

**The Effects of Social Media Use Reduction on Emotional Distress in Transitional-Aged
Youth.**

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Abstract:

Background: Depressive and anxiety symptoms are prevailing among transitional aged youth (TAY) putting this population at high risk for lifelong mental illness as these disorders track through adulthood. Heavy social media use (SMU) is prevalent among TAY, which is concerning given it is associated with emotional distress in the form of depression and anxiety, with evidence that unfavourable social comparisons may be a primary mechanism. However, most research is cross-sectional in nature, highlighting the need for experimental studies to provide a greater understanding of how SMU impacts mental health and social comparisons. Accordingly, the primary aim of this study was to examine whether reducing SMU to 1 hour/day reduced depressive symptoms in distressed TAY. Secondary objectives included the examination of intervention effects on anxiety symptoms, and whether social comparison mediated the relationship between SMU reduction and reduced depressive and anxiety symptoms. Exploratory objectives included examining the intervention effects on individuals with greater/lesser emotional distress at baseline.

Design and Methods: A randomized controlled trial was used to assign 218 (77% female) TAY (aged 17-25 years) to either the intervention group (n=116) or the control group (n=102). The intervention group was instructed to reduce smartphone-based SMU to a maximum of 1hr/day while the control group had no SMU restrictions. Study duration included 1-week baseline period followed by a 3-weeks intervention period; and mental health outcome measurements were taken at baseline and 4-weeks. Depressive symptoms were measured using the Center for Epidemiologic Studies Depression Scale (CESD-10), and anxiety symptoms were measured using the Generalized Anxiety Disorder scale (GAD-7), while social comparison was measured using the Technology-Based Social Comparison and Feedback-Seeking subscale (SCFS), which is a subscale of the Motivations for Electronic Interaction Scale (MEIS).

Results: Analysis of variance (ANOVA) revealed the intervention was successful in limiting SMU, evidenced by a significant group x time interaction showing a greater reduction of SMU in the intervention group compared to the control group ($p < .001$, partial $\eta_p^2 = .286$). Simple effects showed that intervention participants spent less time in SMU than controls at week two (79.8min (45.6) vs 186.8min (98.21), $p < .001$), week three (75.97min (53.78) vs 189.67min (84.38), $p < .001$), and week four (76.01min (57.48) vs 188.8min (94.94), $p < .001$). There was good adherence to submitting screenshots (94%) and this did not differ by group at baseline ($p = 0.474$) or during the 3-week intervention period ($p = 0.834$). ANOVA also revealed a significant group x time interaction showing a greater reduction for the intervention group compared to the control group at week 4 in depressive symptoms ($p = .019$, partial $\eta_p^2 = .025$) and anxiety symptoms ($p = .015$, partial $\eta_p^2 = .027$), but groups did not differ on changes in social comparison ($p = .593$, partial $\eta_p^2 = .001$). Three-way interactions showed that relative to controls, SMU reduction produced a greater reduction in anxiety symptoms for those with high baseline scores ($p = .008$, partial $\eta_p^2 = .032$) compared to those with low baseline scores, whereas this three-way interaction was not significant for depressive symptoms ($p = .438$, $\eta_p^2 = .003$).

Conclusion: Our data suggest that reducing SMU to approximately 1hr/day may be a feasible, inexpensive and effective therapeutic component that should be considered in the overall management of anxiety and depressive symptoms in TAY with emotional distress, a vulnerable population for lifelong mental illness.

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List of Abbreviations:

CMHA	Canadian Mental Health Association
CONSORT	Consolidated Standards of Reporting Trial
FoMO	Fear of Missing Out
GAD	Generalized Anxiety Disorder
MH	Mental Health
RCT	Randomized Controlled Trial
SMU	Social Media Use
TAY	Transitional Aged Youth
WHO	World Health Organization

Chapter One: Introduction

1.1 Mental Health Crisis:

Transitional age youths (TAY) are described in the literature as young people in the developmental period of late adolescence to early adulthood which is between the ages of 16 to 29 (Davis et al, 2006; Mandarino, 2014; Heflinger & Hoffman, 2009). This period involves progressive independence and the establishment of career, families and core values. Transitional aging to adulthood is a unique formative time that can expose their mental health (MH) to vulnerabilities due to the rapid change in social, physical, and neurobiological development (Burnham, et al, 2015; Paus, 2005). Failing to address TAY mental health challenges results in pressing public health concerns as MH problems track into adulthood and degrade both their physical and mental wellbeing (Chan et al, 2019; Jurewicz, 2015).

Epidemiological studies have shown that, by age 25, at least one out of every five young people in Canada will suffer from at least one mental disorder in any given year (Mental Health Commission of Canada (MHCC), 2019). Depressive disorders and anxiety, the most common forms of mental illness, occur in 5-22% of TAY, with subclinical symptoms occurring in 21-50% (de Lijster et al, 2017; Beesdo, Knappe & Pine, 2009). Generalized Anxiety Disorder (GAD) is the most prevalent anxiety disorder affecting 9.7% of Canadian youth. In addition, around 5% of males and 12% of female youth aged 12 to 19 experience a major depressive episode, characterized by severely depressed mood and activity levels that persist at least two weeks (Canadian Mental Health Association (CMHA), 2021). Given over 70% of adult mental illness has its origins in the early years, and MH persists and tracks from childhood into adulthood (Centre for Addiction and Mental Health (CAMH), 2020; Merikangas & Avenevoli, 2002), it is crucial to identify and evaluate novel, scalable and effective interventions targeting TAY suffering from emotional distress to prevent adult mental illness.

Depression is a psychiatric illness classified as a mood disorder with major health, economic, and social consequences. It is characterized by sadness, loss of interest or pleasure, low self-worth, feelings of guilt, disordered sleep or appetite, low energy and poor concentration (Dinas, Koutedakis & Flouris, 2011; World Health Organization (WHO), 2020). Other aspects of depression include restlessness, hopelessness, and irritability. In addition, no one is immune to depression as it can impact people from different ages, sex and diverse backgrounds (Dinas, Koutedakis & Flouris, 2011). According to the WHO (2020), “Depression is a leading cause of disability worldwide and is a major contributor to the overall global burden of disease”. This is because depression can have profound effects on all aspects of life affecting people’s ability to function and live a rewarding and productive life. Depression can be acute or chronic, often periodic; and at its worst, it could lead to suicide (WHO; 2020). Moreover, individuals suffering from depression pose a significant economic burden as they have significantly higher healthcare costs and are more likely to have inpatient and outpatient services when compared to patients without depression (Gu et al, 2020). The Conference Board of Canada (2016) reported that the economic cost of depression is at least \$32.3 billion annually, while anxiety costs another \$17.3 billion a year. Once depression is recognized, it can be treated with pharmacological agents and/or behavioural intervention (including healthy lifestyle behaviour changes) and these treatments are effective for 80% of people who are affected, allowing them to get back to their regular activities (WHO, 2020; CMHA, 2021).

Anxiety is an emotion characterized by feelings of tension, stress, worried thoughts and physical changes like increased blood pressure, heart rate and/or sweating (Kazdin, 2000). Anxiety is a

normal and often healthy emotion and necessary for survival. When it is triggered by sensing danger, anxiety causes the flight-or-flight reaction, a physiological response to an alarming situation caused by a rush of adrenalin. Though, when anxiety occurs on a regular and disproportionate level, it may become a psychiatric disorder and results in restlessness, uncontrollable feelings of worry, panic, increased irritability, concentration difficulties, sleep and appetite difficulties. This disorder and subclinical manifestations can interfere with interpersonal relationships and academic achievements as well as overall wellbeing and quality of life (Garber & Weersing, 2010).

There are several types of anxiety disorders, with Generalized Anxiety Disorder (GAD) being the most prevalent type and the targeted outcome measured in the proposed study. People with GAD display excessive worry and anxiety most days about several things such as personal health, social interactions, work and daily life routine (National Institute of Mental Health (NIMH), 2018). Other anxiety disorders include panic disorder that causes panic attacks which are periods of intense fear that can peak within minutes and can occur suddenly or brought by a trigger (e.g. feared object or situation); social anxiety disorder which is a general intense fear and anxiety toward everyday social situations characterized by excessive self-consciousness. It can occur in a range of situations, such as the workplace or school environment (NIMH, 2018).

The causes of anxiety differ from person to person and are usually a combination of biological, psychological, environmental and developmental factors (Narmandakh et al, 2020). It is common that anxiety and depression co-occur or could be sequentially related in TAY where experiencing one often increases the risk of the other over time (Kalin, 2020). Similar to depression, anxiety in

childhood can also track into adulthood and could increase the risk of suicide and other psychopathologies (Garber & Weersing, 2010).

Moreover, the pandemic has made the prevalence of anxiety and depressive symptoms worse regardless of the MH history. More specifically, individuals from all ages with pre-existing MH conditions have shown to be more vulnerable and at higher risk of negative impacts on their MH due to the pandemic (Kozloff et al, 2020). There was an unprecedented number of youth hospital admissions and increases in ER visits for MH and suicide concerns during the pandemic (Vaillancourt et al, 2021). Mental health difficulties were more prevalent as the pandemic persisted suggesting that as the length of the pandemic continued, clinically significant anxiety and depressive symptoms also increased (Giuntella et al, 2021). This highlights the urgent need to address this high level of mental distress now more than ever.

1.2 Social Media Use:

Paralleling the increasing prevalence of mental illness in TAY is the high prevalence of social media use (SMU). Social media use employ internet-based interactive technologies that facilitate the creation or exchange of information, ideas, thoughts and other forms of expression through virtual networks and communities (Kietzmann et al, 2011). Social media is a collective term representing the websites and applications that allow for communication and community-based interactions and content sharing. Social media features quick communication of user-generated content including personal information, documents, videos, and photos. User engagement with social media can be through electronic devices such as smartphones, tablets or computers or via web-based softwares or applications. Although not in the scope of this study, there are two types

of SMU behaviours “active” and “passive” which could influence the experience of SMU (Verduyn et al, 2017). Active SMU refers to being directly engaged in exchanges among users, such as chatting, commenting, sharing and creating posts. On the other hand, passive SMU refers to monitoring and consuming content of others without being directly engaged (Verduyn et al, 2017).

SMU is prevalent among TAY, with approximately 81.3% of Canadian TAY reporting moderate-to-heavy (2hrs or more) daily use prior to the pandemic (Sampasa-Kanyinga, Chaput, & Hamilton, 2019). Social media has brought a change to the technology use landscape with 93% of TAY using social media on a daily basis (Rideout & Fox, 2018), and 45% saying they are online on a near-constant basis, indicating that social media has become an integral part of TAY’s daily life (PEW Research Center, 2018). Ever since the COVID-19 lockdowns and social restrictions, there has been a large increase in TAY’s use and dependency on social media platforms for both educational and recreational purposes (Marciano et al, 2021). For example, applications such as TikTok, Pinterest, Facebook, Snapchat, Instagram, and Twitter witnessed growth in active users ranging from 8 to 38%. (Statista, 2021). The high prevalence of heavy SMU among TAY has sparked a considerable body of research into its potential effects on MH.

Many people depend on social media for work, school and social life. It is intended to bring many benefits to people’s life and wellbeing, such as facilitating communications and emotional connections with friends and family around the world, seeking and offering emotional support during rough times, and finding platforms for self-expression and creativity. While these benefits are important, excessive SMU can be problematic for MH, potentially promoting a reward cycle

each time someone gets a positive response on social media. More specifically, social media platforms include features, such as likes, comments, and shares on posts as well as the number of followers allowing for a vast virtual network. These features introduced a system where people's social worth can be publicly and visibly quantifiable. This has been reported to lead people to portray false or enhanced images of their appearance, self-representation, achievements, and lifestyles given that these platforms allow one to seemingly edit photos and decide to specifically select and post positive aspects of their life that are socially desirable, which are reinforced by likes, comments, and other design features. All of this provides unrealistic standards of body image, success and social desirability; In a TAY culture constantly attached to their social media, this could promote negative emotions, such as the feeling of inadequacy about one's life and appearance, depressed mood, anxiety, self-esteem and negative social comparison. These effects of SMU may present more harm than good, aggravating insecurities and risking of MH problems to vulnerable populations, such as TAY with pre-existing MH issues (Lee et al, 2020; Hunt et al, 2018). This population are more likely to be isolated and have less in-person contact with peers, and may use social media as a way to meet their psychological needs, making them more vulnerable to the harmful effects of SMU (Przybylski et al. 2013).

In relation to the excessive SMU, there is the feeling missing out on a connection or experience that another person has experienced. More time spent on SMU is proportionally linked to more exposure to people's social lives and more opportunities for individuals to develop Fear of Missing out (FoMo), a form of anxiety referring to the feeling or perception that an individual is being excluded from social activities of their peers and that others are experiencing better things (Przybylski et al, 2013; Gupta & Sharma, 2021). This feeling comes from unmet social needs and

a deep desire to belong to similar others. Those experiencing FoMO often compare themselves with people from a group or individuals who are more well liked and is conceptualized to result in both depression and anxiety. One study found that individuals with higher levels of FoMO were related to more depressive symptoms and tended to turn to SMU for a need of belonging (Abel et al, 2016). FoMO is not a phenomenon exclusively related to SMU. For example, hearing about missed opportunities in-person could lead to FoMO and it produces the same negative mood response as on SMU (Przybylski et al, 2013). However, SMU could lead to greater FoMO as it provides greater exposure to missed opportunities due to the vast social networks and endless content of others compared to in-person contacts. Even though outside of the scope of this study, FoMO has been considered a problematic attachment to SMU as it can be linked to a range of negative feelings and experiences that result in negative social comparisons, unstable interpersonal relationships and stimulates a desire to continually consume social media content and stay up-to-date with what others are doing (Przybylski et al, 2013; Hunt et al, 2018).

1.3 Mental Health and Social Media:

When examining individual studies, a pattern of mixed findings appear in regard to the association between SMU and mental health outcomes for TAY (Heffer et al, 2019; Valkenburg et al, 2017; Berryman et al, 2018; Nabi et al, 2013). For instance, SMU was found to be strongly associated with psychological distress in youth, specifically depression and anxiety (Sampasa-Kanyinga & Lewis, 2015; Nesi & Prinstein, 2015). Other longitudinal studies provide evidence that SMU may also be predictive of anxiety and depression (Frison et al, 2017; Vernon et al, 2017), while still others found that SMU did not influence self-esteem or depressive symptoms in TAY (Valkenburg et al, 2017; Heffer et al, 2019). Large scale epidemiological studies have shown that twice the

number of heavy users (> 2 hrs/day) of social media had clinically relevant symptoms of depression compared to non-heavy social media users (Sampasa-Kanyinga & Lewis, 2015), findings that are consistent with other studies among TAY (Kelly et al, 2018; Twenge & Campbell, 2019). Boers et al (2020) reported that 1-hour increase in time spent on social media in TAY was associated with an increase in the severity of anxiety symptoms within the same year.

Moving away from examining single studies allows a clearer evaluation of the strength of the associations of interest. A review of reviews using meta-analyses found small but reliable positive correlations between SMU and depressive symptoms ranging from $r = 0.11$ (Wenninger et al, 2019) and $r = 0.13$ (McCrae et al, 2017) to $r = 0.17$ among TAY (Vahedi & Zannella, 2021) (Orben, 2020). Another systematic review found similar patterns of small and positive associations between SMU and anxiety symptoms in youth (Keles et al, 2020). Interestingly, weaker and inconsistent associations have been found between SMU and emotional wellbeing, highlighting that associations may be stronger for pathological constructs than positive psychology ones. Results from meta-analyses suggest that using social media excessively is reliably associated with more severe levels of depressive and anxiety symptoms among TAY. However, there is substantial heterogeneity in methodology and statistical analyses across studies that, when pooled, it obscures a differentiation in effect sizes in select populations, so relationships among TAY with emotional distress, who were grossly under represented in these analyses, remains unknown. Moreover, the evidence from these meta-analyses has been reported to be of low-quality and primarily based on cross-sectional studies (Orben, 2020), highlighting the importance of well-controlled intervention studies to better establish the directionality of the relationship between SMU and MH.

A quasi-experimental study using an abstinence model on participants (n=61) with an average age of 22.4 years showed that short-term (7-day) abstinence from SMU reduced perceived fear of missing out (FoMO), a type of anxiety, and improved wellbeing and social connection (Brown & Kuss, 2020). Another quasi-experimental study investigated TAY abstaining from all media for one day, and found distress was the most experienced outcome including high anxiety and isolation (Roberts & Koliska, 2014). These negative feelings could be due to abstaining from all forms of social media which is a crucial component in the life of many TAY. Moreover, anxiety and distress usually reach high levels at the beginning of abstinence due to initial withdrawal and reduced reinforcements, but it often drops over time due to being able to adapt and find fulfillment of psychological needs elsewhere (Abel et al, 2016). In fact, a seven-day Facebook abstinence study on TAY (n=555) demonstrated a significant reduction in stress post-abstinence in comparison to the control group who did not abstain. These effects in reduced stress were more pronounced in heavier social media users (Turel et al, 2018). The showcase of these positive effects of abstinence observed for the longer intervention period (seven-days) compared to acute abstinence (24 hours) supports the concepts of positive adaptation to the elimination of social media. This is consistent with another 99 days Facebook abstinence study on adults (n=3539) where participants found their urge to check the social media platform was stronger in the initial of abstinence phase and it dropped over time for those who fully complied (Baumer et al, 2015). Although these interventions provide greater insight on the effects of SMU on MH compared to observational studies, the quasi-experimental designs that lack random assignment and proper controls still limit causal inferences, highlighting the need for experimental studies.

One experimental study in TAY showed that participants who were randomly assigned to the intervention group and completely eliminated their use of Facebook for a period of one week, showed improvement on two dimensions of wellbeing: life satisfaction and positive emotions (Tromholt, 2016). Although the randomized controlled trial design of this study establishes a causal relationship, limitations that affect the utility of findings are the short intervention period (1-week) and the self-reported collection of SMU data from only one social media platform (Facebook). While Facebook was completely banned for participants in the intervention group, they may still have had access to other social media accounts, such as Instagram and Snapchat, which are also known to be heavily used among TAY (Tromholt, 2016). Another experimental study in a healthy sample ($n=77$) of TAY showed null effects on loneliness and wellbeing from reducing SMU over 4 weeks (Agadullina et al, 2020). This study, however, again relied on self-reported compliance to SMU restriction. Self-reported SMU has been shown to be a poor predictor of actual use (Parry et al., 2020). Another step taken to assess compliance was for the research staff to check the participants' social media accounts on a daily basis for activity, which would only detect if any posts were made. This is not a reliable method of assessing SMU as it does not capture when participants are only browsing and not necessarily sharing or being active on their social media, and in fact passive use (scrolling) accounts for the majority of time spent on SMU (Beyens et al, 2020).

Another experimental study found that reducing SMU, which was objectively measured, led to reduced depressive symptoms and loneliness in TAY, with stronger effects observed with those with elevated depressive symptoms at baseline (Hunt & al, 2018). The design of this study allowed for several methodological advantages over previous studies. These include the fact that SMU was

objectively measured on smartphones and was limited to 30min/day for 3 weeks and not completely eliminated as it is not realistic to completely cut important communication platforms in TAY's lives. It also took into consideration multiple social networking platforms. The study measured MH attributes at baseline, and 3-weeks post-intervention. This study, however, did not measure SMU on other devices as participants in the intervention condition could have switched to using social media on other devices after reaching their daily limit on smartphones. Moreover, the study targeted healthy TAY. A similar pilot randomized controlled trial (RCT) was conducted on a small TAY population ($n=38$) with emotional distress indicated that reducing SMU to 1hr/day for a period of 3 weeks showed a greater reduction in anxiety but not depression (Thai et al, 2021). Although encouraging, Thai et al 2021 had a small sample size that likely limited power to detect differences, which may explain the null intervention effects on depressive symptoms.

Even though these experimental studies bring methodological rigour and further confirm the findings of the existing literature on the relationship between excessive SMU and negative MH outcomes, these studies are limited by either small sample sizes that limit generalizability and threaten the internal and external validity of findings, preponderance of self-reported SMU known to be an unreliable measure of compliance, lack of measurement of SMU on all devices, or targeting only one SMU platform (Tromholt, 2016; Hunt et al, 2018; Thai et al, 2021). Furthermore, all of these studies, except that of the pilot study by Thai et al. (2021) focused on healthy populations, thus are not easily generalized to groups with higher baseline MH challenges due to possible floor effects, thus creating a need to address the aforementioned limitations and fill the scientific gaps. Not only is TAY at a critical developmental stage with many MH challenges making this population vulnerable, but TAY attending post-secondary studies tend to experience

higher rates of MH problems including depressive and anxiety symptoms relative to their non-college attending peers. Adding to this vulnerability, TAY with emotional distress, an understudied population, are at high risk for lifelong mental illnesses in comparison to those without distress (Chan et al, 2019; Jurewicz, 2015). TAY also tend to be heavy social media users, qualifying them as an ideal target population for such experimental studies due to these vulnerabilities and the fact that they have never known a world without social media (Chan et al 2019; Blanco et al, 2008).

1.4 Social Comparison Theory as a Guiding Framework for SMU and MH:

There may be many ways in which social media use can have a negative effect on MH in TAY. For example, cyberbullying and the normalization of self-harm and suicidality among TAY can be a mediator on the effects of SMU on the psychosocial functioning of youth (Sampasa-Kanyinga & Hamilton, 2015; Abi-Jaoude, Naylor, & Pignatiello, 2020). This is intuitively reasonable as social media can be used to start the spread of harmful rumors and act as the conduit for abusive language that can leave lasting emotional scars. However, emerging research supports social comparisons as a potential mediator that explains how SMU can lead to poor MH. Social media can be problematic for MH as it presents bias toward presenting only positive aspects of one's life (e.g. vacations, restaurants, parties) which are seen as a measure of accomplishment and popularity, making these platforms drivers of social comparison and social approval (Warrender et Milne, 2020).

Social comparison theory is defined as the process by which people get to know themselves and evaluate their attitudes, abilities, social standing, performances and traits by comparison with others in a hierarchical manner (Swencionis & Fiske, 2014). Seeking information about other

individuals and groups is important to satisfy basic human needs, such as the need for affiliation and esteem (Festinger, 1954). It is a core feature in human nature and social evolution to evaluate and compare oneself with others, and this process is especially pronounced during adolescence and young adulthood (Festinger, 1954). When individuals do not have criteria for self-evaluation, which is the case for a lot of youth, they mostly rely on other people to compare their own abilities (e.g., who is better or worse) and opinions (e.g., beliefs and norms) with those of others (Festinger, 1954).

There are two kinds of social comparisons, the first one being upward (unfavourable) social comparison, the second being downward (favourable) social comparison. Firstly, unfavourable social comparison takes place when individuals compare themselves with others who are thought to be better off, often resulting in feeling inferior. This type of social comparison could sometimes be part of identity formation and a source of motivation to achieve more, though it could also have negative impacts on self-esteem, self-image and wellbeing due to the constant negative evaluation in comparison to others (White et al, 2016). Secondly, favourable social comparison refers to individuals comparing themselves to others whom they see to be worse off or equal, therefore resulting in enhanced subjective wellbeing and positive feelings regarding the individual's own situation and perceived abilities, but often at the expense of one's attitude to those around you (Buunk & Gibbons, 2007).

The role of social comparison in relation to the self has been investigated in social psychology through different avenues over the past 60 years ranging from social status, achievement-based comparisons, to health condition and image-based comparisons (McCarthy & Morina, 2020).

Though, there has been less emphasis on the implications of social comparison on clinical outcomes where the focus of these studies have been on affective disorders and anxiety.

To better understand the process of social comparison in terms of manipulation and outcomes, it has been classified into three facets that are interconnected including acquiring social information, evaluating the outcomes in comparison to self, and reacting to those evaluations of social information via cognitive, affective, or behavioural responses (Wood, 1996). These facets have been considered in clinical outcomes suggesting that negative social comparisons are more common in individuals showing high symptoms of depression and anxiety (McCarthy & Morina, 2020).

As for the first facet, individuals with depressive symptoms are more likely to acquire social comparison information than non-depressive individuals showcasing more nuanced effects of frequency in social comparison (Bäzner et al, 2006). Similar trends were identified for individuals with anxiety disorders (Antony et al, 2005). The social evaluation facet is shown to be associated with symptoms of depression and anxiety. This is supported by experimental studies where depressive groups often evaluated others as better-off (e.g. Alloy & Ahrens, 1987); and by observational studies where negative self-evaluation and comparison is significantly associated with increased depressive symptoms (e.g. Gilbert, 2000). Moreover, evidence from studies assessing the facet of reactions towards social comparisons that were based on manipulating the evaluation facet found that that distressed groups were more likely to seek upward (negative) comparisons compared to healthy groups, a tendency that is exacerbated in unfavourable conditions (Appel et al, 2015; McCarthy & Morina, 2020).

In essence, individuals with elevated distress tend to report more extreme negative reactions to social comparison information that is worsened with higher frequency of social comparison (Weary et al., 1987), which perpetuate or exacerbates emotional distress. Even though more negative MH effects are also perceived after engaging in upward social comparison (Appel et al, 2015) and more positive MH effects after downward social comparisons (Gibbons, 1999), these effects can be moderated by different factors including the frequency of comparisons. Furthermore, the literature further demonstrates evaluating and reacting to social information in distressed samples and among individuals is influenced by the amount of information available and how it is presented (McCarthy & Morina, 2020). Therefore, the frequency of social comparison could be an important factor that influences the degree of depressive and anxiety symptoms especially since individuals who often compare frequently tend to compare unfavourably, notably in a vast virtual network in which there will always be people of higher perceived social status or rank, as further discussed in the following sections.

There is a growing research in TAY that shows the frequency of offline social comparison to be related to negative MH outcomes including depressive mood and anxiety. A recent systematic review and meta-analysis, included 54 relevant studies including studies on TAY, 14 of which were suitable for a meta-analysis, examined the relationship between social comparison and MH revealed that social comparison plays a role in depression and anxiety (McCarthy & Morina, 2020). The meta-analysis results indicated significant correlations of -0.53 and - 0.39 between social comparison and depression and anxiety respectively in clinical populations. These correlational results do not indicate the directionality of this association, which highlights a need

for experimental studies to better understand the role of social comparison in depression and anxiety.

Building on cross-sectional studies, an experimental study on university TAY examined the effects of social comparison on depressed mood state in which participants were asked to imagine a friend who always gets what they want out of life, then they were asked questions in relation to comparing themselves with this person. Results indicated that negative social comparison induced a negative change in positive affect and self-esteem, and greater depressive symptoms. These effects were more pronounced on participants with high baseline depressive symptoms (Bäzner et al, 2006). Social comparison has also been implicated in the initiation and maintenance of anxiety symptoms, but these effects have received less attention in the scientific community. For example, high social comparison was found to be positively associated with higher anxiety levels in TAY, and linked to negative self-appraisals (Mitchell & Schmidt, 2014). Similarly, individuals who scored high in social comparison were more likely to experience emotional distress and low self-esteem than those low in social comparison (Butzer & Kuiper, 2006).

In relation to the virtual world, two meta-analyses demonstrated that social comparisons taking part on social media are associated with more severe depressive symptoms and lower wellbeing with effect sizes ranging from small to medium (Yang et al, 2019; Yoon et al, 2019). Feinstein et al. (2013) provided longitudinal evidence whereby TAY who were more likely to engage in social comparisons on Facebook demonstrated higher depressive symptoms three weeks later indicating that social comparison led to worsening depressive symptoms. Given most of these studies were observational, limiting causal inferences, more well-controlled studies are needed.

A quasi-experimental among healthy TAY showed that those who were exposed to fake profiles of attractive peers (careers, education, friends, likes, and comments) reported more envy than those who viewed unattractive profiles (Appel et al, 2015), supporting the notion that unfavourable social comparison leads to more dysphoric mood. Higher levels of social comparison on social media are generally unfavourable because there is a higher chance of engaging in unfavourable social comparisons given the nature of those platforms, which result in experiencing envy, guilt, regret, self-judgement, anxiety and depressed mood symptoms in adolescents (Nesi & Prinstein, 2015; Vogel et al, 2014).

One study experimentally investigated the effect of Facebook use on transitional aged women's mood and body image, and found that exposure to Facebook (relative to a control website) resulted in more negative mood and body dissatisfaction which was moderated by high social comparison (Fardouly et al, 2015). Another experimental lab study among TAY demonstrated that participants who tended to engage in social comparison had poorer self-perceptions, lower self-esteem and more negative affect than their counterparts with low social comparison, after briefly being instructed to engage in social comparisons (5 minutes) through browsing Facebook profile of an acquaintance than the control group who were instructed to either browse their own Facebook profile or read reviews of a consumer product (Vogel et al, 2015). This study shows that the individual tendency to engage in unfavourable social comparison influences the effects of exposure to SMU. People who tend to engage in more social comparisons tend to show more negative emotional response such as developing feelings of inferiority leading to negative emotions (Wang et al, 2017).

Given the well documented relationships between SMU and social comparison, combined with offline and online relationships between frequency of social comparison and anxiety and depressive symptoms, reducing exposure to SMU may reduce the frequency of social comparisons, which may reduce anxiety and depression. However, to date no experimental studies have investigated whether social comparison is a mechanism linking the effects of reduced SMU on depressive and anxiety symptoms beyond the laboratory, underscoring another gap in the scientific literature that needs to be filled.

1.5 Summary of the Research:

Research shows that excessive SMU is associated with more severe symptoms of anxiety and depression, but studies are primarily limited to cross-sectional designs, limiting causal inferences. Furthermore, most quasi-experimental studies found that abstaining from SMU could lead to improved MH outcomes, but these studies also lack causal inferences due to methodological and design limitations. On the other hand, experimental studies looking at the effects of reduced SMU showed improvement in depression, anxiety, loneliness, and wellbeing in a sample of healthy TAY. Though, many of these studies relied on self-reported measures of SMU, focused on Facebook rather than multiple platforms, included a short intervention period (i.e. 7-days), used a small sample size, did not assess SMU on other devices or targeted a healthy population without elevated symptoms of mental distress (Tromholt, 2016; Hunt et al. 2018; Thai et al, 2021). Furthermore, as little is known about the effects of reducing excessive SMU on anxiety and depressive symptoms for distressed TAY, a population at risk of lifelong mental illness, an experimental study that addresses the methodological weaknesses previously noted in other studies

is needed. Moreover, no study to date has examined whether reduced social comparison mediates the effects of social media use reduction on anxiety and depressive symptoms using a randomized controlled trial design, another gap filled by the present study.

1.6 Research Objectives & Hypotheses:

1.6.1 Research Objectives:

The primary aim of this study was to examine the impact of reducing SMU to 1hr/day on depressive symptoms at 4-weeks immediate post-intervention in TAY aged 17-25 with baseline mental distress. A secondary objective was to examine the intervention effects on anxiety symptoms at 4-weeks, and the extent to which social comparison mediates the relationship between SMU and the MH outcomes. Exploratory objectives included comparing the intervention effects on individuals with greater vs lower emotional distress at baseline.

1.6.2 Hypotheses:

It was hypothesized that participants in the intervention group required to limit SMU to 1hr/day would demonstrate greater reduction in depressive (primary outcome), and anxiety (secondary outcome) symptoms at 4-weeks than the control group who had unrestricted SMU. It was predicted that participants in the intervention group would show greater reductions in social comparisons than those in the control group, and that these changes would mediate reductions in depression and anxiety symptoms. It was also predicted that individuals assigned to the intervention group with high baseline depression and anxiety scores would show greater reduction in depressive and anxiety symptoms relative to controls compared to those with low baseline scores.

Chapter Two: Methodology

2.1 Study Design:

In this experimental study, we used a parallel-group randomized controlled trial design to assign participants to either intervention or control via a computer-generated randomization scheme. This study is part of a larger study that examined other outcomes as well. Participants had an equal chance of being assigned to either the intervention group (n=116) or the control group (n=102). The intervention group were asked to reduce SMU to a maximum of 1hr/day for a period of 3-weeks. This SMU reduction target was based on epidemiological data suggesting that using over one hour of social media per day or more was associated with greater emotional distress (Twenge & Campbell, 2019). The social media platforms targeted in this study included Facebook, Instagram, TikTok, Snapchat, Pinterest, and Tumblr. Messaging apps (e.g., Facebook Messenger, WhatsApp, Slack, and texts) were not targeted for reduction as research has shown these to be separate domains of social media (Kuss & Griffiths, 2017). Participants in the intervention group used the screen time reports feature that is integrated on their smartphones to generate daily screen time reports that objectively provide the time spent on each social media platform per day. Moreover, reminder emails were also sent to the intervention group participants if they exceeded the 1-hour limit in an attempt to promote better adherence. The intervention also included evidence-based behavioural change principles for modifying lifestyle behaviours. Specific, Measurable, Achievable, Relevant, and Time-Bound (SMART) goal attainment strategies were implemented and reinforced through prompting for change, and positive reinforcement. For example, self-monitoring of SMU was used to create awareness about the SMU behaviour which is the first step to behavioural change. Goal setting was also used to make the SMU reduction target specific and measurable (1hr of SMU daily for a period of 3-weeks). Additionally, feedback on goal attainment via daily emails from the research staff was used to promote adherence and

motivation to stay on track. Finally, positive reinforcement for the SMU reduction goal attainment was used to reward adherence to SMU limits and motivate future compliance.

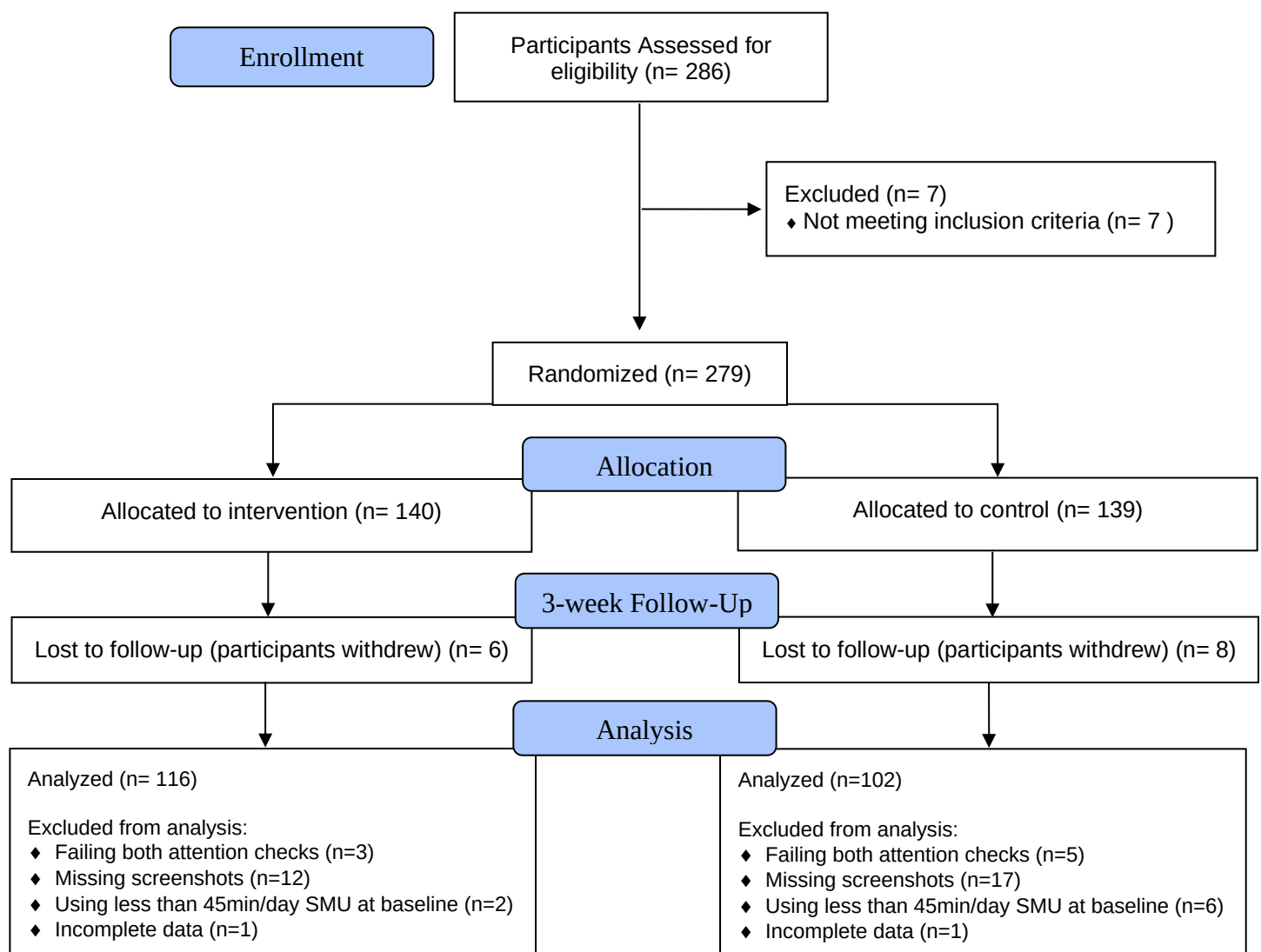
Participants in the control group had to monitor their daily SMU by sending daily screenshots of the amount of time spent in SMU using the same objective screen time report technology, but their SMU was not limited. Participants in the control group were instructed to continue to use social media as they normally do. Requiring participants in the control group to submit screenshots made them an “active control”, meaning that they engage in some task during the intervention period, which allows for controlling the effects of self-monitoring which are known to influence MH outcomes (McLoughlin et al, 2019). Moreover, participants in each group monitored their SMU for 7 days at baseline (week 1), then the intervention/control took place in weeks 2-4. This study received approval by the Office of Research Ethics from Carleton University (#111107) and the Children’s Hospital of Eastern Ontario (20190589) and all participants provided informed consent prior to enrollment.

2.2 Sampling Strategy:

Our population of interest were TAY aged 17-25 who are experiencing elevated levels of mental distress and thus represent a vulnerable cohort. Our non-probability sampling strategy to approach the targeted population involved recruiting a convenience sample of 218 participants aged 17-25 years old (see power analysis). Participants were enrolled in undergraduate programs at Carleton University taking the university’s first or second-year Psychology courses (PSYC 1001, 1002, 2001, and 2002). The data collection period was from January 15th 2021 to October 30th 2021 where (n=62) were recruited in the winter semester, (n=26) in the summer semester, and (n=198)

in the fall semester. They were recruited for this study via SONA (Carleton University's Psychology Experiment Sign-up System). Promotion material included a poster titled "Limiting Social Media Screen-time on Personal Devices" that was shared via SONA providing students with the study description, eligibility, duration, and compensation. Interested participants registered for the study and were contacted by a research assistant through Zoom to verify that they meet the inclusion criteria as well as to provide them with a general description of the study, obtained their informed consent, and answered their questions. Figure 1 demonstrates the flow of participants in alignment with the Consolidated Standards of Reporting Trial (CONSORT) guidelines.

Figure 1. Consort Flow Chart of participants enrollment, randomization, allocations and analysis throughout the study timeline.



2.3 Inclusion and Exclusion Criteria:

Participants who fell in the age range of 17-25 years old who were enrolled in Carleton University's first or second-year Psychology courses (PSYC 1001/1002/2001/2002) and who self-reported elevated symptoms of depression and anxiety were considered. Screening for mental distress was assessed through 4 items, including two items related to depression from the Center for Epidemiological Studies Depression Scale (CESD-10) and two items related to anxiety from the Generalized Anxiety Disorder-2 (GAD-2) scale. The items have yes/no answer options with a score of 1 for "yes" and 0 for "no". Participants must have scored greater than the cutoff of 2. Additionally, participants needed to own a smartphone or tablet running on iOS 12 or more recent or an Android running on 9 Pie or more recent and use social media for at least 2 hours/day. The only other exclusion criterion was not understanding written or spoken English.

2.4 Study Procedure:

2.4.1 Recruitment & initial Screening:

This study was conducted in compliance to CONSORT guidelines for non-pharmacological trials (Boutron et al., 2017) and was assessed for usability/feasibility of the technology through a short pilot study (n=38) (Thai et al, 2021). Data collection included three semesters starting in the Winter 2021 semester and finished in the Fall 2021 semester. Contact information of newly assessed participants who meet the eligibility criteria was sent to our inventory on the platform Qualtrix. Interested participants were invited to a virtual Zoom call to undergo screening to confirm meeting the inclusion criteria and the minimum score for mental distress, to inform them of the study objectives, and to obtain their verbal consent.

2.4.2 Baseline: week 1

After providing informed consent via zoom, participants were instructed on how to take screenshots from their smartphone and send it to the secured study inbox at 9am of the following day to capture SMU for the whole day. They received daily reminders in the morning to send their daily screen time report. Participants were informed about the 0.5% credit/week compensation upon completing the study (a total of 2% course credits) and that they have a 50% chance of getting assigned to either group. Participants were then invited to complete the baseline questionnaires online using Qualtrix (25 min).

2.4.3 Randomization:

Immediately following the 1-week baseline, participants in both groups were randomized into either the intervention or the control group using a computer-generated randomization scheme through the random number generator function in Excel. No stratification on gender was used.

2.4.4 Intervention Phase: week 2-4

Weeks 2-4 consisted of the intervention period during which the participants randomized into the intervention group had their SMU reduced to 1hr/day, while control participants were instructed to use social media as usual throughout the study. Participants in the intervention and control group monitored their daily SMU and sent daily screenshots. Finally, participants in both groups completed their second (post-intervention) repeated measures online test day at the end of week 4.

2.5 Measurements

2.5.1 Demographic Characteristics:

Participants' information on age, gender identity (male/female/other), student number, and email address were used to link their data and were collected through questionnaires provided by our lab. Additionally, two simple attention check questions were added to some of the MH outcome questionnaires in order to flag inattentive participants based on their answers (e.g. respond with 'Very True') on a 5-item Likert scale ranging from 'Not at All' to 'Very True'. If participants responded incorrectly to both attention checks, their data was discarded to ensure better validity.

2.5.2 Social Media Use:

SMU on smartphones was measured using the integrated screen time technology embedded in iPhones and Android phones. Baseline SMU use was calculated using the average daily SMU of day 1-7 and intervention SMU was measured using the average use of day 8-28. The compliance requirement for valid data for screenshots had a minimum cutoff of 5 out of 7 days at baseline and 17 out of 21 days for the intervention period. Participants were also asked at both baseline and post-intervention to estimate their SMU on other devices during the last week (i.e. In the past week, how much time did you spend using other devices (e.g., computers) for the following purposes: Social media, overall (Count time spent on things such as Facebook, Snapchat, Instagram, Musically, Tumblr, Twitter, WhatsApp, Pinterest, Myspace) using sliders ranging from 0-10hrs in 1hr increments.

2.5.3 Depression:

Depressive symptoms were assessed by the 10-item (Center for Epidemiological Studies Depression Scale (CESD-10), which is a screening measure of depression over the past seven days, validated in TAY (Radloff, 1977). There are 5 items within the scale including depressed mood (e.g. I felt depressed), feelings of guilt, worthlessness and helplessness (e.g. I felt lonely), psychomotor retardation (e.g. I had trouble keeping my mind on what I was doing), loss of appetite and sleep difficulties (e.g. My sleep was restless). In each item, the individual is asked to select the statement that best describes their feelings with a Likert rating scale of 0-3 with 0 indicating “Rarely or none of the time (less than 1 day)”, 1 “Some or a little of the time (1-2 days)”, 2 “Occasionally or a moderate amount of time (3-4 days)”, and 3 “All of the time (5-7days)” (Radloff, 1977). Scoring is reversed for items 5 and 8, which are positive effect statements. Total scores can range from 0-30 with higher scores suggesting more severe symptoms and a cutoff score of 10 or higher indicates the presence of clinical depression (Zhang et al, 2012). Psychometric evaluation of the CESD-10 in TAY shows strong internal consistency reliability ($\alpha = .91$), good construct validity and sensitivity (.88) (Haroz, Ybarra, & Eaton, 2014; Nishiyama et al, 2009). The CESD-10 was determined to have good responsiveness (ability to detect change over time) to both positive changes and negative changes in depressive symptoms for young adults (Chin et al, 2015). No minimal clinically important difference (MCID) for the CESD-10 has been established in the literature.

2.5.4 Anxiety:

Anxiety was assessed using the Generalized Anxiety Disorder-7 (GAD-7) which is a self-report assessment that assesses severity of anxiety symptoms (e.g., not being able to stop or control

worrying) and is validated in TAY (Spitzer et al, 2006; Tiirikainen et al, 2019). It includes 7-items that are rated with a 4-point Likert scale ranging from 0-not at all to 3-nearly every day that was added up to obtain a total score that can range from 0-21 points, with high scores indicating more severe anxiety. Scores above 8 are considered to be in the clinical range (Plummer et al., 2016) This scale has good psychometric properties with good internal consistency (Cronbach's $\alpha=0.91$) in TAY (Tiirikainen et al, 2019). A systematic review and meta-analysis of the cutoff point of 8 pooled a sensitivity and specificity of 8 of .83 and .84 respectively (Plummer et al., 2016). The MCID is estimated at 4 points on the GAD-7 total score based on a distressed adult population as the MCID for TAY has not been established yet (Toussaint et al, 2020). The General Anxiety Disorder-2 (GAD-2) was used to screen for the anxiety inclusion criterion and has a sensitivity of .86 and specificity of .83 for diagnosis of generalized anxiety disorder in TAY and adults (Kroenke et al, 2007).

2.5.5 Social Comparison:

Social comparison was measured using the Technology-Based Social Comparison and Feedback-Seeking subscale (SCFS), which is a subscale of the Motivations for Electronic Interaction Scale (MEIS) (Nesi & Prinstein, 2015). This subscale is used to evaluate attitudes and behaviours on social media platforms to get a sense of participants' electronic interaction. It consists of 10 items (e.g. "I use electronic interaction to compare my life with other people's lives and "I use electronic interaction to compare the way I look with other people's looks"). It includes a 5-point Likert scale to rate each item to personal relevance from 1= Not at all true to 5= Extremely true. The overall average score is used to indicate higher levels of technology-based social comparisons whereas

lower scores indicate the opposite. This scale has strong internal consistency among TAY ($\alpha = .92$; Nesi & Prinstein, 2015).

2.6 Power Analysis:

GLIMMPSE 3.0.0 software for longitudinal designs was used to determine the required sample size. This was based on a hypothesized condition x time interaction using a repeated measures analysis of Variance (ANOVA) where participants in the intervention groups were expected to show a 1/3 of a standard deviation decline in the main outcomes (depressive and anxiety symptoms) whereas no change was expected for those in the control group (Kreidler et al., 2013). Assuming a criterion for significance of $p = .05$, a sample size of 200 was required to provide sufficient power (.80) to detect intervention effects on the primary outcome (depression), as well as to assess secondary and exploratory objectives.

2.7 Statistical Analysis Plan:

2.7.1 Demographic & Descriptive Statistics:

Measures of primary study outcomes (depression) and secondary outcome (anxiety, social comparison) and exploratory outcome (high vs low baseline scores) were tested for normality using the Shapiro-Wilks test. Since ANOVAs are robust against small violations of normality, and our data had slight deviations of skewness and kurtosis in a relatively large sample size (Blanca Mena et al, 2017), data were not transformed for analyses. Moreover, patterns of results from the transformed data were the same as untransformed; thus, untransformed results were used to provide meaningful interpretation of effects. Descriptive statistics were used to characterize the sample at

baseline, where group differences were evaluated by independent t-tests for continuous data and Pearson's chi-square tests for categorical data. Group differences for compliance to submitting daily SMU data and daily SMU on other devices were assessed by independent t-tests.

2.7.2 Manipulation Check:

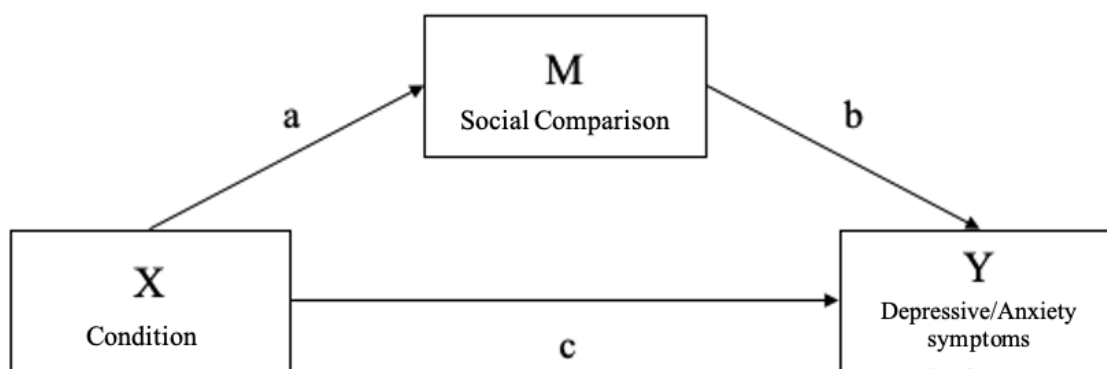
A 2x4 mixed ANOVA consisting of a between-subjects factor of condition (control vs intervention) and a repeated measures factor of time (week 1, 2, 3 and 4) was conducted to compare daily SMU among participants in each condition during the four-week study period. A 2 x 2 ANOVA was also used to assess group differences on changes in the amount of time spent in SMU on other devices.

2.7.3 Main Analyses:

To test whether the intervention had effects on the MH outcomes (depression and anxiety) over the study duration, two-way mixed ANOVAs were conducted separately for each outcome consisting of a between-subjects factor of condition (control vs experimental) and a repeated factor of time (baseline vs post-intervention). Significant condition x time interactions indicating group differences in changes over time in outcome variables were explored using simple effects. Effect sizes for each ANOVA were reported in partial eta-squared, with values ranging from 0.01-0.05, 0.06-0.13, and 0.14 or higher representing small, medium, and large effects, respectively. Two-sided alpha levels $\leq .05$ was considered statistically significant for all analyses and data were analyzed using SPSS version 24.

2.7.4 Mediation Analysis:

To date, there is no software capable of running mediation analyses for prospective experimental studies. A proper software for those studies should allow for assessment of the pre- and post-intervention changes in the mediator (i.e. social comparison) and dependent variable (i.e. depression) in consideration of the change in the independent variable (i.e. SMU). In the absence of such software, we used a stepwise logical pathway analysis to assess for mediation, as described by Montoya & Hayes (2017), where each step relies on the previous step meeting a statistical significance threshold. In the event of one step being proven not significant, the model would be invalid and there would be no point in further proceeding in the model. The goal of this mediation analysis is to estimate the pathways of influence from the causal variable (X) on outcome variable (Y) in addition to the pathway that operates through a mediator M. The sequence of causal steps consists of the direct pathway c in which X affects Y, and the indirect pathway a and b, in which X affects the mediator M, which in turn causally influences Y. The diagram below provides a visual representation of the overall mediation relationship.



The first step in this model was to analyse whether condition (SMU reduction in intervention vs control) led to a reduction in the dependent variable (depression) using ANOVA (described

above), which represents pathway c. The second step consisted of analysing whether condition led to a reduction in social comparison using ANOVA (described above), which represents pathway a. The final step was to investigate whether change in social comparison affected the dependent variables (depression/anxiety), which represents pathway b.

2.7.5 Exploratory Analysis:

To assess the exploratory objective and assist with interpretation of the intervention effect, we split the sample into high and low baseline scores of depression and anxiety symptoms. The clinical cutoff for participants with high scores on baseline depression was based on the empirically validated score of 10 points or higher on the CESD-10 and 8 points or higher for anxiety as measured by the GAD-7. Anyone who scored lower than those values was considered to be below the clinical range and conceptualized as “low” in distress. Three-way mixed ANOVAs were conducted separately for each outcome and consisted of two between-subject factors (condition and high/low baseline distress score) and a repeated measure of time (baseline vs post-intervention). A significant 3-ways interaction would indicate that baseline distress moderated the effects of the SMU intervention on anxiety and depressive symptoms.

Chapter Three: Results

3.1 Demographic and Descriptive Characteristics:

As illustrated in Table 1, the sample population was 77% female and most of the sample (77.3%) fell into the 17-19 years-old category, with (17.4%) in the 20-22 years-old category and the rest (5.3%) in the 23-25 years-old category. Seventy percent scored above the CESD-10 clinical depression threshold of 10 and 58% of participants scored above the GAD-7 clinical threshold of 8 at baseline.

A condition by gender chi-square test indicated that the groups did not differ by gender, $\chi^2(1) = 2.48, p = .290$. The condition by age group chi-squared test was also not significant, $\chi^2(2) = 1.63, p = .441$, indicating groups did not differ by age.

During the baseline period, 94.5% provided screenshots on all 7 days and 93.2% provided screenshots on at least 20 of the 21 days following randomization. The intervention and control groups did not differ significantly in the number of daily screenshots submitted during the baseline period (week 1), $t(218) = .72, p = .474$, or during the 3-week intervention period, $t(218) = .21, p = .834$. Additionally, groups did not differ in average daily SMU during the baseline period, $t(218) = 1.36, p = .177$. Table 1 shows the baseline characteristics of the study population on demographic values, mental health indicators and time spent on social media by group.

Table 1. *Baseline characteristics of study population on demographic values, mental health indicators and time on social media/*

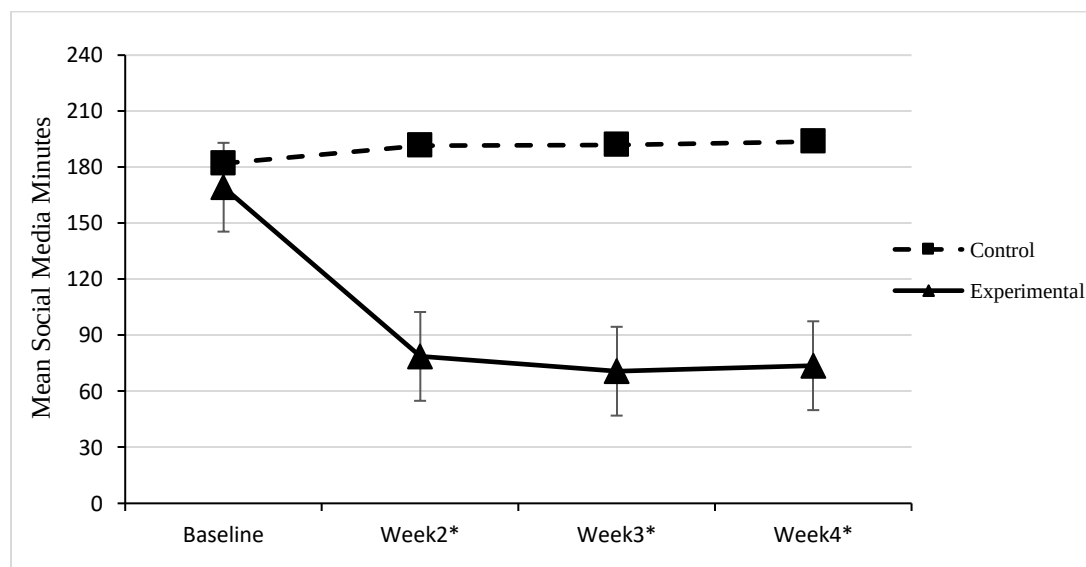
Variable	Condition			Differences between groups <i>p</i>
	Grouped N= 218	Intervention N= 116	Control N= 102	
Gender (Male/Female)	49M/167F/2 O	25M/91F	24M/76F/2 O	0.998
Age				0.701
17-19 years old (n)	160	84	76	
20-22 years old (n)	36	21	15	
23-25 years old (n)	11	4	7	
Baseline Variables	<i>M (SD)</i>	<i>M (SD)</i>	<i>M (SD)</i>	
Depression	14.32 (5.66)	13.98 (5.52)	14.52(5.82)	0.483
Anxiety	9.87 (6.17)	9.43 (6.41)	10.37 (5.87)	0.262
Social comparison	2.19 (0.84)	2.25 (0.84)	2.13 (0.84)	0.293
Monitoring SMU Compliance on smartphone (screenshots)				
Baseline screenshots (day 1-7)	6.95 (0.21)	6.94 (0.22)	6.96 (0.2)	0.474
Intervention screenshots (day 8-28)	20.77 (0.69)	20.78 (0.78)	20.76 (0.6)	0.834
SMU Compliance on smartphone (min/day)				
Baseline Week 1	174.21 (76.8)	167.4 (74.64)	181.84 (78.83)	0.177
Week 2	129.15 (91.62)	79.82 (45.6)	186.79 (98.21)	0.001*
Week 3	129.28 (89.91)	75.97 (53.78)	189.67 (84.38)	0.001*
Week 4	131.03 (96.19)	76.01 (57.48)	188.84 (94.94)	0.001*

Notes. * indicates statistical significance ($p < .05$); Missing age data of 11 participants.

3.2 Manipulation Check:

There was a significant condition by time interaction ($F(3, 543) = 72.61, p < .001, \eta_p^2 = .286$) illustrating the expected differences between the experimental and control conditions in SMU on smartphones. The intervention group reported significantly less time in mean SMU (min/day) than controls at week two, $t(204) = 10.26, p < .001$, week three, $t(207) = 11.75, p < .001$, and week four, $t(199) = 10.25, p < .001$. Over the 3-weeks intervention period, the intervention participants averaged 77.26 min/day (52.28) whereas the control participants averaged 188.43 min/day (92.51). Figure 2 shows the interaction between groups across the 4-week study period, where the intervention group significantly decreased SMU and the control group slightly increased in SMU over time. On average, those in the intervention condition approximated the limit of 1hr/day at weeks two $M = 79.82$ (45.6), three $M = 75.97$ (53.78), and four $M = 76.01$ (57.48) — reducing their overall SMU by approximately 50% from baseline. Table 1 summarizes compliance to SMU screenshot submissions data and compliance to the SMU restriction.

Figure 2. *Total daily social media use over time by condition*



Note: Error bars represent standard errors. * indicates statistical significance ($p \leq .05$)

Many participants did not provide self-report data on SMU on other devices. Though, the average for those who did ($n=159$) was approximately 50 min/day at both baseline and during the intervention and the groups did not differ at baseline. However, ANOVA revealed a significant condition x time interaction on daily SMU time on other devices ($F(1, 216) = 5.63, p < .05$, partial $\eta_p^2 = .025$) such that those in the intervention group reported reduced SMU on other devices 37 min/day during the intervention, whereas the control group increased to 66min/day.

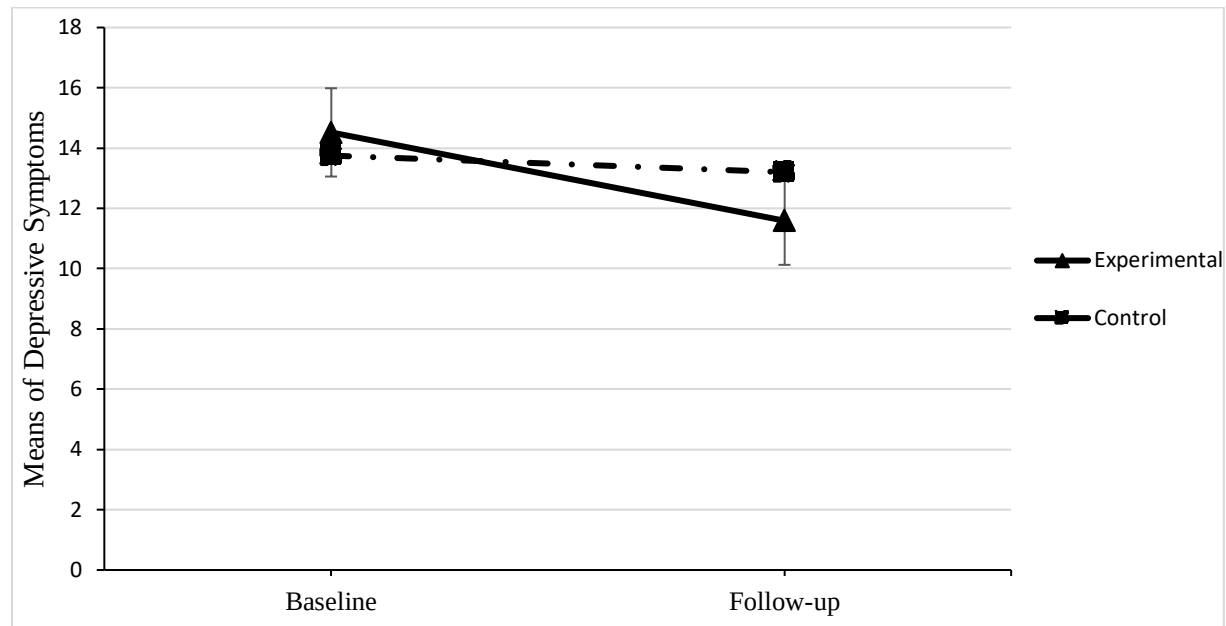
3.3 Main Analyses:

3.3.1 Depressive Symptoms:

There was a statistically significant interaction of conditions and time on depressive symptoms ($F(1, 216) = 5.59, p < .05$, partial $\eta_p^2 = .025$). Simple effects indicated that depressive symptoms were significantly lower at post-intervention than baseline for the intervention group (Mean change = -2.39 points, 95% CI = 1.44, 3.36), whereas they were not statistically significantly different for the control group (Mean change = -.79 points, 95% CI = -.15, 1.72).

There was no statistically significant main effect of condition on depressive symptoms at post-intervention ($F(1, 216) = 3.56, p > .05$, partial $\eta_p^2 = .016$). There was a statistically significant main effect of time on depressive symptoms whereby scores dropped significantly when collapsed across groups ($F(1, 216) = 21.82, p < .001$, partial $\eta_p^2 = .092$).

Figure 3 illustrates the changes in depressive symptoms of both groups at baseline and post-intervention.

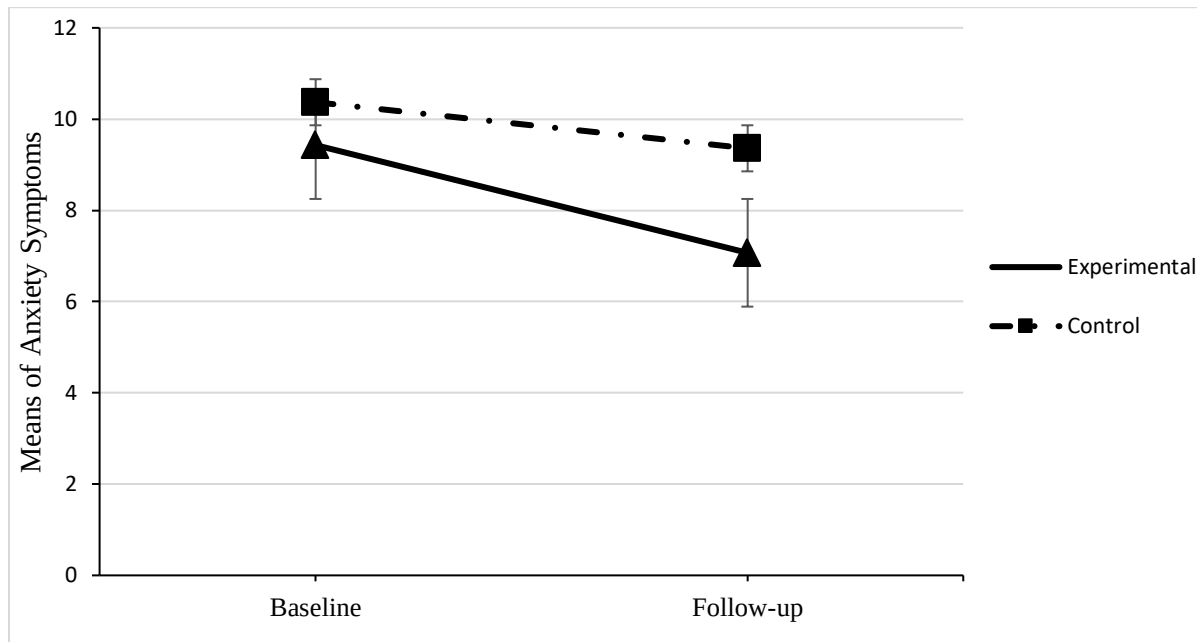
Figure 3. *Change in depressive symptoms for intervention and control groups over study duration*

Note: Error bars represent standard errors.

3.3.2 Anxiety Symptoms:

There was a statistically significant interaction of conditions and time on anxiety symptoms ($F(1, 216) = 5.99, p < .05$, partial $\eta_p^2 = .027$). Simple main effects indicated that anxiety symptoms were significantly lower at post-intervention than from baseline for the intervention group (Mean change = -2.36 points, 95% CI = 1.54, 3.19), whereas scores did not change significantly for the control group (Mean change = -1.01 points, 95% CI = .32, 1.7). There was a statistically significant main effect of condition on anxiety symptoms at post-intervention ($F(1, 216) = 4.33, p < .05$, partial $\eta_p^2 = .02$). There was a statistically significant main effect of time on anxiety symptoms indicating anxiety symptoms dropped over time when collapsed across groups ($F(1, 216) = 37.17, p < .001$, partial $\eta_p^2 = .147$).

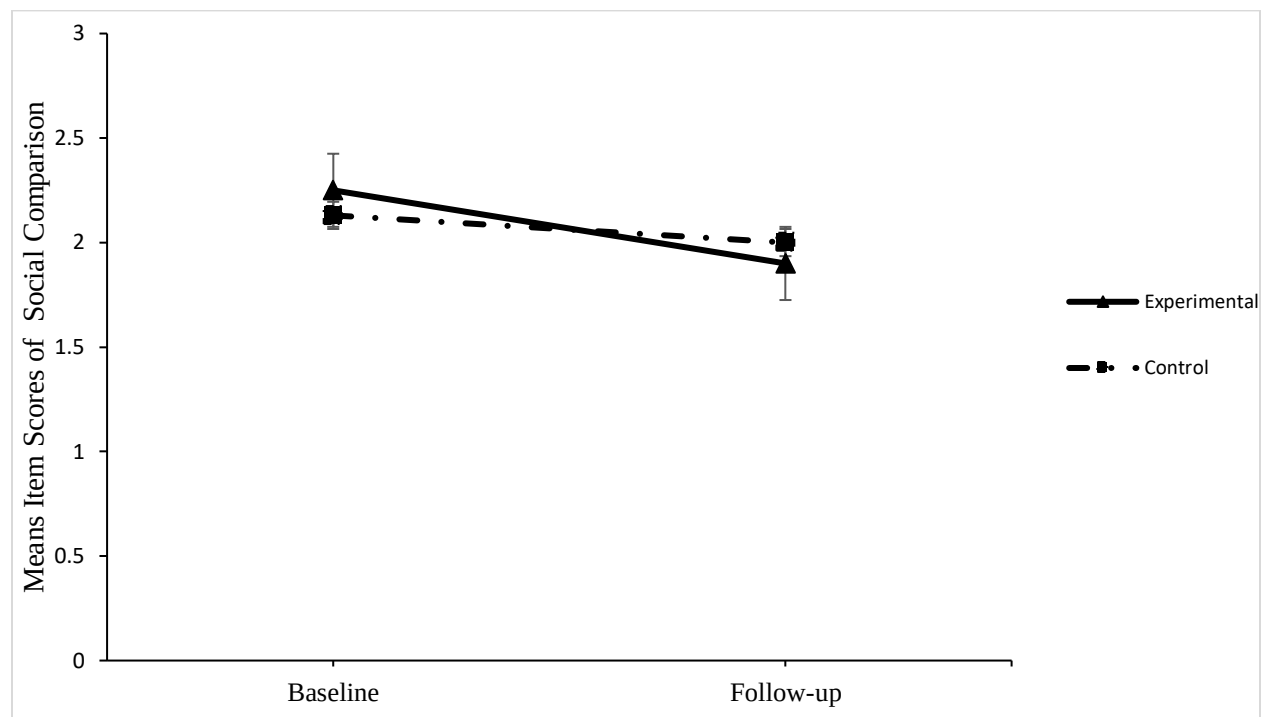
Figure 4 illustrates the changes in anxiety symptoms of both groups at baseline and post-intervention.

Figure 4. *Change in anxiety symptoms for intervention and control groups over study duration*

Note: Error bars represent standard errors.

3.3.3 Social Comparison:

There was no statistically significant interaction of conditions by time on social comparison ($F(1, 216) = .29, p = .593$, partial $\eta_p^2 = .001$). The main effect of condition ($F(1, 216) = 1.77, p = .184$, partial $\eta_p^2 = .008$) was not statistically significant. There was a statistically significant main effect of time on social comparison ($F(1, 216) = 28.45, p < .001$, partial $\eta_p^2 = .116$) in which social comparison scores dropped when collapsed across groups. Figure 5 illustrates the changes in social comparison of both groups at baseline and post-intervention.

Figure 5. *Change in social comparison for intervention and control groups over study duration*

Note: Error bars represent standard errors.

Table 2 provides a summary of the ANOVA results of both primary (depressive symptoms) and secondary (anxiety symptoms and social comparison) outcomes.

Table 2. *Comparison of intervention and control groups within and between subjects for mental health indicators and social media use.*

Variable	Condition	Mean ± SD		Mean Differences [95% CI]		<i>p</i>	Partial Eta Squared	F Statistics
		Baseline	Final	Within Group Change from Baseline to Final	Between Group Change at Final (Intervention - Control)			
Depression	Intervention	13.98 (5.52)	11.59(5.82)	-2.39 [1.44, 3.36]		.001*	.175	24.42
	Control	14.52(5.82)	13.73 (6.14)	-0.79 [-.15, 1.73]		.099	.027	2.77
	Intervention vs. Control				1.6 [.267, 2.95]	.019*	.025	5.59
Anxiety	Intervention	9.43 (6.41)	7.07 (5.7)	-2.36 [1.54, 3.19]		.001*	.218	32.03
	Control	10.37 (5.87)	9.36 (6.3)	-1.01 [0.32, 1.7]		.262	.076	8.32
	Intervention vs. Control				-1.35 [.264, 2.44]	.015*	.027	5.99
Social comparison	Intervention	2.13 (0.84)	1.92 (0.79)	-.22 [.12, .32]		.001*	.131	17.35
	Control	2.25 (0.84)	2.08 (0.81)	-.18 [.75, .28]		.001*	.103	11.61
	Intervention vs. Control				-.04 [-.107, .186]	.593	.001	.29

Note: * indicates statistical significance ($p \leq 0.05$); Social comparison means indicate mean item scores.

3.4 Mediation Analysis:

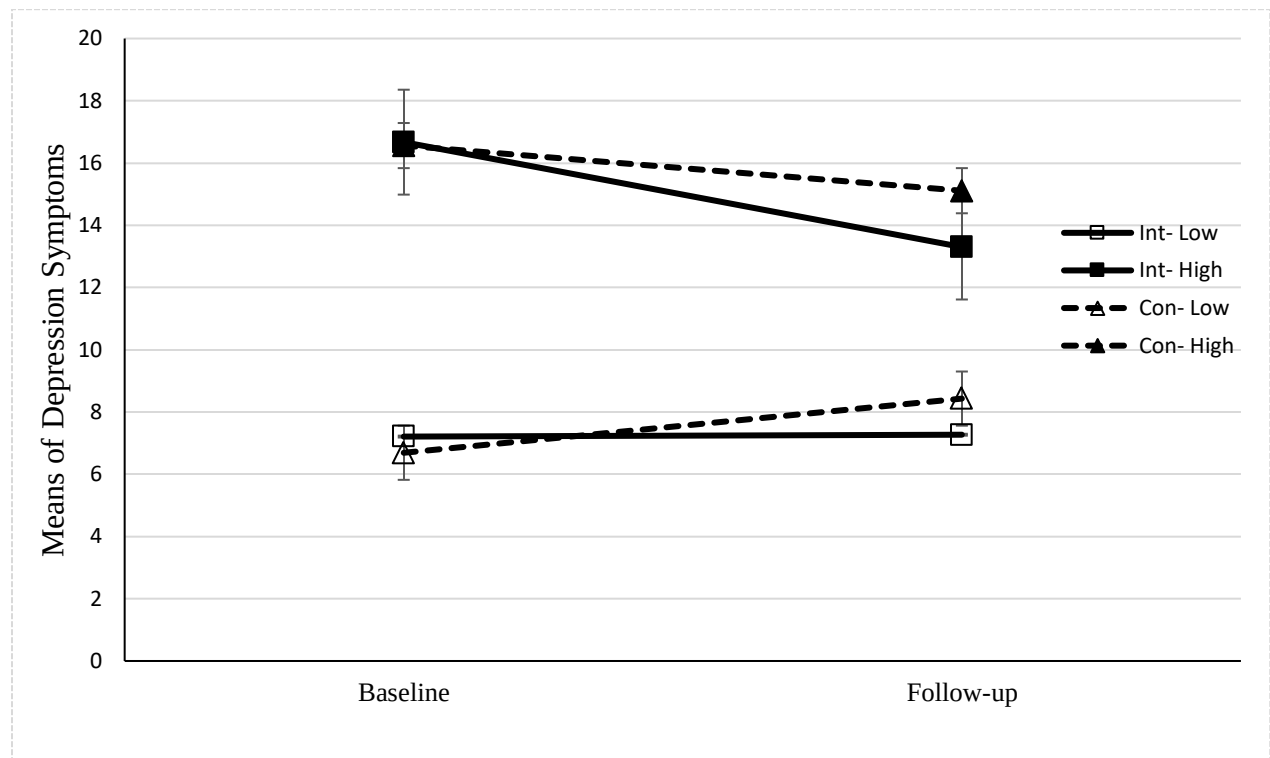
As indicated in Table 2, ANOVA results of the effects of condition (SMU reduction) on social comparison, which represents step two of the mediation model, were not significant as indicated by the condition x time interaction ($F(1, 216) = .29, p = .593$, partial $\eta_p^2 = .001$). Therefore, social comparison cannot be a mediator in the relationship between SMU and the MH outcomes.

3.5 Exploratory Objectives

There was a non-significant three-way interaction of condition x baseline depression x time ($F(1, 215) = .604, p = .438$, partial $\eta_p^2 = .003$). There was a non-significant main effect of condition in high and low baseline depressive symptoms at post-intervention ($F(1, 215) = 2.23, p = .137$, partial $\eta_p^2 = .01$). There was a statistically significant main effect of time ($F(1, 215) = 5.35, p = .022$, partial $\eta_p^2 = .024$) indicating reduced scores when groups were collapsed.

Nevertheless, the intervention group participants with baseline scores that exceeded the clinical threshold showed a trend toward greater changes (Mean change = -3.74 points, 95% CI = -4.04, 5.2) in comparison to those in the control group with high baseline scores who showed a marginal and non-significant change (Mean change = -1.68 points, 95% CI = -2.89, 3.02). On the other hand, participants in the intervention group with low baseline depression score showed virtually no change (Mean change = .6 points, 95% CI = -.28, 2.27), whereas those in the control group with low baseline depression score showed a non-significant increase (Mean change = 1.55 points, 95% CI = -1.1, 2.62). Figure 6 illustrates the changes in depressive symptoms for individuals with low and high baseline scores across study period for both groups.

Figure 6. *Changes in depressive symptoms by condition with high and low baseline CESD-10 score.*



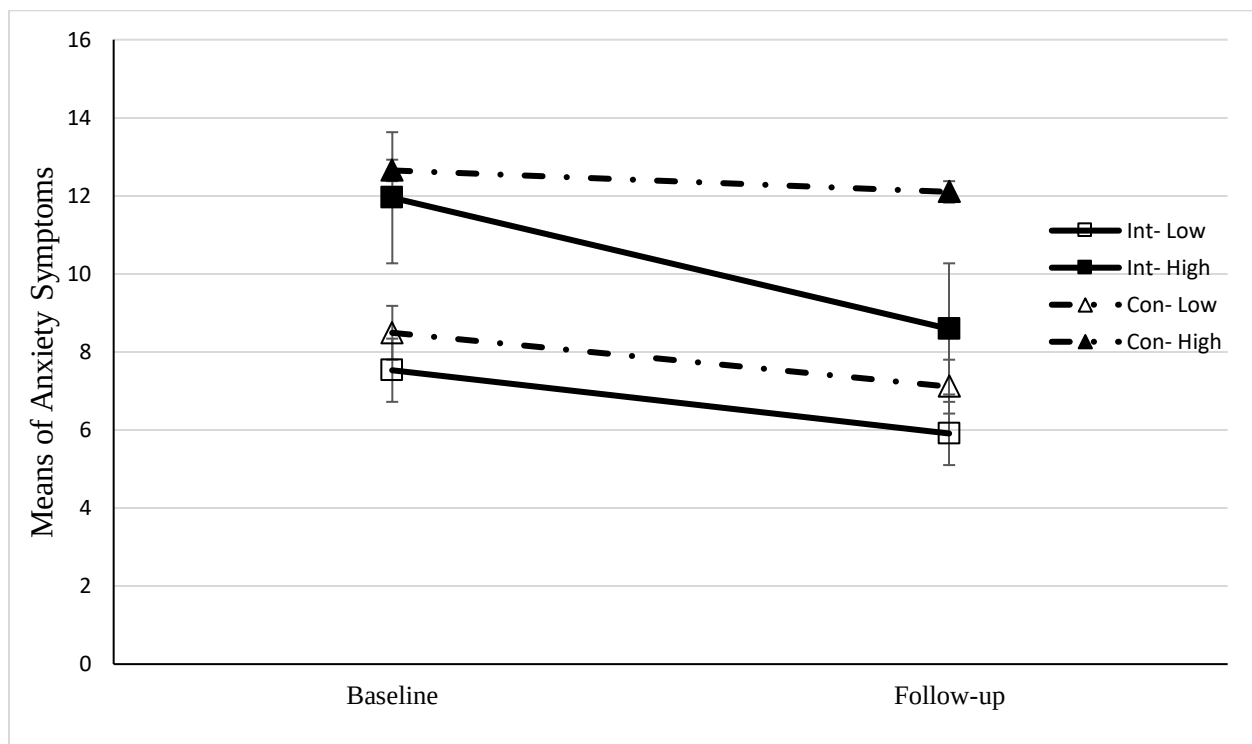
Note: Error bars represent standard errors.

Furthermore, there was a significant three-way interaction of condition x baseline anxiety x time ($F(1, 214) = 7.01, p = .008, \text{partial } \eta_p^2 = .032$), a non-significant main effect of condition ($F(1, 214) = 2.92, p = .089, \text{partial } \eta_p^2 = .013$), and a significant main effect of time ($F(1, 214) = 33.43, p < .001, \eta_p^2 = .135$).

Simple main effects indicated that anxiety symptoms for the intervention participants with high baseline score were significantly lower at post-intervention and exceeded the MCID (Mean change = -4.23 points, 95% CI = -1.54, 3.19) in comparison with participants in the control group with high baseline scores who showed a marginal change (Mean change = -1.5 points, 95% CI = -.99, 2.02). On the other hand, the intervention group with low baseline scores showed only a slight

decrease (Mean change= -.14 points, 95% CI = .12, 1.7) similar to those in the control group with low baseline scores (Mean change= -.18 points, 95% CI = -.04, 1.01). Figure 7 illustrates the changes in anxiety symptoms for individuals with low and high baseline scores across study period for both groups.

Figure 7. *Changes in anxiety symptoms by condition with high and low baseline GAD-7 scores.*



Note: Error bars represent standard errors.

Chapter Four: Discussion

4.1 Summary of Results:

Billions of people use social media around the globe, but there are conflicting conclusions in the scientific community on whether excessive SMU has a positive or negative impact on MH. Some studies showed that excessive SMU is associated with positive and negative psychological outcomes (Sampasa-Kanyinga & Lewis, 2015; Vannucci et al., 2017), and other studies concluded that it accounts for a small amount of variance in MH (Orben & Przybylski, 2019). Results of this study supported the hypotheses that reducing SMU to 1hr/day for 3-weeks for distressed TAY led to significant reductions in depressive and anxiety symptoms. However, reducing SMU did not have a significant impact on social comparison as both groups showed comparable reductions, indicating that social comparison was not the mechanism by which SMU reduction led to decreased emotional distress. Relative to the control group, effects of the SMU reduction were stronger in those with higher baseline anxiety symptoms in comparison to those with lower baseline scores, but no significant intervention effects were observed for participants with higher depressive symptoms compared to those with lower baseline scores.

4.2 SMU Reduction and Depression:

The primary hypothesis of the present study was supported in that the SMU reduction led to a significant reduction in depressive symptoms for the intervention group compared to controls, with a small effect size of $\eta_p^2=.025$. Furthermore, the significant reduction in depressive symptoms from our overall sample aligns with the findings of Hunt et al (2018) who found that reducing SMU to 30 minutes/day for 3 weeks led to significant reductions in depression in a healthy sample of TAY. However, Thai et al found that reducing SMU to 1hr/day for the same duration did not yield significant reduction in depressive symptoms on a distressed sample of TAY. Though, it is

important to recognize that in the Thai et al study, their analyses were underpowered due to the small sample size ($n=47$), which may explain their null association. Although very few experimental trials, quasi-experimental studies can be informative. For example, results from a seven-day quasi-experiment Facebook abstinence study on a population of $n=555$ TAY showed a significant but small reduction in perceived stress for the abstinence group compared to the group who did not abstain. More precisely, the reduction effects were stonger in heavier social media users (Turel et al, 2018). Quasi-experimental studies that investigated depressive symptoms as a MH outcome, are consistent with experimental studies showed the same trend of reduction in symptoms of anxiety, emotional distress and improved wellbeing and life satisfaction (Appel 2015; Przybylski et al, 2021; Vogel et al, 2015; Brown & Kuss, 2020; Tromholt, 2016). Our findings, along with these other findings build on recent meta-analysis indicating positive associations between time spent in SMU and depressive symptoms (Orben, 2020), and are among the first to show a causal link between SMU and depression in TAY.

As an exploratory objective, we examined whether baseline scores on depression moderated the effects of the SMU reduction intervention, with the hypothesis that those with higher baseline scores would report greater reductions in depressive symptoms relative to controls than those with lower scores. Our results did not confirm this exploratory hypothesis as the three-way interaction (high/low baseline score $\times$ group $\times$ time) was not significant. However, the pattern of scores reflects changes in the hypothesized direction where the changes in groups (intervention vs control) with elevated baseline depression showed a greater reduction in depressive symptoms compared to those with low baseline scores. More accurately, participants who scored above the clinical cutoff, showed a trend toward greater symptom reduction from limiting SMU (Mean

change= -3.74 points) relative to controls (Mean change= -1.68 points), whereas those in the intervention who scored low in depression only showed 0.6 mean point change. In addition, 24 participants out of 83 in the intervention group who were above the clinical cutoff for depression at baseline moved to below the cutoff at post-intervention, whereas the proportion of controls showed no change in severity of symptoms. This follows a similar pattern as the Hunt's study where those who scored higher in depression at baseline in the intervention group showed a greater statistically and clinically meaningful difference with an appreciable mean change of 8.5 points reduction in depressive symptoms in comparison to high scorers in control group participants. For context, intervention participants in the Hunt study moved from the moderate clinical range to the mild range of depressive symptoms, whereas controls with high baseline scores on depression showed no change in severity of symptoms.

Although our study showed statistically significant reductions in depressive symptoms with small effect size, Hunt's study participants with high baseline depression demonstrated bigger and perhaps more clinically meaningful changes than ours. However, the depression questionnaire in the present study does not have a minimal clinically important difference score, making the clinical significance more difficult to evaluate than Hunt et al. who used the Beck depression Inventory, which has well-established MCID scores. The Hunt et al study suggests that reducing SMU is most likely to provide disproportionately greater psychological benefits to those with pre-existing depressive symptoms compared to participants with fewer symptoms.

A possible explanation for the null findings observed in the present study's s three-way interaction could be that the score in the lower baseline depression intervention group in our study was higher than in the Hunt et al study since our sample was screened for distress at baseline, whereas Hunt et al sampled from a healthy population. Furthermore, Hunt et al used a median split to stratify

their sample into high and low baseline depression scores and we used a clinical threshold to split our sample. Indeed, median splits facilitate interpretation of the variables and presentation of results because it is easier to identify and present results on relative differences between limited groups than differences along a spectrum (DeCoster et al, 2011). However, this method has been highly criticized because it provides less precise distinction between members of the same group and within different groups; there is other methodological literature indicating that the benefits of median splits do not overcome the costs in terms of statistical power and accuracy of the estimated relations (Cohen, 1983; DeCoster et al, 2011; MacCallum et al 2002). These sample characteristics and stratification methods could prevent a significant intervention effect of SMU reduction given the cutoff points between different scoring participants are not sufficiently different between moderate and severe depression.

Another potential reason that could explain, in part, the discrepant findings between the present study's and those by Hunt et al. 2018 is the use of different measures of SMU restriction targets. This could suggest that a more restricted SMU (total of 30min/day) could be more effective in achieving an improvement in depressive symptoms in those who are depressed. Regardless of the SMU restriction, both studies indicate that this type of intervention may be clinically feasible due to the strong adherence to the SMU restriction demonstrated, and the documented intervention effects on depressive symptoms in healthy and distressed populations of TAY.

4.3 SMU Reduction and Anxiety:

As hypothesized, the reduction in SMU led to a significant reduction in anxiety relative to controls, with a small effect size. Interestingly, our results also support the exploratory hypothesis that the reduction in anxiety from SMU reduction relative to controls was greater for participants with elevated baseline anxiety (58% of participants) compared to the participants with lower baseline

anxiety. Importantly, those with high anxiety at baseline showed a 4.23 point reduction in anxiety symptoms from SMU reduction, which exceeds the minimally clinically important difference threshold (4 points), compared to those with lower baseline scores in the intervention who only showed 1.5 point reduction. The improvements in symptoms of anxiety found in our study are consistent with an experimental study (Thai et al, 2021) that detected significant decreases in anxiety symptoms from SMU reduction to 1 hour/day for 3 weeks with a medium effect size among TAY with emotional distress. However, results of the present study are not consistent with another experimental study (Hunt et al, 2018), where there was no group difference in anxiety from reducing SMU to 30 min/day for 3 weeks, but a slight decline in both groups. Both experimental studies had the same intervention period (3-weeks), and they targeted the same population (i.e. undergraduate students), except that the Thai et al study targeted participants with elevated distress at baseline while the Hunt et al study did not screen for baseline levels of distress. The null finding observed in Hunt et al (2018) could be partially explained by the floor effects suggesting that the initially low baseline scores for healthy individuals on the measurement scale do not allow for much room for change in follow-up. Differences in results across studies could also be due, in part, to differences in anxiety measures. For example, the present study used the GAD-7 to assess generalized anxiety, which may be more sensitive in detecting change compared to the State-Trait Anxiety Inventory used in the Hunt et al. 2018 study. Our findings indicate that a population with high distress appears to benefit more than those lower in distress, perhaps because they may be more vulnerable to the psychological harms of excessive SMU compared to a healthy population. On the same lines, a systematic review highlighted that a major risk related to excessive SMU is the impacts it has on existing MH symptoms, affecting more with high distress including increased severity of anxiety and depressive symptoms (Naslund et al, 2020). Although few experimental

studies have examined the effects of SMU reduction on anxiety, non-experimental studies can be informative. For example, quasi-experimental studies found improvements in perceived anxiety, emotional distress social connection and wellbeing resulting from a 7-day abstinence from Facebook, with effects being stronger in those who were heavy social media users, passive users, and those who tended to envy others on Facebook (Brown & Kuss, 2020; Tromholt, 2016). Cross-sectional studies have found an association between higher daily SMU and elevated dispositional anxiety and lower psychological functioning (Sampasa-Kanyinga & Lewis, 2015; Vannucci et al., 2017).

Additionally, research found a clear association between SMU and MH for individuals living with more severe mental illnesses that may not be present in the general population (Berry et al, 2018; Naslund et al, 2020; Orben & Przybylski, 2019). In this context, it seems that those with emotional distress may be more vulnerable to the “dark” side of SMU such as the over-representation of positive experiences and edited photos, number of followers/friends and displays of likes of posts as a reflection of online popularity, exposure to hostile content, cyberbullying, and of course social comparison.

Given that SMU has triggered this new range of negative consequences, virtual communities function differently compared to traditional communication bearing new norms of social interactions as perceived by TAY. A distinguished negative experience that emerges from those new social interaction norms through SMU is FoMO, which has been associated with a range of negative feelings and emotional control (Alutaybi et al, 2020). Anxiety is a significant part of the FoMo and can therefore explain the fact that reducing SMU may result in being less exposed to missed opportunities and being less continually connected with what others are doing, which may reduce anxiety and FoMO. This is because SMU could lead to greater FoMO as it provides greater

exposure to missed opportunities due to the vast social networks and endless content of others compared to in-person contacts.

Even though not measured in this study, FoMO has been linked to feeling of anxiety, emotional distress, and a range of other negative feelings with the aim of staying updating with social circles. This process can create an emotional dependence loop where distressed social media users depend on social media to fulfill the need to belong and form stable interpersonal relationships that is in itself driving FoMO and increasing the levels of anxiety. It has been shown that greater FoMO leads to higher SMU, creating a vicious cycle (Przybylski et al, 2013). Thus, reducing SMU can attenuate the social media attachment and emotional dependence cycle resulting in a reduction of anxiety symptoms. Further experimental studies should explore if FoMO represents a mechanism regarding the effects of SMU reduction on anxiety and depressive symptoms.

Interestingly, participants in the present study had a comparably similar reduction in anxiety and depressive symptoms. This similarity in reduction is understandable given that these two mental health outcomes are highly correlated, and many people suffer symptoms from both disorders (Kalin, 2020; Goodwin, 2015). Our findings suggest that reduction of anxiety and depressive symptoms are common outcomes of reducing SMU for TAY with elevated levels of mental distress. Further investigation is required to determine the mechanisms explaining how SMU reduction can lead to reduced anxiety and depression.

4.4 Social Comparison as a Mechanism:

With heavy SMU and the extent to which people get exposed to a preponderance of online profiles and posts that over-represent positive experiences, it is expected that virtual social connections

would be more susceptible to more social comparison relative to non-virtual social connections that do not allow for the same frequency and flexibility. Social media has transformed the social landscape for TAY and has fostered idealized self-representations and forming distorted perceptions of their peers creating environments that are more likely to elicit negative social comparisons and a decrease in mood and wellbeing compared to offline environments (Brown & Kuss, 2020). Exposure to the toxic elements of social media (i.e. unrealistic perception of body image, photoshopped photos, high numbers of likes and friends as an indicator of popularity... etc) have been shown to amplify high levels of social comparison that could lead to more negative feelings including anxiety and depression among TAY (Vogel et al, 2014; Nesi & Prinstein, 2015). Social comparison in real life usually involves only limited numbers of individuals, whereas in the virtual world, it involves almost limitless number of individuals for comparison. Also, given TAY tend to have a large online social network, it is likely that many of those online connections are mere acquaintances offline. Thus, in forming impressions of individuals that they do not know well offline, this may lead to negative assumptions and higher engagement in social comparison which is generally unfavourable given the aforementioned nature of social media platforms (Nesi & Prinstein, 2015).

A fair amount of evidence is largely consistent with the notion that high SMU encourages more social comparisons (and inevitably more unfavourable social comparisons), which may in turn lead to depressed mood and/or worsened MH outcomes (Appel et al, 2015; Verduym et al, 2015; Appel et al, 2016). Moreover, distressed individuals with symptoms of depression tend to engage in more social comparisons in general including unfavourable social comparison (Butzer & Kuiper, 2006). This literature informed the hypothesis that reducing SMU may lead to reduced

social comparisons which in turn would lead to reductions in emotional distress. However, the present study found that SMU reduction had no significant impact on social comparison, and thus social comparison did not mediate the reduction in emotional distress elicited by SMU reduction. However, our null findings could be explained by the fact that it is difficult to measure when social comparison happens and distinguish the types of social comparison processes (i.e., favourable, unfavourable). Our intervention allowed participants to be less exposed to SMU-related content that triggers social comparison but it did not actively manipulate the behaviours of participants while interacting with social media (active vs passive, open chats vs closed, number and type of platforms used, etc). To be able to manipulate social comparison behavioural change, specific psychological methodologies need to be employed, such as the experimental study by Appel et al (2015), where participants were exposed to fake Facebook profiles designed to be unattractive and others attractive. However, this kind of behaviour change was done in a controlled lab environment and is not feasible in an intervention study such as ours. This is an opportunity for future research to further investigate the relationship between social comparison and SMU in a more nuanced manner and potentially including related variables like quality of online interactions (Davila et al, 2012) and quality of peer feedback (Valkenburg et al., 2017). Another potential explanation for the null findings could be the study design including the length of the intervention period, in which 3-weeks could have been too short to allow the intervention to have an effect on social comparison. In addition it is possible that the 1hr/day reduction target was not strict enough and still allowed sufficient excessive exposure to SMU to hinder meaningful the change in social comparison. Since social comparison is a form of social cognition, individuals differ in their cognitive processing and affective responsiveness to behavioural change vis-à-vis social comparisons. Therefore, perhaps a more psychologically-based intervention is needed in combination with SMU reduction, such as a

cognitive behavioural therapy elements could perhaps strengthen the effects of the SMU reduction intervention by reducing social comparisons. For example, cognitive restructuring and pleasant distractions are effective interventional techniques have been shown to improve wellbeing and support positive aspects of social situations (Bolier et al, 2013; Wilken, 2018). Therefore, these approaches, in the form of psychoeducation or training, might be suitable to change individuals' social comparison processes. A quasi-experimental study on TAY involving a 9-week training program based on a combination of different cognitive behavioural therapy elements indicated that training led to an increase in subjective wellbeing and positive affect, and a small effect in the general tendency to engage in social comparison.

Another potential explanation for the null finding is that social comparison, in the context of SMU, could have stronger negative effects on MH on younger individuals. Young adolescents are more susceptible to social comparisons as they experience a psychological state that is heightened during those years referred to as the imaginary audience (Elkind, 1967) where they believe that many people are listening and attentively watching them. This causes them to become more self-conscious and add the stress of needing to impress which make them prone to more social comparisons. Social media platforms are the ideal ground to enhance the feeling of being constantly judged that adolescents typically experience, therefore having a greater negative impact on their MH (Peters et al, 2021). Consistent with this notion, research has shown that the relationships between social media and mental health in young adolescents is stronger than older ones (Mougharbel & Goldfield, 2020).

Given the unique context of the pandemic in which this study took place, it could be possible that the lack of in-person interactions because of the restrictions (school closure, work places, gathering places... ect) may have led people to deviate from their typical patterns and amount of time spent on SMU to reduce the to compensate for the lack of real life social interactions. The lockdowns made many people constrained from their activities and perhaps indicated a shift towards more passive SMU and less sharing of personal life accomplishments, which could have made TAY shift towards less unfavourable comparisons, thus mitigating the potential to reduce social comparison that may not have been highly problematic to begin with (Yue et al, 2022).

Although no experimental studies to date have examined the effects of reduced SMU on social comparison in TAY, an interesting, albeit unexpected finding for the present study was a significant main effect of time on social comparison, whereby both groups had a similar and significant reduction in social comparison. Reduction in the control group was unexpected and it could be due to self-monitoring whereby monitoring SMU led participants in the control group to become more aware of how they used SMU and perhaps could have used their social media to actively create content and engage in building and maintaining their social network leading to more fulfillment and less social comparison (Vogel et al, 2014). This interpretation is consistent with the notion that active SMU is associated with less social comparison and therefore monitoring SMU could have led to more active SMU resulting in less social comparison in the control group (Vogel et al, 2014). This unexpected decrease in social comparison observed with the control group appeared to have mitigated the intervention effect, highlighting the importance of employing an experimental study design with an active self-monitoring control group. Although no experimental field trials have been conducted, other laboratory studies manipulated social

comparison on social media by showing attractive and successful profiles found that higher exposure to these fake profiles in TAY resulted in higher frequency of unfavourable social comparison leading to negative MH outcomes including anxiety, body dissatisfaction, and envy (Appel et al, 2015, Fardouly et al, 2015). Other quasi-experimental interventions demonstrated that participants engaging in more SMU had higher experiences of more unfavourable social comparison and these were associated with negative MH outcomes compared to those engaging less in SMU (Przybylski et al, 2021; Vogel et al, 2015). These results combined with results from the present study showing reductions in social comparisons were observed in both groups, suggest that social comparison processes can be modifiable, and highlight that future controlled intervention research is needed to determine whether reducing SMU for more sustained periods of time can reduce social comparison, and whether the degree of restriction, population, measurement, and type of SMU matters.

4.5 Other Potential Mechanisms Linking SMU and Mental Health:

Spending excessive amounts of time on social media may hinder participants in spending time in healthier behaviour, such as sleep (Guerrero et al, 2019; Nie, 2001), physical activity (Mutz et al, 1993), or face-to-face interactions time with friends (Kushlev et al, 2019); all of which have been proven to be protective against mental disorders and vital for wellbeing (Coyne et al, 2020; Escobar-Viera et al, 2018; Kross et al, 2013). This is referred to as the displacement hypothesis, whereby one behaviour (SMU) displaces another (sleep) (Neuman, 1988). Systematic reviews indicate a relationship between shorter amount of sleep and elevated depression and anxiety in youth (Chaput et al, 2016). Moreover, there is consistent evidence that high SMU is associated with delayed bedtimes, and shorter sleep duration. (Sampasa-Kanyinga et al, 2018) Screens spread blue lights that disturb the body's ability to prepare for sleep as it blocks the secretion of melatonin,

a hormone that is released at night and is associated with control of the sleep-wake cycle along with other functions in the body (Faraone & Antshel, 2014). Thus, screen time before bed, including SMU, can disturb the quality and amount of sleep with profound influence on mental and physical health (Wright et al, 2006). Sleep habits can be further challenged during lockdowns due to reduced physical activity, higher distress and low exposure to sunlight (Altena et al, 2020).

Another promising theory to explain how reduced SMU led to reduced distress is the behavioural change theory “emotional self-efficacy”, which is the individual’s perceived ability to regulate and express positive and negative emotions (Bandura et al, 2003). Levels of emotional self-efficacy are negatively associated with depressive symptoms and positively associated with subjective wellbeing in TAY (Bandura, 1997; Caprara & Steca, 2005). Social media platforms are used to share and express emotions as well as to receive feedback from other people which can lead to both positive and negative emotional experiences. Melancholy and negative feelings caused by cyberbullying, sexual harassment, envy and a lack of social belonging that are exacerbated by social media platforms could be mitigated by a reduction in SMU as this decreases the likelihood of being exposed to those negative experiences (Ghaemi, 2020). On the same lines, youth with emotional distress tend to be more socially isolated, engage in more social comparison, and have a higher chance of being exposed to psychologically harmful content on social media, such as cyberbullying and emotionally disturbing posts (Bäzner et al, 2006; Sampasa-Kanyinga et Hamilton, 2015). SMU has been associated with problematic emotional regulation and self-efficacy for TAY with emotional distress (Marino et al, 2020). Given that transitional aging to adulthood is a period characterized by emotional instability and is crucial for the acquisition of self-regulation and management of emotions, and that SMU can be problematic to emotional self-

efficacy, it could be possible that reducing SMU can provide less negative emotional experiences and harmful content, stressors, frequency of social comparison, social exclusion and distractions allowing for better emotional management and regulation; and these benefits could be amplified for distressed youth. In further support of this, it was demonstrated that the effect of SMU on both positive and negative MH outcomes is moderated by the level of emotional self-efficacy (Calandri et al, 2021). Studies found that young girls who use SMU excessively and had low levels of emotional self-efficacy, experience more depressive symptoms, lower affective wellbeing, and life satisfaction (Quinn & Oldmeadow 2013; Calandri et al, 2021). Future studies should investigate how these findings could be extrapolated to TAY and whether reducing SMU can provide psychological benefits through the emotional self-efficacy mechanism.

4.6 Strengths & Limitations:

The main strength of the present study is its design. Although no single study can prove causality on its own, randomized controlled trials reduce bias and provide rigorous methodology that allow the strongest causal inferences. Moreover, this study incorporated conceptual and methodological improvements as suggested by previous research (Kaye et al., 2020; Orben & Przybylski, 2019), including objectively measured SMU and did not rely on self-report which research has shown is inaccurate due to the subjective cognitive functions of the respondent, including self-awareness, perception and attention, which lead to reporting perceived use rather than actual use (Sewall et al, 2022). Moreover, this study used validated measures in addition to the use of an active control group to control the effects of self-monitoring SMU. The study also had a large sample size that provided strong statistical power to detect group differences. Moreover, this experiment provides evidence on the feasibility of achieving good compliance to the SMU limit on smartphone-based

SMU and good rates of adherence to sending screenshots strengthening the internal validity of the results. Adhering to treatment recommendations and restrictions is an important factor for determining the efficacy of the intervention (Middleton et al, 2013). This is supported by numerous studies documenting that participants who adhere to the prescribed behaviour lifestyle change recommendations are those experiencing more clinically significant health improvements (Middleton et al, 2013; Smith et al, 2002). Therefore, an intervention involving SMU restrictions that shows good adherence and can be potentially reinforced by technological innovation is a promising practice for feasibility in the real world yielding the desired outcomes. Another strength of this study is the target population, TAY with emotional distress, which provides clinical relevance as this population tend to be more vulnerable to the negative effects of social media (Hunt et al, 2018; Thai et al, 2021) and are at risk of lifelong mental illness (Kessler et al, 2005).

Despite these strengths, there are several limitations that need to be acknowledged and considered for future research. First, even though we used a device-based objective measure to capture SMU on smartphones, time spent using social media on other devices, such as laptops, tablets, and family members or friends' devices, was self-reported. This limitation is difficult to overcome as it is impossible to objectively track, in an integrated way that would allow a coherent restriction, SMU on all available devices on the participant's home environment or entourage as this technology does not exist. There are some parental-control devices that track internet activities on all devices connected to the router, such as "Circle", but there are ways around these devices and participants can always use their friend's devices. This limitation may not have greatly impacted the validity of the present study's findings as participants in both groups showed relatively stable patterns of SMU behaviours from self-report measures (i.e. SMU on other devices) and in fact, intervention

participants self-reported a reduction in SMU on other devices while the control group participants reported an increase over time. Furthermore, this study only focused on the quantity of SMU and not on the quality including passive, active, public and private SMU. Doing otherwise could be a challenge as there is likely technological limitations, not to mention ethical/privacy constraints, to objectively capturing and distinguish the activities and behaviours done when using social media (Kross et al, 2021), although several studies have captured these quality factors using self-report and found they indeed had different associations with anxiety, depression, and other MH outcomes highlighting that how SMU is used matters (Escobar-Viera et al, 2018; Kingsbury et al, 2021; Rozgonjuk et al, 2019; Verduyn et al, 2015). The sampling strategy used for this study limits the generalizability of findings as only distressed undergraduate students were targeting and those who volunteered to participate in a SMU reduction study may also not be representative of all transitional aged youth, either enrolled or not enrolled in university. Finally, it is important to note that there are possible threats to the internal validity of this study; the data collection period was done in the midst of the COVID-19 pandemic where several social distancing restrictions in the province of Ontario where the study was conducted were in order, which could have had an impact on the social media behaviors of participants, their offline social interactions, and their levels of stress and anxiety. The pandemic and the social restrictions are linked to elevated levels of isolation, stress, anxiety, and uncertainty, which negatively impact mental and physical health and lead to an aggravation of depression and anxiety symptoms (Panchal et al, 2020). Another threat to internal validity are history events that could have had unrelated influences on the outcomes, such as exams and everyday life events (e.g. breakups, promotions). Social desirability is also another threat to internal validity as participants knew the purpose of the study when it was explained to them during the initial assessment, which could have had an influence on the outcome.

Though, the random allocation of participants and active control group somewhat mitigates the known and unknown threats to internal validity.

4.7 Future Research Directions:

Although not a limitation, future studies could investigate the intervention effects over a longer period of time and perhaps conduct a post-intervention follow-up period to see the maintenance effects of the intervention. Another methodological consideration for future research is the conduct of dose response approaches of different SMU reduction targets for different groups as well as a relative reduction target (e.g., 50% vs 75% reduction of average daily SMU). This is important because dose response approaches are considered strong evidence for a causal relationship between the exposure (i.e. SMU) and the outcome. This approach could determine the efficacy of intervention effects based on different SMU targets and deriving a dose-response curve for selection of optimal reduction targets. A standard one-size-fits-all SMU reduction may not reach optimal intervention effects. Future research could also look into identifying specific platforms and how they influence depression and anxiety. For instance, there could be different psychological effects of visual-based platforms (e.g., Pinterest, Instagram, Tik Tok, Facebook, SnapChat) compared to interactive opinion-based platforms (e.g., Twitter). Furthermore, it is important for future research to consider a broader scope of MH outcomes (e.g., loneliness, wellbeing, FoMO, and body image) and examine potential moderators and related mechanisms (e.g., cyberbullying, sleep, and physical activity) that might be linked to excessive SMU. A systematic review identified several moderators of depression, anxiety and SMU such as social aspects of SMU including social support and connectedness, and cognitive aspects including social comparison and negative perceived interaction quality; other potential moderators include gender,

the size and structure of the social network and heavy (vs light) social media users (Seabrook et al, 2016).

It is important to acknowledge that not all SMU behaviours are bad or harmful and it cannot be denied that social media has become an essential part of the daily life of people. In other words, even though some aspects of social media can have negative impacts on TAY mental health, other aspects might be beneficial and these should be distinguished (DeAndrea et al, 2012). Social media use is a habit and for some people it could become an addiction where they become overly concerned and uncontrollably driven by social media. The current study used a simple reduction intervention without providing supportive tools for behavioural change. Thus, despite showing significant intervention effects of SMU on depression and anxiety symptoms, future studies should incorporate more intensive behavioural change strategies to promote, strengthen and sustain changes over time. Not every TAY will experience negative impacts on their MH from SMU as there are complex and different factors that shape TAY's reaction to SMU. Social media users have different needs that influence their selection and preferences of social media. According to the differential-susceptibility model, individual differences in the susceptibility of the harmful effects of SMU depend on a complex combination of cognitive (effort invested), physiological (stimulation received), behavioural (frequency of use) and personality characteristics (Mougharbel & Goldfield, 2020; Rentfrow et al, 2011; Valkenburg & Peter, 2013).

Social media often provides positive impact as some might use it to cope with certain problems and to find support. Therefore, it is important to investigate the type and quality of SMU including active, passive, social, and private use. As previously mentioned future studies should investigate how reduced SMU might impact other psychosocial indicators such as emotional wellbeing, life satisfaction, as well as loneliness, envy, and jealousy as research has shown these are associated

with SMU (Hunt et al, 2018; Kross et al, 2013; Tandon et al, 2021; Tromholt, 2016; Doğan, 2016; Wu & Srite, 2021). Moreover, interventions that focus on media literacy designed to promote healthier and more adaptive use of SMU and whether this translates to better mental health and wellbeing should be evaluated. Early work by the Digital Health Task Force of the Canadian Pediatric Society (2019; 2017) show that recommendations on promoting digital media literacy may be a promising avenue to promote healthier SMU and better mental health for youth and TAY. Recommendations include avoiding screens at least 1hours before bedtime, having screen-free times for social events (e.g. family meals), plan time for alternative hobbies (e.g. outdoor physical activity). Additionally, the physiological mechanisms behind the drive to constantly be hooked on social media are not well understood. When getting positive social feedback on social media, it triggers the brain's reward system and creates a feedback loop mechanism through the release dopamine as the neurotransmitter of this pathway, which rewards that behaviour and prolongs the SMU habit in a similar manner as gambling or recreational drugs (Burhan & Moradzadeh, 2020). Future research designed to better understand the neurobiological effects of social media may reveal insights that inform SMU addiction treatment and prevention strategies.

Chapter Five: Conclusion & Significance of Research

The negative impacts of excessive SMU on vulnerable TAY is a continuously growing public health concern especially during the mental health pandemic that Canadian TAY are facing. The high demand for mental health services created a significant disparity between the supply and the need resulting in long waitlists and difficult access to other MH services. Mental health wait times are a public health issue and when patients are left with no care, it has profound impacts on the individual, families, the broader health system, hospitals, and schools (CMHA, 2021). Thus, cost-effective and scalable behavioural interventions designed to help health services manage the long wait times are needed - along with public health messaging around the safe use of social media among TAY. This study provides evidence for the effectiveness of SMU reduction on depressive and anxiety symptoms among TAY. Even though the reduction on depressive and anxiety symptoms was statistically significant, these changes did not attain the MCID for anxiety symptoms, whereas the minimum clinically important difference for the CESD-10 is yet to be established. However, when these groups were examined on their baseline levels of MH outcomes, those with high baseline anxiety in the intervention group demonstrated a reduction in anxiety symptoms that exceeded the MCID. It is possible that with longer periods of SMU restriction, intervention effects could become more clinically meaningful for all groups. In this context, our analysis builds on previous research and may have important implications for including social media use reduction as a component in the clinical management and prevention of TAY presenting with symptoms of anxiety and depression. One must be mindful that not all SMU is harmful and that this reduction intervention is not a one-size-fits-all approach as some TAY use social media to cope with their emotional distress, seek support, and engage in positive communications. Our study warrants further experimental investigation with a longer intervention duration, a follow-up

assessment to evaluate maintenance effects, and ideally with a study design that more assesses the quality of SMU rather than just the quantity.

Finally, well-controlled intervention research identifying the various mechanisms by which SMU reduction leads to reduced emotional distress, and which types of users benefit most, will deepen our understanding of the causal relationship between SMU and mental health among TAY, a population that is predisposed to mental illness.

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Appendices:

Appendix A: *pre-screening questionnaire*

Study Name:

- Limiting Social Media Screen-time on Personal Devices

Description:

For this study, you have a 50-50 chance of being asked to limit your social media (e.g., Facebook, Snapchat, Instagram) screen-time. Participants will be asked to email daily screenshots of their screen-time usage for a period of four weeks. Participants will also be asked to complete questionnaires and attend an initial laboratory session where instructions will be provided.

Eligibility Questions:

We are looking for participants who answer "Yes" to at least two of the following four statements:

- 1) Over the past two weeks, I have not been able to stop worrying.
- 2) Over the past two weeks, I have been worrying too much.
- 3) Over the past two weeks, I felt depressed.
- 4) Over the past two weeks, I had trouble keeping my mind on what I was doing.

Risks:

We realize that limiting social media screen-time is hard for many people to do. In the first few days of limiting your screen-time, you may feel some distress. You are participating in this study voluntarily, so if you feel that you do not wish to continue, you may quit the study without penalty.

Duration and Locale:

One hour in-lab in the Social Sciences Research Building (SSRB 304), 2-5 minutes daily for four weeks via email, and one 30-minute questionnaire at the end of the four-week period.

Compensation:

You will receive up to 3.5% towards your course (PSYC 1001, 1002, 2001, or 2002) for your time, based on the following:

- Attending the initial meeting where the study is described, consent form is reviewed, and the initial questionnaires are completed will be compensated with 1% grade-raising credit.
- Sending in daily screenshots of social media usage will be compensated with a further 0.5% per week ($4 \times 0.5 = 2\%$).
- Completing the survey four weeks after you begin the study will be compensated with 0.5% credit.

Appendix B: Informed Consent Form**Name and Contact Information of Researchers:**

Dr. Chris Davis, Professor, Dept of Psychology, Carleton U. (613-520-2600x2251) email: chris.davis@carleton.ca

Project Title

Limiting Social Media Screen-time on iPhones and Androids

Project Sponsor and Funder (if any)

Unfunded

Carleton University Project Clearance

Clearance #: 111107

Date of Clearance: June 30, 2020

Invitation

You are invited to take part in a research project because you 1) tend to feel stressed or distressed at least occasionally; 2) use an iPhone running on iOS 12 or later, or an Android running on 9 Pie or later and 3) are a regular social media user. The information in this form is intended to help you understand what we are asking of you so that you can decide whether you agree to participate in this study. Your participation in this study is voluntary, and a decision not to participate will not be used against you in any way. As you read this form, and decide whether to participate, please ask all the questions you might have, take whatever time you need, and consult with others as you wish.

What is the purpose of the study?

The purpose of the study is to assess the effect that limiting social media screen-time has on one's level of emotional health.

What will I be asked to do?

If you agree to take part in the study, we will ask you to: 1) send us daily (by email) screen-shots showing the amount of time you have been using social media on your iPhone or Android every day for four weeks; 2) complete some questionnaires at an initial meeting and after 4-weeks; and 3) for a random half of participants, you will be asked to limit your social media screen-time for a period of three weeks. There is a 50-50 chance that you will be asked to limit your screen time.

Risks and Inconveniences

We realize that limiting social media screen-time is hard for many people to do. In the first few days of limiting your screen-time, you may feel some distress. You are participating in this study voluntarily, so if you feel that you do not wish to continue, you may quit the study without penalty.

Possible Benefits

You may find that by limiting your social media screen-time, you have more time for other activities that you enjoy or for school assignments.

Compensation/Incentives

You will receive course credit based on the extent of your participation. Attending the initial meeting where the study is described, consent form reviewed, and initial questionnaires completed will be compensated with 1% grade-raising credit for PSYC 1001/1002/2001/2002. Sending in daily screen-shots of social media usage will be compensated with a further 0.5% per week ($4 \times 0.5\% = 2\%$). Completing a follow-up survey after a few weeks of trying to cut back on social media screen-time will be compensated with .5% credit, totaling 3.5%

No waiver of your rights

By signing this form, you are not waiving any rights or releasing the researchers from any liability.

Withdrawing from the study

If you withdraw your consent during the course of the study, all information collected from you before your withdrawal will still be used, unless you request that it be removed from the study data. Once data have been rendered anonymous at the end of the study, it will not be possible to withdraw your data.

Confidentiality

We will remove all identifying information from the study data as soon as possible, which will be after you have submitted the follow-up survey 4 weeks after you started the study.

We will treat your personal information as confidential, although absolute privacy cannot be guaranteed. No information that discloses your identity will be released or published. Research records may be accessed by the Carleton University Research Ethics Board in order to ensure continuing ethics compliance.

The results of this study may be published or presented at an academic conference or meeting, but the data will be presented so that it will not be possible to identify any participants unless you give your express consent.

You will be assigned a code [or pseudonym] so that your identity will not be directly associated with the data you have provided. All data, including coded information, will be kept in a password-protected file on a secure computer and/or on a secure cloud. Data, with all identifiers removed, will be maintained for five years after publication of findings, as required by the American Psychological Association.

Because you will be granted course credit for taking part in the study, identifying information will be retained using a code until the course credit is granted.

Data Retention

After the study is completed, your de-identified data will be retained and used in aggregate (with other participants' data) for research and teaching purposes. Screen-shots of your social media usage will be destroyed (deleted) within 24-hours of each submission.

New information during the study

In the event that any changes could affect your decision to continue participating in this study, you will be promptly informed.

Ethics review

This project was reviewed and cleared by the Carleton University Research Ethics Board – B. If you have any ethical concerns with the study, please contact the REB Chair, Carleton University Research Ethics Board (by phone at 613-520-2600 x 4085 or by email at ethics@carleton.ca).

Statement of consent – print and sign name

I voluntarily agree to participate in this study.

___Yes ___No

I agree to submit daily screen-shots of social media usage

___Yes ___No

Signature of participant

Date

Research team member who interacted with the subject

I have explained the study to the participant and answered any and all of their questions. The participant appeared to understand and agree. I provided a copy of the consent form to the participant for their reference.

Signature of participant

Date

Days 1-6 – Subject Line: Social Media Screen-time (Day X)

Hi,

Just a quick reminder to take a screenshot of your social media use for today. Please send it in by midnight tonight, or first thing tomorrow morning. If you have any questions or concerns, please reply to this email with your question.

Thanks,

Social Media Research Team

Participants randomly assigned to the control group continue to receive the same message.

Day 7 – Subject Line: Limiting your Social Media Screen-time! (Day 7)

Hi,

Starting tomorrow morning, we want you to limit your social media screen-time to 60 minutes per day. We recognize that this may be hard for some people to do, especially the first few days, but we think you can do it. If you exceed this limit, that is ok. We realize that some days will be harder than other days to stick within this limit. Try your best, but don't get upset with yourself if you exceed this limit.

Remember to send in your screenshot tonight!

If you have any questions or concerns, feel free to reply to this email.

Thanks,

Social Media Research Team

Day 8 – Subject Line: Limiting your Social Media Screen-time (Day 8)

Hi,

Congratulations for successfully limiting your screen-time! We hope it wasn't as hard as you thought it would be. Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.

Thanks,

Social Media Research Team

Overuse reminder email

Hi,

We noticed you have exceeded your social media smartphone time limit on one or more days. We would like to remind you to try your best to meet the 60 minute per day limit. Thank you for trying so hard to comply with our study requirements.

Thanks,

Social Media Research Team

Days 9-13 – Subject Line: Limiting your Social Media Screen-time (Day X)

Hi,
Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.
Thanks,

Social Media Research Team

Day 14 – Subject line: Limiting your Social Media Screen-time – 1 week in! (Day 14)

Hi,
Congratulation on getting through the first week limiting your screen-time. Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.

Thanks,
Social Media Research Team

Days 15-25 – Subject line: Limiting your Social Media Screen-time (Day X)

Hi,
Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.

Thanks,
Social Media Research Team

Day 26 – Subject line: Limiting your Social Media Screen-time – almost done! (Day 26)

Hi,
Only two days left of limiting your screen-time. Hang in there!
Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.

Thanks,
Social Media Research Team

Day 27 – Subject line: Limiting your Social Media Screen-time – almost done! (Day 27)

Hi,
Only one day left of limiting your screen-time!
Please remember to send in your screenshot tonight. If you have any questions or concerns, please reply to this email with your question.

Thanks,
Social Media Research Team

Day 28 (Experimental) – _Subject line: You Made it! Last Night Limiting your Social Media Screen-time! (Day 28)

Hi,

Today is the last time we will ask you send in your screenshot! Please send your screenshot by the end of the night.

The study is almost done. When you get the chance in the next day or so, could you please complete this online survey?

https://carletonpsych.co1.qualtrics.com/jfe/form/SV_51KRaSbK7PTuBuJ

As a reminder, your participation is voluntary, and you may quit the study at any time without penalty. If you withdraw your consent during the course of the study, all information collected from you before your withdrawal will still be used, unless you request that it be removed from the study data. Once data have been rendered anonymous at the end of the study, it will not be possible to withdraw your data.

We will remove all identifying information from the study data as soon as possible, which will be after you have submitted the follow-up survey. We will treat your personal information as confidential, although absolute privacy cannot be guaranteed. No information that discloses your identity will be released or published. Research records may be accessed by the Carleton University Research Ethics Board in order to ensure continuing ethics compliance. All data, including coded information, will be kept in a password-protected file on a secure computer and/or on a secure cloud. Data, with all identifiers removed, will be maintained for five years after publication of findings, as required by the American Psychological Association.

By completing and submitting this survey, you will receive a .5% grade raising credit towards your PSYC 1001/1002/2001/2002 final grade, which is part of the 3.5% grade raising credit promised for completing all parts of the study.

If you have any questions or concerns, please reply to this email with your question.

Thanks,

Social Media Research Team

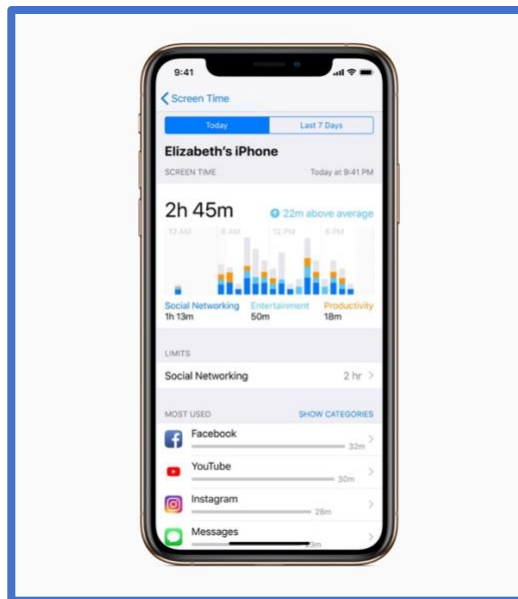
Day 28 (Control) – _Subject Line: You Made it! Last Night Monitoring Social Media Screen-time (Day 28)

The same email was sent to the control group with a different subject line

Appendix D: Screenshot instructions

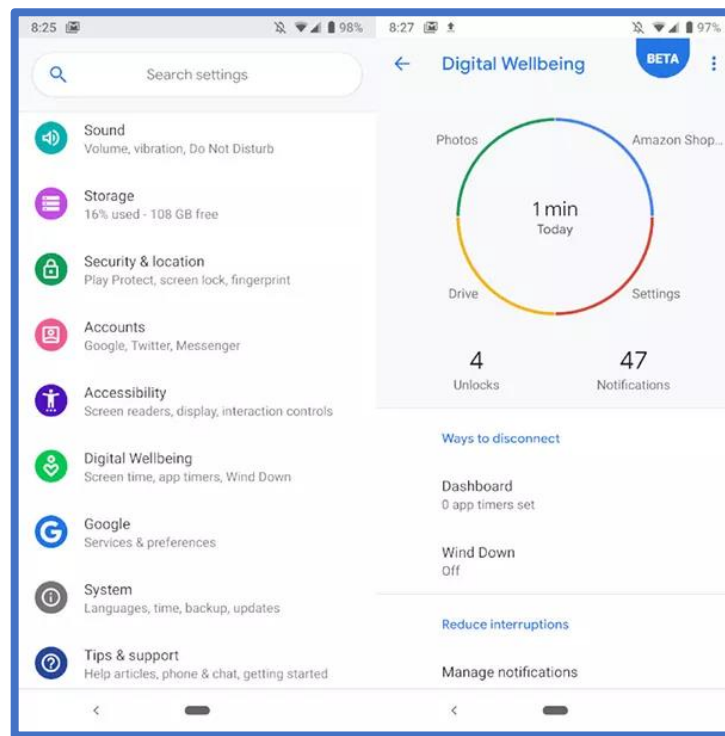
iPhone Instructions

1. Go to your *Settings*.
2. Tap on *Screen Time*.
3. Select “See All Activity.”
4. Make sure you select the tab for *Today* (located on the top of the app).
 - a. If you forget to submit a screenshot for a specific day, use the navigation arrows to access screen time data for missing day.
5. Under “Most Used” (bottom of the app), press on “Show Categories.”
6. Go to the “Social (Networking)” and take a screenshot.
 - a. You can take a screenshot using iPhones by simultaneously pressing the “**home**” and “**side**” button.
 - b. Make sure all the apps are visible—you may need to take more than one screenshot.
7. For TikTok users, go to the “Creativity” category and take a screenshot.
8. Send all screen shots to the email address:



Android Instructions

1. Go to your *Settings*.
2. Select the app *Digital Wellbeing*.
3. Tap on the circular chart which displays your screen-time for all apps. This will show a more detailed breakdown for each individual app.
4. Take a screenshot of the time for all relevant social media apps (may require more than one).
 - a. Facebook, Instagram, Twitter, Tumblr, WeChat (and other Chinese apps, such as Weibo and QQ), Pinterest, Snapchat, TikTok, etc.
 - b. You are *not* required to send screenshots of any apps used purely for communication (e.g., Messenger, WhatsApp, etc.).
5. Send all screen shots to the email address:
SMU.CHEO@gmail.com



Appendix E: Study Material and Questionnaires**Study Materials**

Please provide the following information so that we can link your data. All identifying information will be deleted once you have been credited:

- Name:
- Age:
- Gender:
- Student Number:
- Email that we should use to communicate with you:

Note: Neither student number nor communication email were asked during follow-up.

General Anxiety Disorder-7 (GAD7):

Over the last **two weeks**, how often have you been bothered by the following problems?

	Not at all	Several days	Over half the days	Nearly everyday
1. Feeling nervous, anxious, or on edge.	0	1	2	3
2. Not being able to stop or control worrying.	0	1	2	3
3. Worrying too much about different things.	0	1	2	3
4. Trouble relaxing.	0	1	2	3
6. Being so restless that it's hard to stay still	0	1	2	3
6. Becoming easily annoyed or irritable.	0	1	2	3
7. Feeling afraid as if something awful might happen.	0	1	2	3

Center for Epidemiological Studies Depression Scale (CESD-10)

Please indicate how often you have felt this way during the past week by checking the appropriate box for each question.

	none of the time (less than 1 day)	Some or a little of the time (1-2 days)	Occasionally or a moderate amount of time (3-4 days)	All of the time (5-7 days)
1. I was bothered by things that usually don't bother me. _	☐	☐	☐	☐
2. I had trouble keeping my mind on what I was doing.	☐	☐	☐	☐
3. I felt depressed.	☐	☐	☐	☐
4. I felt that everything I did was an effort.	☐	☐	☐	☐
5. I felt hopeful about the future.	☐	☐	☐	☐
6. I felt fearful.	☐	☐	☐	☐
7. My sleep was restless.	☐	☐	☐	☐
8. I was happy.	☐	☐	☐	☐
9. I felt lonely.	☐	☐	☐	☐
10. I could not "get going"	☐	☐	☐	☐

Modification of the MEIS

Motivations for Electronic Interaction Scale (MEIS)

Comparison and Feedback-Seeking Subscale (MEIS-CF) in bold

1 = Not at all true

2 = A little bit true

3 = Somewhat true

4 = Very true

5 = Extremely true

I use Electronic Interaction (text, Facebook, etc.) ...

1. ...to check out the way others look.
2. ...to compare the way I look with other people's looks.
3. ...to try and get support when I am sad/upset.
4. ...to get feedback from others on the things I send/post.
5. ...to see what others think about how I look.
6. ...to feel less lonely.
7. ...to compare my body/shape with other people's bodies/shapes.
8. ...to see what others think about the things I send/post
9. ...to see if others think I am cool, funny, or popular.
10. ...to ask my dating partners how they are doing.
11. ...to see what others think about my photos.
12. ...to see how my dating partners are doing.
13. ...to see what the "popular" people think about me.
14. ...to let someone know I'm mad at them.
15. ...to try and feel better when I'm sad/upset.
16. ...to compare my life with other people's lives.
17. ...to make social plans with my dating partners.
18. ...to talk to my dating partners about using condoms.
19. ...to talk to my dating partners about using birth control (like the pill).
20. ...to talk to my dating partners about sexually transmitted diseases (STDs).
21. ...to talk to my dating partners about my sexual limits (what I will/will not do).
22. ...to talk to my dating partners about risk of pregnancy.

Note: The term "dating partners" was changed to "friends" in questions 10, 12, and 17. Questions 18 to 22 were excluded from the survey itself as sexuality was not relevant to the current study.