Social Media Use and Symptoms of Anxiety and Depressed Mood among Adolescents

by

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Abstract

Many studies have found a relationship between social media use and symptoms of emotional distress, such as depression and anxiety. However, the existing research lacks longitudinal analyses, a thorough understanding of the possible mechanisms involved in this relationship, and if they appear to be similar for girls and boys. This Thesis extends previous research by examining longitudinally the association between social media use and symptoms of emotional distress among a cohort of adolescents, as well as the possible mechanisms involved. The specific aims of the Thesis were to 1) examine changes in symptoms of anxiety and depressed mood among male and female adolescents in Iceland from 2006 to 2016; 2) examine longitudinally the association between time spent on social media and symptoms of anxiety and depressed mood; 3) examine active and passive social media use and how different types of social media use relate to symptoms of anxiety and depressed mood. Cross-sectional data among participants in the eighth to tenth grade from compulsory schools in Iceland and longitudinal data from a cohort of adolescents born in 2004 were used in the analyses. Data were analyzed using analysis of variance, linear regression, binomial logistic regression, hierarchical linear regression, and mixed model design. When looking at patterns based on cut-off scores, the proportion of adolescents reporting high symptoms of depressed mood increased over time by 1.6% and 6.8% for girls and boys, respectively, and high symptoms of anxiety increased by 1.3% for boys and 8.6% for girls. Mean level change in these symptoms significantly increased for girls, but symptoms of anxiety decreased for boys. The interaction between time spent on social

media and time was significant for symptoms of depressed mood and physical symptoms of anxiety, and the relationship between time spent on social media and all three psychological distress outcomes was significantly stronger for girls than boys. Passive social media use related to greater symptoms of emotional distress and active social media use to fewer symptoms. After adding known risk and protective factors to the analyses, only passive social media use remained significant for emotional distress. Time spent on social media had a stronger relationship with emotional distress for girls than boys. Overall, the findings reveal that there is an increase in symptoms of emotional distress among adolescents and that social media use is associated with these symptoms. It is important to examine further the different types of social media use instead of focusing on time spent on social media alone, as well as taking individual factors and gender into account. A deeper understanding of the possible risks and benefits involved in social media use, however, will be necessary if social media is to play a greater role in fostering healthy relationships and connections.

Útdráttur

Fjölmargar rannsóknir hafa sýnt fram á tengsl á milli þess tíma sem varið er á samfélagsmiðlum og vanlíðanar, til dæmis kvíða og þunglyndis. Enn er þó mörgum spurningum ósvarað um hvernig þessum tengslum sé háttað; hvort tími óháð eðlis notkunar sé aðaláhrifaþáttur eða hvort að hægt sé að greina tíma á samfélagsmiðlum betur eftir eðli notkunar. Verulega skortir langtíma rannsóknir á sviðinu og að sama skapi rannsóknir á því hvort þessi tengsl séu svipuð meðal stúlkna og drengja.

Tilgangur þessarar doktorsritgerðar var að koma til móts við þennan skort á þekkingu, með því að greina nánar en fram til þessa hefur verið gert, tengsl notkunar samfélagsmiðla og einkenna vanlíðanar á meðal ungmenna yfir þriggja ára tímabil. Auk þess að skoða tengsl mismunandi notkunar á samfélagsmiðlum við andlega vanlíðan. Sértæk markmið rannsóknarinnar voru að: 1) Skoða breytingar á einkennum kvíða og þunglyndis á meðal unglingsstúlkna og unglingsdrengja á Íslandi milli áranna 2006 og 2016; 2) skoða langtímatengsl á milli tíma sem unglinga verja á samfélagsmiðlum og einkenna kvíða og þunglyndis; og 3) skoða virka og óvirka notkun samfélagsmiðla og hvort og hvernig ólík notkun samfélagsmiðla tengist einkennum kvíða og þunglyndis. Notast var við þversniðsgögn úr Ungt Fólk rannsóknum Rannsókna & greiningar á meðal þátttakenda í áttunda, níunda og tíunda bekk grunnskóla á Íslandi. Auk þess voru notuð langtímagögn úr LIFECOURSE rannsókninni sem nær til ungmenna sem fæddust á Íslandi árið 2004. Við greiningu á gögnunum var notast við dreifigreiningu, línulega aðhvarfsgreiningu, tvíkosta aðhvarfsgreiningu og blandað líkanasnið.

Niðurstöður leiddu í ljós að á tíu ára tímabili jókst hlutfall stúlkna og drengja sem greindi frá miklum einkennum kvíða og þunglyndis. Á sama tíma greindist meðaltalshækkun í einkennum kvíða og þunglyndis einungis hjá stúlkum en meðaltalslækkun var í einkennum kvíða meðal drengja. Rannsóknin leiddi í ljós marktæka samvirkni á milli tíma mælt í árum og tíma varið á samfélagsmiðlum fyrir einkenni þunglyndis og líkamlegra einkenna kvíða. Auk þess var sambandið á milli vanlíðanar og tíma varið á samfélagsmiðlum marktækt sterkara fyrir stúlkur en drengi. Óvirk notkun samfélagsmiðla svo sem að skoða síður annarra tengdist meiri einkennum vanlíðanar og virk notkun samfélagsmiðla tengdist minni einkennum. Eftir að tillit hafði verið tekið til áhættu- og verndandi þátta, líkt og sjálfsálits, líkamsímyndar, stuðnings vina og félagslegs samanburðar við greiningarnar kom í ljós að aðeins óvirk notkun samfélagsmiðla tengdist vanlíðan. Þá leiddu niðurstöður í ljós að tengsl þess tíma sem varið var á samfélagsmiðlum tengist vanlíðan stúlkna sterkar en drengja. Á heildina litið leiða niðurstöður rannsóknarinnar í ljós aukningu á einkennum vanlíðanar hjá unglingum og notkun samfélagsmiðla er tengd þessum einkennum, hvort sem greind eru þversniðsgögn eða langtímagögn. Rannsóknin undirstrikar mikilvægi þess að skoða ólíka samfélagsmiðla í stað þess að einblína á magn þess tíma sem varið er á samfélagsmiðlum. Þá leiðir rannsóknin í ljós mikilvægi þess að greina niðurstöðurnar eftir kynjum. Samfélagsmiðlar eru komnir til að vera. Aukinn skilningur á því hvernig notkun þeirra tengist líðan ungmenna er lykilatriði, svo unnt sé að draga úr áhættu á vanlíðan tengdri notkun þeirra og grunnur þess að hægt sé að stuðla að forvörnum byggðum á traustum rannsóknum.

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To my husband Helgi Þór, thank you for being optimistic when I was pessimistic, for being a voice of reason, for endless support and encouragement, and for being an exceptional human being. To my children, Theódór Ares, Kristófer Atlas and Gunnhildur Aþena, thank you for maintaining balance, for putting life into perspective, for your hugs, love and at times, for your understanding. Finally, yet importantly, Tóti and Dóra, you are amazing and inspiring. Thank you for having always encouraged me to finish what I started, even when I felt like I had nothing left. Simply, the best parents in the world.

List of studies

This Thesis is based on the following studies, referred to in the text by their Roman numerals

I. Thorisdottir, I. E., Asgeirsdottir, B. B., Sigurvinsdottir, R., Allegrante, J. P. Sigfusdottir, I. D. (2017). The increase in symptoms of anxiety and depressed mood among Icelandic adolescents: time trend between 2006 and 2016. European Journal of Public Health, 27(5), 856-861. DOI: 10.1093/eurpub/ckx111 [Republished with permission of Oxford University Press; permission conveyed through Copyright Clearance Center, Inc.]

II. Thorisdottir, I.E., Sigurvinsdottir, R., Kristjansson, A.L., Allegrante, J.P., Lilly, C.L., Sigfusdottir, I.D. (2019). Longitudinal association between social media use and psychological well-being among adolescents. [Revised and re-submitted to Preventive Medicine]

III. Thorisdottir, I. E., Sigurvinsdottir, R., Asgeirsdottir, B. B., Allegrante, J. P. Sigfusdottir, I. D. (2019). Active and Passive Social Media Use and Symptoms of Anxiety and Depressed Mood Among Icelandic Adolescents. Cyberpsychology, Behavior and Social Networking, 22(8), 535-542. DOI: 10.1089/cyber.2019.0079 [Republished with permission from Mary Ann Libert, Inc; permission conveyed through Mary Ann Libert, Inc Customer Questions].

Declaration of Contribution

The doctoral candidate, Ingibjörg Eva Þórisdóttir (IEÞ) wrote this doctoral thesis under the guidance of Inga Dóra Sigfúsdóttir (IDS), supervisor, and the thesis committee, Álfgeir Logi Kristjánsson (ÁLK), Ásgeir Rúnar Helgason (ÁRH), Bryndís Björk Ásgeirsdóttir (BBA) and John P. Allegrante (JPA). Further collaborators on the manuscripts were Rannveig Sigurvinsdóttir (RS) and Christa L. Lilly (CLL). Grants were applied for by IEÞ with the guidance of IDS. The contribution to each study is as follows:

I. IEÞ developed the initial version of the research questions in collaboration with BBA and IDS. IEÞ was responsible for the design of the study, data analysis, interpretation of results, and drafting of the manuscript. All co-authors (BBA, RS, JPA, IDS) made critical revisions to the article for relevant scientific and intellectual content.

II. IEÞ was responsible for the design of the study. IEÞ performed the statistical analysis and interpreted the results in collaboration with CLL, ÁLK, and RS. IEÞ was responsible for drafting the manuscript. All co-authors (RS, ÁLK, JPA, CLL, IDS) made critical revisions to the article for relevant scientific and intellectual content.

III. IEÞ and RS developed the study design, performed the statistical analysis, and interpreted the results. IEÞ developed the first draft in collaboration with RS, IDS, and BBA. All co-authors (RS, BBA, JPA, IDS) made critical revisions to the article for important scientific and intellectual content.

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Chapter 1: Introduction

Mental health problems often begin in childhood or early adolescence (Catalano et al., 2012; Thapar et al., 2012), and half of all mental health conditions start by 14 years of age, with a vast majority of cases undetected and untreated (WHO, 2013). In the last decade several population-based studies have concluded that adolescent mental health is declining (Collishaw, 2015; Collishaw et al., 2010; Durbeej et al., 2019; Hagquist, 2010; Mojtabai et al., 2016; Sigfusdottir et al., 2008; Sweeting et al., 2009; van Geelen & Hagquist, 2016; von Soest & Wichstrøm, 2014). Some others find that mental health has remained relatively stable (McMartin et al., 2014; Sourander et al., 2012; Wiens et al., 2017). To further complicate matters there is an inconsistency in findings on the gender aspect of mental health where some evidence suggests that it is only among girls that mental health is worsening (Bor et al., 2014). In an attempt to explain changes in adolescent self-reported internalizing symptoms many contemporary scholars have studied changes in the social environments of youth, underscoring the increasing role of digital media and more specifically social media, and the possible impact of this recent technology in adolescents (Baker & Algorta, 2016; Barry et al., 2017; Booker et al., 2018; Bruggeman et al., 2019; Gerwin et al., 2018; Heffer et al., 2019; Jensen et al., 2019; Keles et al., 2019; Kelly et al., 2018; McCrae et al., 2017; Orben et al., 2019; Orben & Przybylski, 2019a, 2019b; Przybylski & Weinstein, 2017; Seabrook et al., 2016; Twenge, 2019; Twenge, Joiner, Martin, et al., 2018; Twenge, Joiner, Rogers, et al., 2018; Twenge, Martin, & Campbell, 2018; Twenge & Campbell, 2019; Yang et al., 2013).

The majority of the studies conducted to date on the relationship between social media and psychological well-being have been cross-sectional, and it is only in the last two years that longitudinal studies have started to emerge. Evidence from these studies reveals mixed findings on the role of social media in adolescent mental health. The interpersonal-connection-behaviors framework (Clark et al., 2018) provides a promising new perspective to study the potential effects of social media on adolescent mental health. The framework focuses on explaining the relationship between social media and well-being by the activities that take place online. Not so much just being present on social media but the specific features of what social media is used for, for example, engaging with others and creating connections or scrolling passively through newsfeeds.

Through the lens of the interpersonal-connection-behaviors framework, the objective of this Thesis was to extend the literature on social media use and its potential impact on adolescent mental health by examining data in several ways: First, by examining changes over time in self-reported symptoms of anxiety and depressed mood among adolescents at the population level; second, by examining the longitudinal relationship between social media use and emotional distress; and third, by examining the possible mechanism between social media use and emotional distress. Results from this Thesis may clarify which risk and protective factors are of importance for adolescent mental health as they engage with social media.

Background

Adolescent mental disorders weigh significantly in the burden of disease for both genders. Anxiety and depressive disorders are among the top 10 causes of years lost to disability (Mokdad et al., 2016) with approximately 25% of youth world-wide having experienced a mental disorder in the past year and one-third will do so across their lifetime (Merikangas et al., 2009). The average lifetime prevalence of any mood disorder for adolescents 13–18 years of age is 14.3%; for girls, it is 18.3% and for boys 10.5%. The average lifetime prevalence of any anxiety disorder for adolescents is 31.9%; for girls, it is 38.0% and 26.1% for boys (Merikangas et al., 2010). At the individual level, the consequences of not addressing mental health conditions extend into adulthood, and young people with mental health problems are at a higher risk of poor mental health throughout their life (Kessler et al., 2007). Mental disorders and chronic physical disease are often comorbid (Daré et al., 2019), therefore they represent an immense psychological, social and, economic burden for societies (Trautmann et al., 2016). Promoting a healthy start by addressing various risk and protective factors for mental health early in life is vital for societies to be able to reduce the burden of mental disorders globally as well as improving population mental health (Allen et al., 2014).

Large-scale trend studies that examine changes and development in internalizing symptoms among adolescents have produced mixed findings. Trend studies from Scandinavia, the United States and Great Britain (Collishaw, 2015; Collishaw et al., 2010; Durbeej et al., 2019; Hagquist, 2010; Mojtabai et al., 2016; Sigfusdottir et al., 2008; Sweeting et al., 2009; van Geelen & Hagquist, 2016; von Soest & Wichstrøm,

2014) show that adolescent mental health is worsening. At the same time, studies from Canada and Finland suggest that mental health has remained relatively stable (McMartin et al., 2014; Sourander et al., 2012; Wiens et al., 2017). One study among adolescents in Scotland from 1996 to 2004 concluded that adolescent mental health had even improved (Levin et al., 2009). Recent findings from a Swedish population-based twin study found that there were small increases over sequential birth cohorts in frequencies of depression and anxiety for both genders (Durbeej et al., 2019). These findings are inconsistent with previous results from a systematic review that concluded that the burden of internalizing symptoms had increased for girls only. In contrast, findings for boys were mixed but pointing towards stability (Bor et al., 2014).

Looking to explain these changes in adolescent self-reported symptoms of anxiety and depressed mood many contemporary scholars have sought to look at other changes that have been occurring in the environment of youth, such as the arrival and availability of digital media (Baker & Algorta, 2016; Barry et al., 2017; Booker et al., 2018; Bruggeman et al., 2019; Gerwin et al., 2018; Heffer et al., 2019; Jensen et al., 2019; Keles et al., 2019; Kelly et al., 2018; McCrae et al., 2017; Orben et al., 2019; Orben & Przybylski, 2019a, 2019b; Przybylski & Weinstein, 2017; Seabrook et al., 2016; Twenge, 2019; Twenge, Joiner, Martin, et al., 2018; Twenge, Joiner, Rogers, et al., 2018; Twenge, Martin, & Campbell, 2018; Twenge & Campbell, 2019; Yang et al., 2013). Digital media refers to digitized content transmitted via the internet or computer networks and is most often accessible through smartphones, tablets, and computers. Digital media supports technology such as gaming, videos, social media, audio, and internet browsing. In the last

15 years, digital media use, including social media, has increased markedly. Smartphone ownership is widespread among adolescents, with 95% of U.S. teens reporting to own a smartphone or have access to one (Anderson & Jiang, 2018). Adolescents spend on average 3 hours per day on social media (Anderson & Jiang, 2018; Vannucci & McCauley Ohannessian, 2019), with most adolescents using social media regularly, 45% report being connected almost constantly and 44% report being connected several times a day (Anderson & Jiang, 2018). Among adolescents in Iceland, 25% report spending 4 hours or more on social media each day (Palsdottir et al., 2018). Social media platforms change and develop at a rapid pace and in 2018 the most popular platforms among teens in the United States were YouTube, Instagram and Snapchat (Anderson & Jiang, 2018). Among adolescents in Iceland the most popular platforms were Instagram and Snapchat (DeVito, 2019). Due to this fast-changing development of social media platforms where different features emerge, it can be difficult to examine the content and context of these platforms to be able to compare studies over time.

One of the first studies on internet use and psychological well-being published in 1998 titled the HomeNet study (Kraut et al., 1998), was conducted in a longitudinal design where 169 participants from 73 families were tracked for their first 1-2 years of internet use. Findings revealed that initial depression did not predict subsequent internet use, but more use of the internet correlated with higher depressive symptoms, even after correcting for previous depressive symptoms. A few years later, Kraut and associates revisited the sample and gathered follow up data. They found that these negative associations between internet use and emotional distress had dissipated (Kraut et al.,

1998). Some research has suggested that this is due to the changing nature of the internet use itself as people get more used to the technology (Bessière et al., 2008). Still, another possible explanation is that internet use changed due to the availability of new online activities.

The first study on internet use and psychological well-being (Kraut et al., 1998, 2002) produced inconsistent findings within the same sample across both studies. This inconsistency is still the issue at hand. The previously discussed cross-sectional studies have produced mixed results, and the same applies to the longitudinal studies on the relationship between social media use and psychological well-being (Boers et al., 2019; Coyne et al., 2020; Jensen et al., 2019; Riehm et al., 2019; Vannucci & McCauley Ohannessian, 2019). Some recent longitudinal studies have found a relationship between social media use and internalizing symptoms among adolescents (Boers et al., 2019; Riehm et al., 2019; Vannucci & McCauley Ohannessian, 2019). For example, adolescents who belonged to a group of high social media users experienced greater symptoms of depression, panic disorder, and anxiety-related school avoidance at six-month follow-up, compared to high-Instagram/Snapchat and low social media use subgroups (Vannucci & McCauley Ohannessian, 2019). Social media use among girls at age ten has also been shown to predict lower well-being at age 15 (Booker et al., 2018). However, others find that frequency of social media use does not predict later mental health outcomes (Coyne et al., 2020; Jensen et al., 2019).

The longitudinal evidence base for the relationship between social media use and poor mental health is far from conclusive. One potential explanation for the disparate

findings is that the concept itself is broad, often vague, and measured in many different ways. Additionally, studies vary widely in their operationalization of outcomes. Some use well-being scales (Booker et al., 2018; Orben et al., 2019), others operate with general distress measures (Jensen et al., 2019; Riehm et al., 2019) while still others examine symptoms of internalizing problems, such as anxiety and depression (Boers et al., 2019; Coyne et al., 2020; Heffer et al., 2019; Vannucci & McCauley Ohannessian, 2019). In the latter two cases, the absence of symptoms is then considered to suggest positive psychological well-being.

Further complicating the picture, studies have produced mixed findings on the potential impact of gender in the social media - psychological well-being association. When gender differences have emerged, the relationship between social media and worse mental health has either been stronger for girls (Frison & Eggermont, 2016a) or only existing for girls (Devine & Lloyd, 2012). Orben, Dienlin, & Przybylski (2019) concluded that when examining the relationship between social media and life satisfaction, the importance of gender was apparent since the within-person models were significant for 2 out of 6 domains for boys and 5 out of 6 domains for girls. However, two longitudinal studies have not found gender differences in the relationship between social media use and internalizing symptoms (Riehm et al., 2019; Vannucci & McCauley Ohannessian, 2019). A meta-analytic review of sex differences in emotion expression involving a large number of participants demonstrated that girls show more internalizing symptoms than boys overall, even though the differences were small (Chaplin & Aldao, 2013). Furthermore, a recent meta-analysis concluded that girls both give and receive

more social support via social media than boys, which could explain girls' greater online presence (Tifferet, 2020). Given these disparate findings, examining the role of gender by stratifying analyses or testing for gender interactions in variable relationships is essential (Booker et al., 2018).

Mechanisms of social media use and mental health

Focusing on the amount of time spent on social media or frequency of use may be overly simplistic as the different activities in which adolescents engage while on social media vary widely and may play different roles in their emotional distress. These activities can be exclusively passive, such as scrolling through the profiles of others, or very active, such as chatting or sending videos. Examining content and context surrounding social media use is also important since social media has the potential to both positively and negatively affect adolescents. A recent Pew survey revealed that 31% of adolescents report that social media mainly has a positive effect, 24% say that the impact is mostly negative, and 45% say that it is neither positive nor negative (Anderson & Jiang, 2018). There is now a substantial body of evidence for both positive and negative impacts of social media on mental health. Taken together, they point to a complicated relationship (Best et al., 2014; Seabrook et al., 2016; Spies Shapiro & Margolin, 2014). Some argue that social media can serve as a protective factor as it provides levels of support, connections and enables social interaction (Bessière et al., 2008; Deters & Mehl, 2013; Wright et al., 2013). However, others believe that social media use is detrimental to mental health through bullying, lack of "in-person" contact

and peer pressure (Huang, 2017; Kross et al., 2013; Sampasa-Kanyinga & Lewis, 2015; Shakya & Christakis, 2017; Twenge, Joiner, Rogers, et al., 2018; Twenge, Martin, & Campbell, 2018; Vannucci et al., 2017; Viner et al., 2019).

It is very likely that superficially similar behaviors, such as spending time on social media, can have very different outcomes when examining behaviors in more detail. Using social media actively or passively may be critical factors that differentially relate to emotional distress, as active use involves connecting with others, but passive use does not (Clark et al., 2018; Frison & Eggermont, 2016b). To improve our understanding of whether social media may be harmful or helpful to adolescent mental health, it is of key importance to understand the mechanism through which social media may affect emotional distress and to examine possible mediators.

Even though the distinction between active and passive use exists in the literature, few studies have examined the process of how different kinds of social media use may lead to emotional distress. One possibility is that social media use may relate to emotional distress because it helps increase or decrease already known risk and protective factors for youth mental health. The literature on adolescent mental health has established risk factors for poorer mental health, such as social comparison and poor body image (Bucchianeri et al., 2016; Diener & Fujita, 1997; Jang et al., 2016; Rawana & Morgan, 2014). Others are protective, such as greater self-esteem and greater peer support (Asgeirsdottir et al., 2010a; Diener & Fujita, 1997; Dyl et al., 2006; Frost & Rickwood, 2017; Rueger et al., 2010; Thoits, 2011). In line with other scholars (Cairns et al., 2014), the terms risk and protective factors describe mechanisms that increase or decrease the

likelihood of a negative outcome, such as emotional distress. Active and passive social media use may boost or diminish known risk and protective factors of emotional distress. These include social comparison, poor body image, and self-esteem, which longitudinally predict later emotional distress (Rueger et al., 2010; Sowislo & Orth, 2013; Steers et al., 2014; Steiger et al., 2014; Stice & Bearman, 2001), and offline peer support, which has been found to be a protective factor for emotional distress (Rueger et al., 2010).

Social Comparison

Social comparison has been shown to be a risk factor for emotional distress (Diener & Fujita, 1997; Jang et al., 2016). Social comparison theory states that people compare their abilities and qualities with others to evaluate their own standing (Festinger, 1954). Social media may provide adolescents with a new, constantly accessible way of comparing themselves to others. Upward social comparisons are frequent on social media because users disproportionally post positive content from their lives while downplaying the negative, which paints an abnormally rosy picture of their lives (Barash et al., 2010). This is problematic as upward comparisons relate to greater negative affect (Bäzner et al., 2006; Wheeler & Miyake, 1992). Time spent on social media is related to greater social comparison (Hanna et al., 2017; Jang et al., 2016; Steers et al., 2014) and social comparison has been found to mediate the relationship between Facebook activity (number of logins) and general mental health symptoms (Hanna et al., 2017). Experimental evidence shows that social comparison is a mediator between Facebook activity and subsequent depressive symptoms (Steers et al., 2014).

Studies that have specifically examined types of social media use have found that passive use is connected with greater social comparison (Rousseau et al., 2017). Passive use may, therefore, lead to greater levels of social comparison, which may then represent a particular risk factor for emotional distress.

Poor Body Image

Body dissatisfaction is a risk factor for adolescent internalizing symptoms, such as anxiety and depression (Bucchianeri et al., 2016; Rawana & Morgan, 2014). Longitudinal evidence shows that poor body image predicts depressive symptoms among adolescent girls (Stice & Bearman, 2001). Media use affects body dissatisfaction, both for traditional media (Perloff, 2014) and social media (Fardouly & Vartanian, 2016; Haferkamp & Krämer, 2011; Marengo et al., 2018). Body image concerns mediate the relationship between the use of visual social media sites (e.g., Instagram and Snapchat) and internalizing symptoms (Marengo et al., 2018). Body image concerns are connected with social comparison, as youth may internalize unrealistic ideals and engage in appearance comparison, self-surveillance, and self-objectification (Fardouly & Vartanian, 2016; Manago et al., 2015; Vandenbosch & Eggermont, 2012). Social media studies usually focus on the amount of time spent on social media (Fardouly & Vartanian, 2016; Kim & Chock, 2015; Meier & Gray, 2014; Stronge et al., 2015). A study on the effects of active social media engagement with peers on body image found that engagement with attractive peers increased negative state body image (Hogue & Mills, 2019). However, one study found passive Facebook use to be connected with greater body image concerns,

and that social comparison mediates the relationship between passive use and body image concerns (Rousseau et al., 2017). Active social media use with attractive peers, and passive social media use may, therefore, relate to poorer body image, which is connected to increased emotional distress.

Peer Support

Decades of research have shown that social support is a protective factor against emotional distress (Aro et al., 1989; Oh et al., 2014; Rueger et al., 2010). The Rich-get-Richer hypothesis proposes that individuals with good offline social relationships are more likely to use social media to extend their social networks and the quality of their friendships (Kraut et al., 2002), these may overlap somewhat (Subrahmanyam et al., 2008). Using social media in an active manner (such as online chatting with friends) may have positive effects on social support and social inclusion in the offline domain. Active social media use relates to less loneliness (Burke et al., 2010; Deters & Mehl, 2013), greater feelings of bonding, increased social capital (such as emotional support from friends) (Burke et al., 2010) and greater daily online social connectedness to friends (Deters & Mehl, 2013). In addition, online social support has been found to mediate the relationship between active use and decreased symptoms of depressed mood (Frison & Eggermont, 2016b). However, limited research is available connecting active social media use to offline peer support. Given that social support is protective against emotional distress, active social media use may boost peer support, which is connected with fewer symptoms of anxiety and depression.

Self-Esteem

High self-esteem has been found to be a protective factor against emotional distress (Asgeirsdottir et al., 2010a; Sowislo & Orth, 2013). The evidence is particularly strong for depression, where longitudinal studies show low self-esteem increasing vulnerability for later depression (Sowislo & Orth, 2013; Steiger et al., 2014). Limited work exists on the topic, but greater social media use is connected with lower self-esteem (Twenge, Martin, & Campbell, 2018; Vogel et al., 2014; Woods & Scott, 2016), and negative self-esteem is a mediator between Facebook use and psychological distress (Chen & Lee, 2013). The relationships between different types of social media use (active and passive) have not been examined in the context of self-esteem. This is important, given that self-esteem relates to less emotional distress.

Limitations of the current literature

Individuals and social context share reciprocal relationships, where the social context does not only influence the individual, but the individuals themselves also shape their contexts (Levesque, 2011). Social media, a relatively new social setting where people interact and view the lives of others, is an extension of the traditional social environment. However, social media is different because it is accessible at all times and filtered through selective access. Technological development is rapid; information is instantaneous and constant change is among the few certainties today. The breaking down of cultural and national boundaries because of expanded media and communication technologies have affected lifestyle patterns to a great extent. Cyberspace is thus without

limits, and today's teenagers are mobile in more than one sense of the word, they no longer live in one world but many. Because of this, it may boost and suppress known risk and protective factors for symptoms of emotional distress. Adolescence is a complicated time in the life course, and due to the emergence of social media, this period of development is perhaps different from those experienced by previous generations. Understanding the role of social media within the developmental context could shed light on the contribution to adolescent well-being.

Cohort effects, i.e., different groups being assessed at different times, can partly explain conflicting results on the development of internalizing problems across cultures. Measurements vary, and sometimes boys and girls are separately evaluated and sometimes in combination. Social media use is one factor that has been used to explain worsening mental health trends among adolescents in the Western World (Twenge, 2017). However, linking social media use to worse mental health outcomes using cross-sectional studies is not sufficient to guide preventive work on adolescent mental health since there is a lack of understanding of the longitudinal impact as well as the possible mechanisms involved with social media use. This Thesis and the studies that comprise it address this gap in the literature by looking first at the development of symptoms of depressed mood and anxiety among adolescents living in Iceland; next by longitudinally assessing the relationship between social media use and symptoms of anxiety and depressed mood; and third by attempting to explain the mechanisms by which social media is associated with symptoms of anxiety and depressed mood.

Purpose and Aims

The overall purpose of this Thesis was to: 1) examine changes in symptoms of anxiety and depressed mood among adolescents over time; 2) examine the longitudinal relationship between time spent on social media and symptoms of anxiety and depressed mood; and 3) examine the possible mechanisms involved in the relationship between social media and symptoms of depressed mood and anxiety by looking at the potential impact of different risk and protective factors, as well as active and passive social media use. Results from this Thesis may help clarify the current knowledge base regarding the impact of social media use on symptoms of depressed mood and anxiety among adolescents, potential gender differences in this relationship, and how different types of social media use, as well as possible risk and protective factors, relate to adolescents' self-reported symptoms of anxiety and depressed mood.

Specific Aims

Each aim of this Thesis is related to one independent study. Within each study, there were several specific hypotheses. Specific aims of this Thesis were as follows:

1. Examine changes in symptoms of anxiety and depressed mood among adolescents from 2006 to 2016.
2. Examine the longitudinal association between time spent on social media and symptoms of anxiety and depressed mood among adolescents.
3. Examine how active and passive social media use relate to symptoms of anxiety and depressed mood among adolescents.

Hypotheses

Study I

1. Mean symptoms of anxiety and depressed mood have increased among adolescents from 2006 to 2016.
2. There is an increase in the proportion of adolescents reporting high symptoms of anxiety and depressed mood from 2006 to 2016.
3. The increase in symptoms of depressed mood and anxiety is greater for boys than girls.

Study II

1. Time spent on social media is positively related to symptoms of depressed mood, physical symptoms of anxiety, and symptoms of social anxiety.
2. An increase in time spent on social media is associated with a significant increase in observed symptoms of depressed mood, social anxiety, and physical symptoms of anxiety.
3. The relationship between time spent on social media and symptoms of depressed mood, physical symptoms of anxiety, and symptoms of social anxiety is stronger for girls than boys.

Study III

1. Time spent on overall social media is related to greater symptoms of anxiety and depressed mood among adolescents.
2. Active social media use is related to lower symptoms of anxiety and depressed mood among adolescents.

3. Passive social media use is related to higher symptoms of anxiety and depressed mood among adolescents.
4. Active social media use and passive social media use are more strongly related to symptoms of anxiety and depressed mood for girls than for boys.

Summary and Transition

In summary, this Thesis aimed to investigate: 1) the development of symptoms of anxiety and depressed mood for adolescents from 2006 to 2016; 2) the longitudinal relationship between social media use and symptoms of depressed mood and anxiety, and 3) how active and passive social media use are differently related to symptoms of depressed mood and anxiety. Chapter 2 contains the theoretical framework underlying the Thesis. Chapter 3 includes a description of study design, research methods, and analytical approach to each of the three Thesis aims, as well as ethical considerations. Chapter 4 contains a summary of the research that highlights results from each of the three studies that comprise the Thesis. The findings are discussed in Chapter 5, along with conclusions and recommendations for future research. Finally, Appendices include the full peer-reviewed manuscripts of the three studies.

Chapter 2: Theoretical Framework

The literature on child and adolescent mental health is abundant as the fields of psychology, psychiatry and sociology have, together, arrived at a reasonably well-developed understanding of the importance of biological, psychological and social factors that are related to children's mental health as these have been studied for decades (e.g., Rae-Grant et al., 1989; Rutter, 1985). The development of both anxiety disorder and depression are considered to be multifactorial, where it is unlikely that any single factor provides sufficient explanation for its emergence (Hankin, 2006; Murray et al., 2009). Healthy adolescent development is therefore dependent on complex pathways and processes where the environment, biology, and social factors interact (Sigfusdottir et al., 2017). A large number of mental health disorders begin in childhood or during adolescence, and early intervention is recommended to delay or prevent the severe sequelae often associated with their onset (Catalano et al., 2012; Thapar et al., 2012). Mental health risk factors contribute to an increased probability of onset, greater severity, and longer duration of episodes of poor mental health (World Health Organization, 2004). Protective factors for mental health refer to conditions that improve people's resilience and resistance to risk factors and clinical disorders and have been defined as those factors that modify, ameliorate or alter a person's response to hazards that predisposes a maladaptive outcome (Rutter, 1985).

Early adolescence is characterized by a marked increase in symptoms of internalizing problems (Costello et al., 2003), with girls having higher levels of symptoms than boys (Altemus et al., 2014; McLaughlin et al., 2012; Van Oort et al.,

2009). However, the developmental trajectories of anxiety and depression do not follow the same pattern. Most types of anxiety symptoms decrease across early to middle adolescence (Burstein et al., 2010; Hale et al., 2008; Van Oort et al., 2009), while symptoms of depression increase during this age period, especially in girls (Twenge & Nolen-Hoeksema, 2002; Van Oort et al., 2009). During adolescence, considerable changes take place both within each individual as well as in their social environment (Erikson, 1968). At the individual level, there are psychological and biological changes, pubertal onset initiates hormonal shifts and alterations in brain structure, which increase reactivity and sensitivity to environmental stimuli and social stimuli, which in turn allows for learning and psychosocial development to occur (Tottenham & Galván, 2016). Adolescents develop a sense of identity and greater autonomy. At the social level, peer relationships become increasingly important and central to self-evaluations, family relationships realign as adolescents strive for increased independence, their daily environment becomes more massive and more complex (Erikson, 1968). At this time, social media is commonly introduced. In the following sections, theories that offer a perspective on how to explain the relationship between mental health and social media use will be explored. First, by looking at more traditional theories that relate to self-representation and social comparison, which are important to understand the possible mechanisms involved in the relationship between social media use and emotional distress, then by discussing the interpersonal-connection-behaviors framework which is the theoretical framework for the Thesis.

Self-representation theories

According to Erikson (1968), identity formation is one of the tasks of adolescence, and success leads to the individual staying true to him or herself, while failure leads to role confusion and a weak sense of self. While identity captures the idea of who a person is, self-representation is what the person chooses to show at any given time (Cooley, 2019; Goffman, 1959; Mead, 1913, 1934; Moncur et al., 2016).

Cooley's theory of the looking glass self from 1902 (Cooley, 2019), Mead's theory of the self from 1913 (Mead, 1913, 1934) and Goffman's theory of self-representation from 1959 (Goffman, 1959) all argue for the importance of social context and social interactions in the development of the self. Cooley theorized that the self consisted of three elements, the imagination of our appearance to others, the imagination of the judgment of others on that appearance, and some sort of self-feeling or emotion. These self-representation theories apply to modern-day social media, where adolescents have more opportunities for self-representation as well as the ability to sculpt a thorough image of how they want to represent themselves. Furthermore, the imagination of the judgment of others is closer on social media since more feedback is given than in the offline world. Goffman calls this self-representation performance, and when the performance or the self is different from one's identity, it can lead to role confusion or identity crisis (Boyd, 2007; Zhao, 2005).

Social comparison theory

Another theory that has frequently been used to explain the relationship between social media use and mental health is social comparison theory (Festinger, 1954). The theory suggests that individuals have the tendency to compare themselves to objective standards to ensure their opinions about their abilities are accurate. In the absence of these objective standards, individuals will compare themselves to their peers or others in their social world. The comparison is often unfavorable since it is more likely to be upward than downward, that is comparing to someone that we believe is better than us or has a better life than us rather than comparing to someone worse off or not as good as us in one way or another. This unfair comparison may lead to individuals feeling poorly about themselves. Social media is an optimal breeding ground for social comparison through status updates and visual-based platforms such as Instagram, Pinterest, and Snapchat. Therefore it has been proposed that individuals who spend more time on social media may engage in social comparison more frequently which could, in turn, make them feel worse about themselves if they perceive their life or looks poorer in comparison with others (Best et al., 2014; Calancie et al., 2017; Nesi & Prinstein, 2015; Vogel et al., 2014).

The interpersonal-connection-behaviors framework

According to the interpersonal-connection-behaviors framework, the relationship between social media and well-being can be explained by the activity that takes place online (Clark et al., 2018). Social media sites benefit their users when the activities online

encourage meaningful social connections. However, when social network use is not focused on promoting connection, the consequences can be more complex and even harm the user through byproducts of social media use such as isolation and social comparison. The assumptions of the interpersonal-connection-behaviors-framework can be seen in various studies. Studies that find a positive association between social media use and well-being are often looking at connection and positive experiences as primary drivers or mediators (Bessière et al., 2008; Burke et al., 2010; Deters & Mehl, 2013; Kraut et al., 2002). On the other hand, studies that find a negative association between social media use and well-being are commonly addressing behaviors that are known to have adverse effects outside the social media domain (Chen & Lee, 2013; Fardouly & Vartanian, 2016; Hanna et al., 2017; Hogue & Mills, 2019).

The framework calls for researchers to examine the specific behaviors of users in context when studying social network sites. Distinguishing between active and passive social media use is one way to capture the essence of connection promoting behavior versus not (Escobar-Viera et al., 2018; Frison & Eggermont, 2015, 2016b; Rousseau et al., 2017; Verduyn et al., 2015). Where active use is supposed to foster social support while passive use can lead to negative consequences such as upward social comparison and self-objectification. Studies that have used this approach have found that passive use was related to increased emotional distress (Escobar-Viera et al., 2018) and declines in well-being (Verduyn et al., 2015), while active social media use has been related to decreased symptoms of depression among adults (Escobar-Viera et al., 2018) and among adolescent girls (Frison & Eggermont, 2016b). According to Clark et al. (2018), the

inconsistent findings in studies on social media and well-being can largely be explained by what we do on social media and how we do it. It is only by exploring in more detail the situational factors and circumstances of social media use that we can hope to understand how it relates to mental health. In this Thesis, the interpersonal-connection-behaviors framework will be used as the basis to understand how social media relates to mental health.

Chapter 3: Research Method

This Thesis consists of three independent manuscripts, each consisting of one individual study that addresses one of the three specific aims. Table 1 provides an overview of the three studies and the design, participants, measurements (main study variables), control variables, and data analysis for each.

Table 1 *Overview of Studies I, II, and III*

Study	I	II	III
Design	Trend analysis on population-based cross-sectional data from 2006, 2009, 2010, 2012, 2014 and 2016	Three waves annual longitudinal cohort-survey from 2017 to 2019	A cross-sectional population-based survey in 2018
Participants	Students attending 9th and 10th grade. N=43,482, 14 to 16-year olds	Adolescents born in Iceland in 2004. N=2,211	Students attending the 8th, 9th and 10th grades of compulsory school, 13 to 16-year olds. N=10,563
Measurement (main study variables)	Symptoms of depressed mood Symptoms of anxiety	Symptoms of depressed mood Physical symptoms of anxiety Symptoms of social anxiety Time on social media	Time on social media Type of social media use Symptoms of depressed mood Symptoms of anxiety Offline peer support Social comparison Self-esteem Poor body image
Control variables	N/A	Gender Family structure Parental support	Gender Family structure Parental support Subjective relative deprivation

Data analysis	ANOVAs with Bonferroni post hoc test Linear regression Binomial logistic regression Multiple group SEM tests of invariance	Mixed model design with unstructured covariance matrix	Frequencies Spearman correlations Hierarchical linear regression

Methodology

Participants

The study utilized nationally representative data from the Youth in Iceland surveys and longitudinal data from the LIFECOURSE study of risk and protective factors for healthy adolescent development among Icelandic children. The Icelandic Centre for Social Research and Analysis (ICSRA) has collected the Youth in Iceland surveys since 1997 in collaboration with the Ministry of Education, Science and Culture. In Iceland, schooling is obligatory for grades one through ten, and all compulsory schools receive funding from the municipalities and are supervised by the Ministry of Education, Science and Culture. The Youth in Iceland population-based cross-sectional surveys are collected biennially among adolescents in compulsory schools in Iceland and monitor a wide range of behavioral and health-related variables that are used for work within the Icelandic Model of Prevention (Kristjansson et al., 2020a, 2020b; Sigfusdottir et al., 2009). All students in grades 8-10, 13-16-year-old, were offered to participate. In 2017 and 2019, the LIFECOURSE study and the Youth in Iceland surveys were conducted in conjunction with one another, using the same questionnaire.

Study I

Data for Study I comes from the nationally representative Youth in Iceland surveys from 2006 to 2016. Participants were students in the ninth and tenth grade in all Icelandic secondary schools, 14-16-year-old. Table 2 shows the number of students in the six time points that were used for the study, gender division, and the response rate per year. There was no data collected in 2008 due to the economic crisis; therefore, data were collected in both 2009 and 2010. Participation was based on passive consent. An introductory letter was sent home to parents about the study where they were offered an opportunity to withdraw their child from the study or to contact the research team with any questions they had. Furthermore, students were allowed to decline participation on the day of the survey.

Table 2 *Number of participants by year and response rate per year.*

Year	Number of participants (% girls)	Response rate
2006	7,232 (50.1%)	81.4%
2009	7,377 (50.8%)	83.5%
2010	7,125 (50.3%)	85.6%
2012	7,202 (50.1%)	86%
2014	6,966 (50.8%)	86.3%
2016	7,041 (49.6%)	86%

Study II

Three waves of school-based survey data from the LIFECOURSE study were utilized for the longitudinal analysis in Study II. Of the 3,914 individuals born in Iceland in 2004 that were approached for participation, 2,373 (60.6%) provided active, informed parental consent and student assent, with 2,278 (96.0%) responding to the baseline survey of consented participants in 2017, 2052 responded in 2018 (86.5%) and 2097 in the year 2019 (88.4%). The LIFECOURSE study was reviewed and approved by the National Bioethics Committee of Iceland (Protocol # 11-078), and the study has been registered and acknowledged by the Icelandic Data Protection Authority.

Study III

Data for Study III comes from the Youth in Iceland survey in 2018 among students in the eighth to tenth grades of compulsory secondary school, ages 13 to 16. Valid responses were received from 10,563 students (girls: 50.3%), and the response rate was 84% nationwide. The number of students in the eighth grade was 3,606, in the ninth grade 3,523, and in the 10^{th} grade 3,312, with 122 students providing insufficient information on their grade. Participation was based on passive consent. An introductory letter was sent home to parents about the study where they were offered an opportunity to withdraw their child from the study or to contact the research team with any questions they had. Furthermore, students were allowed to decline participation on the day of the survey.

Procedures

ICSRA conducted both the Youth in Iceland survey and the LIFECOURSE survey. The Youth in Iceland surveys were conducted from 2006 to 2018 in either February or March, and the LIFECOURSE surveys were conducted in February in 2017, 2018, and 2019. Both of the surveys were conducted in all secondary schools in Iceland using procedures developed by ICSRA in collaboration with the Icelandic Ministry of Education, Science and Culture over a 20-year period (Kristjansson et al., 2013).

Anonymous questionnaires were administered to all students participating in the Youth in Iceland surveys. Teachers distributed the questionnaires, and students returned them sealed in blank envelopes upon completion. Participants in the LIFECOURSE study received a non-traceable, unique research identification number. For each wave of data collection, teachers at individual school sites supervised participation of students in the classroom and administered the survey questionnaire using a double-envelope system to identify students while distributing the surveys in classroom settings, omitting their identification post-survey completion (non-traceable ID printed on each individual questionnaire for scanning and data processing). In both the Youth in Iceland Study series and the LIFECOURSE study, students were instructed not to write their names, social security numbers, or any other identifying information anywhere on the questionnaire. Upon survey completion, students were asked to place their completed questionnaire in a blank and pre-sealed envelope provided to them before returning it to the supervising teacher. A key that links individual names and contact information from the LIFECOURSE participants to research IDs is maintained by a third party at the Primary

Health Care Clinics of the Capital Area in Iceland and is not accessible to the research team.

Measures

The primary outcome variables of interest were symptoms of depressed mood and anxiety.

Symptoms of depressed mood

The Original Symptoms Checklist (Derogatis et al., 1973) was used to measure symptoms of depressed mood. Participants reported how often in the previous week they experienced symptoms of depressed mood such as feeling hopeless, without energy, lonely. Participants answered nine questions on a four-point scale. The items were combined into a scale. The scale demonstrates good internal consistency and test-retest reliability (Derogatis & Unger, 2010). In all three studies, reliability was robust, with Cronbach's Alpha of 0.91.

Symptoms of anxiety

Two different scales were used to measure symptoms of anxiety. In Study I, three items from the anxiety dimension of the Original Symptom Checklist were used (Derogatis et al., 1973). Participants were asked how often during the previous week they had experienced nervousness, felt suddenly scared for no reason, and felt tense or overstrung. Responses were given in four categories, and items were combined into a

scale. The scale had adequate reliability, with the average Cronbach's Alpha of .78 across 2006 to 2016.

In Study II anxiety was measured with two dimensions from the Multidimensional Anxiety Scale for Children (MASC). Physical symptoms of anxiety were measured with the 12-item physical symptoms scale from the Icelandic version of the MASC (Olason et al., 2004). Participants reported how often statements apply to them; examples of statements include "I feel nervous", "I get dizzy and feel like I am fainting", "I find it difficult to catch my breath". A four-category response scale was employed (never applies to me to often applies to me). MASC has been validated in a sample of Icelandic adolescents and has good reliability and validity (Olason et al., 2004). In this sample, reliability was robust (Cronbach's $\alpha = 0.91$).

Symptoms of social anxiety were measured with the 9-item social anxiety scale from the Icelandic version of MASC (Olason et al., 2004). Participants reported how often statements apply to them; examples of statements include "I worry that people will laugh at me," "I am afraid that others find me stupid," and "I worry about embarrassing myself." A four-category response scale was employed (never applies to me to often applies to me). MASC has been validated in a sample of Icelandic adolescents and has good reliability and validity (Olason et al., 2004). In this sample, reliability was excellent (Cronbach's $\alpha = 0.91$).

In Study III, the physical dimension and social anxiety dimension from the MASC were computed together into one scale to capture symptoms of overall anxiety. The reliability was excellent (Cronbach's $\alpha = 0.95$).

Social media use

Social media use was assessed both by asking about time spent on social media as well as different types of social media use.

Time on social media was assessed with one question in the three studies. Participants were asked on average how many hours a day they spend on social media (e.g., Facebook, Snapchat, Twitter, and Instagram). The eight-category response scale ranged from "almost no time" to "6 hours or more". These responses are comparable to other studies that have examined how much time adolescents spend on social media (Przybylski & Weinstein, 2017; Twenge, Martin, & Campbell, 2018).

Different types of social media use were assessed in Study III, using a modified version of the Multidimensional Scale of Facebook Use (Frison & Eggermont, 2015). The scale was modified to include all types of social media and not just Facebook. The scale was translated to Icelandic and then translated back to English for quality check. Participants answered six questions on how often they take part in the following activities on social media "send a private message, picture, video, or chat", "send a private message, picture or a video that disappears after being seen", "post a picture or video from your life", "look at friends profiles or accounts", "browse profiles or accounts of people you do not know", and "post something other than pictures such as links, games, news, or web pages". The Multidimensional Scale of Facebook Use consists of three subscales, Active private social media use, Active public social media use, and Passive social media use (Frison & Eggermont, 2015). For the modified version of the questionnaire, a principal component exploratory factor analysis with varimax rotation

showed that the six items loaded onto only two factors, active and passive social media use, explaining 71% of the variance. Both factors had acceptable internal consistency (active social media use: Cronbach's $\alpha = 0.80$, passive social media use: Cronbach's $\alpha = 0.74$). A confirmatory factor analysis revealed an adequate fit of the two-factor model (Comparative Fit Index =0.98, Tucker-Lewis Index=0.96).

Peer support

In Study III, participants were asked how easy or hard it is for them to receive caring and warmth from their friends, discussions about personal affairs, advice about their studies, advice about other issues, and assistance with things. These five items were measured on a four-point scale with a higher score indicating higher perceived peer support. In this sample, reliability was good (Cronbach's $\alpha = 0.89$). The measure of peer support has previously been used among Icelandic adolescents (Kristjansson et al., 2010; Mann et al., 2015).

Self-esteem

In Study III, Self-esteem was measured with ten statements from the Rosenberg Self-Esteem Scale (Rosenberg, 1965). The scale consists of positive and negative self-appraisal statements rated on a four-point scale, and negative self-appraisals were reverse coded before analysis. Higher scores indicate a higher level of self-esteem (Asgeirsdottir et al., 2010b). The scale has shown good psychometric properties (Eklund et al., 2018;

Martín-Albo et al., 2007). In this study, scale reliability was excellent (Cronbach's α = 0.90).

Body Image

In Study III, body image was measured with five items from the body image subscale of the Offer Self-Image Questionnaire (Offer & Howard, 1972). Participants indicate how much they agree or disagree with statements about their body, such as: "I am happy with my body" and "I often feel unattractive or ugly." The statements are both phrased positively and negatively on a four-point scale, to create the body image scales one item was reverse coded, and higher scores indicate a more negative body image. The Offer Self-Image Questionnaire has been used in adolescent research and has high reliability (Patton & Noller, 1994) and moderate discriminant validity (Laukkanen et al., 1999). In this study, scale reliability was good (Cronbach's α = 0.82).

Social Comparison

In Study III, social comparison was measured with the 11-item Iowa–Netherlands Comparison Orientation Measure (Gibbons & Buunk, 1999). The measure was translated into Icelandic and then back-translated into English. Participants were asked how much they agree with statements such as: "I often compare myself with others with respect to what I have accomplished in life." Participants answered on a five-point scale, ranging from strongly disagree to strongly agree. Higher scores indicate a greater tendency to compare oneself with others. The scale is widely used and has good reliability and

validity (Gibbons & Buunk, 1999; Schneider & Schupp, 2014). In this study, scale reliability was high (Cronbach's $\alpha = 0.83$).

Gender

In all three studies, gender was a binary variable asking participants to indicate whether they were a boy (1) or a girl (2).

Subjective relative deprivation

In Study III, subjective relative deprivation was measured by asking participants how well off financially their family is compared with other families in Iceland, the seven-point scale ranged from much worse off to much better off. This measure has previously been used among Icelandic adolescents (Bernburg et al., 2009).

Family structure

In Study II and Study III, family structure was used as a control variable. Participants were asked to indicate the individuals who live in their household. This selection resulted in a dummy-coded variable for those living with both biological parents and those living in other arrangements. In Study II, 74.0% of students from the LIFECOURSE cohort lived with both parents at baseline (T1), and in Study III, 69.8% of students lived with both biological parents.

Parental support

In Study II and Study III, parental support was measured with The Perceived Parental Support Scale (PPS), which consists of five items measured on a four-category response scale, concerning how adolescents perceive general support from parents. Participants were asked how easy or hard it is for them to receive the following from their parents: caring and warmth, discussion about personal affairs, advice about their studies, advice about other issues, and assistance with other things. A higher score reflects more parental support. The scale has been validated in a multi-country sample and shown good internal consistency and convergent validity (Kristjansson, Sigfusdottir, Karlsson, & Allegrante, 2011). In this both studies reliability was high (Study II: Cronbach's $\alpha = 0.87$, Study III Cronbach's $\alpha = 0.88$).

Missing values

In general, non-response to individual questions is not a serious problem in the Youth in Iceland data set. In Study I, missing values on the analyzed variables were mean imputed—the ratio of missing values from Study I can be found in Table 2.

In Study II, missing values within individual variables ranged from 1.7% to 5.8%. The total ratio of missing cases within all of the variables was 24.34%. Restricted maximum likelihood (REML) was used to handle missing data with 100 iterations.

In Study III, the proportion of missing values on each item ranged from zero to 8.1%, with an average of 4.4% of missing values used in the analysis. Missing data were not handled specifically, and listwise deletions were used.

Table 3 *Missing value analysis showing the minimum number of missing values, the maximum number of missing values, and average missing values from all analyzed variables in Study I.*

Year	Minimum	Maximum	Average missing
2006	1.7%	2.7%	1.9%
2009	1.7%	2.4%	1.9%
2010	1.0%	3.2%	2.4%
2012	0.9%	2.1%	2.1%
2014	0.5%	2.0%	1.6%
2016	0.5%	2.1%	1.3%

Data Analysis Plan

Study I

The first step before analyzing the cross-sectional changes over time in symptoms of anxiety and depressed mood was to test for measurement invariance of the scales, described in more detail in Study I (see appendix). Several different methods were used to examine changes in symptoms of anxiety and depressed mood among adolescents from 2006 to 2016. Analysis of variance with Bonferroni post hoc test was used to test the differences in mean scores of symptoms of depressed mood anxiety between years, for boys and girls separately. A linear trend in mean levels was also examined for the

genders separately by using survey year as the predictor variable and symptoms of depressed mood and anxiety as the outcome variables.

To examine the pattern of change in symptoms of anxiety and depressed mood among adolescent boys and girls and the arbitrary cut-off score was created by identifying those that scored in the top 5% in 2006, this method has previously been used to examine changes over time in adolescent mental health (Hagquist, 2010). Binomial logistic regression was used to examine changes over time between time points in the proportion of girls and boys who showed high symptoms of anxiety and depressed mood as determined by the cut-off scores. Finally, two binomial logistic regression models with gender as an interaction variable were run to test if the trends in high levels of symptoms were significantly different for the girls and boys.

Version 24 of the Statistical Package for the Social Sciences (SPSS) and Mplus version 6 were used for all data analysis.

Study II

Three linear mixed-effects models were used to examine the relationship between social media use and 1) symptoms of depressed mood, 2) physical symptoms of anxiety, and 3) symptoms of social anxiety. In all three models, the control variables used were gender, family structure, and parental support. Family structure and parental support have been linked to emotional distress (Stadler et al., 2010; Turner et al., 2013). The reason for including gender as a control variable is because girls are more likely to report symptoms of emotional distress than boys (Bor et al., 2014).

The correlation structure of the linear mixed-effects models was chosen on the best fitting model using Akaike's Information Criterion (Gurka, 2006). All possible correlation structures were analyzed, and an unstructured matrix was deemed most suitable.

In addition to main effects models, two interaction effect models were tested. First, time spent on social media by time was assessed to identify whether the relationship between time spent on social media and the three outcomes increases as participants grow older. Second, time spent on social media by gender was tested to assess if the over-time relationship between time on social media and the three outcomes may be different between girls and boys. In the interaction effect models, time spent on social media was mean-centered using the grand mean. All analyses for Study II were conducted in SPSS version 26.

Study III

The bivariate relationship between variables was calculated with Spearman correlations. Hierarchical linear regression was conducted to analyze the unique effects of social media use, both as time spent on social media and active and passive social media use, on symptoms of anxiety and depressed mood. In model 1, control variables were examined; these were family structure, parental support, relative deprivation, and time on social media. In model 2, time spent on social media use was added. In model 3, active and passive social media use were added to the analysis. In model 4, self-esteem, body

image, peer support, and social comparison were added. Finally, two-way interactions with gender and social media variables were added to the analyses.

The control variables family structure, relative deprivation, and parental support have been related to emotional distress (Mishra & Carleton, 2015; Stadler et al., 2010; Turner et al., 2013). Gender was included because girls are more likely to report emotional distress (Bor et al., 2014), compare themselves on social media, report worse body image (Hanna et al., 2017), and use social media more often (Rideout, 2016; Sampasa-Kanyinga & Lewis, 2015). SPSS 25 was used in all analyses except for the confirmatory factor analysis of the Multidimensional Scale of Facebook use were Mplus version 6 was used.

Ethical Procedures

The Youth in Iceland surveys (Study I and Study III) have been acknowledged by the Icelandic Data Protection Authority, and due to the anonymity of the study it does not require formal authorization by the agency. With the new act on Data Protection and the Processing of Personal Data that was implemented in Iceland on July 15, 2018 (Act no. 90/2018), ICSRA received further confirmation from the Icelandic Data Protection Authority that the Youth in Iceland surveys are exempted from formal permission requirements. Data collection is based on passive informed consent, guided by a framework developed by ICSRA and in compliance with Icelandic law on the protection of human subjects. No identifying information was collected or obtained (see Kristjansson et al., 2013, for a detailed description of the data collection protocols).

The LIFECOURSE study (Study II) was approved by the National Bioethics Committee of Iceland (protocol # 11-078) as well as being registered and acknowledge by the Icelandic Data Protection Authority. Participants and their parents were informed of the study by a letter. Participation in the LIFECOURSE study is contingent on active parental consent and student assent. Participants were allowed to withdraw at any time from the study without any further explanation or effects. A key that links individual names and contact information from the LIFECOURSE participants to research IDs is maintained by a third party at the Primary Health Care Clinics of the Capital Area in Iceland and is not accessible to the research team.

All data is stored on secure servers at Reykjavik University without identifiable information.

Chapter 4: Results

The overall aims of the Thesis were to: 1) examine the trends in symptoms of anxiety and depressed mood for adolescents, 2) to examine the longitudinal relationship between social media use and symptoms of anxiety and depressed mood and; 3) to examine how time spent on social media, as well as different types of social media use, relate to symptoms of anxiety and depressed mood. This section presents the key results of the Thesis based on the three individual papers. For a more detailed description, please refer to the individual papers in the Appendices.

Study I

Analyses into changes in symptoms of anxiety and depressed mood for adolescents showed that girls and boys followed a different pattern of change. Among girls, there was a significant ($p < .001$) increase in mean levels of depressive symptoms from 2009 to 2010, from 2012 to 2014, and from 2014 to 2016. There was also a significant ($p < .001$) increase in mean symptoms of anxiety among girls from 2012 to 2016. Among boys, symptoms of depressed mood remained relatively stable over the entire period with a significant ($p < 0.001$) decrease in mean symptoms from 2010 to 2012 and a significant ($p < .01$) increase from 2014 to 2016. Mean symptoms of anxiety decreased significantly ($p < .001$) for boys over the ten-year period, with the most notable decrease from 2010 (M= 1.78, SD=1.96) to 2012 (M=1.37, SD=1.84). For girls, a linear increase was observed in symptoms of anxiety (β= 0.0039, $p < .001$) and

depressed mood (β= 0.06, p < .001) while boys had a linear decrease in symptoms of anxiety (β= -0.07, p < .001) with non-significant changes in depressed mood.

An arbitrary cut-off score was created to assess more closely if there was a change in those reporting high symptoms of anxiety and depressed mood over the study period. Based on those findings, the odds of having high symptoms of anxiety and depressed mood were significantly higher in 2016 than in 2006 for both genders. An interaction test between year and gender indicated that the trends in high symptoms of anxiety (OR 1.11, 95% CI 1.05–1.17, p < .001) and depressed mood (*OR* 1.09, 95% CI 1.03–1.16, p= .005) were significantly different for boys and girls, with girls being more likely to belong to the high symptom group.

Study II

Over the three-year period of study, there was a general mean increase in the three outcome variables of interest, symptoms of depressed mood, symptoms of social anxiety, and physical symptoms of anxiety. Time spent on social media also increased significantly over the three years, while a decrease was observed in perceived parental support (p <. *05)*.

Tables 2 to 4 in Study II (see appendix) show the results for all linear mixed-effects models. For all three psychological distress outcome variables, a significant main effect of parental support, family structure, and gender were observed. A negative relationship was identified for depressed mood, physical and social symptoms of anxiety, among those who reported greater parental support, living with both parents, and being

male. Time on social media was also significantly associated with increased symptoms of depressed mood, symptoms of social anxiety, and physical symptoms of anxiety over time. There was also a significant main effect of time on all three outcome variables, which indicates that symptoms increase between data collection waves 1, 2, and 3 while controlling for other variables in the models.

In the second model for each of the three outcomes, the interaction term between time and time spent on social media was statistically significant for symptoms of depressed mood and physical symptoms of anxiety, but not for symptoms of social anxiety, indicating that the impact of time spent on social media on the outcomes grew stronger over time. Finally, the third model revealed that the interaction effect between gender and time spent on social media was statistically significant for all outcomes. This means that the relationship between time spent on social media and all three outcomes was significantly stronger for girls than boys.

Study III

Findings from this study showed that adolescents in Iceland are frequent and active users of social media; however, they use social media passively to a less extent. Girls reported using social media more than boys (see Table 1, Study III in appendix).

Time spent on social media was associated with greater symptoms of depressed mood ($\beta = 0.153$, $p < .001$) and anxiety ($\beta = 0.122$, $p < .001$) for adolescents after controlling for family structure, parental support, and subjective relative deprivation. Adding to the model active and passive social media use revealed that passive use was

related to greater symptoms of anxiety (β= 0.098, p < .001) and depressed mood (β= 0,086, p < .001) and active use to fewer symptoms of anxiety (β= -0.04, p < .01) and depressed mood (β= -0.046, p < .01). When adding the risk and protective factors to the hierarchical linear regression model, passive use remained significantly associated with increased symptoms of anxiety (β= 0.036, p < .001) and depressed mood (β= 0.036, p < .001), but active use was no longer a significant contributor to symptoms of emotional distress.

Girls reported greater symptoms of anxiety (β= 0.237, p < .001) and depressed mood (β= 0.128, p < .001) than boys, even after controlling for time spent on social media, type of social media use, self-esteem, body image, peer support, and social comparison. Significant interaction effects emerged as time spent on social media had a stronger relationship with symptoms of depressed mood (β= 0.093, p < .001) and anxiety (β= 0.063, p < .05) among girls than boys. In addition, passive use was more strongly related to symptoms of depressed mood among girls over boys (β= 0.045, p < .05).

Summary of main results from Studies I - III

The results from Study I demonstrated that symptoms of anxiety and depressed mood increased for girls from 2006 to 2016. The change in symptoms was both found when looking at the mean level as well as when using a cut-off score to determine the change in patterns, a greater number of adolescent girls were experiencing high symptoms of anxiety or depressed mood. Among boys, mean level changes suggested that symptoms of anxiety were decreasing and symptoms of depressed mood remaining

relatively stable. However, when looking at changes within the cut-off scores, there was slightly increased odds of high symptoms of anxiety and depressed mood for boys from 2006 to 2016. Changes in patterns of symptoms of anxiety and depressed mood can be determined by looking at both mean level change and change based on cut-off scores, which is important when working with cross-sectional data over time. The mean level change does not reveal how many respondents are reporting lower or higher scores, and therefore, only by looking at the patterns based on cut-off scores are we able to identify if there was a substantial change in reporting of symptoms. However, that does not translate to clinical cut-off scores.

Study II is the first longitudinal study in Iceland on the relationship between social media use and symptoms of emotional distress. Study I supported the hypothesis that there was a change in symptoms of depressed mood and anxiety over time. These findings led us to focus our effort on assessing other changes within the environment of youth, and social media use stood out as recent change. The interaction effects between time and time spent on social media were significant for both symptoms of depressed mood and physical symptoms of anxiety but not for symptoms of social anxiety. This indicates that as adolescents get older, the impact of time spent on social media becomes stronger. The findings showed that the relationship was stronger for girls than boys.

Study III further confirmed the relationship between time spent on social media and symptoms of depressed mood and anxiety. More specifically, it showed that different types of social media use are important for emotional outcomes, with active use being likely to serve as a protective factor or neutral factor while passive use negatively relates

to mental health. Time spent on social media had a stronger relationship with emotional distress for girls than boys, and using social media passively was also more strongly related to symptoms of depressed mood for girls.

Overall the findings suggest that symptoms of anxiety and depressed mood have increased for adolescents. Results also reveal that there is a longitudinal relationship between time spent on social media and symptoms of depressed mood and physical symptoms of anxiety, and that above time spent on social media, different types of social media use are differently related to symptoms of anxiety and depressed mood. All of these findings point to the fact that these relationships are either stronger for girls compared to boys, or only exist for girls.

Chapter 5: Discussion, Recommendations, and Conclusions

In this Thesis, changes in symptoms of anxiety and depressed mood among adolescents in Iceland over a 10-year period are were examined using six cross-sectional, population-based school surveys. Secondly, a longitudinal analysis was conducted on the relationship between time spent on social media and symptoms of depressed mood, physical symptoms of anxiety, and symptoms of social anxiety. Thirdly, the relationship between social media use and emotional distress was examined further by assessing the potential impact of different types of social media use while including known risk and protective factors for psychological well-being in the analysis. The findings are relevant for an improved understanding of the context and content of social media use and how it relates to emotional distress during adolescence.

Discussion

The overarching goal of this Thesis was to examine the relationship between social media use and symptoms of depressed mood and anxiety among adolescents. The main findings are that symptoms of anxiety and depressed mood have increased for adolescents. There was a longitudinal relationship between time spent on social media and symptoms of depressed mood and physical symptoms of anxiety, and thirdly that above time spent on social media, different types of social media use (active and passive) were differently related to symptoms of anxiety and depressed mood. It is well documented that the first onset of anxiety and depressive disorders most frequently occurs during adolescence and young adulthood, with girls being more at risk than boys to develop such disorders (Altemus et al., 2014). In all three studies, girls reported higher symptoms of anxiety and depressed mood, which is consistent with previous literature on the topic (Bor et al., 2014; McLaughlin et al., 2012; Van Oort et al., 2009).

Symptoms of anxiety and depressed mood had increased for girls from 2006 to 2016, both when looking at mean level change as well as using a cut-off score. Among boys, mean level changes suggested that symptoms of anxiety were decreasing and symptoms of depressed mood remaining relatively stable. However, when using the cut-off scores, there was slightly increased odds of high symptoms of anxiety and depressed mood for boys from 2006 to 2016. These findings are consistent with previous studies that have found adolescent mental health to be declining (Collishaw, 2015; Collishaw et al., 2010; Durbeej et al., 2019; Hagquist, 2010; Mojtabai et al., 2016; Sigfusdottir et al.,

2008; Sweeting et al., 2009; van Geelen & Hagquist, 2016; von Soest & Wichstrøm, 2014).

Symptoms of depressed mood, physical anxiety, and social anxiety increased among adolescents in relation to social media use over time. The interaction between time and time spent on social media was significant for both symptoms of depressed mood and physical symptoms of anxiety but not for symptoms of social anxiety. This indicates that as adolescents get older, the impact of time spent on social media becomes stronger. Longitudinal studies on the relationship between social media use and mental health have been few to date, but are growing. However, the previously published studies are far from conclusive. Some find a relationship between social media use and internalizing symptoms (Boers et al., 2019; Riehm et al., 2019; Vannucci & McCauley Ohannessian, 2019) while others find no such relationship (Coyne et al., 2020; Jensen et al., 2019).

The nature of adolescent use of social media differently relates to symptoms of depressed mood and anxiety, with active use serving as a protective factor or neutral factor while passive use is negatively related to mental health. Time spent on social media had a stronger relationship with emotional distress for girls than boys, and using social media passively was also more strongly related to symptoms of depressed mood for girls. These findings are in line with previous studies that have found that active use relates to decreased symptoms of depression for both genders (Escobar-Viera et al., 2018). Furthermore, another study found that active Facebook use related to decreased depressive symptoms only among girls, while active public Facebook use was connected

with greater depressive symptoms for boys (Frison & Eggermont, 2016b). By including known risk and protective factors for adolescent emotional distress, an attempt was made to weave out the unique effects of time spent on social media and different types of social media use on anxiety and depressed mood. Poor body image (Dyl et al., 2006) and social comparison (Lee, 2014) were positively related to emotional distress, while peer support (Oh et al., 2014; Seabrook et al., 2016) and self-esteem (Sowislo & Orth, 2013) were negatively related to emotional distress. After adding these individual risk and protective factors to the models, active use no longer related to emotional distress but, passive use remained statistically significant. These findings are in line with the interpersonal-connection-behaviors framework (Clark et al., 2018), which focuses on explaining the relationship between social media use and mental health by identifying the activities that take place online. Adolescents that engage in passive social media use are not increasing their social capital or interacting with peers, and they are more likely to be browsing content created by others or scrolling through feeds. While we were able to include variables of individual differences such as self-esteem, body image, and social comparison, the distinction between active and passive social media use was not clear enough to explain how exactly different social media behaviors lead to different emotional outcomes. If the devil really is in the details, a more thorough approach will be required to gain a better understanding of how social media relates to emotional well-being and emotional distress.

The positive relationships between social media use and psychological distress were clear in this study, but this question has been debated (Orben et al., 2019; Orben &

Przybylski, 2019b; Twenge, 2019; Twenge & Campbell, 2019). Potential explanations include the lack of consensus on what measures to use (those examining positive or negative aspects of mental health with varying specificity) and how to analyze the data, and how to measure and analyze time spent on social media. In this Thesis, time was treated as a continuous linear variable, comparable to some studies (Boers et al., 2019), but others have chosen to compare subgroups of low and heavy users (Kelly et al., 2018; Riehm et al., 2019). The former approach assumes that the effects of time should be similar across the spectrum of social media use, but the latter promotes the Goldilocks hypothesis, that is some social media use may be beneficial but for those with high or low social media use there is no benefit (Przybylski & Weinstein, 2017). Perhaps the greater question at the heart of this issue is whether social media use represents a meaningful factor in the mental health of young people. This is a topic of significant controversy, in the field, as Twenge (Twenge, 2019; Twenge, Joiner, Rogers, et al., 2018; Twenge, Martin, & Campbell, 2018; Twenge & Campbell, 2019) has found a comparable relationship and concluded that using the medium may have harmful effects. On the other hand, this viewpoint has been criticized by others because typically the effect sizes of social media use are small, arguing that other factors may play a more significant role (Orben et al., 2019; Orben & Przybylski, 2019a, 2019b; Przybylski & Weinstein, 2017). Complicating matters even further, different methods of analyses on the same data sometimes produce different results. For example, Riehm et al. (2019) found that adolescent that report more frequent social media use report greater symptoms of psychopathology one year later. However, Keyse and Kreski (2020) replicated their

analysis by adding confounding variables from wave two and found that the analytic strategy used by Riehm et al. (2019) was vulnerable to substantial residual confounding. After adjusting for psychopathology measured concurrently with social media use, the association that Riehm et al. (2019) had found disappeared except for the most frequent users of social media. Taken together these two different analyses highlight the fact that there is a gap in the literature on the causal link between social media use and emotional distress. There is a need for more rigorous longitudinal research, and in the case of social media use and mental health, a quasi-experimental study with a crossover design could provide valuable insight as each participant would be tested in both groups.

Anxiety and depressed mood are multifactorial constructs, and no one known stressor causes symptoms to emerge (Hankin, 2006; Murray et al., 2009). A cumulative risk score of biological, interpersonal, cognitive, and emotional factors is much more likely to provide an explanation. Therefore it is possible that the small effects of social media can contribute to the development of depressed mood and anxiety over time. However, social media use has the potential to bring both positive and negative affect on the individual. For improved understanding, future studies should strive to monitor the total experience related to expression, interactions, and passive scrolling with deliberate attention to the multiple and ever-changing components of social media.

Limitations of the Study

Several limitations of the Thesis need to be acknowledged. First, the study relied solely on self-report data to measure social media use. Assessing exactly how much time

is spent on social media can be difficult. Individuals have been found to underestimate the time they spent on social media if they are heavy social media users but overestimate their time if they do not use social media much (Junco, 2013). Increased awareness of excess screen use could lead to social desirability bias in reporting. Furthermore, in all three studies, a single, self-report question was used to measure the frequency of social media use, and it did not differentiate between weekend and weekday use nor measure actual use. Research suggests that self-report time on smartphones is only moderately correlated with actual use, and most individuals would underreport their use (Lin et al., 2015). Second, we did not control for the use of anxiety and depression medication; adolescents that are using medication for anxiety or depressed mood could report having fewer symptoms in the last week due to the medication. Third, only adolescents that speak and read Icelandic participate in the surveys, which could reduce the generalizability for the Icelandic cohort. Finally, we only examined one developmental period instead of over emerging adulthood, which may be important as a recent study over an eight-year period from adolescents to early adulthood found no relationship between social media use and later symptoms of depressed mood and anxiety (Coyne et al., 2020).

Recommendations

The literature on the relationship between social media and mental health measured as either well-being or distress remains mixed. This, in part, is due to the fact that the effects are consistently either small or not present. Since emotional health is a

complex issue, it is unlikely that the basic act of spending time on social media is the main driver for poor mental health; however, if a large number of studies keep finding a small effect, especially among high users, there most likely is something there that needs further examination. That is where the interpersonal-connection-behavior framework can guide the way. However, while scholars are disentangling and understanding this relationship between social media use and well-being, a careful presentation of the narrative is needed.

Results from this study and other recent longitudinal studies highlight the importance of understanding the complicated relationship between social media use and psychological distress among adolescents by assessing the context and content of social media use. Further research to understand and identify beneficial and detrimental behaviors among social media users is needed. Future studies can also expand on the outcome measures by addressing other types of anxiety, anger, or even externalizing disorders. Adolescent peer relationships are changing, and understanding how social media can be beneficial or harmful to the individual will be trivial in the future. Social media companies are already taking responsibility and trying to change their platforms to reduce the mechanisms that can cause harm, such as Instagram hiding the number of likes on a post from everyone except the owner in order to minimize social comparison. The next steps are to develop longitudinal studies that measure the different mechanisms (e.g., active and passive use) at play on social media, as well as different mediators and moderators and how they relate to mental health from early adolescence into emerging

adulthood. Preferably, a study design that begins before children start using social media and take into account a vast number of individual factors and social environment factors.

Conclusions

The relationship between social media and psychological distress among adolescents is likely to be multifactorial. Social media is important in the modern world, and it allows us to connect to others more frequently and easily. However, it can also amplify different aspects of adolescents' lives. Individual factors such as social comparison, body image, and self-esteem are intertwined, and they can increase or decrease the emotional response from social media use. Social media has both benefits and disadvantages for the user, and it is important to keep in mind that it includes some of the same social risks as the physical world, perhaps even at a heightened level since our presence there is near-constant. The burden of mental health disorders has never been as prevalent, and helping youth to navigate the stresses and strains of daily life is more important now than ever. Educating ourselves and our children on how to use social media safely and responsibly is important. This goes beyond the danger of online predators and bullying because we need to teach children and adolescents to protect their self-esteem and self-worth and to use social media for their benefit. It is up to parents, educators, and clinicians to help adolescents develop social media literacy by learning to critically evaluate the content they are exposed to online, understand social media's influence on attitudes, and develop healthy social media habits.

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Appendix: Studies I, II and III

I. Thorisdottir, I. E., Asgeirsdottir, B. B., Sigurvinsdottir, R., Allegrante, J. P. Sigfusdottir, I. D. (2017). The increase in symptoms of anxiety and depressed mood among Icelandic adolescents: time trend between 2006 and 2016. *European Journal of Public Health, 27*(5), 856-861. DOI: 10.1093/eurpub/ckx111 [Republished with permission of Oxford University Press; permission conveyed through Copyright Clearance Center, Inc.]

II. Thorisdottir, I.E., Sigurvinsdottir, R., Kristjansson, A.L., Allegrante, J.P., Lilly, C.L., Sigfusdottir, I.D. (2019). Longitudinal association between social media use and psychological well-being among adolescents. [Revised and re-submitted to Preventive Medicine]

III. Thorisdottir, I. E., Sigurvinsdottir, R., Asgeirsdottir, B. B., Allegrante, J. P. Sigfusdottir, I. D. (2019). Active and Passive Social Media Use and Symptoms of Anxiety and Depressed Mood Among Icelandic Adolescents. *Cyberpsychology, Behavior and Social Networking, 22*(8), 535-542. DOI: 10.1089/cyber.2019.0079 [Republished with permission from Mary Ann Libert, Inc; permission conveyed through Mary Ann Libert, Inc Customer Questions].

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The increase in symptoms of anxiety and depressed mood among Icelandic adolescents: time trend between 2006 and 2016

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Background: Both research and popular media reports suggest that adolescent mental health has been deteriorating across societies with advanced economies. This study sought to describe the trends in self-reported symptoms of depressed mood and anxiety among Icelandic adolescents. **Methods:** Data for this study come from repeated, cross-sectional, population-based school surveys of 43 482 Icelandic adolescents in 9th and 10th grade, with six waves of pooled data from 2006 to 2016. We used analysis of variance, linear regression and binomial logistic regression to examine trends in symptom scores of anxiety and depressed mood over time. Gender differences in trends of high symptoms were also tested for interactions. **Results:** Linear regression analysis showed a significant linear increase over the course of the study period in mean symptoms of anxiety and depressed mood for girls only; however, symptoms of anxiety among boys decreased. The proportion of adolescents reporting high depressive symptoms increased by 1.6% for boys and 6.8% for girls; the proportion of those reporting high anxiety symptoms increased by 1.3% for boys and 8.6% for girls. Over the study period, the odds for reporting high depressive symptoms and high anxiety symptoms were significantly higher for both genders. Girls were more likely to report high symptoms of anxiety and depressed mood than boys. **Conclusions:** Self-reported symptoms of anxiety and depressed mood have increased over time among Icelandic adolescents. Our findings suggest that future research needs to look beyond mean changes and examine the trends among those adolescents who report high symptoms of emotional distress.

Introduction

The health of youth has rapidly emerged as an issue requiring urgent attention in global development. Because mental health problems often begin in childhood or during adolescence,[1,2] improving adolescent mental health remains a challenge for most societies.[3] Approximately one-fourth of youth have experienced a mental disorder in the past year and one-third will across their lifetime.[4] The average lifetime prevalence of any mood disorder for adolescents 13–18 years of age is 14.3% (18.3 and 10.5% for girls and boys, respectively) and any anxiety disorder is 31.9% (38 and 26.1% for girls and boys, respectively).[5] The 2013 Global Burden of Disease (GBD) study showed the significant burden of mental disorders among adolescents for both genders, with anxiety and depressive disorders among the top 10 causes of years lost to disability.[6]

Several large-scale, time-trend studies from Scandinavia,[7–10] the United States[11] and Great Britain[12–15] show that adolescent mental health is worsening, while other studies suggest that mental health has remained relatively stable[16–18] or even improved.[19] Findings from a recent systematic review on adolescent mental health and changes over time suggested that the burden of internalizing problems (e.g. anxiety, depression and withdrawal) have remained stable for boys but increased for girls.[20] All of these studies are based on data from 2011 or before, leaving a 5-year gap that needs to be examined further. However, one recent study using cross-sectional data collected among English students, ages 11–13, in 2009 and 2014, concluded that there were similar levels of mental health difficulties experienced by adolescents in the two time points, with the exception of a notable increase in emotional problems in girls.[21]

In Iceland, concern for the mental health of adolescents has been rising steadily.[22] Cross-sectional data from 1997 to 2006 in Iceland revealed that symptoms of anxiety had increased among Icelandic adolescent boys and girls during that period, and that depressive symptoms had increased significantly for girls.[7] However, from 2000 to 2010, adolescent happiness increased by 5% overall,[23] suggesting that while adolescents were generally happier they were also experiencing anxiety and depressed mood more frequently. Because there are no data on trends from 2006, we do not know if adolescent mental health has improved or if emotional distress and happiness go together.

The objective of this study was to investigate trends in symptoms of depressed mood and anxiety among 14–15-year-old adolescents using population data that have been collected in the Youth in Iceland Survey during a 10-year time period. In order to provide a comprehensive view of trends in symptoms over time, we assessed changes in mean scores of reported symptoms over time as well as changes in symptoms determined by a cut-off score. These cut-off scores were used to detect changes in proportion of adolescents who reported high symptoms of depressed mood or anxiety at each time point and to make comparison across different years of investigation. We hypothesized that mean symptoms of depressed mood and anxiety and the proportion reporting high symptoms will have increased for both genders from 2006, and that the increase would be greater among girls than boys.

Methods

Data sources and participants

Data from the ongoing cross-sectional, population-based study Youth in Iceland in 2006, 2009, 2010, 2012, 2014 and 2016 were analysed. Participants were 14–15-year-old students attending the compulsory 9th and 10th grades of the Icelandic secondary school system. For this study, the number of participants in each year was as follows: 2006, $n = 7232$ (81.4% response rate); 2009, $n = 7377$ (83.5% response rate); 2010, $n = 7125$ (85.6% response rate); 2012, $n = 7202$ (86% response rate); 2014, $n = 6966$ (86.3% response rate); and 2016, $n = 7041$ (86% response rate). Gender distribution was roughly equivalent at all time points, with females representing 50.1% of the sample in 2006; 50.8% in 2009; 50.3% in 2010; 50.1% in 2012; 50.8% in 2014; and 49.6% in 2016. The total number of participants was 43 482.

Measures

As part of the Symptom Check List 90 (SCL-90),[24,25] respondents were asked whether they had experienced the following symptoms of depressed mood and anxiety during the previous week. Prior studies indicate good reliability and construct validity of this measure.[7,24,26]

Symptoms of depressed mood

To measure respondents' symptoms of depressed mood, nine items from the depression dimension scale of the SCL-90 were used.[25] Participants were asked how often during the previous week the following statements applied to them: ''I was sad or had little interest in doing things'', ''I had poor appetite'', ''I felt lonely'', ''I had difficulty falling to sleep and staying sleeping'', ''I cried easily or wanted to cry'', ''I felt sad or blue'', ''I was dispirited'', ''I had little energy and was slow'' and ''The future seemed hopeless''. Each statement ranged from 0 to 3, with higher scores indicating more severity. The items were combined in a scale ranging from 0 to 27. The scale has good internal consistency with the average Cronbach's alpha = .91 across all years of the study.

Symptoms of anxiety

Three items from the anxiety dimension scale of the SCL-90 were used to measure symptoms of anxiety.[25] The participants were asked how often during the previous week they had experienced the following: ''Nervousness'', ''Feeling suddenly scared for no reason'', ''Feeling tense or overstrung''. Each statement ranged from 0 to 3, with higher score indicating more anxiety. The items were combined in a scale ranging from 0 to 9. The scale has good internal consistency with the average Cronbach's alpha = .78 across all years of the study.

Procedures

Anonymous questionnaires containing the measures were administered to all students present in class on the day of the survey, either in February or in March for each year of data collection. The overall questionnaire included items relating to emotional well-being, lifestyle, family and social background and parental and peer relationships. Participants took ~1 h to complete the questionnaire. The Icelandic Centre for Social Research and Analysis conducted all aspects of data collection in accordance with the principles of research ethics stipulated by the National Bioethics Committee and the Icelandic Data Protection Agency.

Analyses

Differences in mean scores of symptoms of depressed mood and anxiety between years was tested for boys and girls separately using analyses of variance (ANOVAs) and Bonferroni *post hoc* tests. Year was the independent variable and the continuous measures of symptoms of depressed mood and anxiety were the dependent variables. Simple linear regression analyses were then used to test for a linear trend in mean levels of symptoms over time for girls and boys separately, using year of study as the predictor variable and symptoms of anxiety and depressed mood as the dependent variables.

In order to test whether the percentage of children with high symptom levels followed a similar pattern over time we used a cut-off score. For symptoms of depressed mood and anxiety, a cut-off score was identified based on the top 5% at the first time point.[8,27] Binomial logistic regression was then used to examine changes over time between time points in proportion of girls and boys who showed high symptoms of anxiety and depressed mood as determined by the cut-off scores. In this analysis, year of study was used as the predictor variable to predict the dichotomous dependent variable contrasting those who met the cut-off score for high levels of symptoms of depressed mood or anxiety and those who did not. Finally, to test if the trends in high levels of symptoms were significantly different for the genders two binomial logistic regression models were run using year of study and gender as the predictor variables, the two dichotomous variables and the dependent variables, testing the interaction between year and gender on high symptoms of depressed mood and anxiety.

Multiple-group SEM tests of invariance were used to test the generalizability of the results for males and females, as well as across the six data collection waves. The measurement invariance across gender refers to the degree to which a test measures the same construct across varied groups, whereas measurement invariance for different time points refers to whether a test reflects the same constructs on different occasions for the same group. To test the measurement invariance for symptoms of depressed mood and anxiety we used the criteria by Cheung and Rensvold[28] who suggest invariance between models if ΔCFI is ≤ 0.01 and the criteria described by Chen[29] who suggest invariance between nested models if ΔRMSEA is ≤ 0.015. Strict invariance with factor variances was established for symptoms of depressed mood over time. Scalar invariance was established for symptoms of depressed mood by gender and for symptoms of anxiety over time and by gender (results available upon request).

All aspects of this reporting are consistent with the STROBE statement reporting requirements for cross-sectional studies.

Results

The results from the ANOVA showed that there was a difference between years in mean levels of anxiety symptoms for girls (F (5, 20943)=31.82, $P < 0.001$) and boys (F (5, 20541) = 38.42, $P < 0.001$). There was also a significant difference in mean levels of symptoms of depressed mood for both genders, F (5, 20173) = 6.31, $P < 0.001$ and F (5, 21110) = 45.62, $P < 0.001$, for boys and girls respectively. Table 1 shows mean scores on anxiety and depressive symptoms and results from Bonferroni *post-hoc* tests. For girls there was a significant ($P < 0.001$) increase in mean levels of depressive symptoms between each time point from 2012 to 2016, as well as between 2009 and 2010. Anxiety symptoms increased significantly ($P < 0.001$) between 2012 and 2016 among girls. Mean levels of symptoms of depressed mood remained quite stable among boys; while mean levels of anxiety symptoms decreased significantly between three time points (see table 1).

Linear regression analysis showed a significant linear trend for girls, with an increase in both mean symptoms of anxiety ($\beta = 0.039$, $P < 0.001$) and symptoms of depressed mood ($\beta = 0.06$, $P < 0.001$) over time. A linear decrease was found in anxiety symptoms over time among boys ($\beta = -0.07$, $P < 0.001$); however, linear changes in symptoms of depressed mood were not significant for boys ($P = 0.38$).

Table 1 Descriptive statistics for symptoms of depressed mood and anxiety with results from Bonferroni *post-hoc* test for boys and girls, 2006–2016

Variables	Year	*N*	Mean	SD	Years	Mean difference	Std. error
Boys depressed mood	2006	3446	4.85	5.11	X06–X09	0.07	0.125
	2009	3411	4.78	5.26	X09–X10	−0.18	0.131
	2010	3280	4.96	5.31	X10–X12	0.53***	0.131
	2012	3376	4.44	5.36	X12–X14	−0.06	0.132
	2014	3228	4.50	5.54	X14–X16	−0.48**	0.132
	2016	3408	4.98	5.63	X06–X16	−0.13	0.129
Girls depressed mood	2006	3517	8.27	6.82	X06–X09	0.43	0.168
	2009	3624	7.84	6.32	X09–X10	−0.59**	0.169
	2010	3448	8.43	6.53	X10–X12	0.51*	0.170
	2012	3498	7.92	7.17	X12–X14	−0.71***	0.170
	2014	3459	8.62	7.81	X14–X16	−1.09***	0.171
	2016	3403	9.71	7.82	X06–X16	−1.44***	0.171
Boys anxiety	2006	3490	1.85	1.90	X06–X09	0.07	0.046
	2009	3504	1.77	1.95	X09–X10	−0.01	0.047
	2010	3365	1.78	1.96	X10–X12	0.41***	0.047
	2012	3444	1.37	1.84	X12–X14	0.04	0.047
	2014	3299	1.41	1.94	X14–X16	0.15*	0.047
	2016	3445	1.56	2.02	X06–X16	0.28***	0.047
Girls anxiety	2006	3559	2.89	2.36	X06–X09	0.03	0.058
	2009	3658	2.87	2.27	X09–X10	0.14	0.059
	2010	3473	3.01	2.41	X10–X12	0.49***	0.059
	2012	3537	2.51	2.42	X12–X14	−0.37***	0.059
	2014	3476	2.88	2.72	X14–X16	−0.52***	0.060
	2016	3413	3.40	2.80	X06–X16	−0.51***	0.060

*: Significant $P < 0.05$
**: Significant $P < 0.01$
***: Significant $P < 0.001$

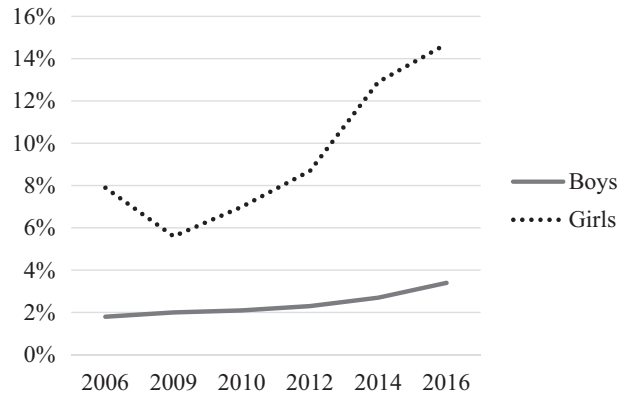

Figure 1 Trends in high symptoms of depressed mood among girls and boys, 2006–2016

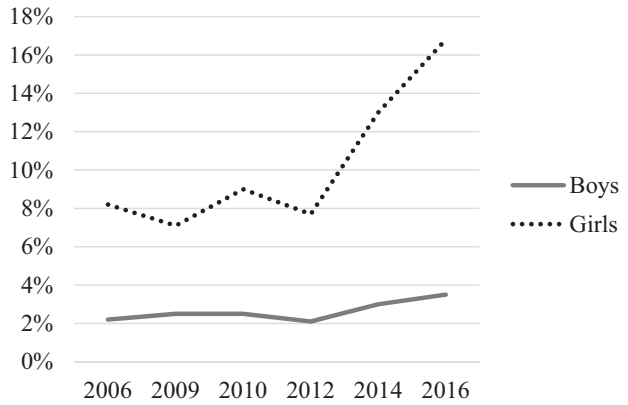

Figure 2 Trends in high symptoms of anxiety among girls and boys, 2006–2016

Figure 1 shows the trends in high symptoms of depressed mood from 2006 to 2016, for boys and girls separately. Comparing the first and last years of investigation, the figures show that the proportion reporting high symptoms of depressed mood increased by 1.6% for boys and 6.8% for girls.

Figure 2 shows the trends in high scores according to definition on anxiety symptoms between 2006 and 2016, for boys and girls separately. Comparing the first and last years of investigation the figures show that the proportion of those reporting high anxiety symptoms increased by 1.3% for boys and 8.6% for girls.

Table 2 shows the results of the binomial logistic regression models. The results indicate that the odds for having high depressive symptoms and high anxiety symptoms, as defined by cut-off values, were significantly higher for both genders in the year 2016 than in 2006. Between other time points under study, the odds of having high symptoms of depressed mood did not change significantly for boys. For girls the odds of having high depressive symptoms increased significantly between all of the time points, except between 2006 and 2009 when they decreased significantly. Odds for reporting high anxiety symptoms increased significantly between 2012 and 2014 for boys, while a significant increase was detected between three time points for girls.

Finally, there was a statistically significant difference in the trends for gender as indicated by a significant interaction between year and gender on high symptoms of depressed mood (OR 1.09, 95% CI 1.03–1.16, $P = 0.005$) and anxiety (OR 1.11, 95% CI 1.05–1.17, $P < 0.001$). These results indicate that the trend in high reported symptoms of depressed mood and anxiety are significantly different for the genders.

Discussion

Mean symptoms of depressed mood and anxiety increased over the study period among Icelandic adolescent girls, but not for boys. The

Table 2 Logistic regression for changes in proportion of adolescent boys and girls reporting high symptoms of depressed mood and anxiety, 2006–2016

Variables	Years	OR	Sig.	CI 95%	β
Boys depressed mood	X06–X09	1.12	0.53	0.79–1.58	0.11
	X09–X10	1.04	0.84	0.74–1.45	0.03
	X10–X12	1.10	0.56	0.79–1.53	0.10
	X12–X14	1.19	0.28	0.87–1.62	0.17
	X14–X16	1.14	0.39	0.85–1.52	0.13
	X06–X16	1.11	0.00	1.06–1.18	0.11
Girls depressed mood	X06–X09	0.69	0.00	0.57–0.83	−0.37
	X09–X10	1.27	0.01	1.05–1.54	0.24
	X10–X12	1.27	0.01	1.07–1.51	0.24
	X12–X14	1.55	0.00	1.33–1.81	0.44
	X14–X16	1.16	0.03	1.01–1.33	0.15
	X06–X16	1.22	0.00	1.18–1.25	0.20
Boys anxiety	X06–X09	1.11	0.49	0.82–1.52	0.11
	X09–X10	1.01	0.97	0.74–1.36	0.01
	X10–X12	0.85	0.30	0.62–1.16	−0.17
	X12–X14	1.44	0.02	1.06–1.96	0.37
	X14–X16	1.17	0.24	0.90–1.54	0.16
	X06–X16	1.09	0.00	1.04–1.15	0.09
Girls anxiety	X06–X09	0.86	0.08	0.72–1.02	−0.16
	X09–X10	1.29	0.00	1.09–1.53	0.26
	X10–X12	0.84	0.05	0.71–1.00	−0.17
	X12–X14	1.81	0.00	1.54–2.12	0.59
	X14–X16	1.35	0.00	1.178–1.539	0.30
	X06–X16	1.20	0.00	1.20–1.17	0.19

proportion of adolescents reporting high symptoms of anxiety and depressed mood increased from 2006 to 2016 for both genders. Even though mean levels did not increase for boys, those that reported high symptoms represented a greater proportion in 2016 than 2006. This highlights the need to examine high-symptom groups as well as mean-level changes. According to data from the GBD study, where data are collected from 188 countries around the world, girls and boys aged 10–14 and 15–19 experienced a similar increase from 1990 to 2013 in years lost to disability due to depressive disorders.[6] Moreover, recent findings from New Zealand showed that symptoms of depressed mood increased between 2007 and 2012 for adolescent boys and girls, with higher rates of girls reporting emotional problems.[30]

A systematic review revealed that recent cohorts of girls are experiencing increases in internalizing symptoms.[20] Even though not entirely comparable, this increase is consistent with our finding of the sharp rise of symptoms of depressed mood and anxiety among Icelandic girls between 2014 and 2016. McMartin et al.[16] examined time trends among Canadian adolescents and concluded that mental health had remained stable from 1998 to 2008; however, the study examined the genders together. The findings from this study and others[7–10,12,14,15,19,31,32] showed an increase in emotional problems, and that the increase had been greater for girls than boys. In our study, the prevalence and mean was lower for boys than girls at all time points for both symptoms of depressed mood and anxiety. According to findings from a systematic review of 19 studies, recent cohorts of girls are experiencing increases in internalizing symptoms (i.e. depressed mood and anxiety) when compared to previous cohorts.[20] We cannot explain the observed difference between males and females in our study, nor do we attribute the difference to any given factor. However, one plausible explanation for the difference might be that females are more open to talking about their feelings than males.

This study has several methodological strengths. First, data for the analyses come from what comprises a large population-based dataset with most Icelandic adolescents, ages 14 and 15, participating in the survey. Second, the data we analysed span a 10-year period, with six surveys of a single geographically defined population. Third, boys and girls were equally represented and we attained a high response rate in each of the years of the study.

There are several limitations. First, our findings are based on self-reported cross-sectional data using selected items from the SCL-90 scale. In the Youth in Iceland surveys, only 3 items of the SCL-90 are included in the anxiety dimension instead of 10 items. Second, we focus on symptoms of depressed mood and anxiety, which are measured on a continuous scale, rather than using clinical diagnoses or a measure of impairment in everyday functioning. Consequently, we cannot know if the observed increase is related to impairment in everyday functioning or due to some other reason. Third, by dichotomizing our measure of high symptoms of depressed mood and anxiety and using an arbitrary single cut-off score to designate high symptoms, we may have used an overly simplistic measure for our analytic purposes. However, in order to examine changes with logistic regression over time in those that report high symptoms it was necessary to create a cut-off score. Previous studies using non-clinical scales have used the top 10% as a cut-off value.[8,9,16,27] The conservative value of top 5% in the first year, for both genders together, was used in this study. Because the objective of this study was to examine trends in subjective mental health and used self-report among the entire cohort at each time point, we were able to include youth who report symptoms of depressed mood or feeling anxious without meeting the clinical cut-offs.

Studies repeatedly have found that adolescent girls report higher levels of internalizing symptoms than boys.[20] However, that does not explain the increase in reports of internalizing symptoms. The findings may reflect genuine changes in mental health symptom burden which is supported by other time-trend surveys of mental health among adolescents.[7–10,12,14,15,30–32] On the other hand, secular trends, for example greater willingness to report symptoms due to decreased social stigma, may be influencing these trends. In 2008, the Icelandic population experienced a very sudden economic crisis. Studies have shown that reduction in disposable family impact can affect the mental health of children and adolescents through various pathways, such as increased economic pressure that in turn influences parental mental health,[33] and increased social exclusion of vulnerable groups.[34] Furthermore, income inequality has been associated with increased mental health problems among adolescents.[35–37] In Sweden, the recession during the 1990s marked the appearance of child and adolescent mental health as a public health issue.[38] Even if the findings from this study do not demonstrate a

sudden increase directly following the crisis, it could be that the effects take longer to unravel. Other changes that have occurred rapidly in the past few years is time spent on electronic screen activities and social media, which has been related to poorer mental health among adolescents.[39,40] Thus, without including other variables, we can only speculate as to what may be driving this change.

In conclusion, whether or not the rise in mental health problems shown in this and other studies is due to increased willingness to report and discuss mental health, the fact that many adolescents are reporting emotional distress is of concern. Widespread discussion of mental health in the Icelandic society has also raised awareness among professionals, teachers and parents. Our findings suggest that monitoring trends in adolescent mental health needs to be a societal priority. Future studies should focus on both genders separately as well as examine further risk and protective factors for adolescent mental health and possible causal factors of worsening mental health over time.

Key points

- The study contributes to the literature by providing recent self-reported data on adolescent mental health.
- Findings support previously observed trends of worsening mental health, especially among girls.
- The results highlight the need to focus specifically on changes in those that report high symptoms of emotional distress, as well as changes in means.

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Longitudinal association between social media use and psychological well-being among adolescents

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Abstract

The aim of this study was to examine in a longitudinal cohort design whether social media use among adolescents is related to symptoms of social anxiety, depressed mood, and physical symptoms of anxiety over time. As part of the LIFECOURSE longitudinal study of risk and protective factors for healthy adolescent development, three waves of school-based surveys of adolescents born in Iceland in 2004 were analyzed. The sample included 2,278 participants who responded to the baseline survey (96.0%), with 2,052 responding roughly 12 months later (86.5%), and 2,097 responding in year 3 (88.4%), with complete responses being collected from 2,211 students in the first wave. Linear mixed-effects models were used to analyze time spent on social media in relation to psychological distress over time. For all participants, more time spent on social media was significantly associated with increased symptoms of depressed mood, social anxiety and symptoms of physical anxiety over time. The impact of time spent on social media on symptoms of depressed mood and physical symptoms of anxiety grew stronger over time, as participants get older. The relationship between time spent on social media and all outcomes of psychological distress were significantly stronger for girls than boys. Confirming the findings of previous longitudinal studies that have reported on adolescent social media use, greater social media use had a positive relationship with symptoms of depressed mood over time. Girls appear to be particularly vulnerable to the impact of social media on their mental well-being.

Keywords: Adolescents, symptoms of anxiety, longitudinal studies, social media use, symptoms of depressed mood

The simultaneous increase in social media use and worsening self-reported mental health among adolescents has motivated researchers to investigate the relationship between social media use and adolescent mental well-being (Heffer et al., 2019; Jensen et al., 2019; Keles et al., 2019; McCrae et al., 2017; Orben and Przybylski, 2019; Seabrook et al., 2016; Twenge et al., 2018). In the United States, 45% of teens report being online almost constantly (Anderson and Jiang, 2018). As with in-person social interactions, social media experiences can be positive, negative, neutral or mixed. Positive aspects include connecting with friends, increased social support and greater levels of self-expression (Anderson and Jiang, 2018; Seabrook et al., 2016; Thorisdottir et al., 2019). However, negative aspects of social media include upward social comparisons, rumor-spreading, cyberbullying, fewer in-person interactions (Anderson and Jiang, 2018; Thorisdottir et al., 2019) and less family time and more conflicts with parents (Williams and Merten, 2011).

Adolescent social life is embedded in the context of social media and explaining how it can influence something as complex as mental health requires a holistic theoretical framework. The transformation framework (Nesi et al., 2018a, 2018b) proposes that the unique context of social media fundamentally transforms adolescents' peer experiences across multiple domains. For example, through what is referred to as asynchronicity or the time that passes between responses in a dialogue online, adolescents can carefully select their words and engage in many conversations at the same time, as well as decide how to present themselves. Furthermore, with the frequency between responses, adolescents might also feel pressure to be constantly online (Calancie et al., 2017). Peer experiences are prospectively associated with mental health symptoms (Landstedt and Almquist, 2019; Modin et al., 2011); thus, understanding whether social media plays a role in adolescent mental health before examining the possible mechanisms is important.

The evidence on how social media use affects mental health, however, is mixed. Some studies have concluded that social media use contributes to lower psychological well-being and increases symptoms of depression, anxiety and psychological distress among children and adolescents (Keles et al., 2019; McCrae et al., 2017); others maintain that there is little or no relationship between youth social media use and symptoms of depression (Heffer et al., 2019) and psychological distress (Jensen et al., 2019). One potential explanation for the disparate findings is that the concept itself is broad, often vague and measured differentially. Some studies use well-being scales (Booker et al., 2018; Orben et al., 2019), while others use general distress scales (Jensen et al., 2019; Riehm et al., 2019) or examine symptoms of internalizing problems, such as anxiety and depression (Boers et al., 2019; Coyne et al., 2020; Heffer et al., 2019; Vannucci and McCauley Ohannessian, 2019).

Most studies of social media use and mental health have been cross-sectional (Keles et al., 2019; Kelly et al., 2018; McCrae et al., 2017; Seabrook et al., 2016) and the few longitudinal studies on the topic have reported mixed findings. Some recent longitudinal studies have found that social media use predicts higher depressive symptoms (Boers et al., 2019; Vannucci and McCauley Ohannessian, 2019), panic disorder symptoms (Vannucci and McCauley Ohannessian, 2019), greater internalizing problems (Boers et al., 2019) and worse well-being measured with the Strengths and Difficulties Questionnaire (Booker et al., 2018). For example, adolescents who belonged to a group of high social media users experienced greater symptoms of depression, panic disorder and anxiety-related school avoidance, but not other types of anxiety (Vannucci and McCauley Ohannessian, 2019). However, others have found that frequency of social media use does not predict later mental health outcomes (Coyne et al., 2020; Jensen et al., 2019).

The role of gender in the social media and mental health relationship has also been inconclusive (McCrae et al., 2017). Where there are gender differences, the relationship

between social media and worse mental health has either been stronger for girls than boys (Frison and Eggermont, 2016; Thorisdottir et al., 2019), or only exist for girls (Devine and Lloyd, 2012). A study on the relationship between social media and life satisfaction measured with six distinct domains (i.e., friends, family, appearance, life, school work and school) found that gender was important; within person models were significant for two out of six domains for boys and five out of six domains for girls (Orben and Przybylski, 2019). However, two longitudinal studies found no gender differences in social media use and internalizing symptoms (Riehm et al., 2019; Vannucci and McCauley Ohannessian, 2019). Given these inconsistent findings, some have called for analyses to be stratified by gender or at least tested for gender interactions (Booker et al., 2018).

The purpose of this study was to examine, over a three-year period, the relationships between time spent on social media and symptoms of depressed mood, social anxiety and physical symptoms of anxiety among Icelandic adolescents. While other studies have typically focused on more general concepts, such as well-being (Booker et al., 2018; Orben et al., 2019) and overall distress (Jensen et al., 2019; Riehm et al., 2019), we specifically examined symptoms of depressed mood and differentiated between physical and social symptoms of anxiety (Coyne et al., 2020; Vannucci and McCauley Ohannessian, 2019). Our study also addresses several shortcomings of previous work. First, because social media is rapidly evolving in the way it alters how adolescents interact with their peers, the recency of our data affords an advantage over the older data analyzed in previous studies in painting a more current picture of the relationship between use and mental health over time. Second, given the high prevalence of anxiety in Western economies, especially among adolescent girls (Bor et al., 2014), we examined whether gender plays a role in the relationship between social media use and mental health over time. Finally, because of the compelling evidence showing the deleterious impact of divorce and other family disruptions on children and adolescents

(Amato, 2000; Behere et al., 2017), we controlled for two important correlates of child and adolescent mental health in our analyses: parental support and family structure (Hall-Lande et al., 2007; Stadler et al., 2010).

We hypothesized that: 1) there is a positive relationship between social media use and symptoms of depressed mood, symptoms of social anxiety and physical symptoms of anxiety; 2) the relationship between social media use and symptoms of depressed mood, symptoms of social anxiety and physical symptoms of anxiety increases over time; and 3) the observed relationships between social media use and symptoms of depressed mood, symptoms of social anxiety and physical symptoms of anxiety is stronger for girls than boys.

Methods

Sample and Participants

Our data come from three waves of school-based surveys from the LIFECOURSE study of risk and protective factors for healthy adolescent development. The theoretical framework of the study has been described elsewhere (Sigfusdottir et al., 2017). Participants were adolescents born in Iceland in the year 2004 and living in Iceland in 2016 (N=2,211 at baseline). Of all adolescents that were eligible for participation, 60.6% provided parental consent and adolescent assent, with majority responding to the survey (Participation rate 2017: 96.0% [49.9% girls], 2018: 86.5% [51.1% girls], and 2019: 88.4% [49.6% girls]).

Procedure

The surveys were conducted by the Icelandic Center for Social Research and Analysis (ICSRA) in February in 2017 (T1), 2018 (T2) and 2019 (T3) in all secondary schools in Iceland using procedures developed by ICSRA, in collaboration with the Icelandic Ministry of Education, Science and Culture over a 20-year period. First, sample contact information was acquired through Statistics Iceland, the national statistical bureau, and sister agencies. A non-

traceable, unique research identification number was created for each participant. For each wave of data collection, teachers at individual school sites supervised participation of students in the classroom and administered the survey questionnaire using a double-envelope system to identify students while distributing the surveys in classroom settings, omitting their identification post survey completion (non-traceable ID printed on each questionnaire for scanning and data processing). Students were instructed not to write their names or other identifying information anywhere on the questionnaire. Upon completion, students were asked to place their completed survey questionnaire in a nondescript, pre-sealed envelope provided to them before returning it to the supervising teacher. A key that links individual names and contact information to research IDs is maintained by a third party at the Primary Health Care Clinic of the Capital Area in Iceland and is not accessible to the investigators. The study was reviewed and approved by the National Bioethics Committee of Iceland (equivalent to a national IRB) and the study was registered and acknowledged by the Icelandic Data Protection Authority.

Measures

Study variables included time spent on social media, symptoms of physical anxiety, social anxiety, and depressed mood. Three control variables were employed: Gender, family structure, and parental support.

Time on social media was assessed at all time points with one question: "On average, how much time do you spend on social media each day (e.g., Facebook, Snapchat, Twitter, and Instagram)?" Responses ranged on an 8-point scale, from almost no time (=1) to 6 hours or more (=8). This scale is comparable with similar measures in other studies examining how much time adolescents spend on social media (Twenge et al., 2018).

Physical symptoms of anxiety was measured with the 12-item physical symptoms Multidimensional Anxiety Scale for Children (MASC), translated and adapted for Icelandic

youth (Olason et al., 2004). Participants reported how often the 12 statements applied to them; examples of statements include “I feel nervous” and “I find it difficult to catch my breath” with four-category responses ranging from never applies to often applies to me. The scale has been validated in a sample of Icelandic adolescents and demonstrated good reliability and validity (Olason et al., 2004). In this sample, Cronbach’s alpha was 0.886 (T1), 0.912 (T2) and 0.919 (T3).

Symptoms of social anxiety were measured with the 9-item social anxiety scale from the Icelandic version of MASC (Olason et al., 2004). Participants reported how often the nine statements applied to them; examples of statements include “I am afraid that others find me stupid” and “I worry about embarrassing myself.” The scale has been validated in a sample of Icelandic adolescents and demonstrates good reliability and validity (Olason et al., 2004). In this sample, Cronbach’s alpha was 0.896 (T1), 0.915 (T2) and 0.920 (T3).

Depressed mood was measured with 9 items from the depression dimension scale of the Original Symptom Checklist (Derogatis and Unger, 2010). Participants reported how often in the previous week they experienced symptoms of depressed mood, such as feeling hopeless and without energy. Participants answered on a four-point scale (never to often). The scale demonstrates good internal consistency and test–retest reliability (Derogatis and Unger, 2010). In this sample, Cronbach’s alpha was 0.900 (T1), 0.906 (T2) and 0.920 (T3).

Gender was a binary variable asking participants to indicate whether they were a boy (=1) or a girl (=2).

Family structure was assessed by asking adolescents who they currently live with. Most reported living together with both biological parents (74%), followed by parents sharing custody and the adolescent lives equally with both of them (11.3%), living with a single mother (9.3%), with a single father (1.3%), with a mother and her partner (3.0%), with a father and his partner (0.8%), or in other arrangements (0.3%). For the purpose of this

analysis, the variable was a coded into a binary variable, participants living with both biological parents (=1) and participants living in other arrangements (=2).

Parental support was measured with The Perceived Parental Support Scale (PPS), which consists of five items measured on a 4-point scale, asking how adolescents perceive general support from parents. Participants were asked how easy or hard it is for them to receive the following from their parents: caring and warmth, discussion about personal affairs, advice about their studies, advice about other issues, and assistance with other things. A higher score reflects more parental support. The scale has been validated in a multi-country sample and shown good internal consistency and convergent validity (Kristjansson et al., 2011). In this sample, Cronbach's alpha was 0.821 (T1), 0.872 (T2) and 0.899 (T3).

Statistical Analysis and Handling of Missing Data

All analyses were conducted using SPSS v.26. Missing values within individual variables ranged from 1.7% to 5.8% and are treated with pairwise deletion unless otherwise specified. All scale variables were treated as continuous and described using means and standard deviations. Gender and family structure were treated as categorical and described using valid percentages. Distributional properties were assessed for the scale variables, and skew and kurtosis determined to be around the common threshold of 1.0 or less in all instances, except the PPS scale where skew was 1.6 and kurtosis 3.0. Alpha was set to 0.05 for all analyses, unless otherwise specified.

Linear mixed-effects models were the primary tool of analysis for the main outcomes of psychological distress over time. These models are designed to model correlations among observations on subjects (over time and/or within groups), and they are valid in the presence of missing at random data (Verbeke and Molenberghs, 2000, p. 568). Various covariance models were compared using Akaike's Information Criterion to determine the best fit to the data (Gurka, 2006), taking into account correlations between observations over time. The best

fitting structure included unstructured covariance matrix. The tests of hypotheses involved the fixed effects portion of the model, namely the association between social media use and three outcomes of emotional psychological distress over time, symptoms of depressed mood, and physical and social anxiety. Control variables in each of these models were gender, family structure and parental support. In addition to main effects models, interaction effects models were tested with two interaction terms; time spent on social media by time was assessed to identify if the relationship between time spent on social media and the three outcomes increases as participants grow older and time spent on social media by gender was tested to assess if the over-time relationship between time on social media and the three outcomes may be different between girls and boys. In the interaction effect models, time spent on social media was grand-mean centered. Accurate model parameter estimation were ensured by use of the residual maximum likelihood (REML) approach with the Kenward-Roger (Kenward and Roger, 1997) approximation of degrees of freedom.

Results

Table 1 shows descriptive statistics for all study variables. Symptoms of depressed mood, symptoms of social anxiety, physical symptoms of anxiety and time spent on social media increased over the three waves of the study, and parental support decreased.
Tables 2 to 4 show the results for all linear mixed effects models. For all three psychological distress outcome variables, symptoms were lowest for those who reported greater parental support, living with both parents and of male gender.

Hypothesis 1. After controlling for time and other covariates, time spent on social media was significantly positively associated with depressed mood (FE=0.04, *SE=0.01*, p = 0.002), physical symptoms of anxiety (FE=0.04, *SE=0.01*, p = 0.001) and symptoms of social anxiety (FE=0.05, *SE = 0.01*, p<0.001). A significant main effect of time indicates that

symptoms increase between data collection waves 1, 2 and 3, after taking account other variables.

Hypothesis 2. There was a significant interaction between time and time spent on social media on symptoms of depressed mood (FE=0.02, *SE*=0.01, $p<0.001$) and physical symptoms of anxiety (FE=0.01, *SE*=0.005, $p= 0.002$), but not on symptoms of social anxiety. This partially supports hypothesis two. The significant social media by time interaction suggests that the impact of social media increases as participants grow older.

Hypothesis 3. There was a significant interaction between time spent on social media and gender for symptoms of depressed mood (FE=-0.05, *SE*=0.01, $p<0.001$), symptoms of social anxiety (FE=-0.05, *SE*=0.01, $p<0.001$) and physical symptoms of anxiety (FE=-0.05, *SE*=0.01, $p<0.001$). The gender by time spent on social media interaction suggests that the relationship between social media and symptoms of depressed mood, symptoms of social anxiety and physical symptoms of anxiety is stronger for girls than boys.

Discussion

Consistent with previous work (Boers et al., 2019; Vannucci and McCauley Ohannessian, 2019), we found a relationship between time spent on social media and symptoms of depressed mood and both social and physical anxiety. There was a positive relationship between social media use and symptoms of depressed mood and physical symptoms of anxiety over time, similar to some other longitudinal studies (Boers et al., 2019; Riehm et al., 2019; Vannucci and McCauley Ohannessian, 2019). Previous work (Vannucci and McCauley Ohannessian, 2019) that has examined use of social media by subgroups found that adolescents who excessively use social media with multiple platforms reported higher levels of depressive symptoms and panic disorder over six months than adolescents who only used Instagram and Snapchat and compared with adolescents who used little social media.

Moreover, that different types of social media use did not predict symptoms of generalized anxiety disorder, separation anxiety disorder or social anxiety disorder. Such findings are similar to those reported here, where time spent on social media was positively associated with physical symptoms of anxiety and not significantly related to symptoms of social anxiety. Different dimensions of emotional distress in relation to social media use need further exploration.

Our results further revealed that social media use became a stronger predictor of depressed mood and physical symptoms of anxiety over time. Previous studies have shown that as adolescents move from pre-teen to teens years, identity exploration increases and the need for peer acceptance becomes more important (Gerwin et al., 2018). The transformational framework (Nesi et al., 2018a, 2018b) proposes that the nature of social media context—frequent contact with peers, the constant feedback, public display of the self—possibly amplifies identity and peer acceptance concerns, which in turn may plausibly explain worsening adolescent mental health (Gerwin et al., 2018; Nesi et al., 2018a) through mechanisms such as upward social comparison, negative self-evaluation and decreased perceived support from friends (Nesi et al., 2018b).

Also consistent with previous work (Booker et al., 2018; Bor et al., 2014; Kelly et al., 2018; Vannucci and McCauley Ohannessian, 2019), girls in our study reported more psychological distress than boys; the relationship between social media use and all three outcomes was significantly stronger for girls compared to boys. Previous longitudinal studies have reported mixed findings on the role of gender (Booker et al., 2018; Heffer et al., 2019; Vannucci and McCauley Ohannessian, 2019), with some studies finding that the relationship is stronger or only exists for girls (Booker et al., 2018) or that there is no gender difference (Heffer et al., 2019; Vannucci and McCauley Ohannessian, 2019).

The positive relationships between social media use and different psychological distress symptoms were clear in this study, but this relationship has been contested (Orben et al., 2019; Orben and Przybylski, 2019; Twenge, 2019; Twenge and Campbell, 2019). Potential explanations include the lack of consensus on what measures to use (those examining positive or negative aspects of mental health with varying specificity) and how to analyze time spent on social media. In this study, time was treated as a continuous linear variable, comparable to some studies (Boers et al., 2019; Twenge et al., 2018) but others have chosen to compare subgroups of low and heavy users (Kelly et al., 2018; Riehm et al., 2019) or different forms of use (Vannucci and McCauley Ohannessian, 2019). The former approach assumes similar effects of time across the spectrum of social media use, while the latter promotes that only heavy use has an impact on psychological distress. Perhaps the better question is whether social media meaningfully contributes to the mental health of young people. This is a topic of significant debate, as Twenge (Twenge, 2019) has found a comparable relationship and concluded that using the medium may have harmful effects. On the other hand, others have argued that the impact of social media is generally limited and therefore other factors may play a larger role in the development of mental health among youth (Orben et al., 2019; Orben and Przybylski, 2019). Thus, we sought to identify the unique relationships of social media with mental health by including control variables, especially parental support, whose protective effects have been widely established (Hall-Lande et al., 2007; Stadler et al., 2010). Our findings suggest that the impact of social media on symptoms of depressed mood and physical symptoms of anxiety increase as participants grow older. However, the parameter estimates are low and should be interpreted as such.

We believe that the focus in the literature needs to shift from whether social media use in general is harmful toward whether specific actions on social media are harmful or beneficial. For example, one important distinction is whether youth use social media actively

(chatting with friends and posting content) or passively (scrolling, looking at content from others). A recent cross-sectional study of Icelandic adolescents found that passive use has a positive relationship with mental health symptoms, but active use appears to have a negative relationship with mental health (Thorisdottir et al., 2019).

There are several limitations. First, we used a single question to examine average social media use and did not include measures on different platforms or different types of social media use, such as active or passive use, which along with time spent on social media, has been shown to be significantly associated with increased psychological distress (Thorisdottir et al., 2019). Second, time was treated as a continuous variable instead of looking at different categories of high versus low social media use, thus diminishing comparability with some other studies. Third, we did not test for possible pathways between social media use and mental health such as cyberbullying, sleep, body image or self-esteem (Kelly et al., 2018). Fourth, preferably, standardized effect size estimates would be helpful when assessing the probable impact of social media use on mental health outcomes among youth. Unfortunately, however, such estimates are not easily calculated from linear mixed effects models such as ours, which represents another important issue for future research in this area. Finally, we did not test for the directionality of effects. Recent studies have begun to do so with one longitudinal study finding that social media use did not predict later depressive symptoms, but rather that greater depressive symptoms predicted more frequent social media use (Heffer et al., 2019). Contrary to these findings, an experimental study found that limiting social media use to 30 minutes a day for 3 days resulted in decreased loneliness and reduced depressive symptoms (Hunt et al., 2018).

Despite these limitations, our study has notable strengths. We used a within-person approach to examine the relationship between social media and symptoms of psychological well-being among a birth cohort over three time points. Our study also benefited from a large

sample and high participant retention across each of the three time points. Finally, the questionnaires were empirically supported with high reliability and we included validated measures on different types of anxiety over three years, the first study to do so.

In conclusion, although adolescent use of social media appears to confer some benefits (Anderson and Jiang, 2018; Seabrook et al., 2016; Thorisdottir et al., 2019), it is also a relatively new and prevalent factor in the lives of adolescents that our data show is positively related to increased levels of emotional distress. However, the effect of social media on psychological distress is most likely multifactorial and a better understanding of the mechanisms involved is required before we can warrant major concerns about the longitudinal impact of social media on adolescent mental health.

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Ingibjorg E. Thorisdottir: Conceptualization, Methodology, Formal analysis, Writing– original draft, Writing - review & editing**. Rannveig Sigurvinsdottir:** Conceptualization, Methodology, Writing– original draft, Writing -review & editing**. Alfgeir L. Kristjansson:** Methodology, Formal analysis, Writing - review & editing **John P. Allegrante:** Writing - review & editing **Christa L. Lilly:** Methodology, Formal analysis. **Inga Dora Sigfusdottir** Funding acquisition, Supervision.

Conflicts of Interest

The authors declare no conflicts of interest.

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Table 1. Descriptive statistics, N = 2,211

Categorical variable (%)	Time 1			Time 2			Time 3		
	Total	Girls	Boys	Total	Girls	Boys	Total	Girls	Boys
Gender		49.9	50.1	n/a	n/a	n/a	n/a	n/a	n/a
Family structure – both biological parents	74.0	75.3	72.7	n/a	n/a	n/a	n/a	n/a	n/a
Continuous variables, Mean (SD)									
Symptoms of depressed mood	1.64 (0.68)	1.70 (0.72)	1.59 (0.63)	1.73 (0.73)	1.86 (0.77)	1.59 (0.63)	1.81 (0.79)	2.02 (0.83)	1.58 (0.68)
Symptoms of social anxiety	1.75 (0.70)	1.90 (0.74)	1.60 (0.64)	1.88 (0.77)	2.10 (0.78)	1.63 (0.67)	1.96 (0.81)	2.26 (0.79)	1.64 (0.69)
Physical symptoms of anxiety	1.67 (0.60)	1.76 (0.63)	1.57 (0.55)	1.76 (0.67)	1.92 (0.69)	1.56 (0.59	1.84 (0.70)	2.08 (0.70)	1.56 (0.60)
Time spent on social media	2.82 (1.64)	3.06 (1.65)	2.57 (1.60)	3.51 (1.78)	3.87 (1.73)	3.15 (1.76)	3.82 (1.84)	4.28 (1.77)	3.37 (1.78)
Parental support	3.64 (0.45)	3.70 (0.72)	3.59 (0.63)	3.58 (0.54)	3.62 (0.52)	3.56 (0.55)	3.57 (0.58)	3.59 (0.55)	3.56 (0.60)

Table 2 Mixed model analysis with depressed mood as the dependent variable, unstructured model with repeated effects of time.

	Model 1. No interactions			**Model 2. With interactions**		
	Fixed effects (SE)	P	95% CI	Fixed effects (SE)	P	95% CI
Intercept	3.06 (0.07)	<0.001	[2.92, 3.20]	3.09 (0.08)	<0.001	[2.93, 3.25]
Male gender	-0.23 (0.02)	<0.001	[-0.28, -0.29]	-0.24 (0.02)	<0.001	[-0.28, -0.19]
Family structure	-0.08 (0.03)	0.002	[-0.14, -0.03]	-0.08 (0.03)	0.002	[-0.14, -0.03]
Parental support	-0.39 (0.02)	<0.001	[-0.43, -0.36]	-0.39 (0.02)	<0.001	[-0.43, -0.36]
Social media time	0.05 (0.01)	<0.001	[0.04, 0.06]	0.04 (0.01)	0.002	[0.01, 0.06]
Time	0.04 (0.01)	<0.001	[0.03, 0.06]	0.04 (0.01)	<0.001	[0.03, 0.06]
Time x Social media time				0.02 (0.01)	<0.001	[0.01, 0.03]
Gender x Social media time				-0.05 (0.01)	<0.001	[-0.07, -0.03]

Table 3 Mixed model analysis with physical symptoms of anxiety as the dependent variable, unstructured model with repeated effects of time.

	Model 1. No interactions			**Model 2. With interactions**		
	Fixed effects (SE)	*P*	95% CI	Fixed effects (SE)	*P*	95% CI
Intercept	2.84 (0.07)	<0.001	[2.71, 2.97]	2.84 (0.08)	<0.001	[2.69, 2.99]
Male gender	-0.31 (0.02)	<0.001	[-0.35, -0.27]	-0.32 (0.02)	<0.001	[-0.36, -0.27]
Family structure	-0.05 (0.02)	0.023	[-0.10, -0.01]	-0.05 (0.02)	0.028	[-0.10, -0.01]
Parental support	-0.32 (0.02)	<0.001	[-0.35, -0.28]	-0.31 (0.02)	<0.001	[-0.35, -0.28]
Social media time	0.05 (0.0005)	<0.001	[0.04, 0.06]	0.04 (0.01)	0.001	[0.02, 0.06]
Time	0.04 (0.01)	<0.001	[0.03, 0.06]	0.04 (0.01)	<0.001	[0.03, 0.06]
Time x Social media time				0.01 (0.005)	0.002	[0.01, 0.02]
Gender x Social media time				-0.05 (0.01)	<0.001	[-0.06, -0.03]

Table 4 Mixed model analysis with symptoms of social anxiety as the dependent variable, unstructured model with repeated effects of time.

	Model 1. No interactions			**Model 2. With interactions**		
	Fixed effects (SE)	*P*	95% CI	Fixed effects (SE)	*P*	95% CI
Intercept	3.06 (0.08)	<0.001	[2.91, 3.21]	3.02 (0.08)	<0.001	[2.85, 3.18]
Male gender	-0.43 (0.03)	<0.001	[-0.48, -0.38]	-0.43 (0.03)	<0.001	[-0.48, -0.38]
Family structure	-0.07 (0.03)	0.015	[-0.13, -0.01]	-0.07 (0.03)	0.016	[-0.13, -0.01]
Parental support	-0.34 (0.02)	<0.001	[-0.37, -0.30]	-0.33 (0.02)	<0.001	[-0.37, -0.30]
Social media time	0.04 (0.01)	<0.001	[0.03, 0.05]	0.05 (0.01)	<0.001	[0.02, 0.07]
Time	0.07 (0.01)	<0.001	[0.05, 0.09]	0.07 (0.01)	<0.001	[0.05, 0.09]
Time x Social media time				0.01 (0.01)	0.130	[0.00, 0.02]
Gender x Social media time				-0.05 (0.01)	<0.001	[-0.07, -0.03]

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Active and Passive Social Media Use and Symptoms of Anxiety and Depressed Mood Among Icelandic Adolescents

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Abstract

Adolescent use of social media platforms such as Facebook, Instagram, and Snapchat has increased dramatically over the last decade and now pervades their everyday social lives. Active and passive social media use may impact emotional health differently, but little is known about whether and to what extent either type of social media use influences emotional distress among young people. We analyzed population survey data collected from Icelandic adolescents ($N = 10{,}563$) to document the prevalence of social media use and investigate the relationship of both active and passive social media use with self-reported symptoms of anxiety and depressed mood. A hierarchical linear regression model revealed that passive social media use was related to greater symptoms of anxiety and depressed mood among adolescents and active social media use was related to decreased symptoms of anxiety and depressed mood, even after controlling for time spent on social media. When adding known risk and protective factors, self-esteem, offline peer support, poor body image, and social comparison to the model, active use was not related to emotional distress; however, passive use was still related to adolescent symptoms of anxiety and depressed mood. The effect of social media on emotional distress differed by gender as time spent on social media had a stronger relationship with emotional distress among girls. In addition, passive use was more strongly related to symptoms of depressed mood among girls. Future research should include risk and protective factors as mediators of different types of social media use and adolescent emotional distress.

Keywords: active social media use, adolescence, anxiety, depressed mood, emotional distress, passive social media use

Introduction

SELF-REPORTED EMOTIONAL DISTRESS, such as symptoms of anxiety and depressed mood, among youth has increased in recent decades, especially for girls.[1–6] Engagement with social media such as Facebook, Instagram, and Snapchat may contribute to this distress.[7] Most adolescents use social media regularly (90 percent in the United States and 93 percent in Iceland), with ~25 percent reporting heavy use (over 4 hours daily).[8,9]

Time spent on social media has been connected to poor psychological well-being[10] and symptoms of depression[7] and anxiety.[11] Similarly, frequency of use is related to poor psychological well-being.[12,13] However, some use may be advantageous, with moderate users reporting the greatest psychological well-being when compared with no use and high use.[7,14]

Focusing solely on frequency or duration of social media use may be overly simplistic. Active use involves chatting, sharing photos, or status updates with a specific audience or posting other personal content that others can then comment or give likes, whereas passive use refers to browsing, scrolling, reposting links, or looking at content from others. Active use can therefore reflect the individual's self-concept, words, or thoughts, which may be used to engage with others.[15] Passive use, however, involves consuming information

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and reposting links not aimed at anyone in particular, unrelated to the person's self-concept and requiring minimal effort. Emerging research suggests that passive use is related to greater depressive symptoms and active use with fewer depressive symptoms.[15–17] Passive Facebook users, for example, benefit from taking a break from the medium in terms of positive feelings and life satisfaction.[18]

Both active and passive use appear to be related to, and may possibly cause, emotional distress because they are connected with known risk factors for poor youth mental health. For example, social comparison is a risk factor for emotional distress,[17,19,20] especially upward comparisons.[21,22] Social media is replete with upward comparisons as users disproportionally post positive content from their lives and downplay the negative.[23] Time spent on Facebook, number of logins, and type of Facebook use relate to greater social comparison,[20,24–26] some report that passive use relates to increased social comparison[17,27] and active use to decreased social comparison,[17] while others have found that both active and passive Facebook use are related to greater social comparison.[26] Similarly, body dissatisfaction is a risk factor for emotional distress.[28,29] Body image concerns relate to social comparison as youth may internalize unrealistic ideals and engage in appearance comparison, self-surveillance, and self-objectification.[30–32] Facebook users report lower body satisfaction[30,33–35] and social comparison mediates the relationship between passive Facebook use and body image concerns.[27]

Both active and passive use may relate to protective factors for emotional distress, such as social support.[36–38] The rich-get-richer hypothesis proposes that individuals with good offline social relationships will use social media to extend their social networks and friendship quality.[39] Active use connects to offline social inclusion and less loneliness,[40,41] greater feelings of bonding,[40] and greater daily online social connectedness to friends.[41] In addition, online social support mediates the relationship between active use and decreased symptoms of depressed mood.[15]

Another protective factor against emotional distress is self-esteem.[42,43] Greater use is connected with lower self-esteem[7,44,45] and negative self-esteem is a mediator between Facebook use and psychological distress.[46] Limited research exists on the relationship between social media use, self-esteem, and symptoms of anxiety and depressed mood. In a network analysis, Facebook use was linked to social comparison and self-esteem, which in turn were linked to anxiety and depressive symptoms. Given that high self-esteem relates to less emotional distress[42,43] and that self-esteem connects Facebook use to symptoms of anxiety and depressed mood,[26] self-esteem should be assessed when examining social media use and mental health.

Although social media use can affect adolescents positively or negatively, the relationship is complex and little is known about it.[47–49] Both time on social media[7,10,11] and type of use may play a role in well-being.[15,16] Parents, school officials, and even developers of social media at Instagram and Facebook are concerned about the possible negative consequences of social media use.[50] Passive social media use can be a risk factor for detrimental influences in the lives of adolescents, such as social comparison and body dissatisfaction.[17,27] Conversely, active use has potential benefits for peer relationships and self-esteem.[15,37,39–41,44,45] Thus, the purpose of this study was to estimate the prevalence of active and passive social media use and to examine how use relates to symptoms of anxiety and depressed mood. We hypothesized that time spent on social media is positively related to greater emotional distress and that emotional distress has a positive relationship with passive use and a negative relationship with active use,[15,40] even after controlling for known risk and protective factors for adolescent symptoms of anxiety and depressed mood.

Methods

Participants and procedures

The data come from a national survey of Icelandic adolescents conducted in February 2018. The sample consists of students, ages 14–16, in the 8th, 9th, and 10th grades of compulsory school, whose parents consented to their participation. Anonymous questionnaires were administered to all students present in class on the day of the survey. Teachers distributed the questionnaires, and students returned them sealed in blank envelopes upon completion. The data collection protocol has been described elsewhere.[51] In total, 10,563 students completed the questionnaire, yielding an 84 percent response rate; 50.3 percent were girls.

Measures

Time on social media. This was assessed with one question: ''On average, how many hours a day do you spend on social media (e.g., Facebook, Snapchat, Twitter, and Instagram)?'' Participants answered on an 8-point scale, ranging from almost no time (=1) to 6 hours or more (=8). This scale is comparable with other studies examining how long adolescents spend on social media.[7,14]

Type of social media use. This was assessed with the Multidimensional Scale of Facebook Use,[52] modified to refer to all types of social media and translated into Icelandic. Participants answered six questions on how often they take part in certain activities on social media. A principal component exploratory factor analysis with varimax rotation showed that the items loaded well onto the two factors, explaining 71 percent of the variance. Both factors had acceptable internal consistency (active: $\alpha = 0.80$, passive: $\alpha = 0.74$). The confirmatory factor analysis revealed adequate fit of the two-factor model (comparative fit index = 0.98, Tucker–Lewis index = 0.96).

Anxiety. This was measured with two dimensions from the Icelandic version of the Multidimensional Anxiety Scale for Children,[53] the physical symptoms scale (12 items) and the social anxiety scale (9 items). Participants reported how often they experienced each symptom on a four-point scale, from never to often. Examples of symptoms include feeling nervous, hands shaking, and worrying about speaking in front of others. The scale has been tested among a sample of Icelandic adolescents and has good reliability and validity.[53] In this sample, reliability was excellent ($\alpha = 0.95$).

Depressed mood. This was measured with 10 items from the depression dimension scale of the Original Symptom Checklist.[54] Participants reported how often in the

previous week they experienced symptoms of depressed mood, such as feeling hopeless and without energy. Participants answered on a four-point scale (never to often). The scale demonstrates good internal consistency and test–retest reliability.[55] In this sample, reliability was high ($\alpha = 0.91$).

Gender. This is a binary variable asking participants to indicate whether they are a boy (=0) or a girl (=1).

Family structure. Participants were asked who they currently lived with, and this variable was coded 1 for both biological parents (69.8 percent) and 0 for other family arrangements. This measure and coding have been previously used among Icelandic youth.[56]

Parental support. The Perceived Parental Support Scale consists of five items measured on a four-point scale, asking how adolescents perceive general support from parents. Participants were asked how easy or hard it is for them to receive the following from their parents: caring and warmth, discussion about personal affairs, advice about their studies, advice about other issues, and assistance with other things. A higher score reflects more parental support. The scale has shown good internal consistency and convergent validity.[57,58] In this sample, reliability was high ($\alpha = 0.88$).

Subjective relative deprivation. Participants were asked how well-off financially their family is compared with other families in Iceland, the scale ranged from much worse off (=1) to much better off (=7). This measure has previously been used among Icelandic adolescents.[59]

Offline peer support. Participants were asked how easy or hard it is for them to receive the following from their friends: caring and warmth, discussion about personal affairs, advice about their studies, advice about other issues, and assistance with other things. Participants answered on a four-point scale, with a higher score reflecting greater perceived peer support. In this sample, reliability was good ($\alpha = 0.89$). This measure has previously been used among Icelandic adolescents.[60,61]

Social comparison. This was measured with the 11-item Iowa–Netherlands Comparison Orientation Measure.[62] The measure was translated into Icelandic and then back-translated into English. Participants were asked how much they agree with statements such as: ''I often compare myself with others with respect to what I have accomplished in life.'' Participants answered on a five-point scale, ranging from strongly disagree to strongly agree. Higher scores indicate a greater tendency to compare oneself with others. The scale is widely used and has good reliability and validity.[62,63] In this study, scale reliability was high ($\alpha = 0.83$).

Self-esteem. This was measured with 10 statements from the Rosenberg Self-Esteem Scale.[64] The scale consists of positive and negative self-appraisal statements rated on a four-point scale. Higher scores indicate a higher level of self-esteem.[42] The scale has good psychometric properties.[65,66] In this study, reliability was high ($\alpha = 0.90$).

TABLE 1. FREQUENCIES OF ACTIVE AND PASSIVE SOCIAL MEDIA USE FOR ADOLESCENT GIRLS AND BOYS

	Never		*1×a month or less*		*1×a week*		*Few times a week*		*1×a day*		*2–5×a day*		*6×a day or more*	
	Boys (%)	*Girls (%)*	*Boys (%)*	*Girls (%)*	*Boys (%)*	*Girls (%)*	*Boys (%)*	*Girls (%)*	*Boys (%)*	*Girls (%)*	*Boys (%)*	*Girls (%)*	*Boys (%)*	*Girls (%)*
Active social media use														
How often do you send a private message, picture, video, or chat on social media?	9.3	2.3	5.3	2.7	3.8	2.3	13.2	8.2	9.5	6.9	21.1	24.6	37.9	53.2
How often do you send a private message, picture, or a video that disappears after being seen?	19.2	7.1	5.4	2.8	4.4	2.5	11.1	6.9	9.5	7.7	17.6	22.9	32.9	50.1
How often do you post a picture or a video from your life?	45.3	22.9	14.9	14.8	6.9	7.8	9.2	11.5	6.7	9.5	7.6	15.3	9.4	18.1
Passive social media use														
How often do you look at your friends' profiles or social media accounts?	48.6	40.1	14.5	13.1	9.6	10.9	13.5	17	5.8	8.2	4.5	7.1	3.4	3.7
How often do you browse social media profiles or accounts of people who you do not know?	58.3	46.8	12.9	12.2	7.3	8.2	10	14.5	4.4	7.3	4.1	7	3	4
How often do you post other than pictures on social media, such as links, games, news, or web pages?	39.4	44.7	15.8	19.7	10.1	8.5	14.6	10.9	7.9	6.5	6.5	5.6	5.7	4.1

Table 2. Spearman Correlations Between Variables of Interest

	Depressed mood	*Anxiety*	*Social media time*	*Active use***	*Passive use*	*Poor body image*	*Social comparison*	*Self-esteem***	*Offline peer support*
Depressed mood	1	0.677***	0.202***	0.114***	0.116***	0.549***	0.275***	–0.623***	–0.255***
Anxiety		1	0.207***	0.141***	0.135***	0.539***	0.352***	–0.570***	–0.186***
Social media time			1	0.533***	0.345***	0.154***	0.195***	–0.188***	0.119***
Active use				1	0.538***	0.059***	0.239***	–0.035**	0.229***
Passive use					1	0.077***	0.244***	–0.064***	0.098***
Poor body image						1	0.240***	–0.726***	–0.264***
Social comparison							1	–0.259***	0.001
Self-esteem								1	0.303***
Offline peer support									1

**$p < 0.01$, ***$p < 0.001$.

Body image. This was measured with five items from the body image subscale of the Offer Self-Image Questionnaire.[67] Participants indicate how much they agree or disagree with statements such as: ''I am happy with my body,'' rated on a four-point scale, and higher scores indicate a more negative body image. The Offer Self-Image Questionnaire has been used in adolescent research and has high reliability[68] and moderate discriminant validity.[69] In this study, reliability was high ($\alpha = 0.82$).

Data analyses

To examine bivariate relationships, we calculated Spearman correlations. To investigate the unique effects of social media on emotional distress (time spent on social media, active use, and passive use) as well as risk factors (social comparison and body image) and protective factors (offline peer support and self-esteem), we performed a hierarchical linear regression. We controlled for family structure,[70] relative deprivation,[71] and parental support[72] because they relate to emotional distress. The analysis examined control variables in model 1, time spent on social media in model 2, active and passive use in model 3, and risk and protective factors in model 4. In the fifth and final model, two-way interactions with gender and social media variables were added because girls are more likely to report emotional distress,[1] compare themselves on social media, report poor body image,[24,73] and spend more time on social media.[74,75] Mplus, version 6.12, and SPSS, version 25, were used.

Results

Table 1 shows that most girls (84.7 percent) and more than half of the boys (68.5 percent) actively use social media once or more a day. Posting a photo or a video on social media is a daily activity for 23.7 percent of boys and 42.9 percent of girls, although 45.3 percent of boys and 22.9 percent of girls report never posting a photo or a video. Passive use is less prevalent, with 13.7 percent of boys and 19 percent of girls looking at their friends' profiles or social media accounts once a day or more and 11.5 percent of boys and 18.3 percent of girls browsing through profiles of people they do not know once a day or more.

Table 3. Hierarchical Linear Regression Predicting Symptoms of Depressed Mood, Standardized Coefficients

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Gender	0.239***	0.201***	0.209***	0.128***	0.053*
Family structure	–0.052***	–0.039***	–0.037***	–0.030***	–0.029**
Parental support	–0.354***	–0.342***	–0.339***	–0.058***	–0.057***
Relative deprivation	0.082***	0.090***	0.092***	0.029**	0.029**
Time on social media		0.153***	0.146***	0.053**	0.015
Active social media use			–0.046**	0.009	0.023
Passive social media use			0.086***	0.036***	0.014
Self-esteem				–0.472***	–0.471***
Offline peer support				–0.108***	–0.109***
Social comparison				0.071***	0.070***
Poor body image				0.101***	0.107***
Gender × time on social media					0.093***
Gender × passive social media use					0.045*
Gender × active social media use					–0.034
Adjusted R^2	0.210***	0.232***	0.237***	0.509***	0.511***

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

Table 4. Hierarchical Linear Regression Predicting Symptoms of Anxiety, Standardized Coefficients

	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*
Gender	0.338***	0.307***	0.315***	0.237***	0.187***
Family structure	–0.009	0.001	0.004	0.009	0.009
Parental support	–0.287***	–0.278***	–0.276***	–0.019	–0.019
Relative deprivation	0.113***	0.119***	0.122***	0.061***	0.062***
Time on social media		0.122***	0.108***	0.024**	–0.002
Active social media use			–0.040**	–0.002	–0.006
Passive social media use			0.098***	0.036***	0.044**
Self-esteem				–0.359***	–0.358***
Offline peer support				–0.098***	–0.099***
Social comparison				0.166***	0.165***
Poor body image				0.156***	0.156***
Gender × time on social media					0.063*
Gender × passive social media use					–0.016
Gender × active social media use					0.018
Adjusted R^2	0.227***	0.240***	0.247***	0.497***	0.498

*$p < 0.05$, **$p < 0.01$, and ***$p < 0.001$.

Symptoms of anxiety and depressed mood were positively correlated with time on social media (Table 2). Both active and passive use correlated with greater symptoms of anxiety and depressed mood. Poor body image and social comparison correlated with greater symptoms of anxiety and depressed mood and self-esteem and offline peer support with fewer symptoms of anxiety and depressed mood.

Regression analysis showed that time spent on social media was correlated with greater symptoms of depressed mood (Table 3) and anxiety (Table 4). When time on social media was controlled for, passive use related to greater symptoms of anxiety and depressed mood, but active use to fewer symptoms of anxiety and depressed mood. When social media time and use were controlled for, self-esteem and offline peer support negatively correlated with emotional distress and social comparison and poor body image positively related to emotional distress. When adding the risk and protective factors, passive use remained a significant correlate of emotional distress, but active use did not. Girls reported greater symptoms of anxiety and depressed mood, even when controlling for use as well as risk and protective factors. Significant interactions emerged as time spent on social media had a stronger relationship with emotional distress among girls. In addition, passive use was more strongly related to symptoms of depressed mood among girls.

Discussion

Consistent with previous articles on psychological well-being[7,14] and emotional distress,[11,76] time spent on social media was correlated with greater symptoms of anxiety and depressed mood. Similar to the limited articles available on the topic,[15,16,26] active and passive use were differentially related to symptoms of depressed mood and anxiety. In addition, passive use was related to greater symptoms of depressed mood for both girls[15,77] and boys.[77] We believe this is the first study to show that passive use is related to greater anxiety symptoms for both genders.

Active use was related to greater emotional distress at the bivariate level, but had a negative relationship when controlling for family structure, relative deprivation, parental support, and time spent on social media. A previous article has found that among adults, active use relates to decreased symptoms, regardless of gender.[16] However, for Belgian adolescents, active Facebook use by girls related to decreased depressive symptoms, while active public use was connected with greater depressive symptoms for boys.[15] Regardless of these observed gender differences, the limited research consistently shows that actively using social media may confer protection against emotional distress.

Emotional distress correlated with known risk and protective factors from adolescents' social environment. Positive relationships emerged between emotional distress and social comparison,[78] as well as poor body image.[79] Conversely, protective factors had the expected negative relationships with emotional distress for both peer support[37,48] and self-esteem.[43] Our findings show that the relationship between time spent on social media and symptoms of anxiety and depressed mood is stronger for girls than boys. Furthermore, passive use more strongly relates to symptoms of depressed mood among girls. This is consistent with articles indicating that girls may be more sensitive than males to feedback from social experiences and be more likely to react by internalizing emotional distress, including depressed mood.[42,80] The relationship between different social media use and risk and protective factors and emotional distress is thus complex. The mechanism is unclear and may be bidirectional or with feedback loops. The cross-sectional nature of our data points to a relationship, but not its directionality. Comparing results from adolescents and adults on self-esteem, body dissatisfaction, social comparison, and the importance of peer relationships on mental health may also be limited as adolescent brains are still developing along with their sense of self-worth. Moreover, most of the previously published articles (with the exception of Faelens et al.)[26] have not separately assessed the related yet distinct concepts of symptoms of anxiety and depressed mood.

Our study has several notable strengths that have not been features of previous articles. First, we added known risk and protective factors for adolescent symptoms of anxiety and depressed mood to our analysis to identify the unique relationship between type of social media use and emotional distress. Second, we examined active and passive use in relation to dissatisfaction with body image, an important aspect

of well-being in which social media may play a role.[29–31] Third, our study utilized a large sample with a high response rate. Finally, we assessed the relationship between emotional distress and social media use across platforms and not just Facebook, as most of the previous articles have done.[12,13,17,18,20,26–28,31,33–35,41,46,52,77] While Facebook is the most commonly used social media app among adults, Icelandic adolescents follow a similar trend as young Americans,[81] with Instagram, Snapchat, and Facebook being the most popular platforms. However, Facebook is mostly used to send private messages or to plan events, not to create or share content.[82]

Despite the strengths of this study, two limitations should be acknowledged. First, we relied on self-reports of social media use. Although self-reports have been considered valid in assessing individual subjective experiences, there is potential for recall bias and inaccurate estimates of time spent on social media. Second, when measuring different types of social media use, we used a scale created for active and passive Facebook use and asked about social media use across platforms. Our factor analysis differed from previous studies since it revealed two factors instead of three.[15] It is therefore possible that the measure of active and passive social media use does not fully capture the difference between what is active social media use and what is passive social media use.

We believe this is the first study to show that passive social media use is related to greater anxiety symptoms for both genders. Our findings also provide insight into the relationship between emotional distress and adolescent social media use in three important ways. First, we found that there are two (i.e., active and passive use) rather than three (i.e., active public, active private, and passive use) distinct factors.[15] Second, when controlling for known risk and protective factors, passive use is positively related to symptoms of anxiety and depressed mood. Finally, the relationship between duration of use and symptoms of anxiety and depressed mood is stronger for girls than boys, and the relationship between passive use and depressed mood is stronger for girls. Future research should focus on examining the relationship longitudinally and whether use of specific social media affects youth in different ways.

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