-post economic collapse rates, neither for hospital attendances (RR 0.95, 95% CI 0.90–1.01) nor suicide rates (RR 0.96, 95% CI 0.67- 1.38). Indeed, hospital attendances for suicide attempts among men were highest in the economic boom. Post-collapse, we observed an increased risk of suicide among single men (RR 1.31, 95% CI 1.03-1.67), and men older than 65 years (RR 2.31, 95% CI 1.24-4.57). While gender-specific analyses by macroeconomic variables showed relatively stable overall attendance rates and suicide rates among women, suicide rates were associated with higher GDP and BoT for men older than 65 years. Also, higher unemployment rates and BoT were associated with reduced self-harm and suicide attempts among men (RR: 0.84, 95% CI 0.76-0.93 and RR: 0.81, 95% CI 0.75-0.88, respectively), but not among women.

Conclusion: The findings of these studies suggest that personal trauma is associated with suicidal behavior, particularly among men. Similarly, our findings indicate that economic fluctuations in Iceland mainly influence suicidal behavior and suicide among subpopulation of men. Contrary to previous findings on economic crises and suicidal behavior, we find higher suicide rates with higher GDP, and a high-point in male self-harm and suicide attempts during an economic boom. Icelandic men seem to be at increased risk for suicidal behavior during a strong economy rather than during a recession.

Keywords: Traumatic life event, Economic fluctuation, Self-harm, Suicide attempt, Suicide.

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Contents

List of abbreviations

DSM-5:	The Diagnostic and Statistical Manual of Mental Disorders, fifth edition
NSSI:	Non-suicidal self-injury
SES:	Socio-economic status
PTSD:	Post-Traumatic Stress Disorder
HPA-axis:	Hypothalamic-Pituitary Adrenal axis
PIN:	Personal Identification Number
GDP:	Gross Domestic Product
SAGA:	Stress and Gene Cohort Study
LUH:	Landspitali National University Hospital
ID-number:	Personal identification numbers
ICD-10:	International Classification of Disease, 10th version
BoT:	Balance of Trade

List of figures

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List of original papers

This thesis is based on the following original publications, which are referred to in the text by their Roman numerals (I-III):

I. **The association between different traumatic life events and suicidality.** Ásgeirsdóttir HG, Valdimarsdóttir UA, Þorsteinsdóttir ÞK, Lund SH, Tómasson G, Nyberg U, Ásgeirsdóttir TL, Hauksdóttir A. (2018) Eur J Psychotraumatol.11;9(1):1510279

II. **Suicide attempts and self-harm during a dramatic national economic transition: a population-based study in Iceland.** Ásgeirsdóttir HG, Ásgeirsdóttir TL, Nyberg U, Thorsteinsdottir TK, Mogensen B, Matthíasson P, Lund SH, Valdimarsdóttir UA, Hauksdóttir A. (2016). Eur J Public Health 1;27(2):339-345.

III. **Suicide rates in Iceland during a period of economic boom, collapse, and recovery. A nation-wide population-based study.** Ásgeirsdóttir HG, Valdimarsdóttir UA, Nyberg U, Tómasson G, Þorsteinsdóttir ÞK, Lund SH, Ásgeirsdóttir TL, Hauksdóttir A. *Submitted manuscript to Int J Epi.*

In addition, some unpublished data is presented.
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Declaration of contribution

The doctoral student, Hildur Guðný Ásgeirsdóttir, wrote this thesis with guidance of her supervisor, advisor and the doctoral committee. In close collaboration with her supervisors, she planned and conducted the research work for studies I, II and III as well as applying for the appropriate ethical and research approvals. She obtained the relevant data and conducted statistical analysis in cooperation with a statistician. Interpretation and conclusions were drawn in close cooperation with her supervisor, advisor and statistician. Hildur drafted all manuscripts and responded to comments and guidance from co-authors and reviewers.

1 Introduction

1.1 Suicidal behavior

Suicide has in recent years been increasingly recognized as a major public health threat. Each death entails a tragedy for family and friends, health professionals and the community - the emotional and societal consequences are extensive. Globally, over 800.000 individuals die due to suicide each year,[1] resulting in a death in every 40 seconds that often could have been prevented. With increasing understanding of suicide risk factors and various community preventive strategies aimed at reducing suicide risk,[2,3] global rates have declined in recent years.[4] However, even though rates have declined in some countries,[5] in others, suicide rates remain unchanged or have even continued to rise, despite preventive efforts.[1,4,6]

Suicidal behavior encompasses suicidal thoughts and active efforts; non-fatal and fatal. The term suicidality has been used to contain non-fatal measures; suicidal ideation, suicidal self-harm and suicide attempts.[7-9] After decades of abundant research, the underlying causes of suicidal behavior are still not fully understood. Continuing research to advance current knowledge is therefore imperative. With a lifetime prevalence of 12-20%,[10-12] the most important risk factor of suicide has been found to be preceding suicidality;[12-15] i.e. suicidal thoughts, self-harm, and suicide attempts.[16] This thesis will focus on suicidal behavior epidemiology, potentially, gender specific risk factors. Specifically, the focus will be on the role of stressful and traumatic life events.

1.1.1 Suicidal ideation

Suicidal ideation is defined as thoughts of ending one´s own life without taking any active efforts to do so. These thoughts can include deciding on a specific method, or even a plan of action. Studies have shown a 9% lifetime prevalence of suicidal ideation.[12] Women more frequently report suicidal ideation than men[17,18] and the prevalence has shown to be highest among adolescents and young adults.[10,19] Although individuals with suicidal thoughts most often do not act on their thoughts, having them increases suicide risk – especially if a plan is included and the intent is strong.[20-22] Suicide prevention is therefore complicated by the fact that it remains difficult to determine individuals or groups that transition from suicidal ideation to active efforts.[23,24]

1.1.2 Self-harm and suicide attempt

Self-harm has been described as an act to relieve psychological pain and distress with intentional, direct injuring of body tissue.[25] Other potentially harmful behaviors, such as reckless driving or destructive behavior such as alcohol and drug abuse have been described as indirect self-harm.[26-28] Harming oneself can occur with or without suicidal intention[29,30] and therefore different terms have been used to describe self-harm. According to The Diagnostic and Statistical Manual of Mental Disorders (DSM-5), non-suicidal self-injury (NSSI) constitutes the act of intentional self-distraction to own body tissue without suicidal intent, e.g. cutting, burning and self-hitting. Another term is deliberate self-harm, often used to describe self-harm with suicidal intent.[29,31] These two types of self-harm may include differences in etiology. Among younger individuals, results are contradictive. Studies have indicated that nearly half report suicidal intent when engaging in self-harm,[28,32] but even after engaging in near-fatal self-harm, only around two thirds may report that the act was associated with suicidal thoughts.[32] Among older individuals, self-harm has been shown to be frequently associated with suicidal intent.[33] Although not always fueled by suicidal intent, self-harm should always be considered a marker for extreme psychological suffering.

The general demographic profile of individuals who self-harm is different from the profile of individuals who have died by suicide. Women have been found to be more likely to engage in self-harm than men,[26] and the prevalence has been shown to be higher among younger than older individuals - especially high among both gender during adolescence.[25,26] Studies have found a self-harm prevalence of 3-6% in the general population[12,34,35], and as high as 17-18% among adolescents,[31,36] or 5-9% when asked about self-harm during previous 12 months.[37,38] Self-harm can be a strong predictor for suicide attempts and suicide,[26,39-41] especially if frequently repeated. Especially, suicide risk after self-harm has been found to be high among older individuals, when self-harm is conducted with suicidal intent or when methods used are highly lethal.[42]

Self-harm with suicidal intent most commonly includes self-poisoning with overdoses,[43] which in fact may be characterized as a suicide attempt. Estimating the degree of suicidal intent can be complicated, since non-suicidal and suicidal self-harm may overlap.[44] Therefore, the term self-harm is commonly used with the inclusion of suicide attempts.

Suicide attempts are self-injurious acts with the intent to end ones own life yet does not result in death. A lifetime prevalence of suicide attempts in the general population of suicide attempts is 3-7%.[12,45] For each completed

suicide, a previous suicide attempt is more than twenty times more frequent, and hospital attendance globally due to suicide attempts are estimated to be 16.000.000 each year.[1] Similar to suicidal thoughts and self-harm, women have been found to be at higher risk of suicide attempts than men.[12] Furthermore, individuals who have once attempted suicide, are at lifelong increased risk of dying by suicide.[46] Individuals with a history of suicide attemptsneed therefore to be monitored closely by their social environment and health care. Knowledge is still scarce on protective factors for proceeding to suicde after first suicide attempt.

1.1.3 Suicide

Out of all causes of death worldwide, 1.5% are due to suicide. The global mortality rate is 11 per 100.000 inhabitants,[1] suicide rate has declined from 12.3 suicides per 100.000 in 2005 to 11.5 per 100.000 in 2010. Even though rates are slowly declining on a global level, they still remain unchanged or even rising in some populations.[1,4,6] Rates may vary greatly between countries, between regions of countries (e.g. higher in rural than urban areas in China,[47] the US,[48] and Australia[49]) and even between ethnic groups living in the same regions.[4,21] In some cases, the varying rates may however be due to a difference in suicide registration and data quality between countries. The greatest burden of suicide is in developing countries, with around 80% of all suicides globally occurring in low- and middle-income countries. Suicide rates are much higher among men than women (global rates 15 per 100.000 for men and eight per 100.000 for women). The male-female ratio is, however, higher in high-income countries than low-income countries (2:1 in Western Europe and 4:1 the US), while not as high in Asian Pacific countries. Women´s rates have even been found to be even higher than men´s in parts of China.[1,50] Globally, the prevalence of suicide is highest among older individuals, although global rates have in recent years been declining for individuals older than 65 years of age. In high-income countries, suicide rates are highest among middle-aged and older men.[1] On the other hand, suicide is also a serious global problem among younger individuals and is the second leading cause of death among individuals aged 19-25 years old.[4,29,50]

1.1.4 Etiology and risk factors of suicidal behavior

Even though the etiology of suicidal behavior is not well understood, the main risk factors have been thoroughly documented. In fact, since the knowledge on suicidal risk factors has increased markedly during recent decades, it is currently recognized that the risk can be modulated by numerous factors at

both individual and societal levels. This has been described in several framework models[21,23,51] that have been developed to increase the understanding of the concurrent factors in the suicidal process. In Figure 1, a number of possible individual- and social risk factors are illustrated. Firstly, psychopathology is the strongest individual risk factor for suicidal behavior.[52,53] For completed suicide, psychological autopsy studies (i.e. when information about the deceased individual is collected via interviews with loved ones and from available health records)[54] indicate that roughly 90% of all suicides are associated with a previous psychiatric disorder.[55] Various psychiatric disorders are well known to increase the risk of suicide, such as major depressive disorder, bipolar disorder, schizophrenia, personality- and substance-related disorders, as well as comorbidity between these.[16,21,54,56] Likewise, studies have shown that a majority of individuals who have self-harmed or attempted suicide had a history of psychiatric disorder,[57] while on the other hand, individuals who report suicidal ideation are not more likely (than those without such ideation) to report prior history of psychiatric disorder.[58] Gender differences in patterns of psychiatric disorders have been described. Men are more likely than women to have substance use disorders, personality disorders, attention deficit hyperactivity disorder (ADHD), and antisocial disorders.[59,60] These disorders are known to heighten men´s suicide risk, in part due to the associated features that are more prevalent in men, such as aggressiveness, hostility and impulsivity.[61] On the other hand, women have a higher prevalence of major depressive and anxiety disorders,[60,62] that are also known to heighten suicide risk.

A number of risk factors have been described as precipitating or proximal factors; individual risk factors that may affect the process involving psychopathology, suicidal ideation, and suicide.[21,23] These factors are for example behavioral factors (such as alcohol, substance use and social isolation), cognitive and psychological factors (such as feelings of hopelessness and entrapment), or personality related (such as aggressive and impulsive traits).[50,63] Other societal and individual risk factors are also important, such as socio-economic status, educational level, marital- and employment status.[50,63] Compared to the general population, suicide rates are higher among vulnerable groups such as individuals with chronic illness or chronic pain,[64] and among groups at risk of experiencing discrimination and exclusion, such as gay, bisexual, transgender and intersex individuals (GBTI)[65] and second generation immigrants.[66] Also, suicide rates are higher among individuals with a history of suicidal behavior in their close social network.[21,50] Still, a combination of lack of awareness, lack of help-seeking

due to social stigma or cultural differences, and limited access to lethal means (e.g. guns) may vary greatly between societies and populations, thereby applying various individual risk effect.

Some individual factors that may have different effects on suicidal outcomes have been described as predisposing or sometimes called distal factors. For example, predisposing risk factors for suicidality (i.e. suicidal ideation, self-harm, and suicide attempts) include young age and female sex, while conversely, predisposing factors for suicide include older age and male sex.[67] The gender difference in suicidal behavior (higher rates of non-fatal suicidal behavior among women and higher suicide rates among men) is often described as the "gender paradox".[68] Men choose methods with higher lethality,[69] while women have a higher prevalence of self-harm and suicide attempts as well as higher depression rates, which are known risk factors for completed suicide.[17]

Possible predisposing factors also include a family history of suicidal behavior,[50] and studies have found that the increased family risk may be linked to heritability.[70,71] However, despite increasing genomewide association studies performed in recent years,[72] researchers have not been able to identify specific genetic variants associated with suicidal risk.[73] Other predisposing factors include neurobiological vulnerability factors, such as serotonergic neurotransmission dysfunction, possibly due to variations in serotonin transmission and receptor genes.[74] Researchers have speculated whether these genetic variations may be affected by acute or chronic stressors, thereby increasing the risk of suicidal behavior and suicide through epigenetic regulation of gene expression,[74] but this theory needs further investigation.

In summary, even though causality of suicidal behavior is not yet fully understood, existing research has led to a better understanding of the interaction of contributory factors as well as awareness of potentially important precipitating factors in suicidal risk. In recent years, knowledge about the role of stressful and traumatic life events in suicide risk has increased substantially.

1.2 The role of trauma and other stressful life events

Although suicidal behavior is never solely a consequence of a single stressor, a large body of evidence has indicated that stress in various forms is an important determinant of psychopathology.[75-77] Furthermore, some suicidal risk factors, such as unemployment, low socioeconomic status, and having a mental disorder, are furthermore associated with psychological stress. Thus,

a stress-diathesis model is often included in contemporary models of suicide, acknowledging that predisposing vulnerable factors can be pronounced with life events or stress and thereby affecting suicidal behavior risk [63,78] (Figure 1).

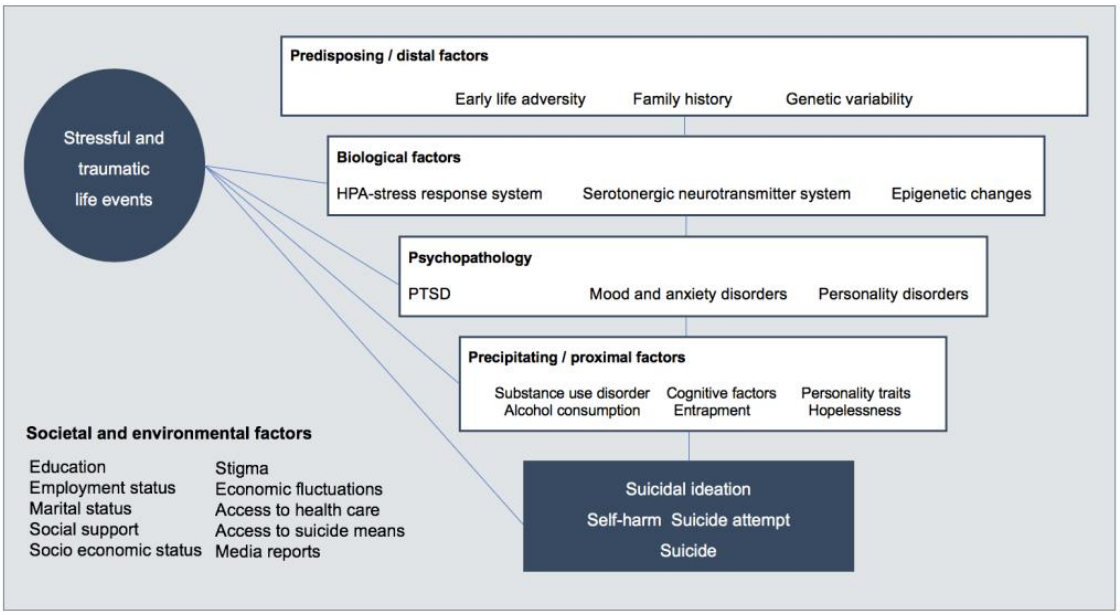


Figure 1: Individual and social risk factors for suicidal behavior and the possible effect of stressful and traumatic life events

1.2.1 The biological effects of stress

In the 1930s, Hans Selye first defined stress as a coordinated physical reaction to any form of detrimental stimulus in life.[79] The body´s reaction to stress is regulated through the hypothalamic-pituitary-adrenal (HPA) axis. When individuals are exposed to a stressful stimuli, the HPA-axis activates the release of the stress hormone cortisol, which causes the body to react and evoke the “fight or flight” response, for example by raising heart rate and blood pressure.[80] When the individual has reacted to the stressful stimuli, the stress system is designed to recover by inhibiting cortisol release, and making neurotransmittor activity go back to baseline. However, when individuals repeatedly experience extreme stress (e.g. war, domestic violence, abuse), the HPA-axis becomes hyperactive - resulting in increased cortisol output and excessive amounts of the hormone in the body´s tissues. Over time, this process, described by Bruce McEwen and coworkers as allostatic load,[81] may result in detrimental health consequences. A large body of evidence has recognized psychological stress to be associated with increased risk of various physical health outcomes, such as cancer,[82,83] cardiovascular disease,[84] chronic pain development,[85] and autoimmune

diseases,[86] possibly explained by these means. Constant cortisol secretion due to chronic stressors have furthermore been linked to major depression disorder.[87]

Based on this knowledge, researchers have aimed to understand the role of cortisol in suicidal behavior. Among individuals with mood disorders, dysregulation of the HPA-axis and the inability to suppress cortisol secretion, has been associated with a fourfold increase in suicide risk.[88,89] On the other hand, some studies have found that the risk of suicidal behavior may increase when HPA-axis regulation is blunted, due to a late response and later adaption to stressful stimuli.[90] Studies also show that individuals who have a history of suicide attempt, or a family history of suicide attempt, have lower cortisol levels than individuals without such a history.[91] These seemingly inconsistent results may be due to an individual variation of epigenetic stress regulation,[92] and therefore possibly explain why stress response may increase vulnerability to suicidal behavior in some, but not others.[92] Age may also play a role in this. In a recent meta-analysis, O´Connor et al.[93] found that the association of high HPA-axis activity and suicide attempts was positive for individuals younger than 40 years of age while among individuals older than 40 years of age, suicide attempts were associated with lower cortisol levels.

Taken together, life events that significantly increase psychological stress may induce unfavorable effects of the stress-response activity, possibly resulting in increased risk of suicidal behavior. Yet, the divergent findings on the interplay between risk factors (e.g. age and gender) and varying physiologic effects on suicide risk call for further studies on how different stressful life events may affect risk of suicide through miscellaneous biologic pathways.

1.2.2 Traumatic life events and suicidal behavior

The description and classification of trauma - an extreme form of psychological stress experienced due to an adverse event - has changed substantially since its first implications were described by Sigmund Freud and Pierre Janet in the 19th century. With advancing research on the effects of trauma, the definition of what constitutes as traumatic event has become more inclusive with every publication of the Diagnostic and Statistical Manual for Mental Disorders (DSM). According to the most recent DSM-5 definition from 2013,[94] trauma is defined as exposure to actual or threatened death, serious injury and/or sexual violence by either: I) Direct exposure to the event, II) Witnessing the event happening to others, III) Learning that the

event has happened to a loved one, or IV) Repeatedly being exposed to details of such events. This definition emphasizes the importance of direct exposure of the event (not through other means, e.g. media) and actual or threatened death must furthermore have happened in a sudden manner, either in a violent or accidental way.

A majority of individuals will experience a traumatic event in their lifetime.[95-97] Results from the WHO World Mental Health surveys in 24 low- to high-income countries, for example indicated that 31% of the population had experienced a sudden death of a loved one, 7.5% had experienced a natural disaster, 8% had been physically abused during childhood, and 3% had been raped.[95] While psychiatric reactions are common following such events, they may vary substantially between population groups and type of traumatic event. Post-Traumatic Stress Disorder (PTSD) is one of the most detrimental mental health problems following traumatic life events.[95] About one third will experience PTSD following trauma,[95] and PTSD has been linked to suicidal behavior.[8,98,99] Women are more frequently diagnosed with PTSD after trauma than men,[100] and some types of events, such as interpersonal violence and an unexpected loss of a loved one, may be more likely to trigger PTSD than others.[95,101,102] Although the symptoms will usually decline or disappear after three to six months, a minority may experience symptoms for years.[103] In addition to PTSD, traumatic life events may also increase the risk of depression, anxiety and physical problems such as chronic pain;[104,105] all factors that have been shown to be associated with suicidal behavior.

In summary, even though the majority will recover after a traumatic life event, others may continue to suffer from different physical and mental morbidities, even to the point of increased suicidal risk.[106] Studies have found heightened risk of suicidal behavior following events such as childhood abuse,[107] losing a loved one,[108] and receiving a diagnosis of a serious disease, e.g. cancer.[108,109] The knowledge is however still limited on why some types of events are associated with suicidal behavior.[110] Taken together, even though trauma has been shown to be a risk factor in suicidal behavior, the effect of different kinds of trauma on suicidal behavior, with regard to individual factors such as age and gender, warrants further study.

1.2.3 Stressful life events and suicidal behavior

Previous research indicates that stressful life events that do not meet the DSM-5 definition of trauma may also have negative effects on health. Such stressful life events have been associated with increased risk of both psychological[75-77] and physical outcomes,[108,111] and may also increase the

risk of suicidal behavior.[106] For example, those who have lost a loved one are at increased risk for both suicide attempts and suicide.[109,112] In addition, a study on the effect of receiving a cancer diagnosis observed a large increase in suicides following the diagnosis of most types of cancer.[108]

In contrast, less is known about stressful life events that affect society as a whole, sometimes referred to as societal trauma. In 1897, the French sociologist Durkheim distinguished the social factor from the psychological one by acknowledging that social factors affecting the whole population are one of the most important markers of suicide risk.[113] Since then, several studies have supported this theory, discovering that societal changes and events can increase suicidal behavior. For example, when changes in a traditional social structure occur, increases in suicide rates have repeatedly been found among natives.[114] Furthermore, higher suicide rates have been observed following events affecting society as a whole, such as war,[115,116] natural disasters,[77,117] and even the death of a famous individual in the society.[118] Another example of societal stress, that may affect the lives of an exposed population as a whole, are macroeconomic fluctuations.

1.3 The 2008 Great Recession as a stressful life event

The economic cycle comprises natural fluctuations in the macroeconomy, growing and contracting due to changes in business conditions. In a growing economy, business is blooming with a subsequent production and service, economic growth, often resulting in increased labor supply and a lower unemployment rate. For various reasons, the economy may contract suddenly, even to the point of collapsing, with a sudden financial downturn. Such a sudden financial downturn is often characterized by a decrease in GDP, lower income, an increase in the unemployment rate and individual financial difficulties. The largest economic downturn since the Great Depression in the 1930´s occurred in 2008. Because of its size and widespread effect it has been termed The Great Recession (world's economic crisis); a global economic crisis that in a matter of months affected the economy, housing market, and employment worldwide.[119] Such major macroeconomic changes may be dramatic to the extent that they can be regarded as a societal trauma. The influence of the Great Recession varied on different countries, ranging from minimal impact, e.g. in Sweden and Australia, to a more extreme impact, e.g. in the United States, Ireland, Greece, Italy – and Iceland.

1.3.1 Health effects of macroeconomic fluctations

Studies have shown that an individual´s financial status may affect health. For example, being unemployed has been linked to a 63% higher risk of all-cause mortality in comparison with not having experienced unemployment, even after adjusting for health behavior following unemployment.[120] Also, socioeconomic status (SES) has been found to be a strong indicator for cardiac and vascular health, with low SES increasing risk for heart disease[121] and type 2 diabetes.[122] Despite this, the effect of macroeconomic conditions on population health is not clear-cut. Although one might believe that health improves in booms and worsens during economic crises, the evidence implies a more complicated picture. Studies have found that all-cause mortality, especially accidental deaths, may decrease during hard economic times[123,124] and Ruhm et al. have shown that modifications in lifestyle, such as decreased smoking and alcohol consumption, possibly due to lower income, may balance possible negative health effects.[125-127] In this study, we will focus on mental health outcomes, or more specifically the most extreme mental health outcome – suicidal behavior.

1.3.2 Self-harm and suicide attempt

Researchers have previously argued that economic recessions may have a negative impact on mental health.[128-130] Epidemiological studies on an individual level have shown that circumstances such as job loss and job insecurity may affect mental health,[131-135] but also societal factors, such as labor market insecurity and raised cost of living.[129,136] The 2008 Great Recession seems to have had effects on mental health outcome in some countries, with an increase in psychiatric disorders,[128,137,138] substance use disorders,[129] and psychotropic drug intake;[139] all factors known to increase risk of suicidal behavior. An adapted model fram Haw et al.[140] (figure 2) describes how economic recession can affect societal and individual factors, and the possible mechanism of increased suicidal behavior.

Along with mental health deterioration following the 2008 economic recession, studies have also found an increase in self-harm and suicide attempts.[141,142] The risk of mental health morbidities during an economic recession varies substantially between economic crises, countries and population subgroups. The rise after the 2008 recession has been most distinct in countries that were severely affected by the economic crisis and where societies were forced to implement austerity measures, such as in Ireland,[143] and Greece, where suicide attempts peaked in 2012 and still remained high in 2015.[144] The variation is exemplified by a study on the

Finnish 1990´s economic recession, where a decrease in suicide attempts, especially for men[145] were found even though studies reported increased incidence of psychiatric disorders.[146] Thus, the added stress associated with financial insecurity may especially affect the mental health and suicidal outcomes of vulnerable groups.[141,147] In a qualitative study, Barnes et al.[148] asked participants about the trigger of their self-harm during an economic recession, and found that while most had a previous history of adverse life events, the added effect of job loss, welfare benefit changes, and severe financial difficulty had affected their engagement in self-harm. Similarly, Hawton et al. found that among individuals who harmed themselves, reported problems with financial status, housing debt, and job insecurity increased during the years 2008-2010 compared to before the recession.[149] Employment problems[38] and rate may be one of the most important factors in that regard, with heightened self-harm and suicide attempt occurrence linked with rising unemployment rates.[149] However, this can vary between men and women. A Greek study, for example, found a 36% increase in suicide attempts between 2009 and 2011, with a significant risk for men ($p<0.001$), but not women ($p=0.165$).

1.3.3 Suicide

Even though results have differed for all-cause mortality in prior studies, many have found a heightened suicide risk following economic downturns.[150] Following the 2008 Great Recession, similar results have been shown. One year into the recession, suicides were already higher than expected in 27 European and 18 American countries.[151] Since then, evidence has accumulated, indicating a general increase in suicide rates associated with the Great Recession,[152-157] although the effect might vary between countries.[158-160] Especially, a heightened level of unemployment rate has been linked with increased suicide rates,[152,159,161] even indicating that the increase in suicide rates were highest in countries with the most pronounced unemployment rates during the recession.[159,162] Yet, a direct causal relationship between unemployment rate and suicide rate during the recession has not been established.[159,163] A study by Stuckler et al. on suicide rates in 26 European countries during economic crises indicated that investing in active labor market programs can counteract an increase in suicide risk despite a high level of unemployment.[158]

Job-related stress probably affects subgroups of populations differently. The link between unemployment rate and suicide rates has been found to be especially strong among younger and working-age individuals.[152,154,161] For

example, in a study on an episode of mass unemployment, an increase of 3% or more in unemployment per year was associated with a 4.5% rise in age-standardized suicide rates, with the largest relative increase in suicide being confined to younger populations.[158] Furthermore, income inequality has been indicated to be a significant mechanism behind fluctuating suicide rates,[164,165] and has been associated with increased suicide rates among older men especially during an economic recession.[166]

The majority of available research further seems to indicate males to be more affected by increased suicide risk than females during an economic recession, especially younger men.[162,167,168] Some studies have found increased risk of suicide among females following economic downturn,[167,169] while other have found women´s suicide rates to be unaffected or even decreased.[156,170,171]

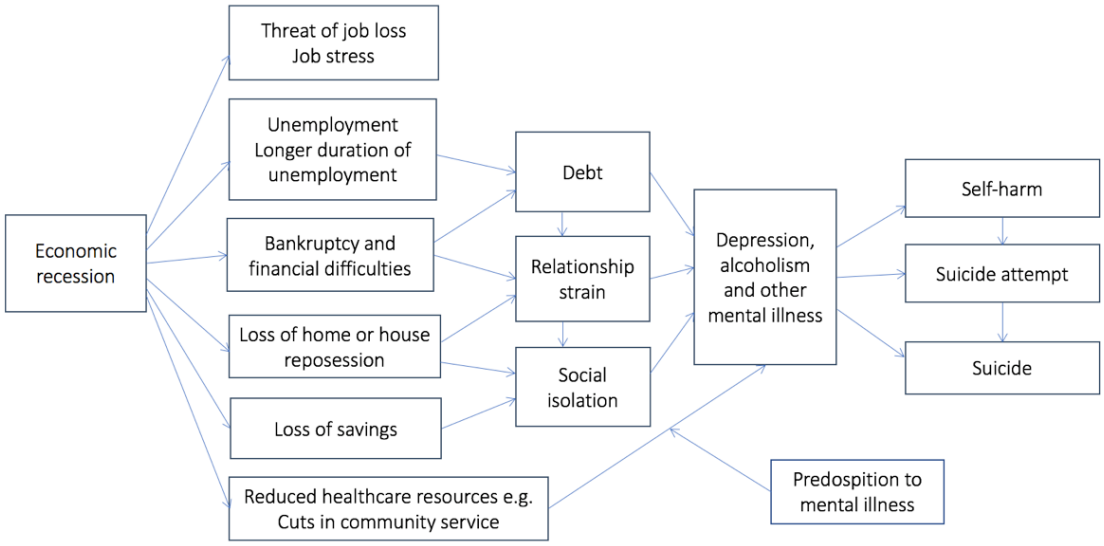


Figure 2: Possible mechanisms linking economic recession to suicidal behavior. An adapted model from Haw et al. 2014

1.4 The case of Iceland

Iceland is one of the Nordic countries with a population of roughly 340 thousand inhabitants. Around 65% of Iceland´s inhabitants live in the capital Reykjavík, and surrounding towns in the southwest of Iceland. The rest of the country is sparsely populated with villages and rural areas, mainly in coastal areas. The health care system is mainly financed through general taxation.

The Icelandic social insurance system covers health insurance when medical help is needed, for all individuals who have lived in the country for a minimum of six months. Every individual with legal residence in Iceland has a personal identification number (PIN) and all personal and health related data are recorded on this unique PIN. Iceland spent 8.4 per cent of GDP on health care in 2012 which is less than other Nordic countries per capita.[172] Still, Iceland has a strong health care system, as shown in a recent research on access and quality of health care, where Iceland ranked as the best country in the world.[173]

1.4.1 Suicidal behavior

With a strong health care system, Iceland has aimed to reduce suicide rates for a while, for example with a launched national protective plan against depression in 2003 and suicide prevention plan in 2018.[174] Yet, similar to other countries, suicide rates are still considered to be unacceptably high. In 2016, the suicide rate in Iceland was 14 per 100.000 individuals (22.3 per 100.000 for men and 5.6 per 100.000 for women). The rate is higher than the global average rates (10.5 per 100.000) and a little below European average rates (15.4 per 100.000). In comparison to other Nordic countries, the rate in Iceland is similar to Sweden (14.8 per 100.000), and lower than in Finland (15.9 per 100.000).[4,175] The suicide rate has remained stable around 10-14 per 100.000 individuals during the last decades, excluding a peak of 16.2 suicides per 100.000 individuals in 2000. Similar to other Nordic countries, suicide rates are higher among men than women, although this gender difference is higher (with higher rates among men) in Iceland and Finland than Sweden, Denmark and Norway.[4] Less is known about the prevalence of self-harm and suicide attempts in Iceland. Previous research has investigated hospital attendance due to poisoning. A study conducted in 2002 found 2.88 cases of poisoning per 1.000 inhabitants,[176] and same authors found in a prospective study in 2017 that the incidence rate was similar 11 years later, or 3.05 per 1.000 in habitants.[177] Another study indicated that hospital attendances due to paracetamol overdose decreased from 30 per 100.000 in 2004 to 16 per 100.000 in 2009.[178] An Icelandic study on suicide risk among individuals who had attended the emergency department of Landspitali University Hospital, indicated that those who had received a diagnosis of a psychiatric disorder, alcohol or drug intoxication, were found to be at increased risk of later suicide, including fatal poisoning.[179]

Icelandic studies on suicidal behavior have mainly focused on self-harm and attempted suicides among adolescents.[180,181] In 2013, an Icelandic self-

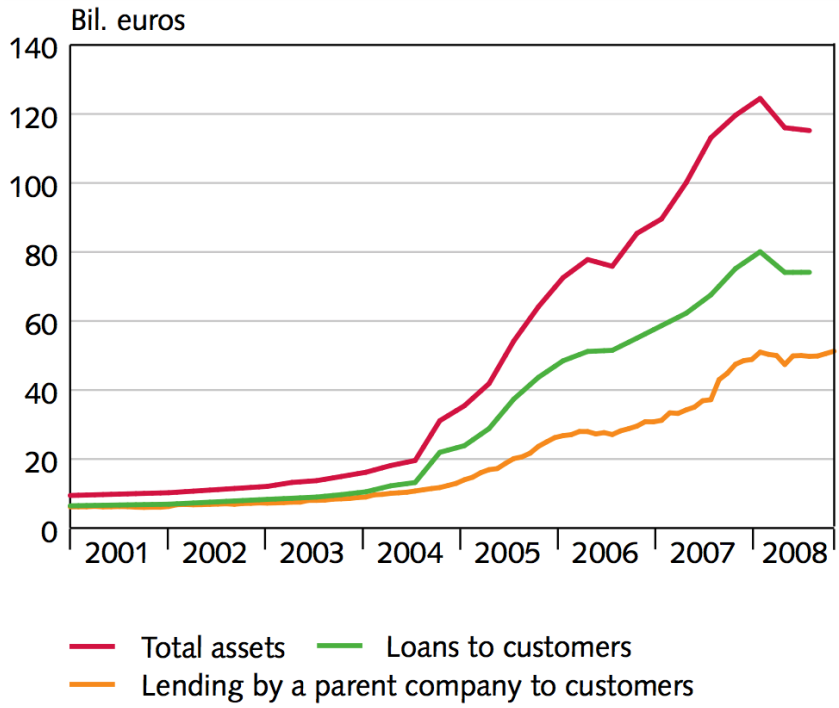
assessed questionnaire study found that among adolescents aged 16-19 years, 10% of girls and 7% of boys reported having attempted suicide.[181] As the suicide rates among the youngest individuals have risen worldwide, there is great concern regarding the mental health of this age-group in Iceland as in other countries. A report from the Directorate of Health in Iceland, conducted in 2018, on self-assessed psychological morbidity among college students, found that self-harm among Icelandic female students had increased during the last years, with currently 13% reporting at least five self-harming episodes during their lifetime. Moreover, 12% of female students and 7% of male students had attempted suicide. A number of students reported that an individual close to them had attempted suicide (40% of female students and 26% of male students), which was found to be among the strongest risk factors for having attempted suicide. Other risk factors were if individuals had scored high in on self-reported depression and anger and had reported history of sexual abuse, low parental support, and substance abuse. Not being heterosexual and having another country of origin than Iceland further increased the risk of suicide attempt.[182] A literature review did not identify other studies on adult´s self-harm or suicide attempts in Iceland.

1.4.2 Trauma, stress and health

Knowledge on the overall prevalence of traumatic life events in Iceland is limited. Studies have however investigated specific traumatic events such as natural disasters and interpersonal trauma. Findings from these research include various health effects, such as increased distress, psychological reactions, and PTSD symptoms, following major earthquakes,[183,184] volcanic eruptions,[185] and catastrophic snow avalanches.[96] Studies have also found indications of an increased risk of mental health morbidity following interpersonal trauma in Iceland, such as interpersonal violence[186] and childhood sexual abuse.[187] In an Icelandic annual report on victims seeking help at a counseling and information center for survivors of sexual violence in 2013-2017 (280-380 individuals seek help each year), 20-24% reported at least one suicide attempt.[188] A history of sexual abuse and family violence has also been associated with an increased risk of substance use, self-injury, and suicide attempts among 16-19 year-old Icelandic students.[180] To our knowledge, no studies have investigated the association of different types of traumatic life events and suicidal behavior in Iceland.

1.4.3 The economic collapse in Iceland as a stressful life event

Iceland was hit especially hard by the Great Recession in 2008. The months and years leading up to this can be characterized by an economic boom. After the privatization of the Icelandic banking sector in 2003, it expanded internationally and became a popular investment place due to high interest rates, a stable political environment, and good sovereign ratings. With free capital flow in a small economy, the country´s balance sheet grew rapidly and the lending and issued bonds during those years resulted in a banking sector that was four times the size of the country´s GDP.[189] The increase in the aggregate size of the three biggest banks is presented in Figure 3.[190]



Reference: The Central Bank of Iceland, Glitnir banki hf, Kaupþing banki l and Landsbanki Íslands hf.

Figure 3: Aggregate size of Iceland´s three biggest banks during the years 2001-2008

In addition to the dramatically expanded banking sector, the country´s annual GDP growth was over 6% (Figure 4). Unsustainable imports and level of consumption of international products were much higher than the level of local production. This resulted in a rapid growth of macroeconomic imbalance and a trade deficit.[189] Quarterly information of the country´s Balance of Trade during these years is presented in Figure 5 (see detailed information on Balande of Trade in 3.2.5). When the global economic crisis set in, it affected

the world credit´s market and the prices of investments of the Icelandic banks (which had now become international investment banks) fell rapidly. As a consequence, in October 2008, the Icelandic economy collapsed. On October 6th, the Prime Minister of Iceland announced to the nation in a live television broadcast, that the banking sector was in a dangerous situation, and that despite government efforts to improve the situation, there was a real threat of national bankruptcy. He ended his speech with the ominous words "God bless Iceland".[191] Many Icelanders remember this moment as the beginning of a new way of living.

Within a week from October 6th, the country´s banking system had fallen and three of the largest banks had been nationalized. The Icelandic króna lost 40% of its value, resulting in a severe currency crisisand a large increase in national debts.[189] The Central Bank increased their interest rate, resulting in inflation, increase in household debts and decreased consumer spending.

For individuals working in the economic and banking sector, suspicion of this threat had possibly already risen, with worldwide changes occurring in the financial market. For the majority of Icelanders however, the news was unexpected, and for some even experienced as traumatic. The following days and weeks after the revelation of the critical situation were filled with unsecurity and worries for a majority of the population. Furthermore, the general public learned that the rapid growth of the bank´s balance sheets had reached far out of their control, and that one of the reasons for the lending portfolios size had been the banking sector's belief that it would receive sovereign support in time of crisis. Anger towards authorities and accusations of corruption and lack of surveillance therefore became apparent and increased in the weeks and months following the collapse. A common fear was that due to negligence of the authorities, the consequences of the economic collapse would land on the population.

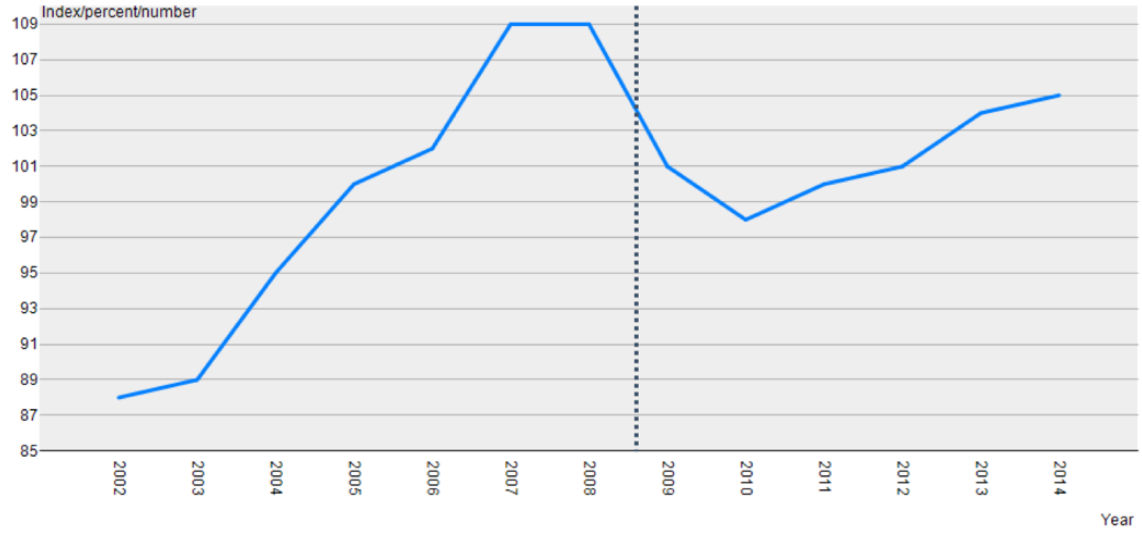


Figure 4: Gross Domestic Product in Iceland during the years 2002-2014.
The dotted line represents the economic collapse in October 2008

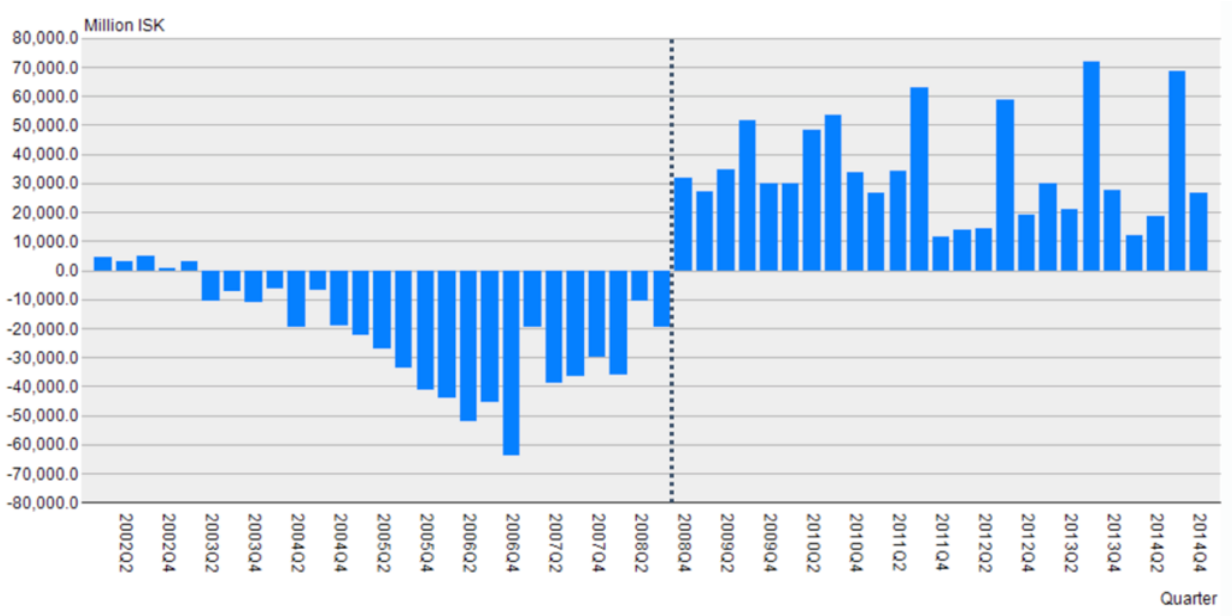


Figure 5: Balance of Trade in Iceland during the years 2002-2014.
The dotted line represents the economic collapse in October 2008

During the four months following the collapse, roughly 10% of the population participated in demonstrations protesting against the government and banking system actions. Those demonstrations resulted in the resignation of the government in January 2009 and new elections in April 2009.
The Icelandic recession was in many ways different to other crises. Despite these dramatic economic changes and the size of the collapse, the Icelandic economy recovered fast.[136] Already in 2011, GDP started rising again (Figure 4), and even though unemployment rates had more than doubled (from 2% to 9%), it balanced back to 5% in 2014.[192] (See Figure 6)

This was in part due to the fact that the devaluation of the country´s currency enhanced exports and encouraged travelers to visit now less expensive Iceland. Consequently, tourism has now become one of the country´s largest income factors.

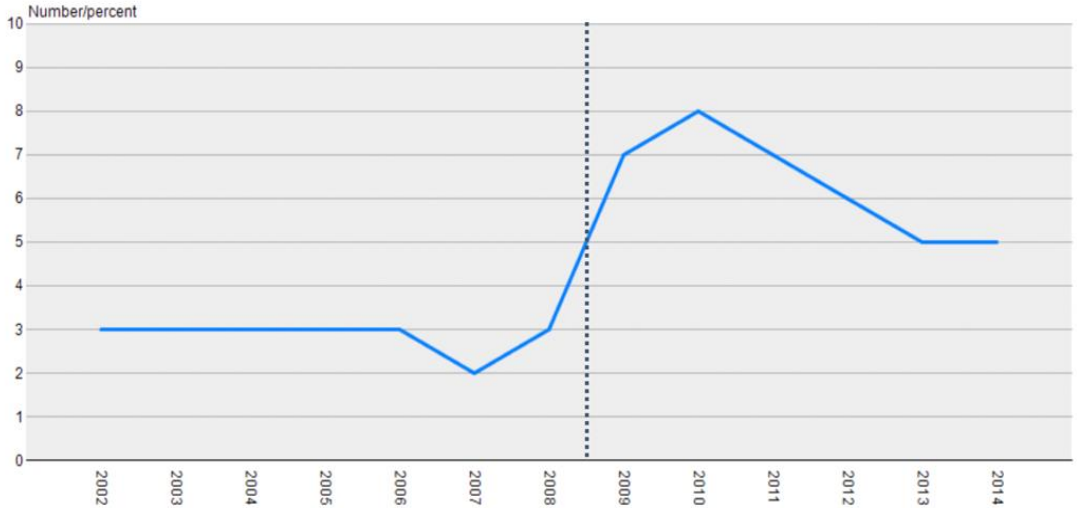


Figure 6: Unemployment rate in Iceland during the years 2002-2014.
The dotted line represents the economic collapse in October 2008

1.4.4 Health effects in Iceland

To date, several studies on health effects following the economic collapse in Iceland have been performed. Two of these found an increased risk of depressive symptoms among both genders and an increase in high-stress levels among women[193,194] in 2009, compared to 2007. Among the many individuals who lost their job in the financial sector, women more frequently reported being shocked by the lay-off and were more likely to experience financial stress than men.[195] A study on cardiac emergency department attendance during a 10 week period around the collapse found an immediate 40% increase in female attendance during the week of the collapse, while

male attendance seemed less affected.[196] Furthermore, Eiriksdottir et al. found that compared to the years before the economic collapse (2005-2008), the risk of hypertension and use of betablockers during pregnancy increased throughout the first year following the collapse, but not in the subsequent years.[197] They also found a risk of low birth weight, indicating reduced fetal growth rate, possibly due to increased stress.[198] It can thus be said that the first Icelandic studies found a certain female stress-effect, not observed at the same level for men.

However, some studies have shown higher risk of negative health effects among men as well. Compared to pre-collapse, Asgeirsdottir et al. showed an increased risk of hypertension among men post-collapse[136] and a delayed effect for women.[199] Also, the adverse health effects of the collapse were more pronounced among lower-income individuals than high-income, especially for men.[200] Sickness absence increased after the collapse among both genders, especially in workplaces that had experienced downsizing, such as in the banking sector.[201] A study on employees in the financial sector found that the psychological health of people who remained employed was worse than among those who had been laid off,[202] especially when they were working at downsizing and rebuilding the workplace.[203] Generally, however, individual´s happiness did not seem to worsen right after the collapse in 2009 compared to 2007, except for those who were hit the hardest financially.[204] After studying infant mortality, disease incidence and psychological health among children after the economic collapse and comparing to before the collapse, Gunnlaugsson et al. did not find these outcomes to be affected among Icelandic children.[205]

Studies on health behaviors have shown that behaviors such as consumption sweets, fast food, and sugared drinks diminished in 2009, shortly after the collapse, compared to before the collapse.[136] Except for consumption of sweets, all of these factors further continued to decline in 2012 compared to before the collapse.[136,206] Also, a reduction was found in smoking and alcohol consumption post-collapse compared to pre-collapse.[207,208]

Taken togher, the evidence for the role of a major societal change, such as Iceland experienced, on the population´s health remains somewhat equivocal. Existing research clearly suggests that the risk of various negative psychological outcomes may increase, while data are scarce on long-term outcomes and potentially different effects on gender and different age groups. Furthermore, even though the effect of traumatic stress on mental health has been well established, knowledge of the different traumatic life

events in Iceland on extreme mental health outcomes such as suicidal behavior has been limited. The special circumstances of the Icelandic economic collapse in terms of magnitude and velocity, along with the opportunity of obtaining unusually comprehensive data on the health of Icelanders, creates a unique opportunity to investigate the effects of stressful/traumatic life events on suicidal behavior.

2 Aims

The overarching aim of this PhD study was to investigate the association between stressful/traumatic life events and suicidal behavior. Firstly, we wanted to examine the prevalence of suicidal thoughts, self-harm and suicide attempts and its association to previous traumatic life events in an Icelandic sample. In addition, using registry data, we aimed to evaluate the association between a specific stressful event in Iceland, the economic collapse in 2008, and suicidal outcomes. By including aggregate economic variables in our analyses, we aimed to investigate whether the severe economic changes during the years surrounding the economic collapse affected the rate of self-harm, suicide attempts and suicide in Iceland. The research resulted in three individual studies, with specific aims:

I. To study the lifetime prevalence of suicidality (suicidal thoughts, self-harm and suicide attempt) and traumatic life events (Study I), attendance rate of self-harm and suicide (Study II), and mortality rates due to suicides (Study III) in an Icelandic population.

II. To study the association between stressful/traumatic events and suicidal behavior in the Icelandic population, with respect to type of event and gender. (Study I)

III. To explore potential changes in rates of hospital attendances due to self-harm and suicide attempts in Iceland during a 10-year period of major economic transition, surrounding the 2008 economic collapse. Furthermore, to investige whether potential changes were due to the extreme changes in the economic climate. (Study II)

IV. To exlore potential changes in suicide rates in Iceland during a 12-year period surrounding the 2008 economic collapse. Furthermore, to evaluate whether potential changes in suicide were affected by the extreme economic transition, including a major economic crisis and recession. (Study III)

3 Materials and methods

This PhD study is based on three different data sources: 1) Questionnaire data from the Stress and Gene Analysis Cohort (SAGA) (study I), 2) Registry data from attendance register from the National University Hospital in Reykjavik (study II), and 3) Registry data from The Causes of Death register (study III). A summary of study characteristics is presented in Table 1. All studies were conducted in Iceland.

Table 1: Overview of study characteristics

3.1 Study I

3.1.1 The SAGA Cohort - Questionnaire data

The principal aim of the SAGA Cohort was to investigate the impact of stress and trauma on health. More specifically, we wanted to look at 1) the lifetime prevalence of various trauma and major adversities among Icelandic women, 2) the health consequences suffered by women exposed to trauma or major adversities and 3) the genetic contribution to varying health trajectories following exposure to trauma. The main study is ongoing and started in spring 2018 where all women living in Iceland, 18-69 years (approximately 110,000 women) are invited to participate in the study.

In spring 2014, we initiated a pilot phase for the study, collecting data from both women and men. The pilot project was a collaborative effort between the University of Iceland, the Icelandic Cancer registry and deCODE genetics. In total, 1640 individuals were invited to participate between February and April 2014. The data collection in the pilot study was two-fold; first through a self-reported, validated, web-based questionnaire and secondly, through a clinical visit with bio-sample collection and simple biometric measures conducted at the Cancer Detection Clinic. Before the clinical visit, the participant finished the online questionnaire which included comprehensive questions divided into 8 sections: 1) Background, 2) Lifestyle, 3) Mental well-being, 4) Physical well-being, 5) Medication, 6) Treatments, 7) Sexual health and 8) Nutrition (response duration approximately 35-50 minutes). Study I is based on SAGA pilot study questionnaire data on background, lifestyle and mental well-being.

3.1.2 Setting and population

The study population (N=1398) consisted of participants in the SAGA pilot study. A random sample of all women attending regular breast and cervical cancer screening at the Icelandic Cancer Society in February-March 2014 were invited to participate in the study (N=742). In addition, a random sample of men from the Icelandic population registry living in the capital area of Reykjavik (N=898) were invited. The Icelandic Cancer Society´s main task is screening for cervical and breast cancer and a majority of all women living in the capital of Reykjavik accept a screening invitation.[209] Except for that the women were recruited through their pending screening attendance and men by an open invitation to the general population, enrolment procedures were the same for both genders. First, all individuals received an invitation letter containing information about the study details and the questionnaire and an

inquiry to participate. The invitation letter was followed by a phone call from a professional working at the study center. A total 689 women and 709 men (see Table 2) met the inclusion criteria of having a listed address and telephone number and speaking Icelandic and received a secure link to the questionnaire via e-mail.

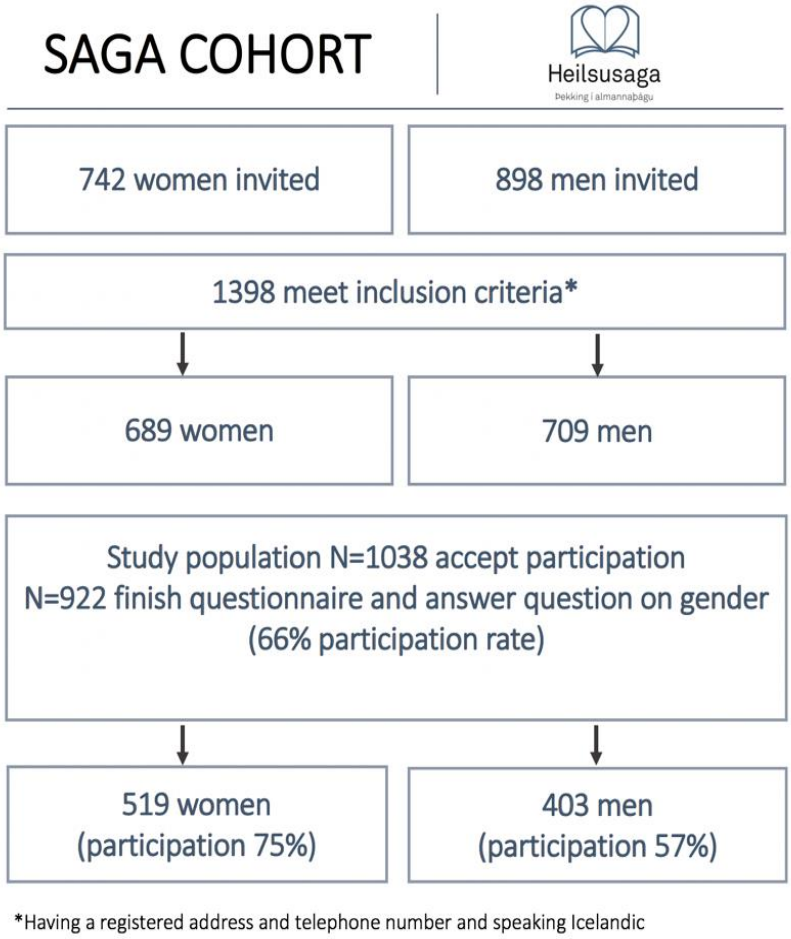


Table 2: SAGA Cohort recruitment, exclusion and participation

3.1.3 Outcome measures

The SAGA Cohort questionnaire included five single item questions related to suicidal thoughts, self-harm and suicide attempts. For estimating life time suicidality we combined answers from these questions: I) Have you ever seriously thought about committing suicide?, II) Have you ever harmed yourself deliberately because of how you felt? (for example, cut into your arm), III) Have you ever planned in what way you would commit suicide?, and IV) Have you ever tried to commit suicide? (Described in more detail in

Appendix, paper I).[210] A "yes" on either lifetime suicidal thoughts (including suicide planning), suicidal self-harm or suicide attempt constituted a measure of lifetime suicidality (See Figure 7). Current suicidal thoughts were measured with a question from a standardized validated questionnaire, PHQ-9:[211] "Over the last two weeks, how often have you had thoughts that you would be better off being dead, or of hurting yourself in some way?" with the response alternatives: 1) Not at all- categorized as "No", and 2) Several days, 3) More than half the days, as well as 4) All the time categorized as "Yes".

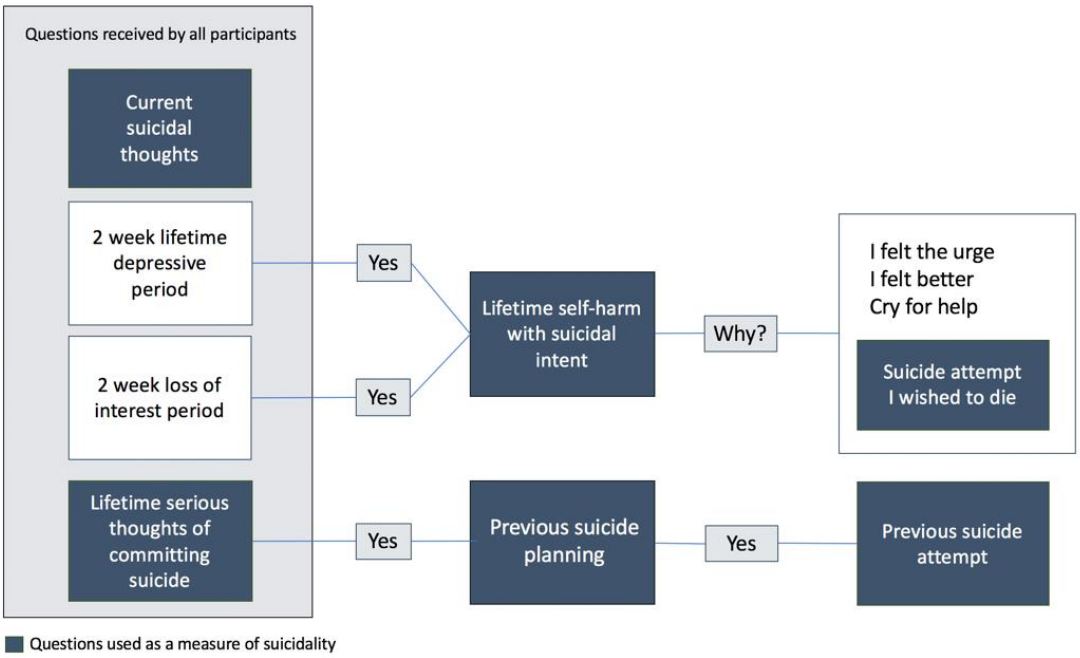


Figure 7: Outcome measures of suicidality in SAGA Cohort study

3.1.4 Explanatory measures

Stressful and traumatic life events were measured with the assessment instrument Life Stressor Checklist-Revised (LSC-R.)[212] This 30-item questionnaire covers various types of life stressors such as loss of significant others, exposure to natural disasters, accidents, and interpersonal, physical or sexual assaults. Traumatic life events were classified according to the DSM-5 definition on trauma-related disorders. Trauma is defined as events where there is either direct exposure to actual or threatened death, serious injury and/or sexual violence, or when individuals witness these events happen to others, learn that they happened to a loved one, or have repeatedly been exposed to details of such events.[94] We classified 11 types of events from LSC-R as traumatic and further subcategorized them into non-interpersonal and interpersonal trauma, see Table 3.

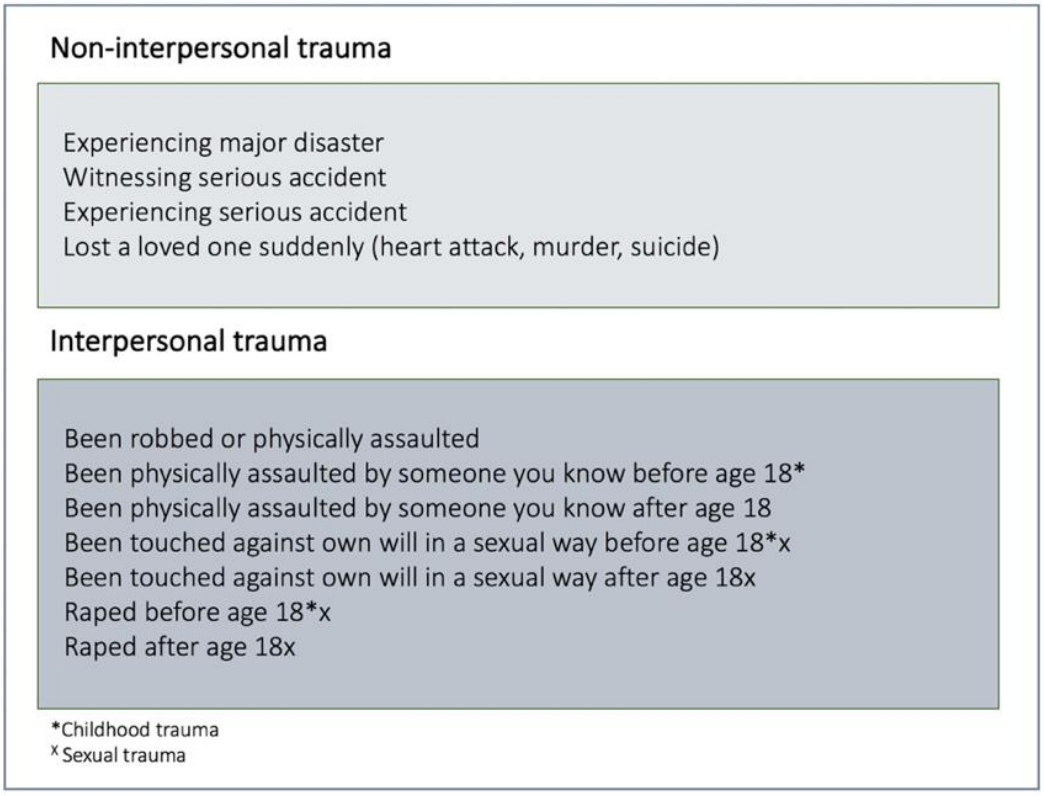


Table 3: Traumatic life events measured with Life Stressor Checklist - Revised. Catagorized into interpersonal and non-interpersonal trauma according to DSM-5

3.1.5 Covariates

The SAGA pilot study questionnaire included questions on sociodemographic factors; participant´s gender, age, education, residency, marital status, employment and social support. We divided age into four categories; 20-35 years, 36-45 years, 46-55 years and 56 years and older and categorized educational level into: Basic (elementary school), Middle (high school), University education (completed) and other/not stated. Residence was divided by postal codes into habitation in the center of Reykjavik capital, suburbs of Reykjavik capital and other municipalities surrounding the capital area. Marital status was divided into: married/cohabiting, in a relationship, single, widow/widower and not stated. We categorized employment status as: employed (including student and being on parental leave), unemployed, disabled/on sick-leave, retired and not stated.

We included two questions on lifetime depressive symptoms based on the Composite International Diagnostic Interview (CIDI) instrument: I) In your lifetime, have you ever had two weeks or longer when nearly every day you

felt sad, empty, or depressed for most of the day? and II) In your lifetime, have you ever had 2 weeks or longer when you lost interest in most things like work, hobbies, and other things you usually enjoy? Furthermore, to evaluate a history of psychiatric disorders, we included a question: “Have you had any of these psychiatric diseases?” with response possibilities that we categorized into: 1) Mood affective disorders (depression and bipolar), 2) Anxiety related disorders (including positive responses on general anxiety disorder, panic attacks, agoraphobia and social phobia), 3) PTSD (positive response on posttraumatic stress disorder), and 4) Other (positive response on: burnout, obsessive-compulsive disorder, schizoaffective disorder, schizophrenia, Asperger, Tourette, autism, personality disorder). Also, the Primary Care PTSD Screen (PC-PTSD) was included, which is used to screen for symptoms of posttraumatic stress disorder with 4 questions: Have you in the past month I) Had nightmares about the event(s) or thought about the event(s) when you did not want to?, II) Tried hard not to think about the event(s) or went out of your way to avoid situations that reminded you of the event(s)?, III) Been constantly on guard, watchful, or easily startled?, and IV) Felt numb or detached from people, activities, or your surroundings? A positive answer in 3 questions calls for a structured interview for PTSD. The symptom-measures are validated[213,214] and adapted to the Icelandic language.

Lastly, we measured social connectedness with Berkman-Syme Social Network Index, a diagnostic questionnaire that measures type and frequency of individual´s social network with the aim of identifying those at risk of social isolation. The questionnaire has previously been used to evaluate social connectedness and health outcomes[215,216] with a similar scoring approach as in our study, and with high predictive validity. We measured social integration in four different areas: partnership, friends, relatives, and participation in group activity. To adapt to the Iceland society where cohabiting is very common, we evaluated partnership specifically (single / widower/ in a relationship = 0, married / cohabiting = 1). Group activity was measured with the following question: Do you participate in any groups, such as a social community group, senior group, choir or hobby group? With a follow-up question for those answering “yes”: How often do you participate in such groups? where we categorized almost never / once or twice a year / every few months, as 0 and once or twice a month or more often = 1. Having 2 or fewer friends or family was categorized as 0, 3 or more = 1. The summed scores were a range of 0-4 which we categorized into low, medium, medium high and high social network level.

3.2 Study II

3.2.1 The discharge data base of Landspitali – the National University Hospital of Iceland – Registry Data

Study II is based on a register including all registered attendances to Landspitali - National University Hospital of Iceland (LUH), an academic tertiary hospital situated in Reykjavík. LUH serves almost all individuals that are severely ill from the whole country and all habitants in the main capital area (64% of the population in 2012). All visits are recorded electronically upon arrival of patients and registered by their unique personal identification number. During the study years, individuals who attended the emergency department due to a suicide attempt or self-harm would have arrived at one of two of the hospital´s emergency departments: Fossvogur campus Accident and Emergency department (ED), serving injuries and unselected acutely ill patients, or the Psychiatric ED, serving patients with psychiatric symptoms. The majority of all ED-patients receive a final diagnosis before discharge from the ED. In case of self-harm or suicide attempt, a psychiatrist will make a discharge diagnosis. In severe circumstances, the diagnosis may never be registered at the ED but only at a specific hospital department (e.g. the intensive care unit). Study II is based on all registered attendances with the registered diagnosis of self-harm and suicide attempt to both emergency departments and admissions to in-patient care through the years 2003-2012. Diagnoses are recorded according to International Classification of Disease, 10th version (ICD-10). The Directorate of Health in Iceland requires thorough inpatient registration and data from a similar period has shown that ICD-10 codes were provided for 98% of discharge diagnoses.[217] Data was retrieved from Electronic Admission Records through the Saga electronic medical record system.

3.2.2 Setting and population

The study population consisted of all individuals who received a discharge diagnosis of self-harm or suicide attempts after attending to emergency department or being admitted to in-patient care at LUH, through the years 2003-2012. We restricted our study population to individuals 18 years and older.

3.2.3 Outcome measurements

We gathered information on all attendances due to self-harm and suicide attempts to LUH using ICD-10 diagnoses (outcomes of the study):

X60-84	Intentional self-harm
X40-49	Accidental poisoning by and exposure to noxious substances
Y10-34	Event of undetermined intent
Y87	Sequel of intentional self-harm, assault and events of undetermined intent
T36-50	Poisoning by drugs, medicaments and biological substances
Z91.5	Personal history of self-harm

We gathered information for each visit on date and time of arrival and discharge, and the patient´s gender, date of birth and residence by postcode. The majority of the study population lives in the capital area, so to evaluate the attendance rate per 100.000 individuals, we used the number of inhabitants in the capital area as a denominator. Also, to evaluate attendance rate for specific study groups, we retrieved information from Statistics Iceland on numbers of inhabitants by age and gender and evaluated attendance per 100.000 inhabitants within each stratum. The data included self-harm both with or without suicidal intent, without the subjective knowledge on the individual's actual intent.

3.2.4 Explanatory measurements

The severe economic collapse in Iceland was defined as a negative stressful event. October 6th 2008 was the day the Prime minister publicly announced the imminent financial threat.[191] Because this date marks the definite starting point of the economic collapse, we used it to categorize the study periods into a pre-collapse period (January 1st, 2003 to October 5th), which was considered unexposed to the economic crisis. The post-collapse period (October 6th, 2008 to December 31st, 2012) was considered as exposed to the economic recession. Individuals who self-harmed, attempted or commited suicide before this date were therefore considered unexposed, and those with these outcomes after this date were considered as exposed.

3.2.5 Covariates

For all hospital attendances, medical records are registered by ID-numbers containing information on the patient´s age. We further gathered information for each visit on date and time of arrival and discharge, and the patient´s

gender and residence by postcode. Age was divided into age groups: 18-25 years, 26-35 years, 36-45 years, and 46 years and older. Place of residence was divided by postal codes into habitation in Central Reykjavik, suburbs of Reykjavik area, other municipalities of the greater capital area and areas outside the capital area.

To evaluate the association between macroeconomic surrounding and rate of self-harm/suicide attempt, we retrieved information from Statistics Iceland on economic indicators. Statistics Iceland was founded in 1914 and is the center for official statistics in Iceland. With the leading role to conduct and coordinate official statistics, it publishes data information on the country´s economy and population. With the aim to aid economic analysis and policy making, Statistics Iceland collects data on national accounts, providing a coherent set of macroeconomic accounts based on internationally accepted concepts. We retrieved traditional aggregate economic indicators on a yearly basis of two economic conditions; unemployment rate and GDP. While those are the two main indicators of business cycles used in the literature, the special circumstances of a trade surplus and the Icelandic debt crisis called for addressing other aspects for completeness. We therefore also used Balance of Trade on quarterly basis to measure potential aggregate explanation for the found effects.[218]

3.3 Study III

3.3.1 The Causes of Death Register - Registry data

The Causes of Death Register contains information on all deaths occurring in Iceland from 1911, based on ICD-10 diagnostic codes retrieved from death certificates. The register is held by the Directorate of Health in Iceland, a government agency that amongst other functions, collects and processes data on health. All death certificates are registered by individual ID-number, and are coded by a specifically trained coder, with information on gender, age, time of death, residence by municipalities in Iceland, along with cause of death. The coding has been electronic from 1971. To increase reliability, the Nordic Classification Centre has used the Automatic Classification of Medical Entities system (ACME, used to support the choice of underlying cause of death) since 2001 to follow up on correct manual coding in Iceland.[219]

3.3.2 Setting and population

In study III, the study population consisted of all individuals who committed suicide in Iceland during the years 2002-2014 and had a legal residence in Iceland at time of death.

3.3.3 Outcome measures

The outcome measure in study III is based on all suicides registered by the Causes of Death registry in Iceland during the years 2002-2014, with the ICD-10 diagnostic codes X60-84 (Intentional self-harm) and Y87 (Sequel of intentional self-harm). For each individual, we retrieved data on date and time of death, date of birth, gender, marital status and residence by municipalities in Iceland. Due to incompleteness of registration on marital status, data on this in study III was retrieved from Register Iceland and linked to the Causes of Death Register. Register Iceland is operated under the authority of the Ministry of transport and Local Government of Iceland. It´s main purpose is to maintain a National Registry, which reserves information on Icelandic citizens by their personal identification number (PIN), such as information on gender, residence and marital status.

The Causes of Death registry contains deaths for the whole Icelandic population. Hence, to evaluate the number of suicides per 100.000 individuals, the suicide rate, we used the number of inhabitants in the whole country each year as denominator. Similarly, to evaluate the suicide rate for each gender and for specific age groups, we used number of inhabitants by age and gender, for each year, as denominator.

3.3.4 Explanatory measures

As in study II, stressful event of the economic collapse in Iceland was defined as the exposure in the study, and the date October 6th, 2008 as the starting point of the economic collapse. The total study period in study III is 2002-2014, and we identified the pre-collapse period was identified as January 1st, 2002 to October 5th, 2008 (considered unexposed to the economic crisis) and a post-collapse period expanding from October 6th, 2008 to December 31st, 2014. The post-collapse period in study III is longer than that in study II. Because economic growth had started during the later years of the study period (2012-2014), and because the pre-collapse period was characterized by an economic boom that peaked during the last year prior to the economic collapse, we further divided the total study period in study III. The pre-collapse period, characterized by a stable economic period and an economic

boom, was divided into two periods: period1: 1.1.2002 - 20.05.2005, period 2: 21.05.2005 - 05.10.2008. The post-collapse period, characterized by an economic crisis period and a recovery period, was divided into two periods as well: period 3: 06.10.2008 - 18.11.2011, and period 4: 19.11.2011 - 31.12.2014.

3.3.5 Covariates

With individual data on gender, age, date and time of death, residence and marital status, we categorized age of death into 4 age groups (age 25 years and younger, 26-45 years, 46-65 years, and older than 65 years). Place of residence was categorized into 1) Reykjavik Capital area, and 2) Rural Iceland (North West Iceland, North East Iceland, South West Iceland, South Iceland and South Peninsula). Marital status was categorized into: 1) Married/Cohabiting, 2) Other (Single/Widowed/Separated/Divorced and Unknown). As in study II, aggregate information on unemployment, GDP and BoT were furthermore used to evaluate changes in suicide rates associated with changes in economic surrounding.

3.4 Data analysis

In all studies, we used descriptive statistics to evaluate the demographic background of the study group and either t-test or Chi-square test to evaluate the differences between background characteristics of the exposed/non-exposed population. We calculated the prevalence of explanatory and outcome measures, for corresponding specific characteristic category in each study.

To explore the association of explanatory variables and outcome in each study – prevalence of lifetime suicidality (study I), attendance rates of self-harm/suicide attempts (paper II) and mortality rates due to suicides (paper III) - we used Poisson regression and adjusted for demographic factors. When evaluating the exposure of traumatic events (study I), we calculated the risk for each type of traumatic life event, using a comparison group that had not experienced an equivalent trauma type. This was done for both overall and in a gender stratified analysis.

When evaluating the effects of the economic collapse (studies II and III), we used the timing of the collapse as a dummy variable to evaluate the risk of post-collapse attendance/suicide rates relative to pre-collapse. In both studies, we found age adjusted incidence rate by calculating incidence per 100.000 inhabitants at the end of each year, with the number of inhabitants of the same gender and age group at the corresponding year as a denominator.

Since the majority of the study population in study II lived in the capital area, we used the whole population in the larger capital area as a reference group. In study III however, the death registry contains deaths for the whole Icelandic population, and we therefore used the whole population in Iceland as a reference group to evaluate suicides per 100.000 individuals. To evaluate the difference between the estimated yearly increases, we used Poisson regression in both studies. To evaluate seasonal variations in study II, we calculated incidence of hospitalizations due to self-harm per 100.000 inhabitants for each consecutive quarter, for both periods pre- and post-collapse. Subgoup analyses in study III had limited statistical power, thus we used Chi-square test to test for seasonal variability. We furthermore divided the pre-collapse period in study III into two periods and the post-collapse period into two periods, to explore both total suicides and suicides per 100.000 individuals for each demographic factor for each period (in total four periods). In both study II and III, to evaluate which economic factors contributed to the association, we used the same method where the dummy variable was replaced with 1 % changes in the Icelandic economic factors; the nation´s unemployment rate, GDP level and Balance of trade. All statistical analysis were done with R statistical program.[220]

3.5 Data protection issues and ethical approvals

Study I: The study was approved by the National Bioethics Committee in Iceland (Ref: VSNb2013010025/03.7) and announced to the Data Protection Authorities in Iceland. Approvals were furthermore obtained from SAGA cohort.

Study II: Approvals were obtained from The National Bioethics Committee (ref: 12-198-V2, S1, VSNb2012110018/03.15) and the Data Protection Authority (ref: 2012121479HGK). Approvals were furthermore obtained from Landspitali-National Universtity Hospital (Tilv. 16, ÞH/eí).

Study III: Approvals were obtained from The National Bioethics Committee (ref: 12-198-V2, S1, VSNb2012110018/03.15) and the Data Protection Authority (ref: 2012121479HGK). Approvals were also obtained from the Directorate of Health (1212023/5.6.1/gkg).

4 Results

4.1 Study I - Traumatic life events and suicidality

The main results of study I were that traumatic life events were associated with lifetime suicidality. The majority of the participants (76%) had at some point in their lifetime experienced a traumatic event. There were no definite differences between the study group´s demographic characteristics with respect to history of trauma (Study I -Table 1), except that the group with no history of trauma was more likely to being employed and have a university education (p=0.009 and p=0.002, respectively). They were also less likely to have a history of depression (p<0.0001), compared to the group with a trauma history.

Slightly over half of the participants were female (56%). The age distribution was significantly different between the genders (p<0.05). Women´s mean age (52.6 years) was higher than men´s (45.6 years). Female participants also had a higher education level than men (p<0.05). Men had a higher prevalence of non-interpersonal trauma than women, but women more frequently reported a history of interpersonal trauma compared to men, both sexual and trauma during childhood. Women were more likely to having had a depressive disorder in their lifetime compared to men (18% vs. 13%, p=0.02). Similarly, the prevalence of having experienced a two-week depressive period was higher among women than men (49% vs. 36%, p=0.0002). Even so, men had a higher prevalence of lifetime suicidality than women (17% vs. 11%, p=0.02), especially suicidal thoughts (p=0.001) and suicide planning p=0.02). (See paper I – Figure 1)

We found overall association between having experienced traumatic life events and suicidality (RR 2.05, 95% CI 1.21-3.75), although statistically significant for men (RR 3.14, 95% CI 1.25-7.89), but not women (RR 1.45, 95% CI 0.70-2.99). For individuals with a history of non-interpersonal trauma exclusively, we found a threefold risk of suicidality among men (RR 3.27, 95% CI 1.30-8.25), but no significant risk for women (RR1.27, 95% CI 0.59-2.70). Interpersonal trauma, on the other hand, was associated with suicidality for both genders (RR 2.97, 95% CI 1.67-5.67), with higher relative risk increase for men (RR 4.30, 95% CI 1.68-10.98). This was true for both childhood trauma and sexual trauma. (See Paper I – Table 3). Similar to this, the prevalence of current post traumatic stress symptoms was higher among

men who had experienced childhood and sexual trauma, than among women with similar trauma history. (See table 4) For the total study group, men were more likely than women to report their level of social connectedness to be low (28% among men and 17% among women). Also, when looking at individuals with a history of suicidality, 43% of the men reported low social connectedness vs.18% of the women.

	Total (%)	Men (%)	Women (%)
Total study group	79/847 (9)	30/371 (8)	49/476 (10)
Suicidal group	40/115 (35)	17/56 (30)	16/40 (40)
All DSM5 trauma	71/657 (11)	28/291 (10)	43/366 (12)
Non-interpersonal trauma	60/561 (11)	25/260 (10)	35/301 (12)
Interpersonal trauma	57/343 (17)	20/109 (18)	26/138 (19)
Childhood trauma	42/196 (21)	16/55 (29)	20/91 (22)
Sexual trauma	37/160 (23)	12/36 (36)	18/82 (22)

Table 4: Prevalence of current PTSD symptoms according to the Primary Care PTSD Screen, among different trauma groups and group with history of suicidality in SAGA cohort population

4.2 Study II - Economic fluctuations, self-harm and suicide attempts

The main findings for study II were that the extreme economic collapse and recession did not result in increased hospital attendances due to self-harm and suicide attempts (RR 0.95, CI 0.90-1.01), neither for women nor for men. In fact, among men, a slight decrease in attendance was found post-collapse compared to pre-collapse, when exploring attendances registered on the most prevalent and specific self-harming ICD-10 codes; Poisoning (RR 0.87; CI 0.78-0.97) and intentional self-harm (RR 0.76; CI 0.62-0.92). (See paper II – Table 2)

Among women, a slight decrease in attendance rate was seen pre-collapse and it continued during the post-collapse period. The difference between the two periods (pre- and post-collapse) was therefore small (p=0.93). For men however, the difference was substantial between periods

(p=0.007), characterized by an increase in attendance before the economic collapse, peaking during the economic boom, and decreasing again post-collapse. (See paper II – Figure 2)

Consequently, sudden changes in economic indicators, such as increasing unemployment rate and BoT during the economic recession, did not increase risk of attendance. In fact, an inverse association was found between an increase in those indicators and self-harm and suicide attempts among men (unemployment rate; RR: 0.84; 0.76-0.93 and BoT; RR: 0.81; 0.75-0.88). This association was not seen among women. (See Figure 8)

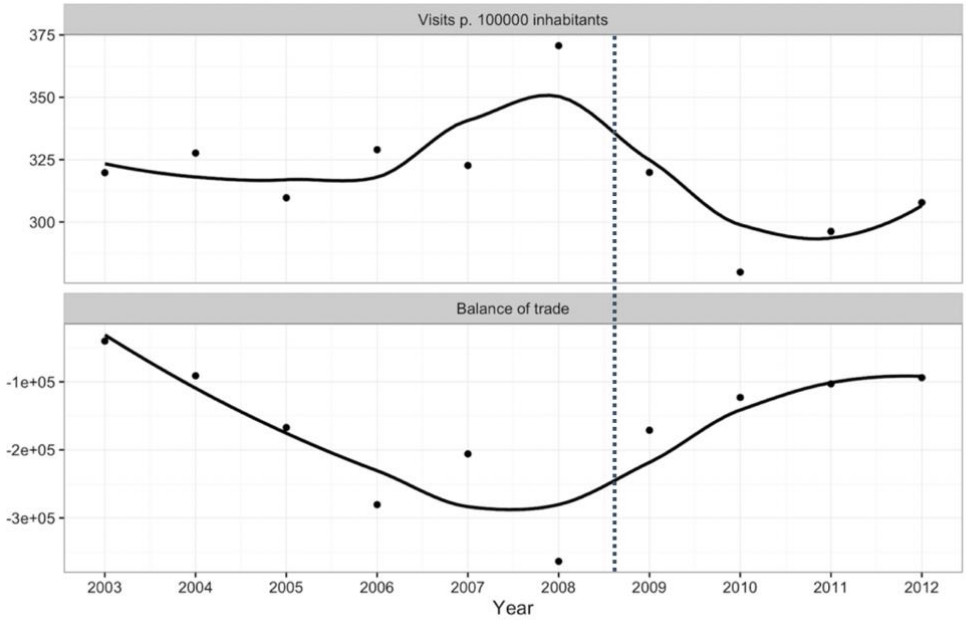


Figure 8: Attendance rate to Landspitali University Hospital due to self-harm and suicide attempts (above) and Balance of Trade (below) in Iceland during the years 2003-2012. The dotted line represents the economic collapse in Iceland in October 2008

4.3 Study III - Economic fluctuations and suicides

The main results of study III were that following an economic boom during the pre-collapse years followed by a sudden economic collapse and recession did not affect suicide rates in Iceland. The mean suicide rate during the whole study period (2002-2014) was 14 per 100.000 individuals, 21 per 100.000 for

men and 7.3 per 100.000 for women. The rate was highest in the age group 46-65 years (19.3 suicides per 100.000 individuals). (See paper III, Table 1)

We found no increased risk of suicides post-collapse compared to pre-collapse (RR 1.12; CI 0.94-1.35), neither for men (RR1.18; CI 0.96-1.46), nor forwomen (RR 0.96; CI 0.67-1.38). However, when evaluating the risk by age group, an increase in suicide rates was seen for the age group 65 years and older (RR 2.02; CI 1.19-3.56). Gender specific analyses revealed that this risk was only significant for men (RR 2.31; CI 1.24-4.57, for women RR 1.30; CI 0.45-3.94). Furthermore, we found increased risk of post-collapse suicides among single men, all ages (RR 1.31; CI 1.03-1.67), but not for women. For these groups at risk, a high point in suicide rate was found during the period of economic recovery (Figure 10 and 11). When evaluating changes in suicide risk associated with changes in economic variables, economic growth characterized by 1% changes in GDP was associated with an increase in suicides among individuals age 26-45 years (RR 1.9; CI 1.09-3.38) and among men 65 years and older (RR 5.3; CI 1.91-16.47).

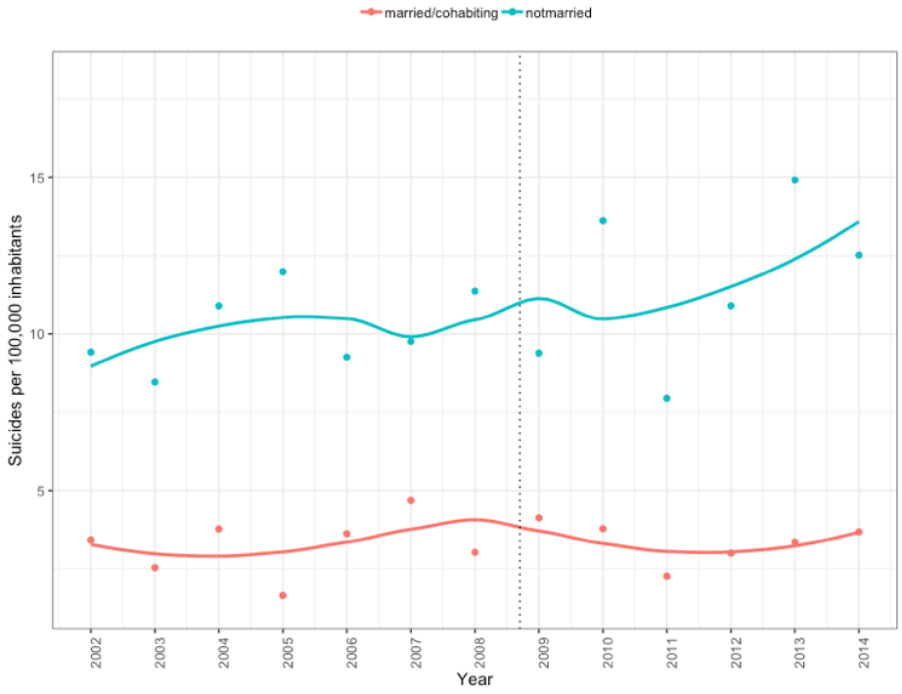


Figure 9: Suicide rates per 100.000 among married and un-married individuals in Iceland 2002-2014

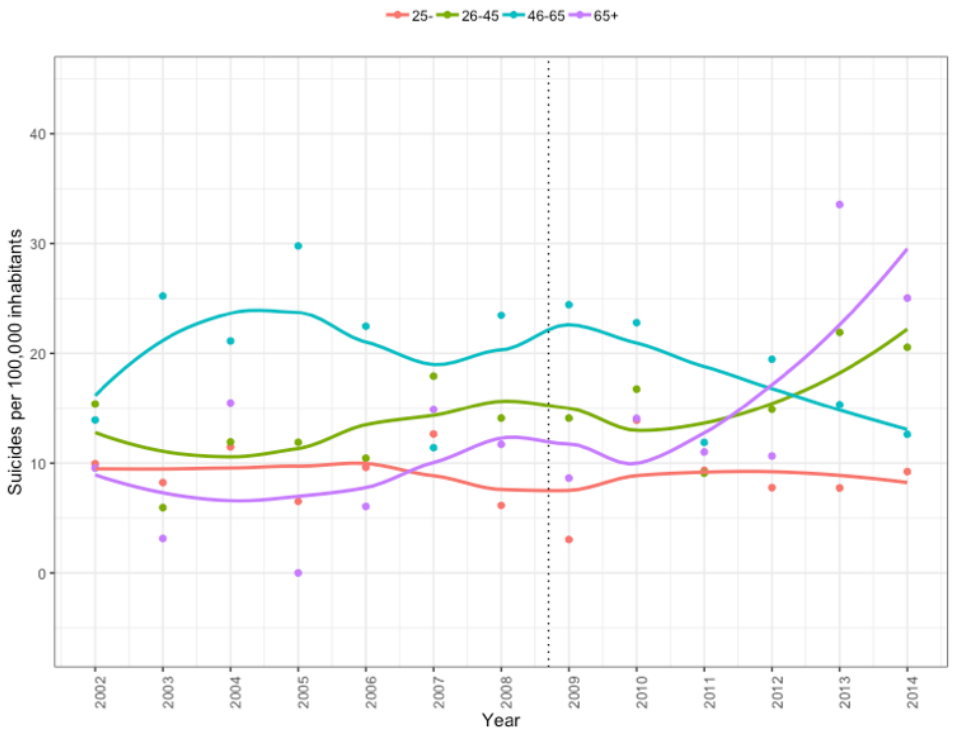


Figure 10: Suicide rates per 100.000 by age group in Iceland 2002-2014

5 Discussion

The results of our studies on the Icelandic population indicate that having experienced a traumatic life event, especially trauma of interpersonal nature, increases the likelihood of suicidality (i.e. suicidal thoughts, self-harm and suicide attempt). The results further indicate an association for trauma of non-interpersonal nature and suicidality for men, but not women. In addition, our findings of this thesis show that a dramatic economic collapse did not seem to increase suicidal behavior, i.e. hospital attendance due to suicide attempts and self-harm. In fact, an inverse relationship was found with rising unemployment rates during the economic recession and attendance rates due to self-harm and suicide attempts among men. Moreover, in contrast to results from numerous studies following the worldwide 2008 Great Recession, overall suicide rates were not affected by the major economic collapse in Iceland. Indeed, when exploring self-harm, suicide attempts and suicide rates in association with macroeconomic variables, the increased risk of suicidal behavior seemed associated with a growing economy or economic boom. We found that the male attendance rates due to self-harm and suicide attempts were indeed at a high point shortly before the economic collapse, close to the peak of the economic boom. Likewise, the risk of suicide among single and older men increased with the rising and recovering economy, after the economic recession.

5.1 Suicidal behavior

Information on the prevalence of suicidal behavior among adults in Iceland has been limited. In our study on any lifetime suicidality (suicidal ideation or planning, self-harm, and suicide attempts), we found an overall prevalence of 13.3%, which is in agreement with previous studies in other developed countries, indicating a lifetime suicidality prevalence of 12-20%.[11,12,18] In total, 5% in our study reported having current suicidal thoughts. This is higher than what was found in data from the WHO World Mental Health Survey (N=108.701), reporting a 12-month prevalence of 2% in high-income countries.[22] During the whole study period in our investigation, the mean suicide rate for Icelandic women was slightly under global rates (7.3 vs. 8 per 100.000). Men´s rate, however, was higher than what global male rates suggest (21 vs. 15 per 100.000). In fact, while women´s rate has declined in

Iceland during the later years, men´s rate has continued to rise (5.6 vs. 22.3 per 100.000 in 2016), resulting in the highest male-female ratio in the Nordic countries,[4] comparable to the ratio in the US (4:1).[50]

Numerous factors may affect the risk of suicidal outcomes, such as socio-economic status, mental disorders, age, and gender. Coherent with other studies, we found that the prevalence of suicidality (suicidal thoughts, self-harm, and suicide attempts) was higher for less educated groups, single individuals, individuals who were currently unemployed, disabled or on sick leave, and among those who reported a current or lifetime history of psychiatric disorders (Study I).[21,26,50]

5.2 Types of traumatic and stressful life events

We found that lifetime exposure to trauma was associated with suicidal behavior. These findings lend support to an extensive litterature on the role of traumatic stress on suicidal behavior, including childhood trauma being linked to a heightened risk of suicidal behavior later in life.[221] While interpersonal trauma was associated with suicidal behavior risk among both genders in our study, non-interpersonal trauma did not seem to have the same effect. This was expected, since previous research has indicated that interpersonal trauma (e.g. sexual abuse, emotional and physical violence), seems to have a stronger impact on suicidal behavior outcomes,[222-226] compared to trauma that is of accidental or environmental nature.[227] For example, Belik et al. reported an association between trauma that involved interpersonal violence and suicide attempts among military personnel, while this connection was not seen for other trauma types such as working in combat, experiencing a car accident or a natural disaster.[228] In contrast, our findings suggest that non-interpersonal trauma seem mainly associated with suicidal behavior among men, but not women. These gender differences may seem surprising but may be explained by several factors. First, a higher likelihood of risky behavior, e.g. reckless driving, is a more common self-harming method for men compared to women,[229] and this may explain the higher association between serious accidents and suicidal behavior among men. Secondly, the sudden loss of a loved (e.g. losing a spouse), has been shown in a number of studies to increase the risk of suicide to a greater extent for men than women.[230-232] Losing a family member by suicide (one type of sudden death), can increase the risk of suicidal outcomes,[71] possibly to a greater extent for men.[46] Following natural disasters, studies have indicated an initial drop in suicidality following the event, while others have found a delayed rising effect on suicide attempts.[233] Gender-specific differences have not been evident,[233] even

though some studies have found an increased risk for suicide attempts and suicides among women following natural disasters, but not men.[234,235]

5.2.1 The role of gender and psychiatric morbidity

Women more frequently reported a history of depressive morbidity than men in study I, which is coherent with previous research reporting a higher prevalence of major depression among women than men.[60,63] Studies have however suggested that men´s depression rates may be underdiagnosed.[17,236] Men may experience symptoms of depression that have not been considered typical for depression and are often misunderstood, such as anger and self-medication with drugs and alcohol. Possibly, traditional depressive symptomsand diagnostic criteria may not describe men´s experience of depression.[59] This could result in a biased lower prevalence and possibly lower understanding of the depressed individual. Also, women are more likely to meet criteria for PTSD,[100] resulting in a twofold risk of PTSD for women compared to men.[237] Men are however less likely to seek help for mental health problems after trauma.[238] In study I, we found that only women reported having been diagnosed with PTSD. Yet, the prevalence of current PTSD symptoms was higher among men than women with a history of childhood and sexual trauma (respectively 29 vs. 22% and 36% vs. 22%, respectively, see Table 2). Interestingly, for these types of trauma, we found a higher likelihood of suicidal behavior among men than women. The role of gender in the association of PTSD and suicidal behavior is still unclear and it is reasonable to believe that social factors play a vital role.

Studies have shown that the lack of social support after a traumatic incidence can increase the risk of health problems,[239] and social support occurring after a traumatic event can be more important than prior to the trauma for buffering symptoms of PTSD.[102] Social connectedness can influence health in a positive,[240,241] and when measuring social connectedness in study I, we found gender differences in the group with a history of trauma, characterized by a lower level of social connectedness among men compared to women.

Our gender-specific results on interpersonal trauma, especially childhood and sexual trauma, with a stronger risk for suicidal behavior observed among men than women after non-interpersonal trauma add significantly to the existing literature and motivate further studies on gender-specific mechanisms. A higher likelihood of suicidal behavior in association with a history of traumatic life events is still a fact for both genders. This emphasizes

the importance of psychological follow-up for both genders after traumatic life events to minimize suicidal risk, especially among vulnerable groups with psychiatric co-occurrence.

5.3 Economic boom, collapse and recovery in Iceland

Our results on the effects of economic collapse and surrounding economic fluctuations are noteworthy in relation to other countries severely hit by the 2008 Economic Recession. One notable difference between the Icelandic context and other settings should, however, be kept in mind. Iceland is a small open economy with its own currency. Fluctuations in the local currency can lead to substantial changes in living conditions that are not due to the level of production within this economy. In other words, consumption and production levels are not always as interrelated as in other contexts. This was the case during the time under examination in studies II and III. During the years leading up to the collapse, there was a continual trade deficit, adding to the experienced prosperity within the country, where locals were consuming substantially more of goods and services than represented by the level of local production. The collapse thus led partly to a debt crisis and a trade surplus. It is not theoretically clear if this matters or not, as potential effects of a business cycle on health may be fully due to labor-market effects. However, this is not known, and we thus acknowledge that the added pre-collapse boom and post-collapse hardship and quick recovery, may be a partial pathway to psychological health outcomes. This was the reason for the inclusion of economic variables, and especially the balance of trade (BoT) measure as a potential aggregate explanation for the found effects.

5.3.1 The Boom

Our results indicating a high-point in self-harm and suicide attempts among men during the major economic boom (study II) were somewhat unexpected. The extraordinary circumstances, high workload, working hours and high pressure “to achieve” may have resulted in these negative outcomes. These factors may have been extreme, primarily in the financial sector. During the height of the boom, some may potentially have suspected the seriousness of the situation, adding financial stress and unemployment insecurity to risk factors of mental health morbidity. A stressful psychosocial working environment and job insecurity, with high demands and low control, has been shown to have negative long-term consequences on health.[242] Still, these stressors should have affected women as well, as the genders’ employment

participation rate is equal in Iceland and women´s participation in the job market is among the highest in the OECD countries.

Some factors may possibly explain the gender differences in heightened attendance rate due to self-harm and suicide attempts during the boom. The majority of the individuals working in the financial sector were males and employment insecurity has been linked to suicidal behavior, mainly among men. The literature has further suggested that men are more materialistic than women and tend to place importance to conspicuousness of product use.[243] Men are also more likely to impulsively buy leisure items that demonstrate independence and activity.[244] The high expenditure as a norm and an elevated standard of living during the consumption boom may therefore have resulted in higher spending, debt and social pressure among men than women – which eventually may possibly have influenced risks of suicidal behavior. Furthermore, alcohol consumption was higher during the pre-collapse years than the post-collapse years.[207] Men tend to use alcohol as a means to reduce stress, and alcohol consumption has repeatedly been associated with suicidal behavior.[21]

5.3.2 The collapse

Based on the above, if true, it can also explain why the attendance rate in self-harm and suicide attempts (study II) decreased among men following the economic collapse – and why the male effect follows a pattern of some macroeconomic variables, specifically GDP and BoT and an inverse pattern with the unemployment rate. In contrast, most studies have however reported a pattern of increased rates of male suicide or suicide behavior with increasing unemployment during recession. In Iceland, both genders may have been protected in the Great Recession by several factors, social and individual.

In considering the special pre-collapse circumstances in Iceland, it should be kept in mind that the post-collapse recession years were unusual as well. Due to the major conversion and shock of the sudden economic change, the government responded quickly with policy measures following the collapse. Instead of reducing public spending and implementing austerity measures, the government invested in social protection and started an immediate implementation plan.[205] With the aim to monitor and act on social and financial effects on inhabitants, a “Welfare-watch” and labor-market programs were established, measures to assist and restructure individual and company´s debt were conducted, a special psychiatric emergency ward was opened shortly after the collapse and physical activity for the unemployed

was financially supported and encouraged. The active measures aimed specifically to protect vulnerable groups: the unemployed, individuals on benefit, children and the elderly. Investing in social protection may have had a protective role against suicidal behavior. This is in fact supported by the literature, indicating higher rates of suicidal behavior in societies where austerity measures were implemented during the economic crisis.[169,245-247]

Even though a link between increased level of the unemployment and suicide rate has been reported in most studies, this association was not confirmed in study III. In fact, the true impact of unemployment itself has been doubted, and researchers have speculated in other countries on to what extent unemployment may contribute to rising suicide rates.[160,248,249] In some countries, especially in Western Europe, the association has in fact seemed to be rather weak. This may be explained by the fact that several factors (that apply to Iceland) have been found to minimize the association of unemployment rate and suicide increase. For example, Stuckler et al. found that money spent on active labor-market programs in Europe during unemployment in economic crisis (as was conducted in Iceland) resulted in reduced impact of recessions on suicide rates.[158] Secondly, Iceland has a strong welfare system, which has previously been found to reduce suicide risk despite rising unemployment. During the early 1990´s recession in Sweden and Finland, that have similarly strong welfare systems to Iceland, a large increase in unemployment did not affect suicide rates. Lastly, when evaluating the effects on suicide rates in 20 European countries, Reeves et al. found that a higher level of gender equality diminished the association between unemployment and suicide rate in times of economic crisis.[250] Even more so, the association between rising unemployment rates and suicide among men was non-existent in countries with a relatively high gender equality, such as Sweden and Austria.[250] This may apply to Iceland as well. Due to equal gender participation rate on the labor market in Iceland the link between men´s unemployment and suicide risk may weaken compared to other countries, where the men may be more likely to be the family's sole provider.

5.3.3 The recovering economy

The Icelandic economy had substantially recovered during the years 2013-2014, and our findings indicate that an increase in suicide rates among unmarried men occurred predominantly during those years. Marital status has been found to be an important indicator of mental health during hard times[251] and married individuals may be at better health, due to more

financial security and steady social support. Research has suggested that social support is a greater protective factor for mortality risk for men than women.[252] On a societal level, social cohesion has been found to be a possible protective factor for psychological morbidity during the economic recession.[253,254] Social cohesion is generelly high in Iceland and similarly, a study on individual social support pre- and post-collapse in Iceland experienced social support was higher during the recession years compared to the years of economic boom.[255] It is possible that most individuals will have recovered emotionally at the time of economic recovery and consequently, social connectedness may have diminished for individuals who were unmarried and living alone. Possibly, the unmarried men may therefore at that time not have enjoyed the buffering effects of social support to the same extent as others.

For the older men however, most men at this age are probably retired or approaching retirement (the retirement age in Iceland is 67 years). Heightened suicide risk among men after the age of 65 years may possibly be related to retirement,[256] although retirement would not explain a heightened suicide risk among this age group during economic recovery. However, men in this age group who might have lost their job during the collapse would have been at least 60 years old, an age where it might be difficult to find a job again before retirement. If so, the unemployment period for them would possibly have been longer than for other age groups, and increased duration of unemployment has been linked to increased suicide risk - especially among men and older age groups.[257] Actually, an Australian study found, that long-term unemployment did not affect men´s suicide rates if unemployment was generally increased in the country. However, during periods of declining unemployment rates (such as during the recovery period in study III), men´s suicide rates increased.[257] In addition, many individuals lost their life savings in the economic collapse. Losing pension savings at this age may definitely be a major stress factor, possibly affecting mental health.

Possibly, the increase in this age group is however in no way related to economic fluctuations, but a part of a general trend of an aging population with more physical, mental and even drug-related problems.[258] Yet, it would not explain the higher risk only observed among men and not women. Also, even though suicide rates are high for older individuals, global rates have the recent years, in fact, declined for individuals older than 65 years.[259,260]

5.4 Strengths and limitations

This PhD project used three rich data sources and various study designs and methodological approaches. Therefore, different limitations and strengths apply to each of these studies. As in all scientific studies it is imperative to thoroughly evaluate all sources of possible errors. Errors in an estimation are either random or systematic errors. Random error is mainly affected by the study size, hence the findings of a large study with limited random error is usually described as precise. Systematic errors are often larger than random errors, and mark the estimate measurement method of the study. Those errors are often referred to as biases.[261] Appreciating systematic errors is important to evaluate the validity of the study – if a particular estimate in a study has few systematic errors it is described as valid. Biases are categorized into i) selection bias (misrepresentation), ii) information bias (misclassification), and iii) confounding. If none of the abovementioned biases are present in a study, random error and confounding are controlled, the study has high internal validity, i.e. it is liable to come to a conclusion which is likely to be correct for that particular study. If internal validity is established, it can be evaluated whether the results can be generalized to other population or other circumstances, i.e. wether the findings of a given study have external validity.[261]

5.4.1 Selection bias / Misrepresentation

Selection bias may be introduced during the procedure of selecting study participants, due to drop-out or non-participation during follow-up, i.e. not all participants will agree to join the study and not everyone sustains their participation throughout a study period. As a result, we cannot conclude whether an obtained outcome would be the same for individuals who were eligible but did not participate.[261] In study I (questionnaire data), even though participation rate was relatively high, particularly for women (75%), we cannot ignore the possibility that non-participants were different to participants (less health conscious, more depressed) in a way that obscures our estimates on e.g. prevalence of suicidal behavior or trauma. This may limit our internal validity. If, and to what extent, this error affects our assessment of the association between trauma and suicide behavior is though hard to predict. Nevertheless, non-particification and gender-specific differences in participation (lower participation among males) is a limitation to study I.

Women were invited through the cancer screening program at Icelandic Cancer Society (ICS). First, the individuals who accept a screening invitation might be more health conscious. We may, therefore, have an oversampling

of women with traumatic event exposure. Yet, women with experience of sexual trauma may be more reluctant to attend cervix screening,[262,263] which may affect their participation in our study. The ICS is a well-known and respected society and their biggest task is screening for breast- and cervical cancer. Each woman in Iceland receives a screening invitation every three years and according to a study in 2016 on the participation rate, 76% of all women invited had the past five years accepted their invitation and attended a screening.[209] Although we adjust for demographic factors in our analysis, it is important to note that women in our study had a similar education level, employment and marital status to women in the general population.[264] These different procedures still add to the risk of selection bias and limit our ability to interpret and conclude on gender differences in study I. Another possible selection bias may be due to the self-reported outcome measure in study I. We may have an underreported prevalence of suicidality and the prevalence may be higher among non-responders.[265] Nevertheless, these measures of prevalence of suicidal behavior in urban Reykjavik are in line with other studies, suggesting 12-20% lifetime prevalence of suicidal behaviors.[11,12,18]

As study II and III are based on the entire, and complete registered total population, selection bias should not be a threat in these analyses.

5.4.2 Information bias / Misclassification

An information bias may occur when the information collected in a study is incorrect, possibly due to measuring errors.[261] These errors may be introduced when crude measures of exposures or outcomes are used. In preparing our studies, we did everything possible to reduce the risk of measurement error, e.g. by using a validated measurements of exposure (Life Stressor Checklist-Revised) and outcome (Patient Health Questionnaire-9) to evaluate current suicidal thoughts, while adding other outcomes measures of lifetime suicide behavior with a single item questions. These single item questions have not been validated, which is a limitation to our study.

In study II, we rely on complete register data on hospital attendances due to self-harm or suicide attempts. Although we probably catch all severe cases, we probably miss less severe cases diagnosed and treated in primary care or not seeking care at all. Moreover, in addition information on self-harm and suicide attempts are collected with specific ICD-10 diagnostic codes that are registered by physicians. ICD-10 diagnostic codes are the standard diagnostic tools in medicine and widely used in epidemiological and clinical research. The specific diagnostic codes used for registering self-harm and

suicide attempts are given by a psychiatrist, increasing the internal validity of the suicidal measurement outcome. Registration procedure furthermore remained unchanged during the whole study period, which should minimize measuring errors risk. We can however not rule out the possibility of misclassification, and that some suicide attempts were in fact without any suicidal intent or vice versa, that suicidal individuals would never have been diagnosed with appropriate ICD code. Yet, it is highly unlikely that such misclassification would be restricted to the observed high point in the economic boom, or that diagnosis would decrease quickly following the collapse when mental health awareness was at its highest. Similar to LUH, The Causes of Death registry uses ICD-10 diagnostic codes, only diagnosed by physicians. The Causes of Death registry is considered of high-quality and no changes were made to the registration process of suicide during our study period.

The main limitation in study II and III, however, is the measurement of exposure. Ecological studies such as these tend to use extensive information on both exposure and outcome, on large populations. This may result in an ecological fallacy; an error in data interpretation characterized by applying information to the individual level, from large population results. However, our small population limits our ability to evaluate and detect weak effects for vulnerable populations, especially on suicide mortality.

5.4.3 Recall bias

Recall bias is a form of information bias relevant for study I where we use retrospective self-reported measures of trauma or suicidal behavior during a lifetime. Recall-induced problems may occur, especially for older individuals or individuals recollecting early-life trauma and suicidal behavior (i.e. long-distant events). As the women in our study were older they may thus be more prone to reall bias then men. However, after adjusting for age, education and other sociodemographic factors, the point estimates representing the association between trauma and suicidal behavior were not significantly changed, for either gender. Recall bias may still affect our results in study I, although the results were similar when focusing on current suicidality.

When comparing participants with a history of traumatic events to participants with no such history, asking about psychological morbidity after questions on lifetime trauma might lead do differential misclassification[266] (i.e. an overrepresentation of psychological morbidity, due to a recent recollection of trauma). This would lead to exaggerated observed relative risk. To avoid

this potential bias, we placed questions on psychological morbidity and suicidal behavior earlier in the questionnaire to the questions on trauma.

5.4.4 Confounding

A confounding factor can lead to over- or underestimation of an association or effect. The criteria for a confounding factors are i) it must be a risk factor for the outcome, ii) it must be associated with the exposure of the study, iii) it must not be affected by either exposure or outcome and not be a mediator in the causal pathway.[261]

In study I, we included a rich collection of questions on possible confounders; age, education, marital status, previous psychological morbidity, and PTSD symptoms, to name a few. Controlling for demographic factors in study I did however not affect our results. Because psychological morbidity and PTSD does not fill the criteria of being a possible confounder, we did not include them in our adjustments. The cross-sectional design of study I does limit our ability to conclude on the causality of trauma and suicidality, although we did find similar results after conducting a sensitivity analysis among individuals experiencing multiple traumas and exploring the association for traumatic events that occurred before the first onset of suicidal behavior.

In the register studies (II and III), we inevitably had less access to possible confounders. To estimate the effects of the exposure (economic collapse) on suicidal outcomes, we used the rates of the pre-collapse period as a reference - as an unexposed cohort. The unexposed cohort may, however, differ from the exposed in many ways that affect suicidal behavior, other than the actual exposure (i.e. the economic collapse). [261] The use of the pre-collapse period as a reference cohort for the exposed cohort may thus have been confounded (numerous social factors can lead to suicidal outcomes during the study period, other than the exact timing of the economic collapse). Apart from volcanic eruptions and increased pollution, factors that changed parallel to the economic study periods were however probably changing due to the economic fluctuations, such as a change in immigration and unemployment level. We adjusted for changes in immigration and emigration as well as changes in the age distribution of the population, with all analyses conducted gender stratified. Furthermore, we in parallel conducted analyses using aggregate information on national economic factors to aid our interpretation of the study findings. Hence, even though we cannot conclude on residual confounding, the risk of various environmental factors should be minimal, if any.

Finally, due to the special circumstances of the economic boom, the suddenness and verocity of the collapse, and relatively quick recovery, we remain cautious with generalizing the findings from studies II and III to other cultures suffering financial meltdown. However, the added information with the specific features of the collapse and economic fluctuations in Iceland and their relation to suicidal behavior add significantly to the existing litterature.

5.5 Public health implications and future studies

The serious public health threat of suicides calls for refined and comprehensive knowledge of risk factors in order to develop coordinated community-based prevention strategies. Because psychiatric morbidity poses the greatest threat for suicidal behavior and mortality, the first aim of public preventive efforts is foremost mental health promotion and securing access to evidence-based treatment of individuals affected with psychiatric disorders.

Our observed higher likelihood of suicidality among men with a history of traumatic life event, also call for a better understanding of gender-specific mechanisms. Future prospective longitudinal research could clarify these potential differences in causal effect for different types of trauma, with respect to gender. Our general findings on trauma effects on suicidality emphasize the importance to screen individuals with traumatic life events for suicidal thoughts, as well as for PTSD and other psychiatric disorders - which in combination may increase suicide risk. Especially, individuals with pre-existing suicidal ideation, self-harm and suicide attempts should be monitored and helped, since they pertain a lifelong high risk of dying by suicide. Men´s suicidal process is shorter and they tend to choose more lethal methods of suicide; with our findings in mind, screening and treatment of men, wether under occupational pressure or after experiencing a traumatic event, may be particularly fruitful. Furthermore, our findings of a higher suicide risk among older and single men motivate further studies and health care interventions targetting mental health in these male populations.

Our findings indicating increased risk of men´s suicidal behavior in growing or booming economy needs further research. Future studies could include data linkage between individual financial data and employment status information, which is obtainable from Statistics Iceland and information on psychotropic drug use from the Icelandic Medicines Registry. Another possibility would be to link data in studies II and III to evaluate previous psychiatric and suicidal history before dying by suicide, which might identify groups or characteristics of individuals at greatest risk during economic fluctuations.

In light of our results on suicidal outcomes following the economic collapse, vulnerable groups may, in fact, have been protected with before mentioned governmental measures. Even though further research is needed, our studies add a certain knowledge supporting the potentially positive effects of investing in social capital and social security measures following an economic downturn.

6 Conclusions

Our findings add valuable information to the growing literature on the role of stressful and traumatic events, economic fluctuation and recession, on populations´ suicidal behavior. In contrast to the findings of most studies in other countries experiencing a dramatic economic downturn, our results indicate that despite a major economic collapse, overall/total suicidal behavior was not affected during the years of economic crisis. This adds speculations to a cultural contexts and whether each economic collapse and recession may impact countries as well as vulnerable subroups in variable ways. Our findings further add support to the increasing understanding of the role of personal trauma in suicidal behavior, and suggest potentially greater impact of these events among men. Additionally, due to gender-specific findings, the study raises concern on adequate psychological support and follow-up up of men's health, both surrounding societal events such as economic collapse, and following personal traumatic events. The results thus highlight the importance of screening for suicidal ideation among individuals experiencing traumatic or stressful events, as well as screening for trauma history among vulnerable individuals at risk of suicidal behavior.

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BASIC RESEARCH ARTICLE

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The association between different traumatic life events and suicidality

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ABSTRACT

Background: Traumatic life events have been associated with increased risk of various psychiatric disorders, even suicidality. Our aim was to investigate the association between different traumatic life events and suicidality, by type of event and gender.

Methods: Women attending a cancer screening programme in Iceland (n = 689) and a random sample of men from the general population (n = 709) were invited to participate. In a web-based questionnaire, life events were assessed with the Life Stressor Checklist – Revised, and the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) criterion was used to identify traumatic life events. Reports of lifetime suicidal thoughts, self-harm with suicidal intent and suicide attempt were considered as lifetime suicidality. We used Poisson regression, adjusted for demographic factors, to express relative risks (RRs) as a measure of the associations between traumatic events and suicidality.

Results: Response rate was 66% (922/1398). The prevalence of lifetime traumatic events was 76% among women and 77% among men. Lifetime suicidality was 11% among women and 16% among men. An overall association of having experienced traumatic life events with suicidality was observed [RR 2.05, 95% confidence interval (CI) 1.21–3.75], with a stronger association for men (RR 3.14, 95% CI 1.25–7.89) than for women (RR 1.45, 95% CI 0.70–2.99). Increased likelihood for suicidality was observed among those who had experienced interpersonal trauma (RR 2.97, 95% CI 1.67–5.67), childhood trauma (RR 4.09, 95% CI 2.27–7.36) and sexual trauma (RR 3.44, 95% CI 1.85–6.37), with a higher likelihood for men. In addition, an association between non-interpersonal trauma and suicidality was noted among men (RR 3.27, 95% CI 1.30–8.25) but not women (RR 1.27, 95% CI 0.59–2.70).

Conclusion: Findings indicate that traumatic life events are associated with suicidality, especially among men, with the strongest association for interpersonal trauma.

La asociación de diferentes eventos traumáticos vitales y suicidalidad

Antecedentes: Los eventos vitales traumáticos han sido asociados con un riesgo más alto de trastornos mentales, incluso suicidalidad. Nuestro objetivo fue investigar la asociación entre diferentes eventos vitales traumáticos diferentes y suicidalidad, por tipo de evento y género.

Método: Fueron invitados a participar las mujeres que se atiendian un programa de detección de cáncer en Islandia (N=698) y una muestra aleatoria de hombres de la población general (N=709) . En un cuestionario online, los eventos vitales fueron evaluados con la Lista de Chequeo de Estresores Vitales-Revisada y se usaron los criterios DSM-5 para identificar eventos vitales traumáticos. Los reportes de pensamientos suicidas, autoflagelación con intención suicida e intento suicida a lo largo de la vida fueron considerados como suicidalidad a lo largo de la vida. Usamos la regresión de Poisson, ajustada por factores demográficos, para mostrar los riesgos relativos como una medida de las asociaciones entre eventos traumáticos y suicidalidad.

Resultados: La tasa de respuesta fue de un 66% (922/1398). La prevalencia de eventos traumáticos a lo largo de la vida fue de 76% para mujeres y de 77% para hombres. La suicidalidad a lo largo de la vida fue de 11% para mujeres y de 17% para hombres. Se observó una asociación global entre haber experimentado eventos vitales traumáticos con suicidalidad (RR 2.05, IC 1.21–3.75), con una asociación más fuerte en hombres (RR 3.14, IC 1.25–7.89) que mujeres (RR 1.45, CI 0.70–2.99). Una mayor probabilidad de suicidalidad fue observada entre quienes han experimentado trauma interpersonal (RR 2.97, IC 1.67–5.67), trauma infantil (RR 4.09, IC 2.27–7.36) y trauma sexual (RR 3.44, IC 1.85–6.37), con una más alta probabilidad para hombres. Además, la asociación entre trauma no-interpersonal y suicidalidad fue identificado en hombres (RR 3.27, IC 1.30–8.25) pero no en mujeres (RR 1.27, IC 0.59–2.70).

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关键词
创伤; 生活事件; 自杀念头和行为; 性别

HIGHLIGHTS

- Traumatic life events were associated with suicidality.
- Non-interpersonal trauma was associated with suicidality among men, but not women.
- Interpersonal trauma was associated with suicidality for both genders, with a higher likelihood among men.

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Conclusiones: Los hallazgos indican que los eventos vitales traumáticos están asociados con suicidalidad, especialmente entre hombres, con una asociación más fuerte para el trauma interpersonal.

不同创伤生活事件与自杀的关系

背景：创伤性生活事件与多种精神疾病的患病风险增加有关，其中也包括自杀风险。我们的研究目的是根据事件类型和性别，分别考察不同创伤生活事件和自杀之间的关系。

方法：被试由参加癌症筛查的冰岛妇女（N = 689）和随机抽样的一般人群（N = 709）组成，在网络上完成调查问卷。生活事件通过《生活压力源检查表 - 修订版》测量，根据DSM-5判断创伤性生活事件。自我报告的自杀念头，有自杀意图的自残和自杀未遂都被视为'终身自杀'（lifetime suicidality）。 我们使用泊松回归，控制人口统计学因素，计算相对风险（relative risks ）来度量创伤事件与自杀之间的关联性。

结果：被试回应率为66%（922/1398）。 终身创伤事件的发生率在女性中为76%，在男性中为77%。 终身自杀率在女性中为11%，在男性中为17%。 经历过创伤事件与自杀的总体相关（RR 2.05，CI 1.21–3.75），在男性中（RR 3.14，CI 1.25–7.89）相比女性（RR 1.45，CI 0.70–2.99）这种关联性更强。 经历人际创伤（RR 2.97，CI 1.67–5.67），童年创伤（RR 4.09，CI 2.27–7.36）和性创伤（RR 3.44，CI 1.85–6.37）的被试自杀的可能性更高，男性尤甚。此外，还在男性中发现非人际创伤与自杀之间存在关联（RR 3.27，CI 1.30–8.25），但在女性中则没有出现关联（RR 1.27，CI 0.59–2.70）。

结论：研究结果表明，自杀与创伤性生活事件有关，尤其是与男性和人际创伤相关最强。

1. Introduction

Suicides are currently a major public health threat and increased understanding of risk factors is important. Suicidality (e.g. suicidal thoughts, suicidal self-harm and suicide attempts) is one of the most important risk factors for completed suicides (Christiansen & Jensen, 2007; Kim et al., 2018). The lifetime prevalence of suicidality in the general population has been shown to be 9% for suicide ideation, 3% for suicide planning and 3% for suicide attempts (Nock et al., 2008). Non-suicidal self-harm is generally not considered as suicidal behaviour, although a strong relationship between self-harm and suicide has been shown (Hawton, Zahl, & Weatherall, 2003; Zahl & Hawton, 2004). Studies have demonstrated a lifetime prevalence for self-harm of 6–24% in the general population, varying between different study groups and definitions of self-harm (Cipriano, Cella, & Cotrufo, 2017; Klonsky, 2011). Even though some risk factors for suicidality are known (e.g. young age, female gender) (Nock et al., 2008; Zalsman et al., 2016), the interaction among social, psychological and behavioural risk factors is complex. Mental disorders are, for example, known to be among the strongest predictors of suicidal behaviour (Harris & Barraclough, 1997; Nock, Hwang, Sampson, & Kessler, 2010). Yet, a large cross-national analysis from the World Health Organization (WHO) world mental health surveys (n = 108,664) found that only close to half of individuals who reported having had serious suicidal thoughts actually reported a previous psychiatric disorder (Nock et al., 2009). For effective prevention of suicidality and suicide risk, this highlights the need to understand more about other risk factors, such as exposure to traumatic events.

A majority (60–90%) of individuals will experience a traumatic event in their lifetime (Kessler et al., 2017; Kilpatrick et al., 2013; Thordardottir et al., 2015). While most individuals adjust to the trauma and recover from the emotional strain that follows, it remains unexplained why some suffer more than others and experience mental health decline, even to the point of suicidal risk . A minority may experience post-traumatic stress disorder (PTSD) following trauma, which has been linked to suicidality (Ford & Gomez, 2015; Krysinska & Lester, 2010; Panagioti, Gooding, Triantafyllou, & Tarrier, 2015). The risk of PTSD may, however, vary according to trauma event type (Kessler et al., 2017; Ozer, Best, Lipsey, & Weiss, 2003). The risk of suicidality may also vary according to type of traumatic event. For example, a study based on the WHO's mental health surveys implemented in 21 countries (n = 102,245) and investigating a range of traumatic events and suicidal behaviour (Stein et al., 2010) found that the strongest associations were found for violence-related events. In addition, previous studies have shown increased risk of suicidal behaviour subsequent to adverse and traumatic life events during childhood (Afifi et al., 2016; Bruffaerts et al., 2010), for both suicidal ideation (Stansfeld et al., 2017) and suicide attempts (Dube et al., 2001; Enns et al., 2006; Ford & Gomez, 2015). Furthermore, studies have found that non-interpersonal events such as the loss of a loved one can increase the risk of self-injury (Bylund Grenklo et al., 2013), suicide attempts and suicides (Jakobsen & Christiansen, 2011; Niederkrotenthaler, Floderus, Alexanderson, Rasmussen, & Mittendorfer-Rutz, 2012). Knowledge on how various types of traumatic event may predict suicidality (Yoo et al., 2018) is, however, still scarce, especially with regard to gender.

Studies have shown that men are more likely than women to experience various types of trauma, except for sexual and violent trauma (de Vries & Olff, 2009; Tolin & Foa, 2006). Women are, however, more likely to engage in self-harm and suicide attempts than men (Nock et al., 2008; World Health Organization, 2014).

The knowledge on trauma event exposure is limited in Iceland and, to our knowledge, no study has studied its association with suicidality. With the overall aim of enhancing current understanding of suicidal behaviour, the objective of this study was to increase knowledge on the association of traumatic life events and suicidality, focusing on type of event and gender.

2. Methods

2.1. Study design and population

With the principal aim of significantly advancing current understanding of the effects of stress, lifestyle and inheritance on health, the Stress And Gene Analysis (SAGA) cohort study was launched with a pilot phase in February to April 2014. We invited 1640 individuals, aged 20–69 years, to participate in the pilot study. Women were invited through the cancer screening programme at the Icelandic Cancer Society (ICS), where the majority of all women accept a screening invitation whether or not they have a history or increased risk of cancer. A sample of women who had accepted a screening invitation and were attending regular breast and cervical cancer screening at the ICS were invited to participate in the study (n = 742). For men, we invited a random sample from the Icelandic population registry living in the area of the capital, Reykjavik, to participate (n = 898). Apart from the method of invitation, the enrolment procedure was the same for both genders. Participants received an invitation letter containing information about the questionnaire and study details. The invitation letter was followed by a telephone call from a professional working at the study centre, introducing the study aims and procedure and offering further information. All participants received a secure link to the questionnaire via e-mail.

2.2. Measurements

2.2.1. Stressful life events

We evaluated stressful and traumatic life events with the assessment instrument Life Stressor Checklist – Revised (LSC-R) (Wolfe, Kimerling, Brown, Chrestman, & Levin, 1996). This 30-item questionnaire covers various types of life stressor such as loss of significant others, exposure to natural disasters, accidents, and interpersonal, physical or sexual assaults. We used the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) definition of trauma-related disorders to evaluate events as traumatic (where trauma is defined as direct exposure to actual or threatened death, serious injury and/or sexual violence, witnessing these events happening to others, learning that they happened to a loved one, or repeatedly being exposed to details of such events) (American Psychiatric Association, 2018). In total, 11 types of event from the LSC-R were classified as traumatic, which we subcategorized into: (1) all traumatic events, classified into (A) non-interpersonal traumatic events and (B) interpersonal traumatic events. We further divided the interpersonal traumatic events into (B1) childhood trauma and (B2) sexual trauma (see Table 3 footnotes).

2.2.2. Assessment of suicidality

For the outcome measurement, we asked participants about current suicidal thoughts, as well as lifetime history of suicidal thoughts, self-harm, suicide planning and suicide attempts. The question on current suicidal thoughts came from a validated depression questionnaire, the Patient Health Questionnaire (PHQ-9), while questions on suicide planning, self-harm and suicide attempts were single-item questions (see Appendix for detailed prescription). We combined all suicidal outcomes as one outcome of lifetime suicidality (present suicidal thoughts, lifetime suicidal thoughts/planning and suicide attempts) and included self-harm with suicidal intent in that measure of suicidality.

2.2.3. Other measures

We asked whether participants had experienced a 2 week depressive period in their lifetime, and whether they had a history of psychiatric morbidity such as depression or PTSD (see Appendix).

2.2.4. Sociodemographic factors

The SAGA questionnaire included questions on participants' gender, age, education, place of residence, marital status, employment and social support (Loucks, Berkman, Gruenewald, & Seeman, 2006). Before conducting the analyses, we divided age into four categories: 20–35 years, 36–45 years, 46–55 years, and 56 years and older. We categorized educational level into: basic (elementary), middle (high school), university education (completed) and other/not stated; and divided residence by postal codes into habitation in the centre of Reykjavik, suburbs of Reykjavik and other municipalities surrounding the capital area. Marital status was divided into: married/cohabiting, in a relationship, single, widow/widower and not stated. We categorized employment status as: employed (including being a student and being on parental

leave), unemployed, disabled/on sick leave, retired and not stated.

2.3. Statistical analysis

We used descriptive statistics to evaluate the demographic background of the participants, using the chi-squared test to evaluate the differences between the groups with and without a history of trauma. We calculated the prevalence for suicidal thoughts, suicidal self-harm, suicide planning and suicide attempts, and evaluated the prevalence for each characteristic category. We calculated the prevalence for the classified groups of traumatic life events, and to evaluate the risk of lifetime suicidality we used Poisson regression for each group with a comparison group experiencing no trauma (or non-equivalent trauma type), overall and by gender. With the same measures, we conducted a sensitivity analysis to evaluate the risk of current suicidality. We performed all statistical analyses with the R statistical program (R Core Team, 2013).

The study was approved by the National Bioethics Committee in Iceland (reference: VSNb2013010025/03.7) and announced to the Data Protection Authorities in Iceland.

3. Results

Individuals who had a listed address and telephone number and spoke Icelandic (n = 1398, 689 women and 709 men) met the inclusion criteria, and out of these, 1038/1398 (74%) started answering the SAGA cohort study questionnaire. We excluded individuals who did not answer the question on gender and those who did not complete the questionnaire, leaving 922 participants (66%). Slightly over half of the participants were female (56%). The total response rate was 58% for men (403/689) and 73% for women (519/709). Female participants had similar educational levels, employment and marital status to women in the general population (Statistics Iceland, 2018). The mean age was 52.6 years for females in the study and 45.6 years for males.

Table 1. Demographics of the Stress And Gene Analysis (SAGA) cohort study population by history of trauma.

	Total	No previous trauma	History of trauma	*p*
Total	922	205/872	667/872	
Men	403 (44)	87 (42)	293 (44)	0.76
Women	519 (56)	118 (58)	374 (56)	
Age group	922	205	667	0.23
18–35 years	149 (16)	39 (19)	102 (15)	
36–45 years	179 (19)	45 (22)	119 (18)	
46–55 years	265 (29)	52 (25)	195 (29)	
≥ 56 years	329 (36)	69 (34)	251 (38)	
Education	920	204	666	0.009
Basic	163 (18)	26 (13)	129 (19)	
Middle	264 (29)	50 (25)	198 (30)	
University (completed)	377 (41)	103 (50)	255 (38)	
Other	116 (13)	25 (12)	84 (13)	
Residence	902	202	663	0.63
Reykjavik centre	272 (30)	66 (33)	196 (30)	
Reykjavik suburbs	232 (26)	53 (26)	172 (26)	
Surrounding municipalities	398 (44)	83 (41)	295 (44)	
Marital status	905	202	655	0.25
Married/cohabiting	668 (74)	158 (78)	477 (73)	
In a relationship	50 (6)	13 (6)	33 (5)	
Single	175 (19)	30 (15)	134 (20)	
Widow/widower	12 (1)	1 (0)	11 (2)	
Employment	912	202	665	0.002
Employed/studying/parental leave	775 (85)	187 (93)	548 (82)	
Unemployed	28 (3)	2 (1)	23 (3)	
Disabled/sick leave	61 (7)	5 (2)	55 (8)	
Retired	48 (5)	8 (4)	39 (6)	
Social connectedness	922	205	667	0.43
Low	201 (22)	42 (20)	134 (20)	
Medium	273 (30)	69 (34)	195 (29)	
Medium high	317 (34)	71 (35)	237 (36)	
High	131 (14)	23 (11)	101 (15)	
Previous psychological morbidity	922	205	667	0.003
Yes	211 (23)	32 (16)	173 (26)	
No	711 (77)	173 (84)	494 (74)	
History of depression	896	205	664	< 0.0001
Yes	362 (40)	56 (27)	297 (45)	
No	495 (55)	140 (68)	339 (51)	
Don't know/not answered	39 (4)	9 (4)	28 (4)	
History of loss of interest	890	201	662	0.0002
Yes	310 (35)	52 (26)	248 (37)	
No	534 (60)	145 (72)	374 (56)	
Don't know/not answered	46 (4)	4 (2)	40 (6)	

Data are shown as n (%).

Characteristics of the total study population are listed in Table 1. Characteristics are also listed by whether or not participants had experienced trauma. A vast majority (667/872, 76%) had experienced a traumatic event in their lifetime. Participants with no history of trauma (205/872, 23%) had a lower prevalence of psychological morbidity than the group with trauma history (16% vs 26%, $p < 0.05$), as well as a lower prevalence of having experienced a 2 week depressive period in their lifetime (27% vs 45%, $p < 0.05$) or a period of loss of interest (26% vs 37%, $p < 0.05$) (Table 1).

3.1. Mental disorders and gender

Sixteen per cent of participants reported having had a depressive disorder during their lifetime. Women were more likely to report having had a depressive disorder compared to men (18% vs 13%, $p = 0.02$), and more likely to have experienced 2 week periods of depressive symptoms (women 46% vs men 33%, $p = 0.0002$) and a period of loss of interest (women 39% vs men 30%, $p = 0.001$). Among those who had a history of trauma, the difference between the genders was similar; men had a lower prevalence of previous depression compared to women (15% vs 22%, $p = 0.03$), as well as a lower prevalence of experiencing a 2 week depressive period (38% vs women 53%, $p = 0.009$) and a period of loss of interest (35% vs 44%, $p = 0.01$).

3.2. Suicidality and gender

Out of 893 individuals answering the question on present suicidal thoughts, 44 (5%) reported having current thoughts. As shown in Figure 1, the prevalence of current suicidal thoughts was not higher among men than women (6% vs 4%, $p = 0.47$), while a lifetime history of having had serious thoughts of dying by suicide was higher among men than women (15% vs 8%, $p = 0.001$), as was having planned a suicide (8% vs 5%, $p = 0.02$), but not lifetime deliberate self-harming (1% vs 1%) or having attempted suicide (3% vs 2%, $p = 0.42$). Table 2 presents the demographics of individuals who reported any suicidality, including current suicidal thoughts, lifetime suicidal thoughts (thought and planning) and suicidal actions (suicidal self-harming or attempting suicide). The overall prevalence for lifetime suicidality was 13% (men 16% and women 11%, $p = 0.017$). Among those reporting lifetime suicidality, 42% reported a previous mood affective disorder and 36% reported having had PTSD (all women; no men reporting suicidality reported previous PTSD).

3.3. Traumatic life events and suicidality

In total, 76% of participants had experienced an event in their lifetime classified as traumatic, 64% had experienced events classified as non-interpersonal trauma (men 68% and women 61%), 40% interpersonal trauma (men 38% and women 43%), 23% trauma during their childhood (men 17% and women 28%) and 19% sexual trauma (men 11% and women 25%). Table 3 presents the association between having experienced traumatic life events and lifetime suicidality. After adjusting for sociodemographic factors, we found that any traumatic life event increased the overall risk of lifetime suicidality [relative risk (RR) 2.05, 95% confidence interval (95% CI) 1.21–3.75], as did non-interpersonal trauma (RR 2.03, 95% CI 1.15–3.59). After stratifying by gender, the risk was found to be increased for men (RR 3.14, 95% CI 1.25–7.89 and RR 3.27, 95% CI 1.30–8.25), but not for women (RR 1.45, 95% CI 0.70–2.99 and RR 1.27, 95% CI 0.59–2.70). We furthermore found that the experience of an interpersonal traumatic life event increased the risk of lifetime suicidality for both

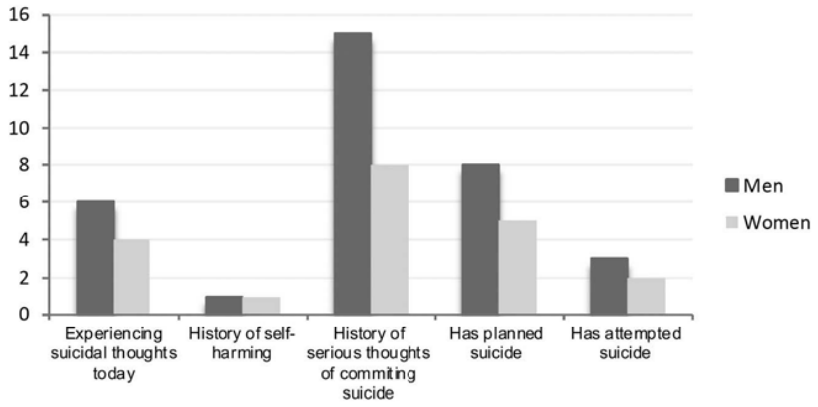

Figure 1. Overall prevalence (percentage) of current suicidal thoughts and history of suicidal thoughts, suicidal self-harm, suicide planning and suicide attempts of the Stress And Gene Analysis (SAGA) cohort study population, presented by gender.

Table 2. Suicidal outcomes by background characteristics among the Stress And Gene Analysis (SAGA) cohort study population.

	Current suicidal thoughts (*n* = 892)	Lifetime suicidal thoughts/ planning (*n* = 900)	Lifetime self-harm/ attempt (*n* = 899)	Lifetime overall suicidality (*n* = 922)
Total	44/892 (5)	120/900 (13)	24/899 (3)	120 (13)
Men	22/389 (6)	65/390 (17)	13/390 (3)	65/403 (16)
Women	22/503 (4)	55/509 (11)	11/509 (2)	55/519 (11)
Age group	*n* = 888	*n* = 899	*n* = 899	*n* = 923
18–35 years	10/145 (7)	27/145 (19)	3/145 (2)	27/149 (18)
36–45 years	8/164 (5)	29/169 (17)	8/169 (5)	29/179 (16)
46–55 years	9/253 (4)	28/256 (11)	7/256 (3)	28/265 (11)
≥56 years	17/326 (5)	36/329 (11)	6/329 (2)	36/329 (11)
Education	*n* = 846	*n* = 897	*n* = 889	*n* = 897
Basic	9/157 (6)	24/159 (15)	8/159 (5)	24/163 (15)
Middle	17/255 (7)	41/255 (16)	8/255 (3)	41/264 (16)
University (completed)	14/366 (4)	41/370 (11)	3/370 (1)	41/377 (11)
Other	4/112 (4)	14/113 (12)	5/113 (4)	14/116 (12)
Residence	*n* = 885	*n* = 892	*n* = 892	*n* = 902
Reykjavik centre	12/265 (5)	42/267 (16)	9/267 (3)	42/272 (15)
Reykjavik suburbs	12/226 (5)	26/230 (11)	7/230 (3)	26/232 (11)
Surrounding municipalities	19/394 (5)	50/395 (13)	7/395 (2)	50/398 (13)
Marital status	*n* = 865	*n* = 884	*n* = 884	*n* = 915
Married/cohabiting	24/651 (4)	65/654 (10)	11/654 (2)	65/668 (10)
In a relationship	3/48 (6)	6/48 (13)	0/48 (0)	6/50 (12)
Single	17/167 (10)	47/170 (28)	12/170 (7)	47/175 (27)
Widow/widower	0/12 (0)	1/12 (8)	0/12 (0)	1/12 (8)
Employment	*n* = 848	*n* = 894	*n* = 894	*n* = 892
Employed/studying/leave	27/726 (4)	88/758 (12)	12/758 (2)	88/775 (11)
Unemployed	3/27 (11)	8/27 (30)	4/27 (15)	8/28 (29)
Disabled/sick leave	12/48 (25)	20/61 (33)	8/61 (13)	20/61 (33)
Pension	2/47 (4)	4/48 (8)	0/48 (0)	4/48 (8)
Psychological disorders*	*n* = 961	*n* = 973	*n* = 973	*n* = 973
Mood affective disorders	24/145 (17)	60/147 (41)	16/147 (11)	62/147 (42)
Anxiety disorders	18/124 (15)	42/126 (33)	11/126 (9)	42/126 (33)
PTSD	5/21 (24)	8/22 (36)	1/22 (5)	8/22 (36)
Other	7/34 (21)	17/36 (47)	4/36 (14)	17/36 (47)
None	12/637 (2)	41/642 (6)	6/641 (1)	41/641 (6)

*Have you had any of the following diseases? Mood disorders = Depression and Bipolar. Anxiety disorders = General anxiety disorder, Panic attacks, Agoraphobia and Social phobia. PTSD = Post-traumatic stress disorder. Other = Burnout, Obsessive–compulsive disorder, Schizoaffective disorder, Schizophrenia, Asperger, Tourette, Autism, Personality disorder. Individuals can answer for more than one psychological disorder; hence the *n*is higher.

Table 3. Experience of traumatic life events and relative risk of lifetime suicidality among the Stress And Gene Analysis (SAGA) cohort study population.

	No./total (%)*	Crude RR of lifetime suicidality (CI)	RR (CI) adjusted†	RR (CI) adjusted‡
Traumatic life event	105/667 (16)	2.31 (1.37–4.21)	2.38 (1.41–4.34)	2.05 (1.21–3.75)
Men	59/293 (20)	3.50 (1.55–10.03)	3.54 (1.57–10.14)	3.14 (1.25–7.89)
Women	46/374 (12)	1.61(083–3.52)	1.71 (0.88–3.74)	1.45 (0.70–2.99)
A. Non-interpersonal trauma	86/568 (15)	2.22 (1.30–4.07)	2.33 (1.37–4.29)	2.03 (1.15–3.59)
Men	53/262 (20)	3.52 (1.55–10.11)	3.59 (1.58–5.10.34)	3.27 (1.30–8.25)
Women	33/306 (11)	1.41 (0.71–3.14)	1.54 (0.77–3.46)	1.27 (0.59–2.70)
B. Interpersonal trauma	82/348 (24)	3.45 (2.02–6.35)	3.45 (2.03–6.36)	2.97 (1.67–5.67)
Men	42/141 (30)	5.18 (2.26–14.99)	5.23 (2.27–15.14)	4.30 (1.68–10.98)
Women	40/207 (19)	2.53 (1.29–5.57)	2.61 (1.32–5.75)	2.25 (1.08–4.70)
B1. Childhood trauma	65/200 (34)	4.76 (2.76–8.83)	4.81 (2.79–8.94)	4.09 (2.27–7.36)
Men	32/66 (48)	8.44 (3.60–24.68)	8.46 (3.60–24.77)	7.32 (2.77–19.31)
Women	33/134 (25)	3.23 (1.61–7.18)	3.31 (1.44–7.40)	2.82 (1.33–5.99)
B2. Sexual trauma	44/162 (27)	4.16 (2.34–7.84)	4.21 (2.38–7.95)	3.44 (1.85–6.37)
Men	18/40 (45)	7.83 (3.12–23.71)	8.36 (3.31–25.48)	7.66 (2.51–23.51)
Women	26/122 (21)	3.01 (1.48–6.76)	3.03 (1.48–6.81)	2.48 (1.15–5.36)

*The number of individuals experiencing suicidality among those experiencing given traumatic events.
† Adjusted for age.
‡ Adjusted for sociodemographic factors: age, residence, education, marital status and employment.
A: Experienced major disaster, witnessed serious accident, experienced a serious accident, lost a loved one suddenly (heart attack, murder, suicide). B: Been robbed or physically assaulted, been physically assaulted by someone you know before age 18, been physically assaulted by someone you know after age 18, been touched against own will in a sexual way before age 18, been touched against own will in a sexual way after age 18, raped before age 18, raped after age 18. B1: Been physically assaulted by someone you know before age 18, been touched against own will in a sexual way before age 18, raped before age 18. B2: Been touched against own will in a sexual way before age 18, been touched against own will in a sexual way after age 18, raped before age 18, raped after age 18.
RR, relative risk; CI, confidence interval.

genders, with higher risk for men (RR 4.30, 95% CI 1.68–10.98) than for women (RR 2.25, 95% CI 1.08–4.70). This further applied to childhood trauma (men RR 7.32, 95% CI 2.77–19.31, and women RR 2.82, 95% CI 1.33–5.99) and sexual trauma (men RR 7.66, 95% CI 2.51–23.51, and women RR 2.48, 95% CI 1.15–5.36).

4. Discussion

In this study, we found an increased risk of lifetime suicidality among individuals reporting lifetime interpersonal, childhood and sexual trauma, with stronger associations observed for men than for women. We furthermore found an association between experience of non-interpersonal trauma and suicidality among men. In addition, we found that while women more frequently reported lifetime depressive periods, men had a higher prevalence of suicidal outcomes.

4.1. Traumatic life events and suicidality

Among those who had experienced interpersonal traumatic life events, we found increased risk of suicidality for both genders. Similarly, studies have found strong associations between interpersonal trauma and suicidality, especially sexual trauma (Stein et al., 2010) and childhood trauma (Afifi et al., 2016; Dube et al., 2001). Among those who had experienced sexual trauma or childhood trauma in our study, we found an association with suicidality in both genders, which was stronger for men.

For non-interpersonal traumatic events, such as the sudden loss of a loved one and experiencing a natural disaster, we found increased risk for suicidality for men only. Similarly, some studies have indicated elevated risk of suicide for both genders following the loss of a loved one, although this was significantly higher for men (Li, 1995; Luoma & Pearson, 2002). Other studies have furthermore indicated that men may be at more risk of suicidal behaviour associated with natural disasters (Chou et al., 2003; Vehid, Alyanak, & Eksi, 2006). To minimize the risk of suicidality, preventive measures aiming at psychological health after traumatic societal events as well as personal trauma may be beneficial, especially for men.

4.2. Gender and suicidality

The total prevalence of any lifetime suicidality was 13% in our study, which largely matches previous research, indicating a lifetime suicidality prevalence of 13–20% in a general population (De Leo, Cerin, Spathonis, & Burgis, 2005; Kessler, Borges, & Walters, 1999; Nock et al., 2008). The observed higher prevalence of suicidality among men than women (men 16% vs women 11%, $p = 0.02$) is, however, unusual. Despite this difference in suicidality, women in our study had a higher prevalence of reported lifetime depressive symptoms and PTSD. The underlying mechanisms for these unexpected findings of higher risk of suicidality but not depressive symptoms in association with exposure to trauma among men are probably multifactorial. First, it has been suggested that traditional diagnostic criteria for depressive symptoms may not detect men's depression (Martin, Neighbors, & Griffith, 2013), leaving untreated and/or unreported symptoms more likely to develop to suicidality. Secondly, men may find it more difficult, and find different ways, to regulate their emotional feelings than women (Beautrais, 2002; Nolen-Hoeksema, 2012). Furthermore, they seem less likely to seek help for mental health problems after trauma (Möller-Leimkühler, 2002), which may leave untreated symptoms more likely to develop to suicidality. Thirdly, following trauma, women are more likely than men to meet criteria for PTSD (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995; Tolin & Foa, 2006). PTSD has frequently been reported to be associated with suicidality and may be an important mediator in further development of suicidality after trauma (Ford & Gomez, 2015; Panagioti et al., 2015; Wilcox, Storr, & Breslau, 2009). In our study, among individuals reporting suicidality, only women reported having been diagnosed with PTSD in their lifetime. The reasons for gender differences in PTSD development are unclear. If men are more reluctant to express their emotional feelings following trauma, they may possibly be less likely to be diagnosed with PTSD and, in turn, less likely to receive help. Our results of suicidality risk associated with non-interpersonal trauma (such as natural disaster), only for men, may be due to higher risk of PTSD among men after such trauma. A study by Arnberg et al. (2015), for example, found increased risk of PTSD in individuals exposed to the 2004 South-East Asian tsunami compared to unexposed individuals, and that the risk was higher for male survivors [hazard ratio (HR) 11.5, 95% CI 6.77–19.47] than for female survivors (HR 6.30, 95% CI 4.25–9.34). In addition, a study on stressful and traumatic life events found that men had higher levels of PTSD after stressful life events than traumatic events, while women had similar levels of PTSD for both type of events (van den Berg, Tollenaar, Spinhoven, Penninx, & Elzinga, 2017).

If men are more reluctant to acknowledge psychiatric morbidity and seek help, it may result in unrecognized PTSD and psychological morbidities, possibly affecting more serious psychological outcomes for men, such as suicidality. If so, this emphasizes the clinical importance of focusing on adequate psychological follow-up after traumatic events and even screening for trauma history among individuals with psychological morbidities, with a special awareness of the importance of reaching both men and women.

4.3. Strengths and limitations

A strength of our study is that it is based on a sample with a relatively high participation rate (66%). In the questionnaire, we used a validated checklist on exposure measurement (LSC-R), using the newest DSM-5 diagnostic codes as a guideline to evaluate the type of traumatic event. Having questions on psychological morbidity after receiving questions on lifetime trauma may lead to differential misclassification when comparing participants with a history of traumatic events to participants with no such history (Hauksdóttir, Steineck, Fürst, & Valdimarsdóttir, 2006). To avoid this potential bias, we placed questions on psychological morbidity and suicidal behaviour earlier in the questionnaire.

Some limitations should be noted; for example, owing to the cross-sectional design of the study, we cannot conclude whether the exposure (specific life event) occurred before suicidality. However, when evaluating the association for traumatic events and restricting the outcome measures for current suicidality only, we found similar significant results. We have no information on those who did not participate in the study or did not complete the questionnaire, and it is possible that such selection affects our observed point estimates. Furthermore, even though the question on current suicidal thoughts is a part of the validated questionnaire PHQ-9, we do not have validated or standardized measurements on self-harm and suicide attempts, which limits our generalization and comparison to other studies. Regarding gender differences, all female participants in the study were women who were already attending a cancer screening clinic, while men were a random population sample. On the one hand, women who have experienced serious trauma, especially sexual trauma, may be more reluctant to attend such a screening programme, and therefore not participate in our study, but on the other hand, women who have experienced trauma in their lifetime may be more likely to seek medical care, especially those with psychiatric disorders. We may therefore possibly have an oversampling of women with traumatic life exposure except for sexual trauma. This may limit the generalizability of findings for women. In addition, the findings may underestimate the prevalence of self-harm with suicidal intent since only individuals answering 'yes' on lifetime depressive symptoms received questions on self-harm (see Appendix). This may be true especially for men, who may be more reluctant than women to report depressive symptoms. The use of retrospective self-reported measures of lifetime trauma and suicidal behaviour is one of the study's limitations raising the risk of recall bias, especially with older age and longer time passed since the traumatic event. The main results did, however, not change significantly after we restricted the outcome measurement to current suicidality. This source of error would be non-differential with respect to suicidality status. In this regard, the mean age was higher for women in our study, which may further explain our gender-specific result. Yet, adjustment for age, education and other sociodemographic factors did not considerably affect the main results on the relationship between trauma and suicidality, for either gender.

5. Conclusion

This study emphasizes the importance of interpersonal trauma as a major risk factor of suicidality and further indicates that trauma, especially non-interpersonal trauma, may be likely to be associated with suicidality among men. To reduce the risk of suicidal thoughts or behaviours, it may thus be beneficial for clinicians to routinely assess trauma history among patients seeking care for psychological problems but also to implicate preventive measures in society in relation to traumatic events.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix

Details of measurement methods

Outcome measurements were further evaluated.

Current suicidal and self-harm thoughts

For the evaluation of current suicidal thoughts, we used an item from the Patient Health Questionnaire (PHQ-9) (Cannon et al., 2007; Kroenke, Spitzer, Williams, & Lowe, 2010): 'Over the last two weeks, how often have you had thoughts that you would be better off being dead, or of hurting yourself in some way?', with the response alternatives: (1) Not at all, categorized as 'No', and (2) Several days, (3) More than half the days, as well as (4) All the time, categorized as 'Yes'.

History of depressive symptoms

In the SAGA questionnaire, we included two questions on lifetime depressive symptoms based on the Composite International Diagnostic Interview (CIDI) instrument:

(1) 'In your lifetime, have you ever had two weeks or longer when nearly every day you felt sad, empty, or depressed for most of the day?' (called depressive period in the manuscript)
(2) 'In your lifetime, have you ever had 2 weeks or longer when you lost interest in most things like work, hobbies, and other things you usually enjoyed?' (called loss of interest in the manuscript).

The response alternatives were: Yes/No/Don't know.

History of suicidality

(3) **Previous self-harm**: 'Have you ever harmed yourself deliberately because of your feelings? (for example cut into your arm)', with response alternatives: Yes/No/Don't know. This question was a

follow-up question for individuals answering 'yes' to either question 1 or 2 on lifetime depressive symptoms. If the participant answered 'yes' to self-harming, follow-up questions were asked on frequency, age of onset and age of last self-harm act, along with the question: 'Why did you harm yourself?', with response alternatives: (1) 'I had the urge to', (2) 'I felt relief doing so', (3) 'It was a cry for help', (4) 'It was a suicide attempt', and (5) 'I wanted to die'. Even though self-harm may increase risk of suicidality, individuals who self-harm may have no suicidal intent (Edmondson, Brennan, & House, 2016), and distinguishing non-suicidal self-harm from suicidality is therefore important. We divided answers 1–3 as self-harm without suicidal intent and 4–5 as self-harm with suicidal intent, and used only answer alternatives 4–5 as an outcome measure of suicidality.

(4) **Previous suicidal thoughts**: (Received by all participants) 'Have you ever seriously thought about committing suicide?' (categorized as 'No' for: No/Don't know/Not answering; and categorized as 'Yes' for Yes, once/Yes, a few times/Yes, often).

(5) **Previous suicide planning**: Those answering 'yes' to having had serious suicidal thoughts received a follow-up question: 'Have you ever planned in what way you would commit suicide?', with response alternatives: Yes/No/Don't know.

(6) **Previous suicide attempt**: Finally, those who answered yes to having planned their suicide received the question: 'Have you ever tried to commit suicide?', with response alternatives: Yes/No/Don't know.

(7) We categorized all questions on self-harm with suicidal intent and suicidal behaviour into suicidal behaviour with and without active measures to evaluate the difference between individuals who had experienced suicidal thoughts (including current thoughts) and those who had acted on their depressive thoughts (attempted suicide and self-harm with suicidal intent). We identified a positive answer on any of the suicidal behaviour questions as lifetime suicidality.

Assessment of other mental health outcomes

(8) To evaluate a history of psychiatric disorders, we included a question: 'Have you had any of these psychiatric diseases?', with response possibilities that we categorized according to definition by DSM-IV (American Psychiatric Association, 2000) into: (1) Mood affective disorders (depression and bipolar), (2) Anxiety-related disorders (including positive responses on general anxiety disorder, panic attacks, agoraphobia and social phobia), (3) PTSD (positive response on post-traumatic stress disorder), and (4) Other (positive response on burnout, obsessive–compulsive disorder, schizoaffective disorder, schizophrenia, Asperger, Tourette, autism, or personality disorder).

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Paper II

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Suicide attempts and self-harm during a dramatic national economic transition: a population-based study in Iceland

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Background: Macroeconomic downturns have been associated with increased suicide rates. This study examined potential changes in suicide attempts and self-harm in Iceland during a period of major economic transition (2003–12). **Methods:** Data were retrieved from the National University Hospital in Reykjavik (population size: 204.725), containing all ICD-10 diagnoses connected to potential suicidal behaviour. Poisson regression models were used to compare attendance rates before and after the 2008 economic collapse. **Results:** During the study period, a total of 4537 attendances of 2816 individuals were recorded due to suicide attempts or self-harm. We noted a significant change in total attendance rates among men, characterized by an annual increase in attendance rate pre-collapse of 1.83 per 100.000 inhabitants and a decrease of 3.06 per 100.000 inhabitants post-collapse ($P = 0.0067$). Such pattern was not observed among women. When restricting to first attendances only, we found a reduced incidence post-crisis among both men (RR: 0.85; 0.76–0.96) and women (RR: 0.86; 0.79–0.92). We further found 1% increase in unemployment rate and balance of trade to be associated with reduced attendance rates among men (RR: 0.84; 0.76–0.93 and RR: 0.81; 0.75–0.88, respectively) but not among women. **Conclusion:** These data suggest no overall increase in attendance rates due to suicide attempts or self-harm following the 2008 Icelandic economic collapse. In fact, a high-point in self-harm and suicide attempts was observed among men at the height of the economic boom and a decrease in new attendances among both men and women after the economic collapse.

Introduction

Large societal and economic changes can affect populations mental health and well-being.[1] Through the years 2003–12, Iceland experienced dramatic changes in the nation's economy, characterized firstly by an economic boom with an average of 6% annual gross domestic product (GDP) growth, and a dramatically expanding banking sector.[2] In the beginning of October in 2008, the blooming economic period came to an abrupt end when the value of the Icelandic selected share index was all-but completely erased and three of the largest banks in Iceland were nationalized. The national currency fell massively until its fall was tempered by the implementation of capital controls.[2] Unexpectedly for the majority of the nation, the Prime Minister announced in a live television broadcast on 6 October 2008, that Iceland was in a real danger of national bankruptcy.[3] A sudden financial collapse had hit Iceland with a following economic recession period, characterized by increasing unemployment rate and decreasing GDP.

Previous studies following the 2008 global economic crisis have found increased risks of psychological morbidity,[4,5] suicidal behaviour[6,7] and completed suicides.[8,9] Although self-harm and suicide attempts are generally more common among women than men,[10] some studies have suggested increased risk among men following an economic collapse, especially with rising unemployment rates.[6,11] However, others have found a decrease in suicide attempts following economic recessions, especially for men.[12] The association between economic recessions and self-harm or suicide attempts are therefore mixed, specifically regarding differential effects for men and women.

Studies on the health effects of the 2008 economic collapse in Iceland have found changes in certain health behaviours[13] and some have found gender specific effects, such as greater increase of stress[14] and immediate increase in attendance to the cardiac emergency among women,[15] while others found an increase in men's hypertension.[16]

Taken together, the long-term mental health effects of the economic collapse and following recession in Iceland are not known. The opportunity of obtaining unusually comprehensive data from the health registries in Iceland, along with such abrupt economic changes, provides excellent conditions for research in this area. We set out to investigate potential changes in prevalence of suicidal behaviour in Iceland for the 10-year period surrounding the economic collapse, 2003–12.

Methods

Study design

The study was based on all registered attendances to the National University Hospital of Iceland (NUH), due to potential suicide attempts and self-harm during the years 2003–12. NUH is an academic tertiary hospital and the largest referral centre in Iceland, serving all inhabitants in the main capital area (64% of Iceland's population in 2012) and nearly all severe cases from the whole country.

Population and data acquisition

All attendances to NUH are recorded electronically and patients receive a final diagnosis before discharge according to the International Classification of Diseases, 10th version (ICD-10). We retrieved attendances with ICD-10 discharge diagnosis indicating suicide attempts or self-harm from 1 January 2003 to 31 December 2012, all confirmed and registered by a physician. To our knowledge, this registration process has remained the same through the whole study period and no structural or austerity changes were made before or during the economic recession in either NUH or smaller health clinics. In case of critical cases of suicide attempts or self-harm, patients in NUH are admitted from the Emergency Department (ED), to the psychiatric clinic, or a specialized hospital ward (e.g. the intensive care unit). To achieve completeness of data, we retrieved all visits to the ED and admissions to in-patient care (hereafter called admissions to NUH).

Outcome measurements

The following ICD-10 diagnoses were retrieved: X60-84: Intentional self-harm, Y87: Sequel of intentional self-harm, assault and events of undetermined intent, Z91.5: Personal history of self-harm, T36-50: Poisoning by drugs, medicaments and biological substances, X40-49: Accidental poisoning by and exposure to noxious substances, and Y10-34: Event of undetermined intent. All medical records are registered by personal identification numbers which are unique for each inhabitant in Iceland. We gathered information for each visit on date and time of arrival and discharge, and the patient's gender, date of birth and residence by postcode.

The majority of the study population lived in the capital area, therefore, we used the whole population living in that area as a source population (N = 204.725).

Explanatory variables

To address whether the years after the economic collapse were characterized by an increase in attendance rates, the study period was dichotomized into a pre-collapse period from 1 January 2003 to 5 October 2008 (unexposed group), and a post-collapse period: 6 October 2008 to 31 December 2012 (exposed group). The date 6 October 2008 marks the definite starting point of the economic recession in Iceland; when the Prime Minister addressed the nation explaining that there was a sudden real danger of national bankruptcy.[3] Hereafter the two periods will be referred as (i) the pre-collapse period—characterized by low unemployment rate and a high annual GDP growth, and (ii) the post-collapse period—characterized by an immediate rising unemployment, decrease in GDP and sudden trade surplus, as opposed to the pre-collapse deficit.

Approvals were obtained for this study from The National Bioethics Committee (ref: 12-198-V2, S1), The Chief Medical Executive of The NUH and the Data Protection Authority (ref: 2012121479HGK).

Statistical analysis

` and by the two different registers (ED visits and admissions to NUH). We chose to evaluate age categories including younger individuals, as the age distribution was similar in the oldest and youngest age group and earlier findings have indicated that younger individuals might be more susceptible to stress in Iceland during the economic recession.[14] The age groups were: 18–25, 26–35, 36–45 and 46 years and older. Residence was divided by postal codes into habitation in Central Reykjavik, suburbs of Reykjavik area, other municipalities of the greater capital area and areas outside capital area.

We calculated attendance rates per 100.000 inhabitants at the end of each year in the larger capital area to explore potential changes in attendance during the total study period, 2003–12.

To further evaluate a difference between the two study periods, seasonal variations and gender differences, we calculated incidence of hospitalizations due to self-harm per 100.000 inhabitants for each consecutive quarter, for both periods. Each incidence is calculated with the number of capital inhabitants of the same gender and age group at the corresponding year as a denominator, to count for demographic changes in Iceland. The trend of attendances in each period for both genders was estimated with Poisson regression analysis. To further evaluate the difference between the estimated yearly increases, we used Poisson regression. When estimating potential change in the yearly incidence rate per 100.000 inhabitants from pre- to post-collapse period, we used Poisson regression model with the timing of the collapse as a dummy variable to evaluate the risk of post-collapse attendance compared to the relative pre-collapse attendance, using the same population data for comparison. This was done for the total study population, by gender and for each age group. We used same measures to evaluate the attendance rate by each specific disease-category (based on previously mentioned ICD-10 codes) during the study period and calculated the risk of post-collapse attendance compared with relative pre-collapse attendance in the two most evident disease categories (X60-84 and T36-50). Finally, same measures were used for all new incidences during the study period. In this analysis, only the first attendance of each individual during a respective observation period (pre- and post-collapse) was counted.

To evaluate which economic factors contributed to the association, we used the same method where the dummy variable was replaced with % changes in the Icelandic economic factors; the natiońs unemployment rate and the GDP level. Although those are the two main indicators of business cycles used in the literature, the Icelandic crisis had another aspect to it that we address for completeness. For increased external validity and to identify if found results are likely to be generalizable or due to the specific characteristics of this crisis, we also consider Balance of trade (BoT) as an indicator of the economic circumstances.[17] All statistical analysis were done with R statistical programme.[18]

Results

Between 1 January 2003 and 31 December 2012, a total of 4537 attendances were registered, involving 2548 individuals, 41% men, 59% women and the majority of patients resided in the capital area (86%) (Table1). The majority (86%) of the attendances were registered visits to the ED (3903 visits), while 14% were retrieved from the in-patient register (634 admissions). The most commonly registered cause of attendance was poisoning (63%), followed by personal history of self-harm (19%), and intentional self-harm (16%).

Characteristics of attendees in the pre-collapse and post-collapse period are presented in Table 1. The number of visits per individuals was higher in the pre-collapse period than the post-collapse period (1.52 vs. 1.42), as could be expected because of the different lengths

Table 1 Description of characteristics of all attendances to The NUH due to self-harm and suicide attempts 2003–8 (pre- and post-collapse periods presented)

Total *N* = 4537 (2548 individuals)	2003–8 (%)	2008–12 (%)
Total days	3300 (56)	2556 (44)
Total number of attendances	2577 (57)	1960 (43)
Total individuals for each period	1698	1372
Average attendances per day	0.78	0.77
Average days per attendance	1.28	1.30
Average attendances per individual	1.52	1.42
Attendances		
ED visits	2194	1709
Individuals	1403	1177
In-patient admissions	383	251
Individuals	295	195
Length of stay (mean days)		
ED	0.43	0.45
In-patient ward	9.19	6.66
Age (mean)		
ED	37.0 years	38.1 years
In-patient ward	39.2 years	39.6 years
Age (classified)		
18–25 years	681 (26)	516 (26)
26–35 years	577 (22)	458 (23)
36–45 years	581 (23)	369 (19)
46+ years	738 (29)	617 (31)
Gender		
Men	1056 (41)	799 (41)
Women	1521 (59)	1161 (59)
Residency		
Capital area		
Reykjavik Centre	825 (34)	615 (33)
Reykjavik Suburb	688 (28)	482 (26)
Capital Suburb	538 (22)	504 (27)
Outside capital area	377 (16)	242 (13)
ICD-10 diagnostic codes		
No of registered diagnoses	2997	2336
X60-84 Intentional self-harm	500 (17)	422 (18)
X40-49 Accidental poisoning	22 (1)	20 (1)
Y10-34 Undetermined event	46 (1)	32 (1)
T36-50 Poisoning	1877 (63)	1424 (61)
Z91.5 Personal history of self-harm	552 (18)	438 (19)

of the two periods. For ED visitors, the mean age was higher in the post-collapse period ($P = 0.03$), explained by an observed increase of individuals in the oldest age group (46^{+} years), rising from 29 to 31% between the two periods ($P = 0.01$). Gender distribution was similar in both periods ($P = 0.52$), but a difference in the residence distribution was however observed between periods ($P = 0.0005$), mainly consisting of a relative increase of attendees living in the capital's suburb areas (from 22 to 27%) in the post-collapse period.

In figure 1[], the annual attendance rate per 100.000 individuals is presented over the whole study period. For comparison, we present annual changes in BoT during the study period. Both are shown with a Loess curve. When evaluating attendance rates per 100.000 inhabitants and risk of post-collapse attendance compared to pre-collapse, no overall statistically significant changes were observed (RR: 0.95, CI: 0.90–1.01).

In figure 2, the quarterly age-standardized attendance rate per 100.000 inhabitants is presented for both periods by gender. The division of the two periods is marked by a white gap, representing 6 October 2008. The calculated time trend for men in the pre-collapse period showed a yearly increase of 1.83 male attendances per 100.000 male inhabitants towards a high point before the economic collapse, while changing to −3.06 per 100.000 in the post-collapse period. For women, we found a slope of −0.90 in the pre-collapse period, and an ongoing downward slope of −0.74 after the collapse, indicating an ongoing decrease of attendance each year. The difference in attendance rate is therefore small between periods for women ($P = 0.9336$), while the attendance rate change is statistically different pre-collapse compared with post-collapse for men ($P = 0.0067$).

Risk of attendance post-collapse compared with pre-collapse divided by gender and age groups is presented in Table 2; showing no increased risk, neither for women (RR 0.97, CI: 0.89–1.04) nor for men (RR 0.94, CI: 0.86–1.03). However, when only evaluating new incidences, a significant decrease was found for both women (RR 0.86, CI: 0.78–0.95) and men (RR 0.85, CI: 0.76–0.96) (Supplementary Table S3).

More than one ICD-10 code can be registered for each visit, hence the total number of diagnostic codes was higher (5333) than the total number of attendances ($N = 4357$). When evaluating risk of attendances for the most specific suicide attempt ICD-10 codes, we did not find a change in risk of attendance. When evaluating by gender, we found no change for womeńs risk of attendance by specific diagnostic codes, while we found decreased risk of attendance for men, both for attendance due to Poisoning (T36-50): (RR 0.87, CI: 0.78–0.97) and own history of self-harm (Z91.5): (RR 0.76, CI: 0.62–0.92).

When evaluating each 1% increase in macro-economic variables and association with attendance, we found a decreased risk of attendance with increasing unemployment rate (RR 0.90, CI: 0.84–0.96) and increasing BoT (RR 0.94, CI: 0.88–0.98). This decreased risk was however only significant for men's attendances with increased unemployment rate (RR 0.84, CI: 0.76-0.93) and with increased BoT (RR 0.81, CI: 0.75-0.88) and not for women [(RR 0.96, CI: 0.88–1.04) and (RR 1.04, CI: 0.97–1.10), respectively]. We found no changes in risk of attendance with GDP increase, neither total (RR 0.90, CI: 0.79–1.02) or by gender (men RR 0.94, CI: 0.78–1.15 and women RR 0.88, CI: 0.75–1.04).

Discussion

In this population-based study, no overall increase in attendance rates due to suicide attempts and self-harm was observed following the 2008 Icelandic economic collapse. In fact, when evaluating new incidences, a decrease was found for both men and women. Gender-specific analyses indicated a high-point in self-harm and suicide attempts during the economic boom for men, but not for women. Furthermore, the findings indicated that this male effect follows the pattern of some macro-economic variables, specifically unemployment rates and BoT.

Following the worldwide 2008 economic crisis, studies have found an increased risk of mental health deterioration,[4,6,19] self-harm and suicide attempts[11]—all known suicide risk factors.[20] Furthermore, numerous studies have indicated increased risks of completed suicides following the 2008 crisis, especially among men.[21,22] Specific austerity-related events following the economic crisis in Greece have been shown to significantly increase suicide rates,[23,24] and in some countries, an excess rise in suicide rate has been linked to increasing unemployment rate,[22,25,26] although the economic causal effect is unclear and may vary across countries.[27–29] Iceland is a small open economy with its own currency. The dramatic change of the economy in Iceland from extreme prosperity to a sudden economic collapse came as a shock to most Icelanders, as indicated by an increase in stress levels in Iceland shortly after the collapse.[14] Pre-collapse, there was a continual trade deficit, adding to the experienced prosperity within the country, with far greater consumption than represented by the level of local production. The collapse, subsequently led partly to a debt crisis and a trade surplus after the collapse. The unemployment rate was low in Iceland before the collapse (2.3%) and rose rapidly to 9% in 2009.[30] Related to this, countries with low unemployment rate before an economic crisis sets in have shown a greater increase in suicides among men, suggesting that sudden fear and earlier unknown insecurity due to employment might play a role.[8,26] Due

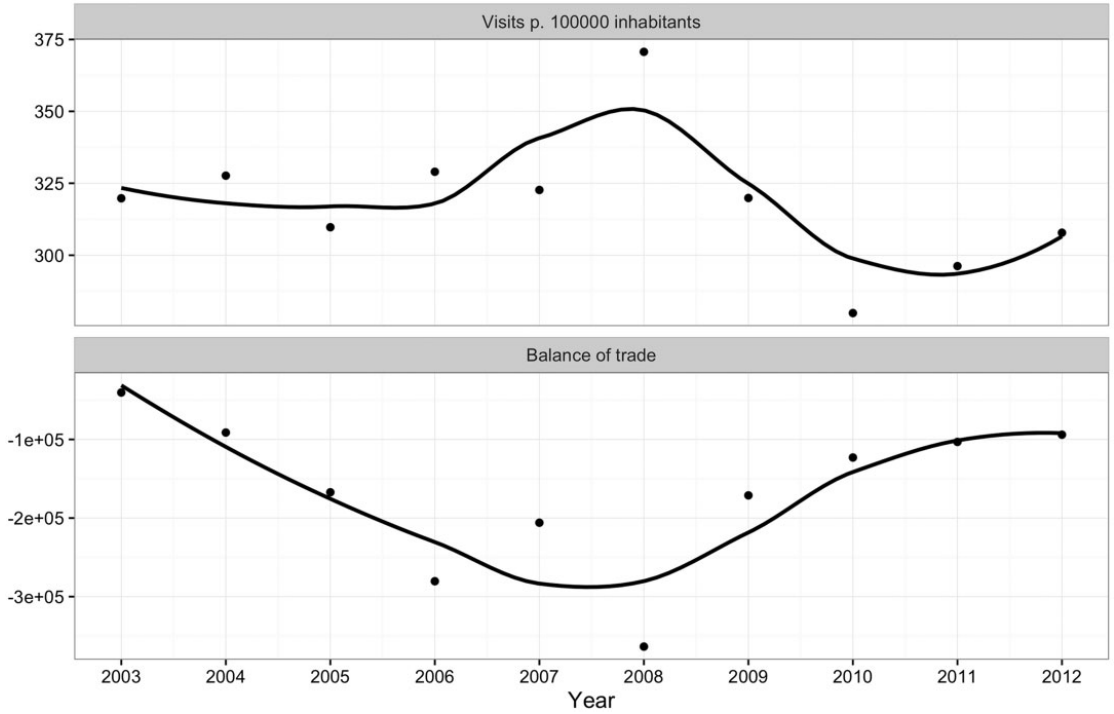

Figure 1 Annual attendance rate due to self-harm and suicide attempts per 100.000 individuals and annual balance of current account in Iceland through the years 2003–12, adjusted for population changes

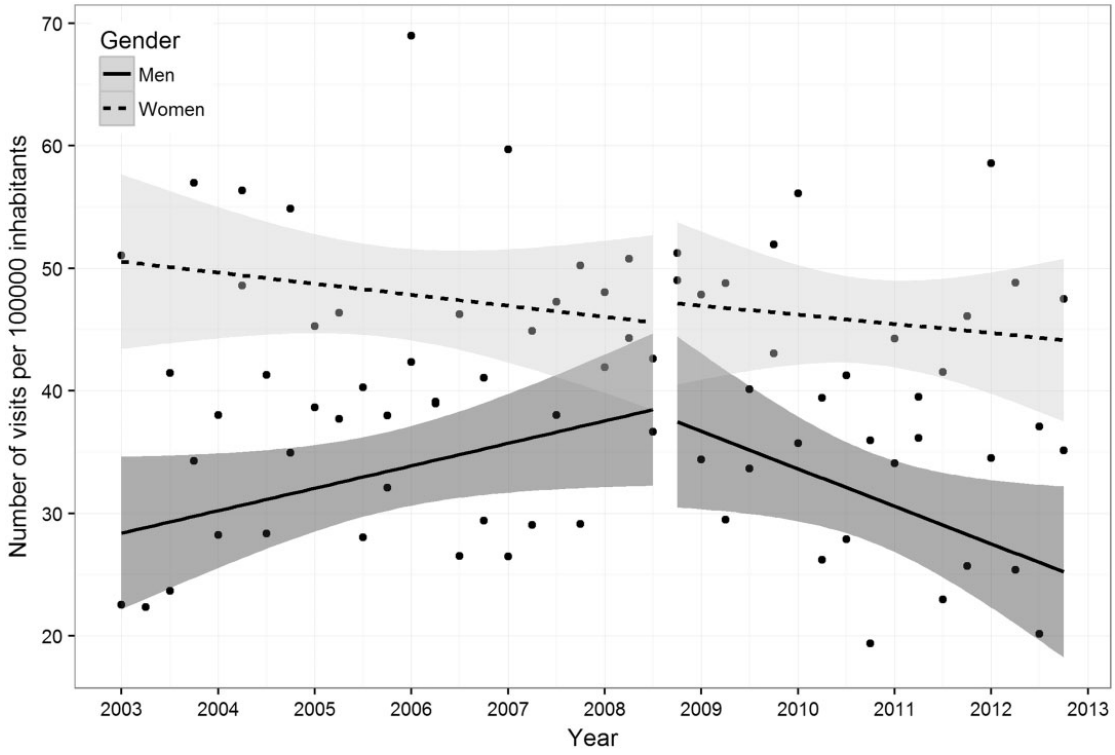

Figure 2 Quarterly attendances to The NUH due to self-harm and suicide attempts per 100.000 inhabitants; pre- and post-collapse, stratified by gender. The white gap represents October 2008

Table 2 Incidence per 100.000 inhabitants and the risk of post-collapse attendance compared with the relative pre-collapse attendance

	Pre-collapse No. events (N)/N per 100.000 per year[a]	Post-collapse No.events (N)/N per 100.000 per year[a]	RR (CI)
Total	2559/80.3	1978/76.5	0.95 (0.90–1.01)
Women–total	1509/93.1	1173/89.9	0.97 (0.89–1.04)
18–25 years	401/160.1	203/151.7	0.95 (0.82-1.1)
26–35 years	296/91.5	274/106.5	1.16 (0.99–1.37)
36–45 years	335/108.3	219/94.2	0.87 (0.73–1.03)
46+ years	326/64.7	373/60.8	0.94 (0.82–1.08)
Men–Total	1050/67.1	805/62.9	0.94 (0.86–1.03)
18–25 years	271/108.7	218/108.8	1.00 (0.83–1.19)
26–35 years	277/82.3	188/68.4	0.83 (0.69–1.00)
36–45 years	243/77.9	153/63.9	0.82 (0.67–1.00)
46+ years	259/38.8	246/43.6	1.13 (0.94–1.34)
Attendances with ICD-10 diagnostic codes			
Intentional self-harm			
Overall	500/62.9	422/63.3	1.01 (0.88–1.15)
Women	315/75.6	267/79.1	1.05 (0.89–1.23)
Men	185/48.8	155/47.1	0.96 (0.78–1.19)
Poisoning			
Overall	1877/225.5	1424/204.5	0.91 (0.85–0.97)
Women	1122/255.0	858/239.7	0.94 (0.86–1.03)
Men	755/192.4	566/167.3	0.87 (0.78–0.97)
History of self-harm			
Overall	552/73.0	438/65.9	0.9 (0.80–1.02)
Women	312/78.9	270/81.5	1.03 (0.88–1.21)
Men	240/66.5	168/50.4	0.76 (0.62–0.92)

Total attendances and attendances stratified by gender, age groups, diagnoses (ICD-10 codes: X60-84 (intentional self-harm), T36-59 (Poisoning) and ICD Z91.5 (Personal history of self-harm).
a: Number of events per year per 100.000 individuals for each age group and gender, adjusted for demographic changes.

to the velocity and shock of the economic collapse, previous literature and observed increased stress and hypertension,[14,16] we anticipated a rise in overall suicide attempts and self-harm in Iceland. Our results do, however, not indicate a rise after the crisis and in fact show the opposite; a decreased risk of attendance due to suicidal behaviour with rising unemployment rate.

Although unemployment is a risk factor for mental health indisposition, one protective factor might be the relatively high level of social capital found in Iceland,[31] possibly diminishing the association between unemployment and suicidal outcomes.[22] In times of hardship, a strong welfare system and social cohesion have been shown to be a protective factor for health,[32–34] both of which apply to the Nordic countries (including Iceland).[31] For example, the number of suicides did not rise in Sweden and Finland during the economic crisis of the 1990's, while the unemployment rate increased substantially from being low before the crisis.[27] One explanation might be that health deteriorates less with higher unemployment rates, due to less social pressure and normalization of unemployment.[35] It has also been shown that areas with active labour-market programmes and sustained welfare spending during recessions have less marked increases in suicide rates than those that cut spending on welfare and job-search initiatives for the unemployed.[7,27,36] For example, a special 'Welfare watch' and special labour-market programmes were established in Iceland following the collapse.[31] These factors could partly explain the decrease found for males during the economic recession and decrease of new incidences for both gender, but not the increase during the economic boom.

The peak in men's attendances during the economic boom was associated with the point of greatest purchasing power and trade deficit of the period. Furthermore, the results show that the decrease in men's attendance coincides with increasing unemployment rate and BoT, which occurred during the recession period. Conversely, majority of previous studies seem to indicate men as an affected group during economic recessions in terms of suicide attempts[11] and especially completed suicides.[22,26] Self-harm and suicide attempts are the most important risk factors for completed suicides,[10,37] and even though Chang et al. found a rise in male suicides in Iceland in 2009, compared with the years prior to the economic collapse ($P < 0.001$);[8] our study does not have data on cause-specific mortality. We thus cannot conclude whether our results on changes in suicide-related morbidities indicate changes in risks of suicide.

For women, some studies have reported less effect from economic crises,[5,8] while others have found women's mental health to be more at risk than men's,[38] including Icelandic studies indicating greater stress[14] and increased cardiac morbidity among females.[15]

One plausible explanation for our boom-effect findings for men might be that the stress levels for men were in some way higher during the years of extreme prosperity, with increased workload, expenditure and pressure to achieve—which might have led to increased risks of these negative outcomes during the economic boom. In considering such possible fast-lane effects, it should be kept in mind that the extreme prosperity of the pre-collapse period was no less unusual than the post-collapse crisis. Some research has shown that men are more materialistic than women and place greater value on the conspicuousness of product use.[39,40] It may thus be hypothesized that the mental pressure of this dramatic consumption boom might have affected men disproportionately.

Strengths and limitation

The greatest strength of the study is the use of rich data source on all attendances to a tertiary national hospital, the only referral centre in the main capital area, serving over 60% of the Icelandic population and severe cases of suicide attempts for the whole country. Assessments and diagnoses are registered by physicians, with ICD-10 diagnostic codes that are the standard diagnostic tools in medicine and widely used in epidemiological and clinical research, and each patient is registered with their own unique personal social security number, which contains information on age and sex. To our knowledge, no changes were made to clinical resources or the registration process during the whole study period, which should minimize the risk of measurement errors. To adjust for societal change, our denominator adjusts for changes in immigration and emigration as well as changes in the age distribution of the population. However, the study has some limitations that deserve attention. The small size of the source population limits statistical power. It is possible that changes in health-care utilization during the study period affect attendances, although we have no knowledge of austerity changes in health services that could affect the number of individuals seeking health care to NUH. Although we have no data to conclude on this matter, given the serious nature of these outcomes it is unlikely that such behavioural factors—particularly given the gender specific findings—affect our results. Last, every economic collapse is unique. Due to the special features of the economic crisis in Iceland (suddenness and velocity, as well as the added consumption effects of the economic collapse), external validity is limited.

In summary, the results surprisingly indicate a peak in suicidal outcomes among men during the economic boom. Although prosperity may have a number of positive health effects, the increasing social pressure to achieve and succeed might also have led to these negative health consequences. Our findings thus indicate that changes in suicidal behaviour and self-harm vary between

different subgroups of populations which future studies should take into account.

Acknowledgements

The results have not been published elsewhere but have previously been presented on poster presentation on European Congress of Epidemiology 2015, 26 June in Maastricht, Netherlands.

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Conflicts of interest: None declared.

Key points

- Following the 2008 economic collapse in Iceland, no overall increase in attendances due to suicide attempts and self-harm was observed.
- A peak in self-harm and suicide attempts was observed among men right before the economic collapse, during the economic boom. A decreased risk of meńs attendance was further found with rising unemployment rate.
- Suicidal behaviour and self-harm may vary between different subgroups of populations during large economic transitions, which future studies should take into account.

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Paper III

Suicide rates in Iceland during a period of economic boom, collapse, and recovery. A nation-wide population-based study.

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Abstract

Background: Economic downturns have been associated with increased suicide rates. The 2008 global financial crisis varied across countries, but hit Iceland relatively hard. We aimed to study potential changes in suicide rates in Iceland during this major economic transition.

Methods: Data was retrieved on all suicides in Iceland during 2002-2014. The study period was divided into a pre-collapse period (2002-2008) and a post-collapse period (2008-2014). Poisson regression models were used to estimate the association between pre-to-post economic collapse and suicide rates, expressed as risk ratios (RR) with 95% confidence intervals. Analyses were stratified by age and sex.

Results: A total of 470 suicides were recorded during the study period. The mean age at death was 45 years and 75% were males. The overall suicide rates per 100.000 person years were 13.3 pre-collapse and 15 post-collapse revealing no overall differences in pre-to-post collapse in suicide rates (RR 1.12; 0.94-1.35). An increase in unemployment rate was not associated with overall suicide rate (RR 1.07; CI 0.86, 1.33). We observed a post-collapse increase in suicide rates among unmarried men (RR 1.31; 1.03-1.67) and men in the oldest age group, 65+ years (RR 2.02; 1.19-3.56) seemingly towards times of economic recovery (2012-14). Suicide rates among older men was associated with a 1% increase in Gross Domestic Product (RR 5.3; CI 1.91-16.47).

Conclusion: The economic collapse in Iceland, starting in 2008, did not result in an overall increase in suicide rates in the Icelandic population. The increase in suicide rates among older and single men towards times of economic recovery calls for further research and public health alertness.

Key points:

- Prior research indicates that hard economic times are associated with an increase in suicide rates.
- No overall increase in rates of suicides was found following the severe 2008 economic collapse in Iceland, except among single and older men during times of economic recovery.
- While the economic collapse was severe, the increased unemployment rate was not associated with suicide rate.
- The increased risk of non-married and older men indicates that suicide risk after economic transitions may vary between different subgroups of the population.

Key words: Suicides, economic recession, gender differences, mental health, public health

Introduction

Past economic downturns have been linked to increasing suicide rates,[1,2] and the worldwide 2008 Great Recession was no exception. Already in 2009, suicide rates had increased and the increase continued during the hard economic times that followed .[3,4-10] The change in suicide rates may differ between countries variously affected by economic crises,[3,11,12] and economic distress may be experienced differently between subgroups of affected populations. Gender and age are known determinants of suicide risk during an economic recession. An increase in men´s risk has been observed, while women´s rates have been unaffected or even decreased.[9,13,14] Some studies have found increased suicide rates in association with rising unemployment rates among younger and working age individuals.[6,7,15,16] An empirical analysis from 26 European countries for example indicated that younger populations in general were at higher risk and more sensitive to negative health effects of rising unemployment during times of recession.[3] In Greece for example, an increased risk of suicidal ideation was shown in older age groups from 2009 to 2011 (1.9% vs. 7.2%), while decreasing in individuals of younger age.[17] Similar results have been found in China.[18]

The Icelandic population experienced one of the most severe and sudden economic collapses, following an extreme economic boom. It started on October 6th 2008, when the Prime Minister of Iceland addressed the whole nation in a live television broadcast, announcing that there was actual danger of national bankruptcy.[19] Following this the nation´s currency was severely devaluated, and three of the country's largest banks were nationalized. National and household debts increased drastically,[20] purchasing power went down and unemployment rates rose from 2% in 2007 to 9% in 2009.[21] However, the recovery of the economy was relatively quick[22] and in 2014, purchasing power had almost hit pre-collapse levels and unemployment levels had declined to 5%.[23]

Shortly after the collapse, a study indicated that the risk of experiencing high stress levels had increased, mainly among women.[24] However, in a study on hospital attendances due to self-harm and suicide attempts in 2003-2012, no increase of attendances were found post-collapse compared to pre-collapse, for either gender. In fact, a peak in male attendance was found right before the collapse- or during the economic boom.[25] This peak was not seen for women. In this study, we aimed to

evaluate trend discontinuity in completed suicides in Iceland during a 12-year period (2002-2014), which was characterized by economic boom, crisis and recovery. We also wanted to evaluate trends by age and gender, with a special focus on the sharp changes in economic factors experienced in 2008.

Methods

Study design and data acquisition

The total population of Iceland was approximately 287.000 at the start of the study period in 2002, increasing to 325.000 in 2014.[26] For all individuals who had a legal residence in Iceland at their time of death, information has been registered in The Causes of death registry. Data in the registry is retained from death certificates and registered electronically by a professional data analyst and preserved by the Directorate of Health in Iceland, with diagnostic codes according to the International Classification of Diseases, 10th version (ICD-10). The study is based on all suicides registered over the years 2002-2014, by ICD-10: X60-84: (Intentional self-harm) and Y87 (Sequel of intentional self-harm). Each individual in Iceland has a unique personal identification number and all individual patient data are registered into medical records according to those numbers, including deaths. For each individual, we retrieved data on date and time of death, date of birth, gender, marital status and residence by municipalities in Iceland.

We used the whole population in Iceland to evaluate suicides per 100.000 individuals, excluding individuals younger than 12 years from the denominator. To account for demographic changes in Iceland, and adjust for changes in immigration and emigration, the number of suicides per 100.000 individuals was evaluated by the size of the population at the end of each year. We did this for both genders and for all age groups and age standardized for each year, thereby evaluating suicide rate for each subgroup, for each year.

Explanatory variables

We used information from Statistics Iceland on changes of macro-economic variables; unemployment rate, gross domestic product (GDP) and balance of trade

(BoT) during the study period, to evaluate whether risk of suicide was modified by economic surroundings. Because October 6th 2008 can be defined as the starting point of the economic collapse, we used it to dichotomize the whole study period into a pre-collapse period (January 1st 2002 to October 5th 2008) and a post-collapse period (from October 6th 2008 to December 31st 2014). Both periods were characterized by major economic fluctuations. The pre-collapse period ended in an economic boom that peaked the last year prior to the economic collapse. Because of these fluctuations, we divided the pre-collapse period into two equally long periods: period 1 with stable economy (1.1.2002-20.05.2005) and period 2 characterized with an economic boom (21.05.2005 – 05.10.2008). We divided the post-collapse period into two equally long periods as well: period 3 which was characterized with an economic recession (06.10.2008 – 18.11.2011) and period 4 with an economic recovery (19.11.2011 - 31.12.2014). Age at time of death was categorized into four age groups; an age group before active working age (age 25 years and younger), a younger and older working age group (26-45 years and 46-65 years) and a retirement age group (older than 65 years). Marital status was retrieved from Register Iceland and was categorized into: 1) Married/Cohabiting, 2) Other (Single/Widowed/Separated/Divorced and Unknown). Residence was categorized into habitation in 1) Reykjavik Capital area, and 2) Rural areas (North West Iceland, North East Iceland, South West Iceland, South Iceland and South Peninsula).

Approvals for this study were obtained from The National Bioethics Committee (ref: 12-198-V2, S1) and the Data Protection Authority (ref: 2012121479HGK).

Statistical analysis

Descriptive statistics were used to describe characteristics of all registered suicides through the years 2002-2014, evaluated by gender, age, residence and marital status. We used Lowess (Locally Weighted Scatterplot Smoothing) curve to present suicide rates during the whole study period, for both genders and for all age groups. To evaluate the estimated yearly increase or decrease in suicide rates for each period for both genders we used Poisson regression. We used the same measures to evaluate the possible effect of economic variables, using 1% increase in the economic parameters as dummy variable and expressing the association as RR. To

address whether the years after the economic collapse (post-collapse period) were characterized by an increase in suicide rates compared to the pre-collapse period, Poisson regression models were used. We used the date October 6th as a dummy variable to evaluate crude risk both for the whole study population and stratified by gender and age groups.

Results

The total number of suicides from January 1st 2002 until December 31st 2014 in Iceland was 470, or 14.2 per 100.000 inhabitants. A majority of individuals dying by suicide were men (75%), with 21.0 per 100.000 men dying by suicide and 7.3 per 100.000 women. (Table 1) The mean age at time of death was 45 years and the highest incidence rate was in the age group 46-65 years (19.3 per 100.000). The majority of individuals (66%) had a registered residency in the capital area (largest habitat in Iceland) at the time of death. Suicide rate was lower among individuals registered as married or cohabitating than among individuals registered as single/widowed/ separated/divorced/unknown (respectively 6.7 per 100.000 and 21.9 suicides per 100.000 individuals). When evaluating yearly increase during the whole study period, there was no increase in suicide per year, neither for men (RR 1.03, CI 1.00-1.06), nor women (RR 1.01, CI 0.96-1.07). (Figure 1)

When evaluating suicide rate during each period (Table 1), the highest total suicide was seen during period 4 (16 suicides per 100.000), among the oldest individuals (22.4 suicides per 100.000 individuals). (Figure 2)

Table 2 presents the risk of suicides in the post-collapse period compared to the pre-collapse period, for both genders, stratified by age, residence and marital status. There was no increased risk of suicide post-collapse compared to pre-collapse for the whole study group (RR 1.12; CI 0.94-1.35) and not either when evaluated by gender (men RR 1.18; CI 0.96-1.46 and women RR 0.96; CI 0.67- 1.38). Total number of days in the study period were 4749: 2470 in the pre-collapse period (52%) and 2279 in post-collapse period (48%). The mean age at time of death was higher post-collapse (46.6 years) than in the pre-collapse period (43.9 years). However, when evaluated by age groups, there was increased risk for those over 65 years of age (RR 2.02; CI 1.19-3.56), significantly so for men (RR 2.31; CI 1.24-4.57), but not

women (RR 1.30; CI 0.45-3.94), with men´s incidence rate increasing from 13 per 100.000 pre-crisis to 30.2 per 100.000 post-collapse. Also, increased risk was found for non-married men post-collapse compared to pre-collapse (RR 1.31; CI 1.03-1.67), not seen for non-married women (RR 0.92; CI 0.61-1.37).

No associations were found between suicide risk and macro-economic factors, neither GDP: RR 1.29; CI 0.94, 1.79 (men RR 1.35; CI 0.93, 1.98 and women RR 1.13; CI 0.61, 2.15), BOT: RR 1.08; CI 0.96, 1.22 (men RR 1.11; CI 0.97, 1.27 and women RR 1.01; CI 0.80, 1.27), nor increase in unemployment rate: RR 1.07; CI 0.86, 1.33 (men RR 1.12; CI 0.87, 1.45 and women RR 0.94; CI 0.60, 1.45). However, when evaluating by age groups, a 1% increase in GDP, increased suicide risk for the age group 26-45 years (RR 1.9; CI 1.09-3.38) and with a 1% increase in both GDP and BOT, the risk increased for individuals aged older than 65 years (RR 5.3; CI 1.91-16.47 and RR 1.59; CI 2.13-2.26 respectively), significantly so for men, but not women.

Table 1: All suicides during the total study period, according to ICD-10 diagnostic codes X60-84 and Y87.0, divided into four economic time periods; period 1 (Stable) and 2 (Boom) before the economic crisis (2002-2008) and period 3 (Crisis) and 4 (Recovery) after the economic crisis (2008-2014).

		Time period*			
	Total (Incidence)	Stable	Boom	Crisis	Recovery
Number of suicides	470 (14.2)	101 (12.6)	120 (14.0)	115 (13.9)	134 (16.0)
Gender					
Male	350 (21.0)	73 (18.3)	87 (20.1)	94 (22.6)	96 (23.0)
Female	120 (7.3)	28 (7.0)	33 (7.8)	21 (5.1)	38 (9.1)
Age groups					
≤ 25 years	73 (8.9)	18 (8.8)	20 (9.4)	17 (8.3)	18 (8.9)
26-45 years	162 (14.3)	31 (10.9)	44 (14.8)	36 (12.8)	51 (18.8)
46-65 years	176 (19.3)	43 (21.2)	46 (19.9)	49 (21.1)	38 (15.6)
> 65 years	59 (13.1)	9 (8.3)	10 (8.9)	13 (11.8)	27 (22.4)
Residence					
Capital	312 (12.4)	68 (11.1)	81 (12.6)	75 (12.0)	88 (13.7)
Rural	158 (10.7)	33 (8.9)	39 (10.1)	40 (11.0)	46 (12.7)
Marital status					
Married/cohabiting	110 (6.7)	24 (5.9)	31 (7.3)	28 (6.9)	27 (6.6)
Other **	360 (21.9)	77 (18.9)	89 (21.1)	87 (21.5)	107 (26.0)

***** Period 1: 1.1.2002-20.05.2005, Period 2: 21.05.2005 – 06.10.2008, Period 3: 07.10.2008 – 18.11.2011, Period 4: 19.11.2011 - 31.12.2014.

**Single, Widowed, Separated, Divorced and Unknown. Information on marital status is only available for individuals 16 years and older; hence, individuals who committed suicide younger than 16 years of age are not included in the presentation of incidence per 100.000 individuals according to marital status.

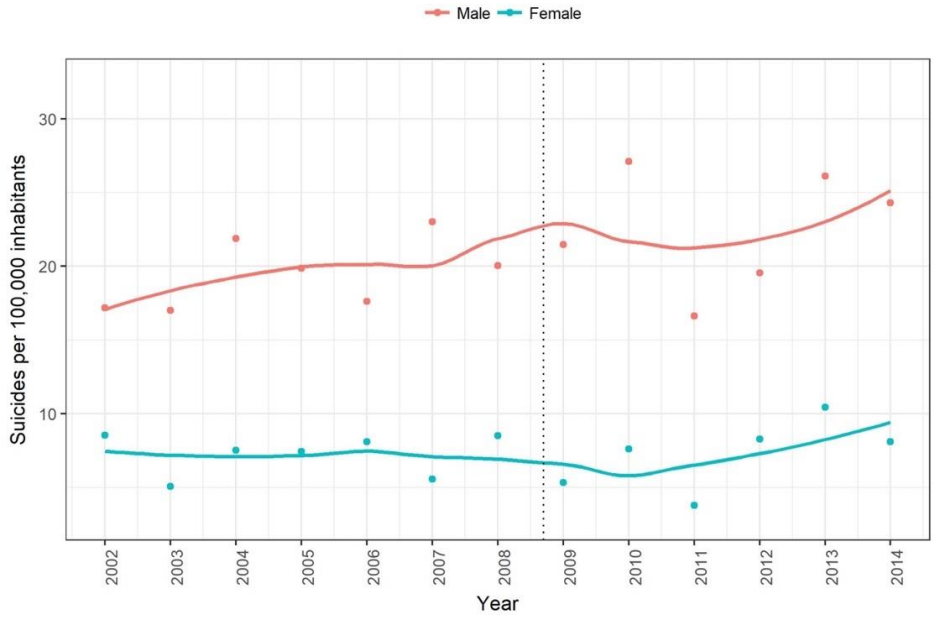

Figure 1 : Suicides per 100 000 inhabitants through the years 2002-2014 in Iceland for both genders, presented with a Lowess curve.

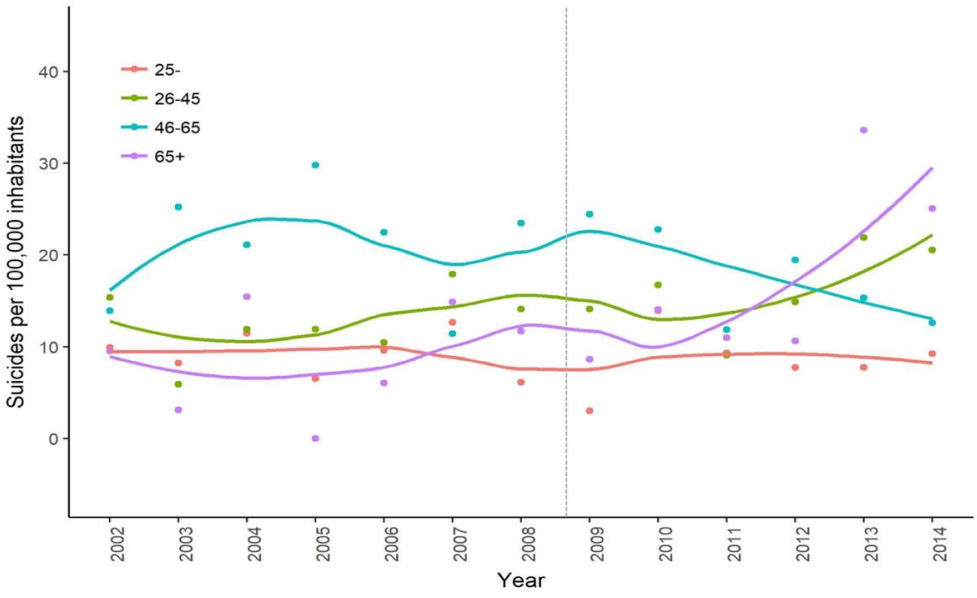

Figure 2: Suicides per 100.000 inhabitants through the years 2002-2014 in Iceland, presented with a Lowess curve for age groups 1) ≤ 25 years, 2) 26-45 years, 3) 46-65 years and 4) > 65 years.

Table 2

Suicide incidence per 100.000 inhabitants in Iceland and the relative risk of post-collapse suicides (2008-2014) compared to the pre-collapse period (2002-2008)

	Total incidence			**Men**			**Women**		
	Pre-collapse	Post-collapse	RR	Pre-collapse	Post-collapse	RR	Pre-collapse	Post-collapse	RR
Total	13.3	15.0	1.12 (0.94-1.35)	19.2	22.8	1.18 (0.96-1.46)	7.4	7.1	0.96 (0.67- 1.38)
Age group									
≤ 25 years	9.1	8.7	0.96 (0.60-1.51)	16.4	14.0	0.86 (0.52-1.40)	1.5	3.0	2.08 (0.55-9.85)
26-45 years	12.9	15.7	1.22 (0.90-1.67)	17.5	24.1	1.38 (0.96-1.98)	8.1	7.0	0.87 (0.47-1.60)
46-65 years	20.5	18.3	0.89 (0.66-1.20)	27.0	25.4	0.94 (0.66-1.34)	13.6	11.0	0.81 (0.47-1.38)
> 65 years	8.6	17.3	2.02 (1.19-3.56)	13.1	30.2	2.31 (1.24-4.57)	4.9	6.4	1.30 (0.45-3.94)
Residency									
Capital	11.9	12.8	1.24 (0.90-1.69)	16.9	19.2	1.31 (0.92-1.87)	6.9	6.6	1.03 (0.52-2.02)
Rural	9.6	11.8	1.08 (0.87-1.35)	14.1	18.5	1.14 (0.87-1.48)	4.7	4.8	0.95 (0.62-1.45)
Marital status									
Married/cohabiting	6.7	6.7	1.02 (0.70-1.48)	10.9	10.3	0.95 (0.62-1.45)	2.4	3.2	1.32 (0.58-3.09)
Not married	20.0	23.8	1.19 (0.97-1.46)	27.8	36.4	1.31 (1.03-1.67)	12.3	11.2	0.92 (0.61-1.37)

Discussion

In this population-based study on suicide in Iceland, we found no increase in suicide rates following the major economic collapse in 2008, when comparing to the years prior to the economic collapse. However, towards the end of the observation period – or during the time of economic recovery - increase in suicides rates was observed among non-married men and men older than 65 years of age.

Our main findings stand in contrast with the bulk of the literature suggesting a measurable increase in suicide rates following macroeconomic downturns.[6-10,27] Iceland was hit particularly hard by the unforeseen economic collapse; therefore a comparable increase in suicide rates during the economic recession years could have been expected. Studies found an increase in self-reported stress,[24] depressive symptoms,[28] increased sickness absence from work[29] and increased risk of hypertension among both gender.[30,31] For women, an increase in attendance rate to cardiac emergency was seen.[32] Given the strong evidence for economic recession as a risk factor for suicide and the velocity and shock of the economic collapse in Iceland, the findings of our study on suicide during the recession years are somewhat unexpected. The increase in suicide rates among non-married and older men during the years of economic recovery further raise questions on whether this may be a delayed effect from the economic collapse or due to other factors.

Protective factors in Iceland

Hard macroeconomic conditions, modeled with unemployment rates, have repeatedly been shown to be an important factor associated with increased suicide rates.[3,16] Yet, the large change in unemployment rate during the economic recession years in Iceland did not seem to affect overall suicide rates. It has been speculated in other countries to what extent unemployment may contribute to rising suicide rates.[33,34] In Western Europe, the association has seemed to be rather weak, if any.[12] One explanation for this variation between countries is that social policy plays an important role in unemployment-related health.[35] The risk of unemployment related suicides may be buffered in countries with strong welfare systems.[36] This may indeed have been the case in Iceland, which has a strong welfare system similar to Finland

and Sweden, where an increase in unemployment rates have not been found to affect suicide rates.[37,38]

The majority of other countries deeply affected by the Great Recession responded by implementing austerity measures and reducing public expenditure.[39] Studies now suggest that such measures may in fact have negative impact on mental health, by increasing the socio-economic risk factors associated with mental health morbidity.[40,41] Individuals with pre-existing psychiatric disorders may be vulnerable to financial difficulties accompanied with austerity measures, which may trigger self-harming behaviour.[42] In Greece, studies have found that rising suicide rates coincided with increasing austerity measures.[43,44] Conversely, higher level of social protection and strong welfare systems may mitigate the risk of suicide during economic recession.[6,45,46] After the economic collapse in Iceland, an immediate implementation plan was conducted, with labour-market programs and debt forgiveness measures. A "Welfare watch" was established with the aim to monitor financial and social repercussions on inhabitants.[47,48] Investing in social protection and rejecting austerity measures following the collapse may have been a suicide preventive factor in Iceland.

Several other factors might have played a protective role as well. Firstly, the small size and homogeneity of the Icelandic population is accompanied with a high level of social cohesion, which may be a protective factor for mental health.[41,49,50] Secondly, gender equality is high in Iceland and Icelandic women have the highest job participation of all OECD countries (80%).[51] During economic crises, increased suicides have been linked to higher level of unemployment rates, especially for men.[4] Reeves and Stuckler recently found that the association of rising unemployment rates and suicide among men during economic crises was not seen in countries where the level of gender equality was high, such as in Sweden and Austria. Possibly, greater gender equality diminishes suicide risk[52] following an economic collapse, especially among men.[53] Lastly, the changes from economic boom to collapse were severe. Our previous study on hospital attendances of suicide attempts and self-harm, indicated a peak in attendance among men just prior to the economic collapse, and declining again post-collapse.[25] Possibly, stressful factors were accompanied with extraordinary circumstances in Iceland prior to the economic collapse. The pre-collapse years were characterized with dramatic changes in the country´s

macroeconomic environment, a rapid growth in GDP and a trade deficit characterized with far higher levels of consumption than production.[54] Increase in consumption along with working hours, liabilities and increased housing depths during these extreme prosperous years,[55,56] may have affected psychological well-being,[57] and more serious outcomes such as suicide attempts and suicides.

Suicides among men during times of economic recovery

Although overall suicide rates did not increase post-collapse, men older than 65 years as well as unmarried men were at increased risk of suicide post-collapse compared to pre-collapse. The observed rise in suicides during economic recessions in other European countries applies mainly to men of working age,[4] and previous studies have found that middle aged individuals were particularly at risk, with declining rates among older age groups.[9,58] Retirement age in Iceland is 67 years. It is possible that individuals of an older age experience job insecurity during the last years of their career and therefore were hit particularly hard. However, this would hardly explain why this delayed effect was not found for females within the same age group. Men may find it more difficult to seek help for their psychiatric morbidity than women,[59] and rely on their social network for support. This could explain why an increase was seen for unmarried (or not cohabiting) men and not women, as marital status may be an important source of social support during hard times.[60] Possibly, the beforementioned protective factors did not benefit older nor unmarried men, resulting in an increased risk of suicide, even after the economy recovered.

Strengths and limitations

A major strength of this study is the use of population-based, prospectively collected registry data. The Causes of death registry uses the widely used standard ICD-10 diagnostic codes, only diagnosed by physicians. By using the unique personal identification number provided for each individual in Iceland, we were able to retrieve additional data for each individual, such as habitation and marital status. Despite the risk of underreporting suicide in official data, the Causes of death registry in Iceland is of high-quality and no changes have been made to clinical resources or the registration process of suicide during our study period. We adjusted for changes in

immigration and emigration as well as changes in the age distribution of the population. However, the study has some limitations that deserve attention. Due to the small population size, we lack statistical power particularly in subgroup analyses. Also, due to the population size and the extraordinary circumstances of the economic collapse (and boom) external validity is limited. However, this can also be seen as a strength. Not all economic fluctuations are alike and this is not a field in which final results will be provided within a single paper. However, over time a pointillistic picture emerges, showing differences in business-cycle effects across health outcomes, social- and institutional circumstances, and not least, types of economic circumstances. We provide one piece to that puzzle.

Conclusion

Despite a major economic crisis in Iceland from 2008, our results indicate no overall increased risk of suicide rates in the Icelandic population. Yet, towards years of economic recovery, we found an increased risk of suicide among older and unmarried men. These findings suggest that a strong welfare system and investing in social protection during economic crisis might mitigate suicide risk. Further research is needed to understand why these measures of social welfare, if important, did not mitigate suicide rates among non-married and older men. Our findings indicate that suicide risk may vary between different subgroups of populations and motivate adequate psychological follow-up of all age groups during and following an economic crisis.

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