

**Investigating the Association Between Computer-Mediated Communication (CMC)
and the Health of Canadian Young People: A Mixed Methods Study**

by

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Abstract

Introduction. Canadian young people are increasingly more connected through technological devices. This computer-mediated communication (CMC) can result in heightened connection and social support but can also lead to inadequate personal and physical connections. As technology evolves, its influence on health and well-being is important to investigate, especially among youth. This study aims to investigate the potential influences of computer-mediated communication (CMC) on the health of Canadian youth, using both quantitative and qualitative research approaches.

Methods. This mixed-methods study utilized data from the 2013-2014 Health Behaviour in School-aged Children survey for Canada (n=30,117) and focus group data involving Ontario youth (7 groups involving 40 youth). In the quantitative component, a random-effects multilevel Poisson regression was employed to identify the effects of CMC on loneliness, stratified to explore interaction with family communication quality. A qualitative, inductive content analysis was applied to the focus group transcripts using a grounded theory inspired methodology. Through open line-by-line coding followed by axial coding, main categories and themes were identified.

Results. The quality of family communication modified the association between CMC use and loneliness. Among youth experiencing the highest quartile of family communication, daily use of verbal and social media CMC was significantly associated with reports of loneliness. The qualitative analysis revealed two overarching concepts that: (1) the health impacts of CMC are multidimensional and (2) there exists a duality of both positive and negative influences of CMC on health. Four themes were identified within this framework: (1) physical activity, (2) mental and emotional disturbance, (3) mindfulness, and (4) relationships.

Conclusion. Overall, there is a high proportion of loneliness among Canadian youth, but this is not uniform for all. The associations between CMC and health are influenced by external and contextual factors, including family communication quality. Further, the technologically rich world in which young people live has a diverse impact on their health. For youth, their relationships with others and the context of CMC use shape overall influences on their health.

Co-Authorship

The thesis reflects the work of Lindsay Favotto with the collaboration of supervisors Dr. Colleen Davison and Dr. William Pickett along with co-author Dr. Valerie Michaelson. The idea to investigate the influence of technology on youth was developed by Dr. Michaelson, Dr. Davison, and Dr. Pickett.

For **manuscript 1** (*Connection Through a Screen: Computer-Mediated Communication and Self-Perceived Loneliness among Canadian Young People*) Dr. Davison and Lindsay Favotto developed the analysis plan and objectives, with analytic expertise from Dr. William Pickett. Lindsay Favotto conducted the statistical analyses, interpreted the results and wrote the manuscript with guidance from Drs. Davison and Pickett. Editorial assistance was given from Drs. Davison, Pickett and Michaelson.

In regards to **manuscript 2** (*Perceptions of the Influence of Computer-mediated Communication on the Health and Well-being of Early Adolescents*), the idea to investigate this issue through a qualitative lens was Dr. Michaelson's and Dr. Davison's. Lindsay Favotto coded the transcripts and developed the categories and themes, with the assistance of Drs. Davison and Michaelson who co-coded segments and provided analytic guidance. Lindsay Favotto wrote the manuscript with ongoing editorial assistance from Drs. Davison and Michaelson.

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List of Abbreviations

CI	Confidence Interval
CMC	Computer-mediated Communication
HBSC	Health Behaviour in School-aged Children
ICC	Intraclass Correlation Coefficient
MSP	Multidimensional Scale of Perceived Social Support
RR	Relative Risk
SNS	Social Networking Site
WHO	World Health Organization

Chapter 1

Introduction

1.1 General Overview

Throughout most of human history, continuous communication between individuals has been bound by limitations of physical proximity [1]. With the rise of digital technological advancements, computer-mediated communication (CMC) has been introduced into the norms of current socialization practices [2]. Through the development of the telephone, followed by Internet connectivity, communication now transpires through desktop computers, modern laptops, tablets and mobile phones, allowing for communication with others regardless of physical distance [3,4]. CMC allows for verbal and text-based exchanges, with some programs allowing for visual capabilities [3]. This mode of communication has become a prominent way of modern socialization for youth [5].

Because the use of CMC has become commonplace in our socialization with others, it is important to consider how this method of communication influences our health. Research thus far indicates that it can have both positive and negative effects. Beneficial impacts of CMC use include providing an environment for self discovery [6], an expansion of social opportunities [7] and social supports [8]. Concerns relate to the ability of CMC to reduce face-to-face contact, negatively influence well-being and social connection and promote loneliness [9–11]. These paradoxical views can likely be explained by the different CMC methods under investigation in a given study, the diverse ages among study populations and by the popularity of CMC at the time a given study was conducted [7,12].

Various studies have investigated the influence of CMC on social support, social connection and networks, [13–15] although the majority of these studies have been with adults. Existing studies have largely focused on general Internet use and have not compared the impact of different types of CMC such as real-time texting or talking or posts read asynchronously for the purpose of socialization with peers. This study investigates three different methods of CMC among young people 11-15 years. This has allowed for a focus on a youth population and examination of differences in the use of different types of CMC for socialization amongst peers. In addition to this, a mixed methods design has been adopted with the qualitative findings providing contextual depth to the quantitative ones. The results provide knowledge to inform interventions aimed at healthy CMC use by identifying ways that use of different CMC methods influence health in different contexts. Further, results shed light on issues and concerns most prominent to the youth population related to CMC, through highlighting the youth voice.

1.2 Thesis Rationale and Focus

Use of CMC such as social media, text messaging and FaceTime has been widely adopted by youth in order to socialize with others [3,5,16]. In 2015, 92% of U.S. adolescents reported being online daily, with 24% online “almost constantly” [3]. CMC is designed to connect us with others and allow for easy communication, but CMC misses key features of face-to-face communication such as eye contact, vocal cues and spontaneity of conversation [17]. Communication quality is reduced without these features, leaving individuals potentially feeling unsupported or alone [17]. However, loneliness can be prevented through use of CMC as it can connect people regardless of physical distance [3,4]. Loneliness is a common feeling during adolescence [18–20]. In 2010, 19% of boys and 26% of girls in grades 6 to 10 across Canada self-reported feeling lonely [21]. The high level of loneliness experienced among youth can

perpetrate psychological stress [22] along with mental health issues such as depression [20] and suicidal ideation [23]. With high prevalence of CMC use for socialization and loneliness among youth, the influence of CMC on loneliness is imperative to explore.

The focus of this thesis is how use of CMC influences self-perceived loneliness and the overall health of Canadian youth. The first manuscript utilizes a nationally representative sample of Canadian young people in grades 6 through 10 to identify the association between CMC to contact friends and their self-perceived loneliness. The influence of family communication quality on this association is also explored. The second manuscript focuses on how CMC influences health, broadly conceptualized. Using focus group data, the experiences, perceptions and opinions of youth regarding this issue are highlighted. Both manuscripts are linked through discussion of the exposure of CMC and its influence on young people's social relationships, social connections and aspects of health.

1.3 Societal and Public Health Importance

There is great concern amongst agencies such as the American Academy of Pediatrics [24] and Public Health Ontario [25] about the screen time behaviour of youth, including their use of CMC. To date, guidelines and recommendations have been provided for parents [24,25], but these have not been informed by youth themselves. Youth have the right to speak to issues that pertain to them and have a voice in health promotion messages targeted at their population [26]. A youth voice can help drive health promotion efforts in addition to the common "adult lens" [27]. Positive youth development is promoted through engagement of youth in research and in creating community supports for healthy development [27]. This thesis will assist in addressing the gap in knowledge regarding the influence of CMC on the youth population and provide insight into the thoughts and opinions of young people specifically regarding this issue. This

could help inform future changes in policy regarding CMC as well as help directly address the issues they are facing regarding CMC and health. Finally, this thesis will highlight the use and utility of a holistic conceptualization of health including emphasizing the potential benefits and drawbacks of CMC on different health domains.

1.4 Theoretical Framework

Various social theories can be utilized to draw the connection between CMC and various domains of health. Drawing upon the population health framework, there are specific determinants of health involving individual and group level factors that contribute to the health of a population [28]. Specifically, CMC influences social environments and social support networks, both of which are determinants of health [28]. The adoption of CMC influences these social determinants, and has changed our social environments with our peers, family and within the workplace. With the integration of CMC, connection and conversation can occur without the requirement of physical proximity and occurs commonly through screens rather than face-to-face [1,3]. Further, social support is affected by adoption of CMC. Currently, support is often exchanged through screen-based CMC, which is both positive and negative. CMC can benefit supports through the continuity of communication but can potentially hinder support and connection since individuals remain physically distant [29]. With focus on these two determinants of health alone, there is a strong link between health and the use of CMC in modern society.

Social Presence Theory and the Theory of Physical Proximity can explain the link between use of CMC to connect with individuals and loneliness specifically [17]. The Social Presence Theory outlines that the various forms of CMC transmit verbal and non-verbal cues differently. Users may experience less satisfaction during their connection when using CMC

when fewer cues are transmitted [17]. Verbal CMC such as Skype and FaceTime allow for visual and audio transmission, closest to that of face-to-face communication. With these visual and audio cues, users may be more satisfied and promote less loneliness compared to messaging CMC, which is limited to text only communication. The Theory of Physical Proximity outlines that physical presence is vital for feeling close and connected to others [1]. With modern technology this barrier is argued to be broken down with individuals connecting through Internet and cell connectivity, benefiting relationships and potentially protecting individuals from feeling isolated or lonely [1]. To date, testing of these theories with respect to CMC has been limited, particularly among youth only populations.

1.5 Methodological Framework

Mixed methods research is defined as the third research paradigm which combines both qualitative and quantitative based investigations to address an overarching research question or set of questions [30]. There are multiple designs that can be utilized in mixed methods research. These designs differentiate based on key properties which include: the level of interaction between qualitative and quantitative approaches, the timing of implementation of the qualitative and quantitative components, the priority of each, along with the stage of integration of both approaches [30]. This study employs an explanatory, parallel, mixed methods study (Figure 2.1). Through this design, the qualitative and quantitative studies remain independent, utilizing separate analyses and drawing independent conclusions. The results from each parallel study are then used to interpret and articulate overall conclusions [30–32].

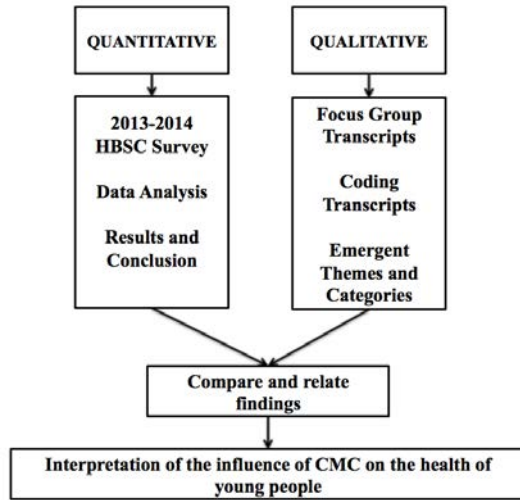


Figure 1.1 Conceptualization of the mixed methods study design

The adoption of a mixed methods design for this research question adds a multitude of benefits to the investigation. First, the integration of qualitative and quantitative studies allows for the complementary strengths of both approaches to be combined to enhance the depth of the data and overall understanding of the topic area as the strengths of one approach address the weakness of the other. Through a mixed methods approach, quantitative associations drive conclusions and, the close narrative of individuals with personal knowledge of the topic adds further depth and detail to conclusions [30]. Given that CMC has a complex and currently poorly understood influence on the health and socialization of young people, a mixed methods approach is appropriate to investigate this issue. The explanatory nature allows for the qualitative findings to enrich and inform the quantitative results to help explain any associations found [30]. Second, previous observational studies investigating the influence of modern communication devices on the health of youth have recommended that future investigations apply mixed methods approaches [11,33]. This insight is based on the need to further understand the complex relationship between CMC and the psychosocial development, well-being and relationships of

young people. Adopting a mixed methods approach also allows for the voices of youth to be highlighted. As Article 12 of the Convention on the Rights of the Child states, all children have the right to be heard and to participate in matters that pertain to them [26]. Given this duty, a mixed methods approach supports the rights of Canadian youth, as they become active participants in this research project, particularly through the qualitative component.

1.6 Research Details

The purpose of this thesis is to investigate the influence of CMC on the health of Canadian youth, focusing on a broad conceptualization of health as well as loneliness as a specific aspect of social or emotional health. To address this purpose, quantitative and qualitative manuscripts have been prepared to address the following aims, objectives and research questions.

The aim of the quantitative manuscript is to identify the influence of CMC on aspects of the psychosocial well-being of Canadian young people, specifically focusing on loneliness. This manuscript addresses the following specific objectives:

- (1) To describe the cycle 7 Health Behaviour in School-aged Children (HBSC) study population in order to identify the prevalence of loneliness along with the frequency of daily use of all CMC types assessed in the HBSC survey.
- (2) To assess the association between use of different forms of CMC for contacting friends and feelings of loneliness reported by Canadian youth in grades 6-10. This will provide insight into any potential differences in influence from three different CMC types, in order to inform the development of focused interventions in the future. It is hypothesized that engagement with the various methods of CMC for daily contact with friends will protect individuals from feeling lonely [34].

(3) The final objective of the quantitative analysis is to examine the impact that quality of family communication has on the association between CMC use and loneliness. It is speculated that experiencing low family communication will increase the risk of loneliness more strongly among non-daily users of CMC compared with daily users [35].

The qualitative manuscript aims to investigate the perceptions and opinions of young people between the ages of 11 and 15 with respect to CMC use and health. The objective is to determine how the use of CMC could impact health, broadly defined, from the youth perspective.

Both manuscripts will be submitted for publication as the quantitative manuscript (Chapter 3) has been formatted for submission to the Journal of Adolescent Health and the qualitative manuscript (Chapter 4) is formatted for submission to the International Journal of Qualitative Studies on Health and Well-Being. Beyond publication, knowledge dissemination began through sharing the final results at the 2016 Canadian Society of Epidemiology and Biostatistics Student Conference, as well as engaging with youth in the Child Health 2.0 Youth Advisory Group. It will continue through sharing findings on the Child Health 2.0 website along with other media outlets of interest and potentially the Canadian Public Health Association conference in the future.

1.7 Thesis Organization

This thesis meets the requirements for the manuscript-based thesis outlined by Queen's School of graduate Studies "General Forms of Theses". This chapter provides a general overview of the entire thesis. The second chapter provides a comprehensive literature review to outline the scope of the field along with how the thesis fits within this area of research. Specifically, it covers use of CMC by youth, the link between CMC and health, the relationship between loneliness and CMC, along with outlining how family dynamics can potentially influence this association. The third chapter reports the results of the quantitative epidemiological study investigating the association between three different CMC methods used to contact friends and self-perceived loneliness, along with the influence of family communication quality. The fourth chapter reports the qualitative study findings related to the influence of CMC on the health of young people. The fifth and final chapter discusses the integration of both quantitative and qualitative findings to provide an overall interpretation of results along with discussion of the strengths and limitations of the thesis overall.

1.8 References

- [1] Monge P, Contractor N. *Theories of Communication Networks*. New York: Oxford University Press; 2003.
- [2] Bargh J, McKenna KY. The Internet and social life. *Annu Rev Psychol* 2004;55:573–90.
- [3] Lenhart A, Page D. *Teens, social Media and technology overview 2015*. PewResearch Cent 2015. Available at <http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/>
- [4] Madden M, Lenhart A, Duggan M, et al. *Teens and technology 2013*. Pew Res Cent 2013. Available at <http://www.pewinternet.org/2013/03/13/teens-and-technology-2013/>
- [5] Steeves V. *Young Canadians in a wired world, phase III: Life online*. MediaSmarts 2014:1–60.
- [6] Turkle S. *Cyberspace and identity*. *Contemp Sociol* 1999;28:643–8.
- [7] Kraut R, Kiesler S, Boneva B, et al. *Internet paradox revisited*. *J Soc Issues* 2002;58:49–74.
- [8] Hlebec V, Manfreda KL, Vehovar V. *The social support networks of internet users*. *New Media Soc* 2006;8:9–32.
- [9] Kraut R, Patterson M, Lundmark V, et al. *Internet paradox*. *Am Psychol* 1998;53:1017–31.
- [10] Moody E. *Internet use and its relationship to loneliness*. *Cyberpsychology Behav* 2001;4:393–401.

- [11] Teppers E, Luyckx K, A Klimstra T, et al. Loneliness and Facebook motives in adolescence: A longitudinal inquiry into directionality of effect. *J Adolesc* 2014;37:691–9.
- [12] Lee Y-C, Sun YC. Using instant messaging to enhance the interpersonal relationships of Taiwanese adolescents: Evidence from quantile regression analysis. *Adolescence* 2009;44:199–208.
- [13] Vergeer M, Pelzer B. Consequences of media and Internet use for offline and online network capital and well-being: A causal model approach. *J Comput Commun* 2009;15:189–210.
- [14] Valkenburg PM, Sumter SR, Peter J. Gender differences in online and offline self-disclosure in pre-adolescence and adolescence. *Br J Dev Psychol* 2011;12:253–69.
- [15] Kuntsche E, Simons-Morton B, ter Bogt T, et al. Electronic media communication with friends from 2002 to 2006 and links to face-to-face contacts in adolescence: An HBSC study in 31 European and North American countries and regions. *Int J Public Health* 2009;54:243–50.
- [16] Deniz L. Excessive internet use and loneliness among secondary school students. *J Instr Psychol* 2010;37:20–3.
- [17] Walther JB. Theories of computer-mediated communication and interpersonal relations. In: Knapp, M L, Daly, J A, editors. *Handb. Interpers. Commun.* 4th ed., Thousand Oaks California: Sage Publications; 2011, p. 443–79.
- [18] Antognoli-Toland P, Beard T. Toward a theory of adolescent loneliness. *J Theory Constr Test* 1999;3:7–12.

- [19] Cacioppo JT, Hawkley LC. Loneliness. *Handb. Individ. Differ. Soc. Behav.*, 2009, p. 227–40.
- [20] Goosby BJ, Bellatorre A, Walsemann KM, et al. Adolescent loneliness and health in early adulthood. *Sociol Inq* 2013;83:505–36.
- [21] Freeman J, Coe H, King M. Health Behaviour in School-aged Children trends report 1990-2010. 2014.
- [22] Chen W, Lee K-H. Sharing, liking, commenting, and distressed? The pathway between Facebook interaction and psychological distress. *Cyberpsychol Behav Soc Netw* 2013;16:728–34.
- [23] Schinka KC, Van Dulmen MHM, Mata AD, et al. Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence. *J Adolesc* 2013;36:1251–60.
- [24] American Academy of Pediatrics. Children, adolescents, and the media. vol. 132. 2013.
- [25] Public Health Ontario. Screen Time: Parental support for child health. Toronto, ON: 2015.
- [26] Office of the High Commissioner for Human Rights. Convention on the Rights of the Child. Available at: <http://www.ohchr.org/en/professionalinterest/pages/crc.aspx>. Accessed May 10, 2015.
- [27] Wong NT, Zimmerman MA, Parker EA. A typology of youth participation and empowerment for child and adolescent health promotion. *Am J Community Psychol* 2010;46:100–14.
- [28] Last J. A dictionary of public health. New York: Oxford University Press; 2007.

- [29] Park N, Lee H. Social implications of smartphone use: Korean college students' smartphone use and psychological well-being. *Cyberpsychol Behav Soc Netw* 2012;15:491–7.
- [30] Teddie C, Tashakkori A. *Foundations of mixed methods research: Integrating quantitative and qualitative approaches in the social and behavioural sciences*. Thousand Oaks, California: Sage Publications; 2009.
- [31] Johnson B, Onwuegbuzie A, Turner L. Towards a definition of mixed methods research. *Jounal Mix Methods Res* 2007;1:112–33.
- [32] Creswell J, Plano Clark V. *Designing and conducting mixed methods research*. 2nd ed. Thousand Oaks, California: 2011.
- [33] Bonetti L, Ed M, Campbell MA, et al. The relationship of loneliness and social anxiety with children's and adolescents' online communication. *Cyberpsychology, Behav Soc Netw* 2010;13:279–85.
- [34] Riedl C, Köbler F, Goswami S, et al. Tweeting to feel connected: A model for social connectedness in online social networks. *Int J Hum Comput Interact* 2013;29:670–87.
- [35] Van Ryzin M, Fosco G. Family-based approaches to prevention: The state of the field. In: Van Ryzin M, Kumpfer K, Fosco G, et al., editors. *Fam. Prev. Programs Child. Adolesc.*, New York, NY: 2016.

Chapter 2

Literature Review

2.1 Overview

The purpose of this chapter is to review the current state of the scholarship around computer-mediated communication (CMC) and health, with special focus on the health of youth. An overview of CMC will be presented including common uses of CMC, variables related to use and ways that CMC influences health and young people's health specifically. Further, loneliness will be defined, risk factors for loneliness will be stated, and an outline of the link between CMC use and loneliness will be provided. Finally, the potential influence of the family unit on health outcomes such as loneliness among young people will be reviewed.

Although this was not a comprehensive, systematic review, a process for identifying relevant literature was followed and documented. To identify pertinent literature in this field, PsychInfo, Medline, EMBASE and CINAHL along with Google Scholar were searched. Books and relevant grey literature reports were also considered. Search terms included: "Internet", "cell phones" and "communication technology" along with "loneliness", "interpersonal relations", "health behaviour", and "child psychology", further limited by English language. Key articles were identified, and their reference lists were also searched for additional relevant literature.

2.2 Computer-Mediated Communication (CMC)

2.2.1 Definition

Throughout the last decade, the use of the Internet in our daily lives has increased. The ubiquity of Internet use is particularly pronounced for the youth population. The Pew Internet Research group found that in 2001 only 45% of U.S adolescents used the internet [1] but by 2015, 92% of adolescents in the United States expressed being online daily with 24% online “almost constantly” [2]. University students in the United States reported use of the Internet seven days a week for an average of 19.4 hours per week [3]; likewise, 37% of another population of university students in the United States reported using the Internet 1 to 4 hours per day [4]. High Internet use is not a sole trait of North American adolescents as 44% of a population of Turkish high school students reported using the Internet for 6 to 15 hours per week [5]. This surge of online activity is partially explained by the widespread adoption of Internet-connected personal devices such as tablets or mobile phones as opposed to shared desktop computers [6–8]. In 2005, the majority of Canadian youth accessed the Internet through desktop computers and only 24% had their own mobile phones. In contrast, by 2013 use of laptops or tablets for Internet access exceeded that of desktop computers as 85% of Canadian youth indicated they owned a cell phone [8]. With this recent increase in the use of mobile devices and the Internet, it is important to investigate how this surge of connectivity influences users.

Canadian young people use the Internet for a variety of activities, including communication with others. Use of Internet and cell connectivity allows for instant communication with others and has become a prominent method for youth to socialize with their peers [2–5,8,9]. Computer-mediated communication (CMC) involves communication with individuals through or by the use of computers or the Internet [10,11]. CMC largely involves

communication without typical features of face-to-face communication including tone of voice and facial expressions [10]. Many studies fail to separate CMC activity online from overall Internet use [5]. Even given this, when youth are connected to the Internet, one of the main activities in which they engage is communicating with others through various CMC methods [3,12,13]. Traditional methods of CMC involve email, and instant messaging [1,6,8] but currently there are many diverse methods such as Skype, FaceTime and social media sites. Currently, the most common methods are not bound to a desktop computer; portable laptop computers, mobile phones and tablets have become more common communication tools [2,6]. In actuality, CMC does not represent one method of communication but is an umbrella term under which the use of many different screen based communication devices are classified.

2.2.2 Types and Frequency of CMC by Youth

With the constant and rapid advancement of technology, methods of CMC that are used by youth are consistently adapting and changing. Current CMC methods include the use of text messaging, Skype, social media or social networking sites, messaging applications (apps) and others [2]. Text messaging involves sending text-based messages, usually using a mobile phone. This method of CMC has developed with the use of emoticons to enhance conversation along with text-based applications to allow for a longer message length and reduced associated costs [2]. Text messaging is a popular method of communication as 91% of U.S adolescents who own a mobile phone utilize text messaging with an average of 67 messages sent or received per day [2]. Other methods such as social media or social networking sites and video chat are also popular among adolescents. These platforms of communication involve sharing short text content, photos, video and/or status updates by friends, strangers and even celebrities [2]. The use of social media involves sharing media content with one another over platforms like

Facebook or Twitter, whereas social networking involves the use of specific Internet sites and spaces for text-based networking and communication. Often sites used by youth involve elements of both social media and social networking. Social media has become very popular amongst youth as 89% of U.S teens use at least one social media platform and 30% of Canadian youth read other's social media posts at least once per day [8]. In 2013, the most popular social media or social networking platforms among Canadian youth from grades 7 to 11 include: Facebook (82%), Twitter (47%), Instagram (42%), Pinterest (13%) and Tumblr (27%) [8]. Video chat is also used by teens as 47% of U.S youth use video chat such as Skype or FaceTime [2]. Messaging applications and free social media sites allow for affordable and multiple forms of CMC to contact others on an ongoing basis throughout normal daily activities [2]. With the heterogeneity in types of CMC, different types of exposure and measurement approaches can make it difficult to make comparisons across multiple research studies.

2.2.3 Variables Related to CMC

The use of CMC to communicate with others is associated with a plethora of personal factors including age, sex, and personality [4,9,14–22]. Age has been directly linked to the frequency and type of CMC in which youth engage [8,9,14,15,18,22,23]. Compared with younger children, it is more common for youth in grades 6 to 11 to own their own cell phone or laptop computer and to use social media sites [8,9,14,15,18,22,23]. Differences have been observed in CMC usage patterns between males and females [8,14,16–20,23]. General computer use and access to the Internet through gaming consoles is higher among males, whereas females utilize CMC more often through cell phones and social media sites [8,14,16–20,23]. To further illustrate this gender difference, the odds of owning a cellphone are lower for males compared to females (OR= 0.44, $p < 0.001$) [16]. Conversely, other studies have not found differences in Internet usage among males and females [4,21]. Personality factors such as conscientiousness, extroversion, high self-esteem, agreeableness, emotional stability and openness have been linked to use of CMC and time spent on the Internet [17,24]. For instance, Wilson, Fornasier and White (2010) found that conscientiousness ($\beta = -0.18$, $p = 0.02$) and extroversion ($\beta = 0.27$, $p = 0.001$) linearly predicted social media site usage. Hours spent on the Internet is positively correlated to low self-esteem ($r = 0.09$, $p < 0.001$) along with being negatively correlated to extraversion ($r = -0.10$, $p < 0.001$), agreeableness ($r = -0.09$, $p < 0.001$), emotional stability ($r = -0.04$), conscientiousness ($r = -0.08$, $p < 0.001$), and openness ($r = -0.01$, $p < 0.001$) [17]. These identified differences demonstrate that certain inherent qualities can predict and influence engagement in CMC.

External factors also influence the use of CMC among youth. Previous studies have identified factors such as family affluence [8], family income [2,16], parent education [14] and family structure [14] that determine access to and use of different CMC methods by youth. For example, youth are less likely to own a cell phone if they are from a family of generally low affluence [8], or a family who earn less than \$50,000 per year [2]. The odds of owning a cell phone is 3.36 times greater for youth whose parents annually earn between \$100,000-\$149,000 compared to \$50,000-\$74,000 (OR= 3.36, $p<0.05$) [14]. In terms of cellphone usage, high parent education and socioeconomic status (SES) along with living with both parents ($p<0.001$) predicts greater use [14]. A low family income is predictive of spending less time online [2] and low parent education, low SES and not living with both parents is associated with low overall computer use ($p<0.001$) [14]. No differences for young people from different ethnic backgrounds were found for overall Internet use [21]. Given these established associations, family structure and family wealth is important to consider when investigating CMC usage patterns among youth.

2.3 Influence of CMC on Health

The use of CMC to connect with others can impact health in various ways. Subrahmanyam and Smahel (2011) proposed three possible mechanisms to explain how use of CMC can influence health. First, the time spent engaging with our CMC devices displaces time spent engaging in other activities or in face-to-face conversation with others. This perspective is commonly known as the displacement theory [25,26], that has been applied to subsequent work in this field [27,28]. The displacement theory explains that disengagement in other activities due to screen time usage results in an impact to health. For example, high CMC use promotes sedentary behaviour (Lepp, Barkley, Sanders, Rebold, & Gates, 2013; Subrahmanyam & Smahel, 2011a) as individuals spend less time being active because their potentially active time

is exchanged for screen time behaviours. In addition to the idea of time and activity displacement, scholars have also highlighted that the nature of CMC limits social cues in interactions, and that this can result in a decreased ability among users to build empathy and connections with others [25,29,30]. In turn, weak connections with others influences well-being and health outcomes negatively [25,29,30]. As a third avenue, the Internet also provides access to a plethora of diverse information and exposures that can be beneficial or harmful to health [30]. In summary, CMC has many mechanisms of influence on health. These mechanisms in relation to specific health outcomes will be discussed further below.

2.3.1 Conceptualization of Health

Health can be conceptualized using different definitions and working theories such as the biomedical model, overall wellness approach and a holistic model of health. The biomedical model views health as “a state characterized by anatomical, physiological, and psychological integrity” [31], which focuses solely on the physical state of the body. Through a wellness perspective health is conceptualized as “a resource for everyday life” [32]. The holistic view of health from the World Health Organization (WHO) defines health as “...a state of complete physical, mental, and social well-being...” [33]. This WHO definition is viewed as a holistic definition of health as it includes multiple domains to consider when discussing overall health. This review will adopt the holistic conceptualization of health and discusses physical, mental and social domains of health applicable to CMC, for a holistic perspective regarding the health of young people.

2.3.2 Potential Health Influences of CMC

Youth in modern society often exceed the recommendations for daily time spent sedentary, partly due to use of screen-based technology [34]. High engagement in screen-based activities promotes reduction of physical activity and sedentary behaviours [30,35], both of which are independently harmful to health [36]. In Canada, only 20% of youth meet the requirement of 60 minutes per day of moderate-to-vigorous physical activity and only 7% of males and 6% of females in grade 10 meet the sedentary based screen time guidelines of 2-hours per day or less [34,37]. During the physical developmental period of adolescence, many changes occur to the body [38]. Significant increases to body-mass index during this period has been attributed to low levels of physical activity associated with frequent and prolonged use of screens including CMC with friends [39]. CMC draws time away from physical activities along with passively increasing young peoples' time spend sedentary [30]. Affinity for CMC may explain why youth are not meeting physical activity guidelines and are exceeding screen time guidelines [30]. High screen time and sedentary behaviour is associated with poor health outcomes such as increased adiposity, psychosocial health (hyperactivity, self control etc.), low self-esteem and poor cognitive development (memory, attention and language) among youth [36,40]. Consistent with the aforementioned, displacement theory, sedentary behaviour is strongly influenced by CMC and is a cause for concern amongst the youth population.

During adolescence, the sleep patterns of youth are affected through changes to their circadian rhythm [41,42]. These biological changes make it more difficult to adjustment to varying sleep patterns during weekdays, weekends and vacation time [42]. In Canada, 75% of females and 62% of males in grade 10 report feeling tired when they go to school in the morning [34]. Use of CMC directly influences sleep time in a negative way, as youth are able to engage in

CMC continuously, even during the night. Using CMC in the evening can delay and interrupt sleep patterns among youth [20,41,43] resulting in loss of sleep [20]. To illustrate this, the odds of youth reporting being tired is two times greater when engaging in CMC through their mobile phone after lights out (OR= 2.2, 95% CI= 1.4-3.4) and the odds of being tired is four-fold when using their phone between midnight and 3 a.m. (OR= 3.9, 95% CI=2.1- 7.1) [43]. Less sleep and wakeful tiredness is linked to poor mood and wake performance [44]. More hours of sleep among youth is linearly associated with lower levels of depression ($\beta = -0.20$, $p < 0.001$) higher self-esteem ($\beta = 0.23$, $p < 0.001$) and better grades ($\beta = 0.31$, $p < 0.001$) [45]. Once again, the displacement theory highlights how time spent using CMC takes away from time spent engaged in other activities, such as sleep, resulting in tiredness and harmful health outcomes for youth.

With use of the Internet, messaging applications and social media or social networking sites, youth are indirectly exposed to many different stimuli that can impact their health, both positively and negatively. First, with added time spent online there is further exposure to negative influences such as promotions for tobacco and alcohol through marketing schemes aimed at youth [46]. On the other hand, Internet connectively allows for exposure to health promotion materials and support such as mood tracking and cognitive behaviour therapy applications for youth [47]. These mobile phone based resources have been demonstrated to increase self-awareness and support in regards to mental health concerns [47]. Second, self-reported frequency of alcohol consumption is significantly greater among those who spend more than one hour text messaging ($F = 14.14$, $p > 0.001$) or IM/emailing ($F = 7.41$, $p < 0.01$) compared to those spending less than one hour on these activities [48], as virtual communication allows for networking without parental observation. Finally, cyber bullying is a concern amongst young people [49–51]. Without eye contact and seeing someone's reaction to hurtful messages, youth

do not gain the empathy required to perceive certain behaviours as hurtful to another [29].

Internet connectivity and use of CMC devices can allow victimization outside of the schoolyard and for it to carry over to the home as most youth are not only targeted at school but also online [50,51]. Illustratively, Internet use did not predict cyber bullying among Canadian young people but the odds of cyber bullying were 2-fold higher for those experiencing traditional bullying by peers (OR= 2.14, 95% CI= 1.83-2.45) [50]. Overall, CMC use makes youth vulnerable to the aforementioned issues, and so raises concerns about many aspects of physical and mental health.

Use of the Internet and CMC have been negatively linked to psychological well-being indicators such as life satisfaction [22], depression [14,17,25,52,53] and overall poor mental health [9]. Boniel-Nissim (2015) identified that among nine HBSC participating countries, mean life satisfaction among youth was greater with less than two hours of Internet use per day compared to 2-6 hours or more than 6 hours per day ($p < 0.001$) [22]. On the other hand, among youth that use of CMC to contact friends mean life satisfaction was greater, until a use threshold of 3-6 days per week was reached, as mean life satisfaction was lower with daily use ($p < 0.001$) [22]. Depression is associated with CMC as those who self report feelings of depression significantly spend more time on the computer ($p < 0.001$) [14], Internet ($r = 0.10$, $p < 0.001$) [17,25], using mobile phones ($p < 0.001$) [14] and instant messaging ($r = 0.17$, $p < 0.001$) [12]. Additionally, Lin et al. (2016) found a two-fold increase in odds of depression among high users of social media compared to the lowest quartile of users (OR=1.66, 95%CI= 1.14-2.42) [52]. Finally, a study conducted in a large Ontario city revealed strong effect sizes between social media site usage and various indicators of poor mental health among students in grades 7-12 [9]. After controlling for grade, sex, SES and parental education, the risk of using social media sites for more than two hours a day is 3.04 times greater for those who self-report poor mental health

compared to those that rate their mental health as excellent (RR= 3.04, 95% CI= 1.30-7.09, p= 0.013).

2.4 Loneliness

2.4.1 Conceptualization of Loneliness

Loneliness is conceptualized in different ways across multiple disciplines. Varying perspectives and theories exist, for example, in psychology, philosophy and theology [54]. At first, theoretical based conceptualizations of loneliness identified it as stemming from unmet attachment [54,55]. Later, Robert Weiss (1973) defined loneliness as inadequacies in the quality and quantity of an individual's social relationships, resulting from a cognitive appraisal of one's social situation and concluding that it is inadequate [54,56–58]. Through this definition, loneliness is further defined by its social and emotional elements. Emotional loneliness transpires when there is lack of meaningful and fulfilling relationships with others [56,57,59] whereas social loneliness is associated with withdrawal from social networks and social isolation [56,57,59,60]. Additionally, it is noted that behavioural cues such as lack of meaningful social interactions along with cognitive signals including a desire for more social contact and seeing social interactions as beneficial are often present among one who self-identifies as lonely [58]. At the same time, the cognitive discrepancy model views loneliness as an outcome of one's social position [54,56,58,61]. Loneliness results from not having the social life that one desires, including perceiving a discrepancy between the social contacts one has in relation to that which they crave, an increase in their need for social connection that is not met, or a subjective feeling of isolation regardless of surrounding social opportunities [54,56,58,61]. These feelings can also emerge through comparing one's own social situation to that of others, causing identification of

gaps in one's social desires [58]. An additional alternate view of loneliness is the product of personality traits and skills such as low self-esteem, shyness, poor social skills and poor sociability [62].

2.4.2 Etiology and Epidemiology of Loneliness

With diverse definitions and conceptualization of loneliness, the etiology of loneliness can differ. Age [63,64], biological sex [65], marital status [64,65], family structure [57] and personality traits [17] have all been linked to feelings of loneliness. Older individuals experience heightened loneliness commonly due to life factors such as loss of partners and reduced social support [65]. Females often report experiencing more loneliness but findings are inconclusive as results differentiate based on the item used to assess loneliness [65]. Youth experience high amounts of loneliness strongly influenced by personality traits [65]. For example, loneliness is positively correlated with low self-esteem ($r= 0.50$) [17,54], depressed mood ($r= 0.50$) [17], autonomy [63], and negatively correlated with extraversion ($r= -0.59$) [17,63], agreeableness ($r= -0.50$) [17,63], emotional stability ($r=-0.38$) [17,63], conscientiousness ($r= -0.09$) [17], and openness ($r= -0.26$) [17]. Less extraverted and open individuals may find it difficult to relate to others and develop relationships [63], supporting the notion that loneliness is correlated with feeling less close to friends compared to those who do not identify as feeling lonely ($p<0.05$) [13]. Feeling less close to friends in turn can lead to lonely individuals not having strong relationships and receiving less social support [66,67]. Furthermore, a more agreeable personality is likely conducive to building relationships with others easily, with few conflicts arising, resulting in these individuals feeling less lonely [63]. Beyond innate traits, having few social interactions can result in loneliness development [64] as reduced face-to-face social interaction is negatively correlated to loneliness ($r= -0.18$, $p<0.01$) [68] and loneliness is

negatively correlated to social ($p < 0.01$) and emotional loneliness ($p = 0.0016$) [69]. Loneliness also linearly predicts lower perceived positive social interactions with others ($\beta = -0.01$, $p < 0.05$) [70], further promoting reduced socialization.

The prevalence of loneliness differs based on age cohorts and across biological sexes. Utilizing a direct measure of loneliness, prevalence was greatest among those 65 years of age and older (25.6%) followed by those 19-29 years of age (22.9%) [65]. Further, males displayed more social loneliness and females more emotional loneliness [65]. Specifically looking at youth, older adolescents who are female often report greater loneliness generally [54,71]. Among Canadian youth grades 6 to 10, from 2002 through to 2010, girls have self-reported more loneliness than their male counterparts [72]. In 2010, 19% of boys and 26% of girls grades 6-10 self-reported feeling lonely [72]. Across both sexes, loneliness has remained relatively constant except for that of young females in grade 6. Loneliness among grade 6 females has increased from 16% in 2002 to 24% in 2010. Within this Canadian cohort, loneliness is greatest among grade 10 females [72]. Since the prevalence of loneliness is high among youth, and is increasing for some sub-groups, loneliness in this age group is an important health issue to investigate.

The high prevalence of loneliness that exists among adolescents can be partially attributed to transition and adjustment that occurs during the adolescent period of development. First, since youth experience a lack of autonomy or role specification in society, they are at risk for identifying as lonely [54,56,57,61]. Second, during adolescence youth experience changes in their social networks as they shift to peer centered socialization [54,56,57,61,73,74]. With this change, youth can feel lonely for various reasons including high expectations, social comparisons to their peers [54,56,57,61,73,74], and withdrawal from family relationships in exchange for peer relationships [41]. Further, the exploration of, and potential difficulties

associated with romantic relationships, can heighten the experiences of rejection and loneliness novel to this period of development [41,74]. Throughout adolescence, some feelings of loneliness are anticipated but persistent loneliness is an issue that requires attention [74].

2.5 Influence of Loneliness on Health

Loneliness is a marker of social isolation, whether subjective or objective, and therefore, directly influences social health and one's psychological well-being. Specifically, feeling lonely is negatively associated with well-being ($\beta = -0.24, p < 0.001$) [75] and mental health problems including depression (OR = 1.45, $p < 0.001$) [61]. The link between loneliness and depression is important to consider as in 2010, 23% of grade 10 boys and 38% of grade 10 girls self-reported feeling depressed or low at least once a month across Canada [72]. There is added concern with regards to subjective feelings of loneliness and the presence of mental illness as risk factors for suicidal ideation among youth. Schinka et al. (2013) identified that among adolescents experiencing the highest score on the Loneliness and Social Dissatisfaction Questionnaire at age 9 and increasing scores until age 15, the odds of experiencing suicidal ideation is 11 times more likely compared to those with the lowest scores which remained stable from birth until 15 years of age ($p = 0.001$) [76]. In Canada, suicide is the 9th leading cause of death, and 12% of deaths involving youth of ages 10 to 14 in 2012 were by suicide [77].

Self-perceived loneliness impacts markers of overall health and specifically physical health in various ways. Goosby, Walsemann and Cheadle (2013) identified that university students who self-report feeling lonely have greater odds of poor self-rated health (OR=1.48, $p < 0.001$) than their non-lonely counterparts [61]. Loneliness was also associated with health issues such as reduced sleep quality ($r = -0.35, p < 0.001$) [54,67], cardiovascular concerns (OR=

1.17, $p < 0.001$) [61] and metabolic conditions ($OR = 1.14$, $p < 0.001$) [61]. Reduction in sleep quality affects interest in leisure time activities further perpetrating feelings of loneliness [67]. Last, lonely individuals see the hassles of daily life as more taxing, resulting in greater stress experienced on a daily basis and a greater release of stress hormones [78,79]. This added stress is thought to provide high load on the body, resulting in poor health as individuals get older [79]. In summary, loneliness influences the domain of social health directly, but it also has implications for physical, mental and emotional health as well.

2.6 Relationship Between CMC and Self-Perceived Loneliness

There is inconsistency in the literature on the relationship between CMC and loneliness. Early observations regarding the technological advancements of the modern world came from McLuhan (1964) who stated that:

...the medium is in the message. This is merely to say that the personal and social consequences of any medium - that is, of any extension of ourselves - result from the new scale that is introduced to our affairs by each extension of ourselves, or by any new technology” (McLuhan, 1964, p.7).

Through this statement McLuhan (1964) identifies that we often do not acknowledge the subtle changes of technological advancements as they occur. It is often after using this innovation for years, that we reflect on the “unintended consequences”, both positive and negative [80]. For example, as communication technology entered our society, it was embraced by Turkle (1999) as an environment for self-exploration of identity and a space where individuals could try new things without consequence [81]. As technology has advanced, increasingly more people have adopted CMC and in turn it has become ubiquitous in modern society. With this strong adoption of communication technology, the early excitement of Turkle (1999) shifted to more cautionary messages around the consequences of use for society. These cautions included concerns over

reductions in face-to-face communication preventing empathy development and connections, issues of distraction, development of anxiety through the pressure of needing to be reachable at all times, and the inability to be alone with our thoughts, feelings and emotions [29,82–84].

Views of how CMC influences our health and socialization have evolved with the technology.

The diverse views presented above are reflected through the inconsistency found in the literature investigating the influence of CMC on people's health, safety and well-being. There are two salient issues specifically related to the influence of CMC on loneliness that merit discussion. First, CMC and social relationships or social connection will be discussed; since loneliness can develop with the absence of these supports, these are potential proxy measures of loneliness [58]. Second, loneliness will be directly addressed in relation to CMC. Both approaches will provide insight into the complex influence of CMC on loneliness, especially among youth.

2.6.1 Influence of CMC on Social Relationships

Social relationships have been shown to be positively and also negatively influenced by Internet and CMC use by both adults and youth [25,85,86]. An early investigation by Kraut et al. (1998) identified that with more hours of Internet use per day, social support was negatively impacted, as social circles linearly decreased with use ($\beta = -0.14$, $p < 0.10$) [25]. These findings support the displacement theory as use of CMC devices reduces time spent face-to-face with others and results in fewer strong relationship ties. This is supported by later work by Turkle (2008), as she documented the lack of conversation that takes place in public spaces due to engagement with technology and communication with those not physically in our present environment [82]. Furthermore, use of CMC to communicate with others is argued to result in weak relationships because individuals cannot provide the same physical social support when

they are at a distance and lack strong depth of conversation [25,66]. Przybylski and Weinstein (2012) illustrated this reduced depth of conversation through their work with university students, showing that the presence of a cell phone alone linearly predicts lower reported relationship quality ($\beta = -0.45$, $p = -0.001$), partner trust ($\beta = -0.69$, $p < 0.001$) and less perceived empathy towards one another ($\beta = -0.72$, $p < 0.001$) when engaging in an important conversation [85]. With negative impacts of CMC on relationships with others, social support and connections are reduced, potentially influencing feelings of loneliness.

In contrast to previous cautions on how the Internet and CMC negatively impact social relationships, studies with different and more positive findings have emerged [49,87–89]. For youth, social networks hold both a physical and virtual element. There is no divide between these two types of networks and a significant correlation exists between online and offline social networks. Those who interact offline also interact more online [49]. CMC benefits relationships as it allows for maintenance of communication during breaks in physical presence and allows for coordinating face-to-face meetings with close friends [87–89]. Qualitative analyses involving high school students along with young adults found positive outcomes of CMC on relationships including increased connection to others, maintenance of relationships and ability to connect with multiple people at once [49,90,91]. Further, CMC by high school students to contact friends positively predicts feeling close to peers ($p < 0.01$) [13]. The introduction of social networking sites and instant messaging has expanded opportunities for communication [91] resulting in increased social connectedness, social capital ($\beta = 0.2$ $p < .001$) [91] and expanded social circles [86,92,93]. Through use of CMC, more social connection and social support can be provided to individuals, which may reduce the experience of loneliness. Overall, considering the current

literature there are identified benefits and drawbacks for social relationships and connection that exist from use of CMC.

2.6.2 Influence of CMC on Loneliness Directly

Just as there is inconsistency regarding the influences of CMC on social relationships, evidence exists supporting both benefits and harms of CMC on loneliness directly. Use of the Internet is associated with self-perceived loneliness among high school students, first year university students and adult populations [25,64,68,69,94,95]. To illustrate this, reliance on an Internet-based friend is associated with increased emotional loneliness ($r_s = 0.16$, $p = 0.04$) [69] and Internet use alone linearly predicted loneliness among youth ($\beta = 0.14$, $p < 0.05$) [68]. When investigated longitudinally, increases in loneliness corresponded with increased Internet browsing over a one-year time interval [64]. Consistent with the displacement of social interaction hypothesis, activities such as surfing the Internet can lead to isolation with reductions in face-to-face interactions and human connection [25]. Loneliness is also associated with CMC directly as social networking site usage increased self-reported loneliness among users compared to non-users [93]. This direct relationship between Internet and CMC on loneliness suggests that there are negative implications of use.

Nevertheless, there has been opposition to the evidence around negative implications of CMC for loneliness [69,86]. In extension to their original investigation in 1998, Kraut et al. (2002) conducted a three-year follow up involving a proportion of original participants, which produced opposing results to the original study. Overall they found that Internet use was no longer associated with loneliness ($\beta = 0.03$, $p > 0.05$) [86]. Moody (2001) provides further support to this, concluding that higher frequency of Internet use is associated with reductions in social

loneliness ($r_s = -0.22, p = 0.004$) [69]. It is speculated that as Internet and CMC became more popular, more people have become connected through this method of communication, combating early findings of isolation [86]. These results suggest that the use of the Internet and CMC directly influences loneliness in a positive way.

2.7 CMC and Loneliness: The Role of the Family

The physical and social environment of the home along with relationships and dynamics between family members can influence multiple aspects of young people's health. Considering a population based health approach, it is recognized that aspects of our physical and social environment impact health [96]. The creation of supportive environments for adolescents involves making improvements to their physical and social surroundings, including their home environment and the relationships that occur at home [97]. Furthermore, the family is often conceptualized as a system in which members of the family are interdependently emotionally connected as changes in well-being of one member influences the others [98]. Therefore, individual emotions such as loneliness or external factors such as CMC use by an individual will potentially influence, and be influenced by, family interactions, relationships, and dynamics as a whole system [98,99].

Features of the home environment and family system can help buffer negative health outcomes for youth. For example, the communication quality of a family will influence the social support provided to youth by their family members, which can act to buffer negative feelings of loneliness [64], depression [100] and can benefit life satisfaction [22]. Social support, especially that coming from the family, benefits various health outcomes for youth as high levels of perceived parent trust and understanding have been associated with a four fold increase in odds of reporting excellent health status among Canadian young people (OR= 4.8, 95% CI: 3.5-6.2)

[101]. Furthermore, social support acts to prevent negative health outcomes attached to loneliness, specifically through providing social ties [56,59,67,102,103]. This buffering effect occurs through increasing the perception of available supports, resulting in the appraisal of a stressful situation in a positive light and, by reducing the emotional or physiological response that the body undergoes throughout a stressful event [103]. With family support and communication benefiting health in various ways, this buffering effect can positively influence any experience of loneliness among youth.

Family relationships are directly influenced by use of the Internet and CMC [21,25,27,99,104]. Spending more hours per week on the Internet linearly reduced family communication ($\beta = -0.08$, $p < 0.05$) [25] and among high school-aged youth, high Internet use (more than 2 hours per day) results in a lower mean relationship score with their mother ($M_{\text{low_user}} = 29$, $M_{\text{high_user}} = 22$, $p < 0.001$) compared to low use (less than one hour per day) [21]. Furthermore, hours spent on social networking sites per day along with greater frequencies of use specifically influences loneliness among youth [27,104]. Time spent on Facebook per day is positively correlated to loneliness originating from the relationships that youth have with their parents ($p = 0.21$, $p < 0.001$) [27]. The frequency of contacting parents through social networking sites per day is linearly associated with higher UCLA loneliness scores among youth ($\beta = 0.15$, $p < 0.05$) [27]. On the other hand, contact through phone calls increases parental relationship quality through higher scores on satisfaction ($\beta = 0.30$, $p < 0.001$), intimacy ($\beta = 0.38$, $p < 0.001$), support ($\beta = 0.34$, $p < 0.001$), aid provided ($\beta = 0.35$, $p < 0.01$) [104] and connectedness [99]. Strong family relationships can positively influence health outcomes of youth through supportive environments, but use of the Internet and CMC can result in negative influence on those relationships.

2.8 Rationale for Thesis

This thesis aims to examine the influence of CMC on the health of Canadian young people. A gap in the current literature exists in measuring different CMC methods in a youth only based population. Previous studies have investigated different definitions of CMC including use of the Internet or text messages in isolation along with individual social media sites such as Facebook. Few of these studies separate CMC into specific mediums of electronic communication to be investigated within the same study. Further, recent CMC advancements such as Skype and FaceTime that have visual capabilities have not been investigated among youth to our knowledge. Few studies provide a Canadian context for these relationships with a focus on the youth population, and finally, it has been suggested that qualitative examination of the relationship would be useful to build our depth of understanding about the nature of associations [105]. A qualitative analysis can highlight the perspective of youth and their awareness of how use of CMC influences their health. This has not previously been done among Canadian young people.

This thesis will contribute knowledge about the influence of different CMC methods on health outcomes. We aim to better understand how use of CMC influences youth, specifically focusing on health impacts and the impact of family communication quality. We will also speak to youth directly to gather their perspectives and opinions about these relationships. The knowledge we build from this mixed-methods study could be used to help inform child and adolescent health promotion programs or policies for the healthy use of technology. Overall, we hope this work helps to support families and the health and well-being of Canadian young people.

2.9 References

- [1] Lenhart A, Rainie L, Lewis O. Teenage life online: The rise of the instant-message generation and the Internet's impact on friendships and family relationships. *Pew Internet Am Life Proj* 2001.
- [2] Lenhart A, Page D. Teens, social media and technology overview 2015. *Pew Internet Am Life Proj* 2015. Available at <http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/>
- [3] Schiffrin H, Edelman A, Falkenstern M, et al. The associations among computer-mediated communication, relationships, and well-being. *Cyberpsychol Behav Soc Netw* 2010;13:299–306.
- [4] Fortson BL, Scotti JR, Chen Y-C, et al. Internet use, abuse, and dependence among students at a southeastern regional university. *J Am Coll Heal* 2007;56:137–44.
- [5] Deniz L. Excessive internet use and loneliness among secondary school students. *J Instr Psychol* 2010;37:20–3.
- [6] Madden M, Lenhart A, Duggan M, et al. Teens and Technology 2013. *Pew Res Cent* 2013:1–19. Available at <http://www.pewinternet.org/2013/03/13/teens-and-technology-2013/>
- [7] Boniel-Nissim M, Lenzi M, Zsiros E, et al. International trends in electronic media communication among 11- to 15-year-olds in 30 countries from 2002 to 2010: Association with ease of communication with friends of the opposite sex. *Eur J Public Health* 2015;25:41–5.
- [8] Steeves V. Young Canadians in a wired world, phase III: Life online. *MediaSmarts* 2014:1–60.

- [9] Sampasa-Kanyinga H, Lewis RF. Frequent use of social networking sites is associated with poor psychological functioning among children and adolescents. *Cyberpsychology, Behav Soc Netw* 2015;18:380–5.
- [10] Bargh J, McKenna KY. The internet and social life. *Annu Rev Psychol* 2004;55:573–90.
- [11] Young CMY, Lo BCY. Cognitive appraisal mediating relationship between social anxiety and internet communication in adolescents. *Pers Individ Dif* 2012;52:78–83.
- [12] Eijnden RJJM Van Den, Meerkerk G, Vermulst AA, et al. Online communication, compulsive Internet use, and psychosocial well-being among adolescents: A longitudinal study. *Dev Psychol* 2008;44:655–65.
- [13] Valkenburg PM, Peter J. Preadolescents' and adolescents' online communication and their closeness to friends. *Dev Psychol* 2007;43:267–77.
- [14] Koivusilta LK, Lintonen TP, Rimpela AH. Orientations in adolescent use of information and communication technology: A digital divide by sociodemographic background, educational career, and health. *Scand J Public Health* 2007;35:95–103.
- [15] Reid DJ, Reid FJM. Text or talk? Social anxiety, loneliness, and divergent preferences for cell phone use. *Spec Issue Impact Tasks Users' Charact Virtual Real Perform* 2007;10:424–35.
- [16] Junco R, Merson D, Salter DW. The effect of gender, ethnicity, and income on college students' use of communication technologies. *Cyberpsychol Behav Soc Netw* 2010;13:619–27.
- [17] van der Al N, Overbeek G, Engels R, et al. Daily and compulsive internet use and well-being in adolescence: A diathesis-stress model based on big five personality traits. *Youth Adolesc* 2009;38:765–76.

- [18] Kuntsche E, Simons-Morton B, ter Bogt T, et al. Electronic media communication with friends from 2002 to 2006 and links to face-to-face contacts in adolescence: An HBSC study in 31 European and North American countries and regions. *Int J Public Health* 2009;27:417–28.
- [19] Coyne SM, Padilla-Walker LM, Day RD, et al. A friend request from dear old dad: Associations between parent-child social networking and adolescent outcomes. *Cyberpsychology, Behav Soc Netw* 2013;17:8–13.
- [20] Espinoza G, Juvonen J. The pervasiveness, connectedness, and intrusiveness of social network site use among young adolescents. *Cyberpsychology, Behav Soc Netw* 2011;14:705–9.
- [21] Sanders C, Field T, Diego M, et al. The relationship of Internet use to depression and social isolation among adolescents. *Adolescence* 2000;35:237–42.
- [22] Boniel-Nissim M, Tabak I, Mazur J, et al. Supportive communication with parents moderates the negative effects of electronic media use on life satisfaction during adolescence. *Int J Public Health* 2014;60:189–98.
- [23] Leatherdale ST. Factors associated with communication-based sedentary behaviors among youth: Are talking on the phone, texting, and instant messaging new sedentary behaviors to be concerned about? *J Adolesc Heal* 2010;47:315–8.
- [24] Wilson K, Fornasier S, White KM. Psychological predictors of young adults' use of social networking sites. *Cyberpsychol Behav Soc Netw* 2010;13:173–7.
- [25] Kraut R, Patterson M, Lundmark V, et al. Internet Paradox. *Am Psychol* 1998;53:1017–31.

- [26] Subrahmanyam K, Smahel D. Internet use and well-being: Physical and psychological effects. *Digit. Youth Role Media Dev.*, London: Springer Science and Business Media; 2011.
- [27] Teppers E, Luyckx K, A Klimstra T, et al. Loneliness and Facebook motives in adolescence: A longitudinal inquiry into directionality of effect. *J Adolesc* 2014;37:691–9.
- [28] Selfhout MHW, Branje SJT, Delsing M, et al. Different types of Internet use, depression, and social anxiety: The role of perceived friendship quality. *J Adolesc* 2009;32:819–33.
- [29] Turkle S. *Reclaiming Conversation: The Power of Talk in a Digital Age*. New York, NY: Penguin Press; 2015.
- [30] Subrahmanyam K, Smahel D. *Internet Use and Well-Being: Physical and Psychological Effects*. *Digit. Youth Role Media Dev.*, London: Springer Science and Business Media; 2011.
- [31] Stokes J, Noren J, Shindell S. Defining terms and concepts applicable to clinical preventive medicine. *J Community Health* 1982;8:33–41.
- [32] World Health Organization. *Health promotion: A discussion document*. Copenhagen: 1984. Available at: <http://apps.who.int/iris/bitstream/10665/107835/1/E90607.pdf>
- [33] World Health Organization. *Constitution of the World Health Organization*. Geneva: 1948. Available at: http://www.who.int/governance/eb/who_constitution_en.pdf
- [34] Freeman J, King M, Pickett W. *Health Behaviour in School-aged Children (HBSC) in Canada: Focus on Relationships*. 2016.
- [35] Lepp A, Barkley JE, Sanders GJ, et al. The relationship between cell phone use, physical and sedentary activity, and cardiorespiratory fitness in a sample of U.S. college students. *Int J Behav Nutr Phys Act* 2013;10:n/a – 79.

- [36] LeBlanc AG, Spence JC, Carson V, et al. Systematic review of sedentary behaviour and health indicators in the early years (aged 0–4 years). *Appl Physiol Nutr Metab* 2012;37:753–72.
- [37] Tremblay MS, Leblanc AG, Janssen I, et al. Canadian sedentary behaviour guidelines for children and youth. *Appl Physiol Nutr Metab* 2011;36:59–64; 65–71.
- [38] Tanner JM. Growth and maturation during adolescence. *Nutr Rev* 1981;39:43–55.
- [39] Subrahmanyam K, Greenfield P. Online Communication and Adolescent Relationships. *Futur Child* 2008;18:119–46.
- [40] Tremblay M, LeBlanc A, Kho M, et al. Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *Int J Behav Nutr Phys Act* 2011;8:98–119.
- [41] Laursen B, Hartl AC. Understanding loneliness during adolescence: Developmental changes that increase the risk of perceived social isolation. *J Adolesc* 2013;36:1261–8.
- [42] Dahl RE, Lewin DS. Pathways to adolescent health: Sleep regulation and behavior. *J Adolesc Heal* 2002;31:175–84.
- [43] Van den Bulck J. Adolescent use of mobile phones for calling and for sending text messages after lights out: Results from a prospective cohort study with a one-year follow-up. *Sleep* 2007;30:1220–3.
- [44] Tarokh L, Carskadon M. Sleep in adolescents. In: Squire L, editor. *Encycl. Neurosci.*, Oxford Academic Press; 2008, p. 1015–22.
- [45] Fredriksen K, Rhodes J, Reddy R, et al. Sleepless in Chicago: Tracking the effects of adolescent sleep loss during the middle school years. *Child Dev* 2004;75:84–95.

- [46] Bailin A, Milanaik R, Adesman A. Health implications of new age technologies for adolescents: A review of the research 2014;26:605–19.
- [47] Clarke AM, Kuosmanen T, Barry MM. A systematic review of online youth mental health promotion and prevention interventions. *J Youth Adolesc* 2014;44:90–113.
- [48] Ohannessian CM. Does technology use moderate the relationship between parental alcoholism and adolescent alcohol and cigarette use? *Addict Behav* 2009;34:606–9.
- [49] Bond E. Managing mobile relationships: Children’s perceptions of the impact of the mobile phone on relationships in their everyday lives. *Child A Glob J Child Res* 2010;17:514–29.
- [50] Cappadocia, C M, Craig, W M, Pepler D. Cyberbullying prevalence, stability, and risk factors during adolescence. *Can J Sch Psychol* 2013;28:171–92.
- [51] Beran T, Mishna F, McInroy L, et al. Children’s experiences of cyberbullying: A Canadian national study. *Natl Assoc Soc Work* 2015;37:207–14.
- [52] Lin L yi, Sidani JE, Shensa A, et al. Association between social media use and depression among U.S. young adults. *Depress Anxiety* 2016;331:n/a – n/a.
- [53] Van den Eijnden RJJM, Meerkerk G-J, Vermulst AA, et al. Online communication, compulsive internet use, and psychosocial well-being among adolescents: A longitudinal study. *Dev Psychol* 2008;44:655–65.
- [54] Cacioppo JT, Hawkley LC. Loneliness. *Handb. Individ. Differ. Soc. Behav.*, 2009, p. 227–40.
- [55] Bowlby J. *Attachment and Loss: Attachment*. vol. I. Basic Books; 1969.
- [56] Perlman D, Peplau LA. *Preventing the Harmful Consequences of Severe and Persistent Loneliness*. 1984.

- [57] Antognoli-Toland P, Beard T. Toward a theory of adolescent loneliness. *J Theory Constr Test* 1999;3:7–12.
- [58] Peplau L, Perlman D. Loneliness and self-evaluation. *Loneliness A Sourceb. Curr. theory, Res. Ther., 1937*, p. 135–50.
- [59] Allen K a., Ryan T, Gray DL, et al. Social media use and social connectedness in adolescents: The positives and the potential pitfalls. *Aust Educ Dev Psychol* 2014;31:18–31.
- [60] Weiss, R S. *The experience of emotional and social isolation*. Cambridge: MIT Press; 1973.
- [61] Goosby BJ, Bellatorre A, Walsemann KM, et al. Adolescent loneliness and health in early adulthood. *Sociol Inq* 2013;83:505–36.
- [62] Marangoni C, Ickes W. Loneliness: A theoretical review with implications for measurement. *J Soc Pers Relat* 1989;6:93–128.
- [63] Teppers E, Klimstra T a, Damme C Van, et al. Personality traits, loneliness, and attitudes toward aloneness in adolescence. *J Soc Pers Relationships* 2013;30:1045–63.
- [64] Stepanikova I, Nie NH, He X. Time on the Internet at home, loneliness, and life satisfaction: Evidence from panel time-diary data. *Comput Human Behav* 2010;26:329–38.
- [65] Nicolaisen M, Thorsen K. Who are lonely? Loneliness in different age groups (18-81 years old), using two measures of loneliness. *Int J Aging Hum Dev* 2014;78:229–57.
- [66] Vergeer M, Pelzer B. Consequences of media and Internet use for offline and online network capital and well-being: A causal model approach. *J Comput Commun* 2009;15:189–210.

- [67] Segrin C, Domschke T. Social support, loneliness, recuperative processes, and their direct and indirect effects on health. *Health Commun* 2011;26:221–32.
- [68] Prezza M, Pacilli MG, Dinelli S. Loneliness and new technologies in a group of Roman adolescents. *Comput Human Behav* 2004;20:691–709.
- [69] Moody E. Internet use and its relationship to loneliness. *Cyberpsychology Behav* 2001;4:393–401.
- [70] Hawkey LC, Burleson MH, Berntson GG, et al. Loneliness in everyday life: Cardiovascular activity, psychosocial context, and health behaviors. *J Pers Soc Psychol* 2003;85:105–20.
- [71] Brage D, Meredith W. A causal model of adolescent depression. *J Psychol* 1994;128:455–68.
- [72] Freeman J, Coe H, King M. Health Behaviour in School-aged Children trends report 1990-2010. 2014.
- [73] Collins W a., Laursen B. Changing relationships, changing youth: Interpersonal contexts of adolescent development. *J Early Adolesc* 2004;24:55–62.
- [74] Heinrich LM, Gullone E. The clinical significance of loneliness: A literature review. *Clin Psychol Rev* 2006;26:695–718.
- [75] Lee K-T, Noh M-J, Koo D-M. Lonely people are no longer lonely on social networking sites: The mediating role of self-disclosure and social support. *Cyberpsychol Behav Soc Netw* 2013;16:413–8.
- [76] Schinka KC, Van Dulmen MHM, Mata AD, et al. Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence. *J Adolesc* 2013;36:1251–60.

- [77] Statistics Canada. Leading cause of death, total population, by age group and sex, Canada, 2012. CANSIM 102-0561. 2015.
- [78] Hawkley LC, Cacioppo JT. Loneliness and pathways to disease. *Brain Behav Immun* 2003;17:98–105.
- [79] Cacioppo JT, Hawkley LC, Berntson GG. The anatomy of loneliness. *Curr Dir Psychol Sci* 2003;12:71–4.
- [80] McLuhan M. *Understanding Media: The Extensions of Man*. New York, NY: McGraw-Hill; 1964.
- [81] Turkle S. Cyberspace and identity. *Contemp Sociol* 1999;28:643–8.
- [82] Turkle S. Always-On/Always-On-You: The Tethered Self. *Handb. Mob. Commun. Stud.*, University Press Scholarship Online; 2008, p. 472.
- [83] Turkle S. The flight from conversation. *New York Times* 2012:1–5.
- [84] Turkle S. *Alone Together*. New York, NY: Basic Books; 2011.
- [85] Przybylski K. A, Weinstein N. Can you connect with me now? How the presence of mobile communication technology influences face-to-face conversation quality. *J Soc Pers Relationships* 2013;30:237–46.
- [86] Kraut R, Kiesler S, Boneva B, et al. Internet paradox revisited. *J Soc Issues* 2002;58:49–74.
- [87] Alison Bryant J, Sanders-Jackson A, Smallwood AMK. IMing, text messaging, and adolescent social networks. *J Comput Commun* 2006;11:577–92.

- [88] Kuntsche E, Simons-Morton B, ter Bogt T, et al. Electronic media communication with friends from 2002 to 2006 and links to face-to-face contacts in adolescence: An HBSC study in 31 European and North American countries and regions. *Int J Public Health* 2009;54:243–50.
- [89] Valkenburg PM, Peter J. Online communication and adolescent well-being: Testing the stimulation versus the displacement hypothesis. *J Comput Commun* 2007;12:1169–82.
- [90] Madell DE, Muncer SJ. Control over social interactions: An important reason for young people’s use of the Internet and mobile phones for communication? *Cyberpsychol Behav* 2007;10:137–40.
- [91] Greenhow C, Burton L. Help from my “Friends”: Social Capital in the social network sites of low-income students. *J Educ Comput Res* 2011;45:223–45.
- [92] Riedl C, Köbler F, Goswami S, et al. Tweeting to feel connected: A model for social connectedness in online social networks. *Int J Hum Comput Interact* 2013;29:670–87.
- [93] Brandtzæg PB. Social networking sites: Their users and social implications - A longitudinal study. *J Comput Commun* 2012;17:467–88.
- [94] Deniz L. Excessive Internet use and loneliness among secondary school students. *J Instr Psychol* 2010;37:20–3.
- [95] Amichai-Hamburger Y, Ben-Artzi E. Loneliness and Internet use. *Comput Human Behav* 2003;19:71–80.
- [96] Last J. *A dictionary of public health*. New York: Oxford University Press; 2007.
- [97] World Health Organization. *Sudsvall statement on supportive environments for health*. Sundsvall Sweden: 1991. Available at <http://www.who.int/healthpromotion/conferences/previous/sundsvall/en/>

- [98] Michael E. One family's story: A primer on Bowen Theory. Available at: <http://www.thebowencenter.org>. Accessed May 2, 2016.
- [99] Padilla-Walker LM, Coyne SM, Fraser AM. Getting a high-speed family connection: Associations between family media use and family connection. *Fam Relat* 2012;61:426–40.
- [100] DeLay D, Hafen C a., Cunha JM, et al. Perceptions of parental support buffer against depression for Brazilian youth with interpersonal difficulties. *Int J Behav Dev* 2012;37:29–34.
- [101] Davison C, Michaelson V, Pickett W. It still takes a village: An epidemiological study of the role of social supports in understanding unexpected health states in young people. *BMC Public Health* 2015;15:295.
- [102] Yarcheski A, Mahon NE, Yarcheski TJ, et al. A meta-analysis of predictors of positive health practices. *J Nurs Scholarsh* 2004;36:102–8.
- [103] Kawachi I, Berkman LF. Social ties and mental health. *J Urban Heal* 2001;78:458–67.
- [104] Gentzler AL, Oberhauser AM, Westerman D, et al. College students' use of electronic communication with parents: Links to loneliness, attachment, and relationship quality. *Cyberpsychol Behav Soc Netw* 2011;14:71–4.
- [105] Bonetti L, Campbell MA, Gilmore L. The relationship of loneliness and social anxiety with children's and adolescents' online communication. *Cyberpsychol Behav Soc Netw* 2010;13:279–85.

Chapter 3

Connection Through A Screen: Computer-mediated Communication and Self-Perceived Loneliness among Canadian Young People

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3.1 Abstract

Purpose: Canadian young people commonly use technological devices to connect with their peers. This form of communication can result in heightened feelings of connection and social support, but can also leave adolescents feeling disconnected from others. This study examines the association between computer-mediated communication (CMC) and feelings of loneliness among Canadian youth, with family communication explored as an effect modifier.

Methods: Data from the Canadian 2013-2014 Health Behaviour in School-aged Children study were used in a cross-sectional analysis (n=30,117; grades 6-10). Random-effects multilevel Poisson regression methods were used to quantify risks for adolescent loneliness related to daily vs. non-daily use of verbal (Skype, phone calls), text/instant messaging and social media CMC with friends. Effect modification was tested via the inclusion of modeled interaction terms.

Results: The prevalence of self-reported loneliness among the sample of Canadian young people was 24.6% (95% CI= 23.6- 25.7%). Risk factors for loneliness included feeling sad or hopeless, experiencing low peer support and low perceived family wealth. Family communication quality modified the relationship between CMC and loneliness. Daily use of verbal and social media CMC was positively associated with loneliness only among youth of high relative levels of family communication.

Conclusion: Overall, influence of daily use of CMC is dependent on the level of family communication that youth experience. Therefore, quality of family communication must remain central in societal discussions of youth loneliness, mental and emotional health and use of CMC.

Implications and Contributions

This study highlights that use of CMC is associated with loneliness among Canadian youth only among youth who experience high relative levels of family communication. When investigating the association between CMC and loneliness among youth, it is essential to consider the level of family communication that youth experience.

Key Words:

computer-mediated communication (CMC), loneliness, young people, social media, text messaging

List of Abbreviations

CMC	Computer-mediated Communication
CI	Confidence Interval
HBSC	Health Behaviour in School-aged Children
ICC	Intraclass Correlation Coefficient
MSP	Multidimensional Scale of Perceived Social Support
RR	Relative Risk

The use of technology for communication has been widely adopted by most Canadian youth because in current social contexts, many of their interactions with other people happen through digital means [1–5]. Engagement with computer-mediated communication (CMC) allows adolescents to connect with peers, and different mediums of CMC permit different methods of communication. Methods such as text messaging and various social media outlets do not allow for eye contact or hearing each other's voice, have limitations to permitted message length, and have potential lag time in message response. These features all have the potential to influence (in either positive or negative ways) the quality of socialization that transpires [6].

Loneliness can develop in young people when they lack meaningful engagement with others or lack connection to social networks [7]. With approximately 20% of Canadian adolescents self-identifying as being lonely, it is important to ascertain the potential influence(s) of CMC on this mental health outcome [8]. Evidence surrounding the benefits or drawbacks of CMC on the psychosocial health of adolescents, or their experience of loneliness, is variable. Early findings, of the late 1990's [9], showed a negative influence of Internet use on social support and time spent face-to-face with friends. Over the last ten years, investigations present more positive conclusions, suggesting that social networks are similar across all mediums and the ability to connect via CMC may expand social opportunities [10]. From the perspective that positive family relationships, communication and spending time together offers protection from poor mental health outcomes amongst youth [11] and increased life satisfaction [12], it is also important to consider how communication in the family influences the association between CMC use and reports of feeling lonely.

This study investigates associations between use of different forms of CMC for contacting friends and feelings of loneliness. It also explores the potential for such relationships to be modified by quality of family communication. It is hypothesized that engagement with the various methods of CMC for daily contact with friends will protect individuals from feeling lonely as they are connecting with others [10]. Further, it is speculated that experiencing low family communication will increase the risk for loneliness more strongly among non-daily users of CMC compared with daily users [11].

3.2 Methods

3.2.1 Data Source and Sample

This study involved examination of data from the 2013-2014 (cycle 7) of the Canadian Health Behaviour in School-aged Children (HBSC) study [13]. The HBSC survey is administered to young people across 44 countries and regions, including Canada, every four years in collaboration with the World Health Organization [13,14]. The focus population is young people aged 11 to 15 years and therefore, in Canada, the target is students in grades 6 to 10 [13]. This age group coincides with the initiation of adolescence, and its study permits investigation of the emotional and physical challenges that mark this transition period, and facilitates capturing the increased responsibility of choices and behaviours during this time [14,15].

In Canada, two-stage cluster sampling was utilized for sample accrual. The primary sampling unit was school classrooms nested within schools and associated school boards [13,15,16]. The 2013-2014 cycle 7 included 30,117 students, before application of survey

weights, from 377 schools across Canada [13]. Overall this cycle attained a 50.3% response rate at the school level and a 77% participation rate at the level of individual students [13].

Missing Data

A complete case analysis [17] was done as the amount of missing data were less than 10% among key exposures [18]. When individuals who were missing responses to key items were removed from the full sample, the frequency of loneliness and daily use of CMC in the sample remained constant, therefore missing data were not determined to be statistically problematic. Removal of individuals with missing variables did result, however, in a higher proportion of females (52.6%) and grade 9 to 10 students (48.1%) in the final sample compared to the original sample (50.7% and 44.4%).

Survey Weights

In order for the sample to represent the Canadian population of young people, the HBSC data are weighted to adjust for over and under sampling at the provincial and territorial level, by sex for each school grade grouping (grades 6-10) [15]. The survey weights ranged from 0.017 to 5.491 for this HBSC cycle.

3.2.2 Variables of Interest

Main Outcome: Loneliness

Data on loneliness were assessed via responses to the HBSC survey item: “I often feel lonely?” (5-point likert scale from “strongly disagree” to “strongly agree”). This individual item is part of the Multidimensional Scale of Perceived Social Support [19], which has been used extensively in past studies [13,20] and subject to repeated tests for face validity to subjectively assess feelings of loneliness in Canada and elsewhere [20]. For the purposes of this study,

responses were dichotomized, and often feeling lonely was defined by reporting “strongly agree” or “agree” to the above item.

Exposures: CMC Use

Cycle 7 of the HBSC provides assessments of overall CMC use to contact friends using five items: (a) phone calls, and use of Skype or FaceTime, (b) instant messaging (BBM, Facebook chat), (c) text messaging, (d) email and, (e) social media (Facebook [not including chat], My Space, Twitter, Apps [Instagram], games [Xbox], YouTube, etc.). Phone calls, Skype and FaceTime use were considered verbal CMC whereas both instant messaging and text messaging use were combined into a summary measure to form a count variable indicating daily use of either of these types of messaging (Cronbach’s $\alpha = 0.72$). Social media and email use were left as separate indicator variables. For all CMC measures, “daily” use of any CMC method was separated from “non-daily” use to create a dichotomous variable, consistent with past precedents [13]. These items have established reliability: verbal $\rho=0.52$ ($p<0.001$), texting and SMS $\rho=0.76$ ($p<0.001$), instant messaging $\rho=0.75$ ($p<0.001$), and social media $\rho=0.64$ ($p<0.001$) along with correlation to the previous HBSC CMC item: verbal $\rho=0.48$ ($p<0.001$), texting and SMS $\rho=0.71$ ($p<0.001$), instant messaging $\rho=0.63$ ($p<0.001$), and social media $\rho=0.52$ ($p<0.001$) [21].

Potential Effect Modifier: Family Communication Quality

To assess family communication quality, four items that are part of the Family Dynamics Measure II scale were used. Young people were asked about the communication that takes place within their family, with five responses ranging from “strongly agree” to “strongly disagree”: “the important things are talking about, “when I speak someone listens to what I say”, “we ask questions when we don’t understand each other”, “When there is a misunderstanding we talk it

over until it's clear". These four items specifically assess the construct of clear communication vs. distorted communication within a family. The scale was validated among Finnish students aged 11-17 (Cronbach's $\alpha = 0.82$), and their parents (Cronbach's $\alpha = 0.85$) [22]. Cronbach's alpha for the scale used in this study was 0.88. The scale was reverse coded and categorized into quartiles for the present analysis. Effect modification was tested through construction of a multiplicative interaction term by multiplying the quartiles of family communication by each CMC exposure.

Potential Covariates

Potential confounders of the relationships between use of CMC and loneliness among young people include: age [23,24], sex [23,24], family characteristics such as family structure [25,26] and family income [27,28], peer characteristics such as perception of peer support, frequency of face-to-face interactions and involvement in group activities [23,28] along with the presence of mental health concerns [29]. These potential confounders were considered for analysis based on existing evidence, identified associations to both exposure and outcome of interest, and the availability of items in the HBSC survey.

Family Structure

The 2013-2014 HBSC assessed family structure by asking with whom the participant lives with in the house they live in most of the time [21]. Self-report of family structure by youth has been used in past studies [31]. A dichotomous variable was created that identified nuclear or non-nuclear family structures (living with both mother and father, or other), consistent with precedent [30].

Family Wealth

To assess family wealth, the HBSC includes a proxy item that asks students to indicate how well off they perceive their family to be (“very well off” through “not well off at all”). This item was added to the HBSC survey in 1993/4 to increase the indicators of socioeconomic status. It generates a measure of relative socioeconomic position that has strong test-retest reliability, and it correlates to both household income and parental education [32,33]. Previous studies have used this measure and found it to be predictive of overall health status among this age group [21,32].

Peer Support

The peer support variable was constructed from four items that are part of the Multidimensional Scale of Perceived Social Support (MSPP), which was developed to quantify the subjective experience of social support [34]. Factor analyses have shown three first-order factors from this scale that measure peer and family support, along with support from others [19]. Items corresponding to the peer support factor were utilized for this measure (5-point likert of “strongly agree” through “strongly disagree”). It has been psychometrically tested among adolescents and university students with good inter-rater reliability (0.75) [34] and internal validity (Cronbach’s $\alpha = 0.90$) [19,21]. The summed score for all items was dichotomized for analysis. Cronbach’s alpha for the peer support composite of four items in this study was 0.92.

Frequency of Contacting Friends

To assess peer contact, participants were asked how often they meet their friends outside of school time during two time points in the evening (before, and then after 8:00 p.m) which has been used in past studies [23]. A dichotomous variable was created through grouping “weekly or

more” interactions with friends for either of the two time points. When combining both time points of assessment, Cronbach’s alpha for these items in this study was 0.73.

Involvement in Group Activities

Students indicated involvement in a sports team, volunteer work, arts or community groups along with “other” activities or groups. Following precedent [35], the overall level of involvement was divided into categories: (a) no involvement, (b) one group activity, (c) two group activities, (d) three or more group activities.

Feeling Sad or Hopeless

To identify students who may be experiencing mental health issues, an HBSC item from the Diagnostic Interview for Children Version IV (DISC-IV) was utilized [36]. This item has strong reliability amongst youth one year following a diagnosis of depression ($k=0.92$) [36]. It is commonly used as an initial screen for suicidal ideation [36] as it asks, “during the past 12 months, did you ever feel so sad or hopeless almost everyday for two weeks or more in a row” (yes or no).

3.2.3 Statistical Analysis

Frequency distributions of key exposures, the study outcome and potential covariates were examined. All individuals missing key variables including exposures, the outcome or potential covariates were excluded from analyses. The final useable sample included 23,218 young people. Prevalence estimates of loneliness, all CMC variables and covariates were estimated. Independent associations between the outcome of loneliness and all exposure variables of interest was tested via the Rao-Scott Chi square test for complex survey data after transforming scales into categorical variables [37].

To identify the level of variance that occurred at the group level of each school, intraclass correlation coefficients (ICC) were estimated using the null model [38]. The ICC indicated that 1.6% of the variance of loneliness was accounted for between the clusters of schools [38]. Even with such limited levels of clustering, random-effects multilevel modeling was conducted to adjust for the nested and clustered nature of data collection. A multilevel Poisson regression [39] was applied with a log link function. Each model quantified the relative risk (RR) and 95% confidence interval (CI) for each association. Modeling was initiated with unadjusted models of each exposure to the outcome of loneliness followed by the addition of potential covariates. Effect modification of family communication quality was assessed through insertion of two-way multiplicative interaction terms for each CMC exposure. The most parsimonious, conservative models were identified through stepwise selection procedures with selection criteria of $p < 0.20$ for potential confounders [40]. Assessment of confounding was also considered through the change in estimate approach [40]. Power calculations [41] were conducted for all three CMC exposures, sub group absolute differences of 2% to 4% are able to be detected with 80% power, with consideration of effect modification.

All statistical procedures were conducted using SAS software version 9.4 (Cary, NC: SAS Institute Inc.). Queen's University Research Ethics Board and the Public Health Agency of Canada's Research Ethics Board approved HBSC Canada. Queen's University Health Sciences Research Ethics Board approved this specific study (EPID-520-15; Romeo approval number #6016097).

3.3 Results

Description of Study Sample

Characteristics of the sample available for study are described in Table 3.1. Table 3.2 includes the characteristics of young people who use CMC methods daily to contact friends. Characteristics of users were similar across all methods of CMC.

Prevalence of Loneliness in the Canadian Population of Young People

The prevalence of young people who perceived themselves to often feel lonely was 24.6% (95% CI= 23.6%-25.7%) among the entire population of Canadian young people. The prevalence of loneliness was greater among female (29.9%, 95% CI= 28.4%-31.3%) compared to male (19.0%, 95% CI= 17.8%-20.2%) respondents (Table 3.3). Loneliness was independently associated with all CMC exposures, with the exception of email ($p=0.46$), and therefore use of email was not considered in subsequent regression analyses. All covariates of interest were independently associated with loneliness ($p<0.001$).

Due to the known strong influence of social supports on adolescent health outcomes [35], family communication quality was investigated as a potential effect modifier (Table 3.4). The latter significantly modified the risk of often feeling lonely with use of verbal CMC ($p=0.011$) and social media CMC ($p=0.012$), but not messaging ($p=0.201$). Table 3.4 identifies the relationship between loneliness and family communication quality among non-daily and daily CMC users. Among non-daily and daily CMC users, a consistent and significant association existed between self-perceived loneliness and lower relative levels of family communication quality. Table 3.5 explores the relationship between CMC use and loneliness, comparing use of CMC within each quartile of family communication. In environments of poor family

communication (Q2-Q4), daily use of all types of CMC showed little to no association with loneliness. Among youth of high relative family communication (Q1), daily use of verbal and social media CMC to contact friends was positively associated with reports of loneliness, compared to non-daily users.

Table 3.6 includes the remaining results of the multivariate regression analyses. Risk factors for loneliness were consistent across all methods of CMC. Peer and family support characteristics, measured through low peer support ($RR_{\text{verbal}} = 1.27$, 95% CI= 1.19-1.35) and low perceived family wealth ($RR_{\text{verbal}} = 1.25$, 95% CI= 1.15-1.35) along with feeling sad or hopeless ($RR_{\text{verbal}} = 3.01$, 95% CI=2.84-1.16) were associated to loneliness. Being male showed a protective association ($RR_{\text{verbal}} = 0.81$, 95% CI = 0.77-0.86) with loneliness.

3.4 Discussion

This study explored associations between the use of three different CMC methods to contact friends and self-perceived loneliness in Canadian young people. Family communication quality was demonstrated to significantly modify the relationship between verbal and social media CMC use and loneliness. Peer and family characteristics, specifically the quality of family communication, are associated with the risk of loneliness among Canadian youth. Overall, our findings indicate that the association between daily use of CMC and loneliness is a concern for youth experiencing high relative levels of family communication quality but not among those experiencing lower relative levels.

This study identified important risk factors for loneliness among youth including: peer and family support characteristics, being female, as well as indications of a mental health concern. These findings are consistent with previous research as it has been established that loneliness is associated to depressed mood [42] and self-reported loneliness is often reported by

more females than males [8]. Further, the experience of loneliness commonly develops through a lack of support from peers and family members [7]. The shift to peer centered socialization and high social pressure among peers within this age groups can result in perception of low social support, leading to feelings of loneliness [7].

Self-perceived loneliness was associated with the quality of family communication that youth experience, with the strongest association observed among low relative levels of family communication. This variation in association is consistent with previous findings [25], which demonstrates that youth gain most social support from their family in early adolescence. The shift to peer centred socialization occurs later on in adolescence [43]. These study findings draw attention to the salient influence of family during this period of youth development and how family relationships predict loneliness among this age group. For one thing, without strong family communication, these youth may perceive a discrepancy in the quantity or quality of interactions that they hope to have, or which they do have with their family members, which in turn may lead youth to self-identify as being lonely [44].

In contrast to the initial hypothesis, among youth experiencing high relative family communication (Q1), daily use of CMC to connect with friends was associated with more reports of self-perceived loneliness. This finding is contradictory to previous literature that identified that strong communication with parents moderated the negative effects that daily use of CMC had on the life satisfaction of youth [25]. This finding can be explained through the use of the displacement theory [45] as young people often engage in CMC in the home when surrounded with family members. They may be together in the presence of their family but displace time spent interacting with them, to instead engage in CMC with their friends. With this, youth may perceive their family to have a supportive family environment but experience loneliness from

reduced family interactions due to CMC use. This displacement may only negatively influence youth of high relative family communication since they would otherwise gain support and protection from loneliness through their supportive family environment. Since family communication is strong, use of CMC to contact peers may only present negative influences to the well-being of youth as daily use may displace time spent with family.

This study has many future implications. First, its findings can inform future research and prevention activities related to youth loneliness. Important themes to further explore include the investigation of how CMC use influences life satisfaction, distraction, cyber bullying and one's self-concept. Equally, future research to identify additional etiological factors of loneliness is important due to the high prevalence of loneliness among Canadian youth and substantial connection to mental illness [27]. Second, the increased risk of loneliness resulting from poor family communication quality suggests adoptions of family-based interventions for prevention of loneliness. Family communication is a modifiable factor that is not dictated by family structure or financial resources but reflects the social interactions that take place within the family unit. Development and implementation of family-based programs to benefit the well-being of youth that includes education about CMC, and provides tools and strategies for building strong family environments and relationships, may be effective [11]. Such family-oriented approaches have been successful with regard to prevention of substance use [11,46], depression and antisocial behaviour [11]. With current success of family-centered interventions, continuation of this approach will further support the psychological well-being of youth to ameliorate feelings of loneliness.

Strengths of this study include the depth and timely nature of the analysis. Findings should be representative nationally as they are based on nationally representative HBSC data.

Further, the current Canadian HBSC survey separated CMC use by types, which allows for increased precision of measurement and the association to be differentiated by the different CMC types used to contact friends. This allows for further insight into specific mechanisms and context of effect. Limitations of this study include the potential for reverse causality due to our use of a cross-sectional design [25]. It is possible that daily use of CMC is associated to loneliness development but it is also possible that loneliness is associated to daily use of CMC. The directionally of interest in this study is supported by previous findings [47,48]. In addition, because loneliness was assessed at one point in time, responses did not reflect potential changes in loneliness over time in association with the exposures of interest. Further, even with the large sample size of the HBSC, we are concerned over the precision and power of this study in order to detect the small sub group differences in the association of interest. Poc hoc power calculations revealed inadequate power in detecting the small difference in effect between messaging CMC daily and non-daily use. There are also limitations to this study in terms of the HBSC item classification and completeness. First, the specific examples listed with each CMC type are somewhat outdated which warrants the consideration that use of newer CMC platforms are missed, causing errors in exposure ascertainment. Second, limitations also exist in our ability to form a strong CMC exposure gradient, as extent of daily use was not available. Third, potential confounders could have been missed resulting in uncontrolled confounding in the analysis. For example, personality traits, such as extraversion, cannot be established from the HBSC survey and are positively associated to CMC use and negatively associated to loneliness [42]. Fourth, the relationship between CMC use and loneliness may be different among populations of youth that do not participate in the HBSC survey (private schools, home-school or those who attend schools on reserves) as they may have different experience of loneliness along

with different socialization experiences using CMC. Last, since a complete case analysis was utilized, the confidence intervals may be larger than if an imputation technique was chosen as simulation studies have shown limited influences on effect estimates but influence to standard error [17].

3.5 Conclusion

Loneliness is closely associated with characteristics such as poor family communication quality, low peer contact and the presence of mental health concerns. The association between daily use of CMC and loneliness is dependent on the level of family communication that youth experience. The use of CMC as well as family characteristics should remain a strong focus of mental health and well-being initiatives to promote the health of Canadian young people.

3.6 References

- [1] Lenhart A, Page D. Teens, social media and technology Overview 2015. PewResearch Cent 2015. Available at <http://www.pewinternet.org/2015/04/09/teens-social-media-technology-2015/>
- [2] Deniz L. Excessive Internet use and loneliness among secondary school students. *J Instr Psychol* 2010;37:20–3.
- [3] Schiffrin H, Edelman A, Falkenstein M, et al. The associations among computer-mediated communication, relationships, and well-being. *Cyberpsychol Behav Soc Netw* 2010;13:299–306. DOI: 10.1089/cyber.2009.0173
- [4] Junco R, Merson D, Salter DW. The effect of gender, ethnicity, and income on college students' use of communication technologies. *Cyberpsychol Behav Soc Netw* 2010;13:619–27. DOI: 10.1089/cyber.2009.0357
- [5] Fortson BL, Scotti JR, Chen Y-C, et al. Internet use, abuse, and dependence among students at a southeastern regional university. *J Am Coll Heal* 2007;56:137–44. DOI: 10.3200/JACH.56.2.137-146
- [6] Bond E. Managing mobile relationships: Children's perceptions of the impact of the mobile phone on relationships in their everyday lives. *Child A Glob J Child Res* 2010;17:514–29. DOI: 10.1177/0907568210364421
- [7] Perlman D, Peplau LA. Preventing the Harmful Consequences of Severe and Persistent Loneliness. 1984.
- [8] Freeman J, Coe H, King M. Health Behaviour in School-aged Children trends report 1990-2010. 2014.

- [9] Kraut R, Patterson M, Lundmark V, et al. Internet Paradox. *Am Psychol* 1998;53:1017–31. DOI:10.1037/0003-066X.53.9.1017
- [10] Riedl C, Köbler F, Goswami S, et al. . Tweeting to feel connected: A model for social Connectedness in online social networks. *Int J Hum Comput Interact*. 2013;29(10):670-687. DOI: 10.1080/10447318.2013.768137
- [11] Van Ryzin M, Fosco G. Family-based approaches to prevention: The state of the field. In: Van Ryzin M, Kumpfer K, Fosco G, et al., editors. *Fam. Prev. Programs Child. Adolesc.*, New York, NY: 2016.
- [12] Jiménez-iglesias A, Moreno C, Ramos P, et al. What family dimensions are important for health-related quality of life in adolescence ? *J Youth Stud* 2015;18:37–41. DOI: 10.1080/13676261.2014.933191
- [13] Freeman J, King M, Pickett W. *Health Behaviour in School-aged Children (HBSC) in Canada: Focus on relationships*. 2016.
- [14] Currie C, Aleman-Diaz. Building knowledge on adolescent health: Reflections on the contribution of the Health Behaviour in School-aged Children (HBSC) study. *Eur J Public Health* 2015;25:4–6. DOI:10.1093/eurpub/ckv017
- [15] Roberts C, Freeman J, Samdal O, et al. The Health Behaviour in School-aged Children (HBSC) study: Methodological developments and current tensions. *Int J Public Health* 2009;54:140–50. DOI 10.1007/s00038-009-5405-9
- [16] Pickett W, King M, Freeman J, et al. *The Health of Canada’s Young People: A Mental Health Focus*. 2011.

- [17] Finch WH. Imputation methods for missing categorical questionnaire data: A comparison of approaches. *J Data Sci* 2010;8:361–78.
- [18] Langkamp D, Lehman A, Lemeshow S. Techniques for handling missing data in secondary analyses of large surveys. *Acad Pediatr* 2011;10:205–10.
DOI:10.1016/j.acap.2010.01.005
- [19] Cheng S-T, Chan ACM. The multidimensional scale of perceived social support: Dimensionality and age and gender differences in adolescents. *Pers Individ Dif* 2004;37:1359–69. DOI: 10.1016/j.paid.2004.01.006
- [20] Nicolaisen M, Thorsen K. Who are lonely? Loneliness in different age groups (18-81 years old), using two measures of loneliness. *Int J Aging Hum Dev* 2014;78:229–57. DOI: 10.2190/AG.78.3.b
- [21] Wild F, Inchley J, Currie C, et al. HBSC Internal Protocol 2013/2014. St Andrews Scotland: HBSC International Coordinating Centre; 2014. iccadmin@hbsc.org
- [22] Rask K, Astedt-Kurki P, Paavilainen E, et al. Adolescent subjective well-being and family dynamics. *Scand J Caring Sci* 2003;17:129–38. DOI: 10.1046/j.1471-6712.2003.00118.x
- [23] Kuntsche E, Simons-Morton B, ter Bogt T, et al. Electronic media communication with friends from 2002 to 2006 and links to face-to-face contacts in adolescence: An HBSC study in 31 European and North American countries and regions. *Int J Public Health* 2009;54:243–50. DOI: 10.1007/s00038-009-5416-6

- [24] Leatherdale ST. Factors associated with communication-based sedentary behaviors among youth: Are talking on the phone, texting, and instant messaging new sedentary behaviors to be concerned about? *J Adolesc Heal* 2010;47:315–8. DOI: 10.1016/j.jadohealth.2010.02.012
- [25] Boniel-Nissim M, Tabak I, Mazur J, et al. Supportive communication with parents moderates the negative effects of electronic media use on life satisfaction during adolescence. *Int J Public Health* 2014;60:189–98. DOI: 10.1007/s00038-014-0636-9
- [26] Goosby BJ, Bellatorre A, Walsemann KM, et al. Adolescent loneliness and health in early adulthood. *Sociol Inq* 2013;83:505–36. DOI: 10.1111/soin.12018
- [27] Schinka KC, Van Dulmen MHM, Mata AD, et al. Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence. *J Adolesc* 2013;36:1251–60. DOI: 10.1016/j.adolescence.2013.08.002
- [28] Prezza M, Pacilli MG, Dinelli S. Loneliness and new technologies in a group of Roman adolescents. *Comput Human Behav* 2004;20:691–709. DOI: 10.1016/j.chb.2003.10.008
- [29] Leena K, Tomi L, Arja R. Intensity of mobile phone use and health compromising behaviours: How is information and communication technology connected to health-related lifestyle in adolescence? *J Adolesc* 2005;28:35–47. DOI: 10.1016/j.adolescence.2004.05.004
- [30] Blackwell D. Family structure and children’s health in the United States: Findings from the National Health Interview Survey , 2001 – 2007. *Natl Cent Heal Stat* 2010;10:1–163.
- [31] Blum RW, Beuhring T, Shew ML, et al. The effects of race/ethnicity, income, and family structure on adolescent risk behaviors 2000;90:1879–84.

- [32] Goodman E, Huang B, Schafer-Kalkhoff T, et al. Perceived socioeconomic status: A New Type of Identity That Influences Adolescents' Self-Rated Health. *J Adolesc Heal* 2007;41:479–87.
- [33] Goodman E, Adler NE, Kawachi I, et al. Adolescents' perceptions of social status: Development and evaluation of a new indicator. *Pediatrics*. 2001;108(2):1-8. DOI: 10.1016/j.jadohealth.2007.05.020
- [34] Zimet G, Dahlem N, Zimet S, et al. The multidimensional scale of perceived social support. *J Pers Assess* 1988;52:30–41. DOI:10.1207/s15327752jpa5201_2
- [35] Davison C, Michaelson V, Pickett W. It still takes a village: An epidemiological study of the role of social supports in understanding unexpected health states in young people. *BMC Public Health* 2015;15:295. DOI: DOI 10.1186/s12889-015-1636-2
- [36] Shaffer D, Fisher P, Lucas C, et al. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *J AM Acad Child Adolesc Psychiatry* 2000;39:28–38. DOI:10.1097/00004583-200001000-00014
- [37] Rao JN., Scott A. On chi-squared tests for multiway contingency tables with cell proportions estimated from survey data. *Ann Stat* 1984;12:46–60.
- [38] Gulliford MC, Adams G, Ukoumunne OC, et al. Intraclass correlation coefficient and outcome prevalence are associated in clustered binary data. *J Clin Epidemiol* 2005;58:246–51. DOI: 10.1016/j.jclinepi.2004.08.012
- [39] Yelland LN, Salter AB, Ryan P. Practice of epidemiology performance of the modified poisson regression approach for estimating relative risks from clustered prospective data 2011;174:984–92. DOI: 10.1093/aje/kwr183

- [40] Rothman K, Greenland S, Lash T. *Modern Epidemiology*. 3rd ed. Philadelphia, PA: Pippincott Williams & Wilkins; 2008.
- [41] Kelsey J. *Methods in observational epidemiology*. USA: Oxford University Press; 1996.
- [42] van der Al N, Overbeek G, Engels R, et al. Daily and compulsive internet use and well-being in adolescence: A diathesis-stress model based on big five personality traits. *Youth Adolesc* 2009;38:765–76. DOI 10.1007/s10964-008-9298-3
- [43] Teppers E, Klimstra T a, Damme C Van, et al. Personality traits, loneliness, and attitudes toward aloneness in adolescence. *J Soc Pers Relationships* 2013;30:1045–63. DOI: 10.1177/0265407513481445
- [44] Weiss, R S. *The experience of emotional and social isolation*. Cambridge: MIT Press; 1973.
- [45] Subrahmanyam K, Smahel D. *Internet Use and Well-Being: Physical and Psychological Effects*. Digit. Youth Role Media Dev., London: Springer Science and Business Media; 2011.
- [46] Dishion TJ, Kavanagh K, Schneiger a, et al. Preventing early adolescent substance use a family-centred strategy for the public middle school. *Prev Sci* 2002;3:191–201.
- [47] Blais JJ, Craig WM, Pepler D, et al. Adolescents online: The importance of internet activity choices to salient relationships. *J Youth Adolesc* 2008;37:522–36.
- [48] Stepanikova I, Nie NH, He X. Time on the Internet at home, loneliness, and life satisfaction: Evidence from panel time-diary data. *Comput Human Behav* 2010;26: 329–38.

Table 3.1 Description of the sample population in the 2013-2014 HBSC study for Canada.

(n= 30,117)

Characteristic	N	%	Characteristic	N	%
Biological Sex			Perceived Family Wealth		
Male	14784	49.3	High	15120	53.5
Female	15178	50.7	Average	10456	37.0
<i>Missing</i>	<i>115</i>		Low	2703	9.6
Family Communication Quality			<i>Missing</i>	1,838	
Q1 (highest)	6303	22.3	Involvement in Group Activities		
Q2	9554	33.9	3+	8313	29.7
Q3	5333	18.9	2	7397	26.4
Q4 (lowest)	7012	24.9	1	8232	29.4
<i>Missing</i>	<i>1915</i>		None	4071	14.5
School Grade			<i>Missing</i>	<i>2104</i>	
6-8	16273	54.6	Primary Outcome: Loneliness		
9-10	13520	44.4	No	20735	73.8
<i>Missing</i>	<i>324</i>		Yes	7376	26.2
Feeling Sad or Hopeless			<i>Missing</i>	<i>2006</i>	
No	20489	71.6	Exposure 1: Email Use		
Yes	8118	28.4	Non-daily User	26549	97.5
<i>Missing</i>	<i>1510</i>		Daily User	681	2.5
Family Structure			<i>Missing</i>	<i>2887</i>	
Nuclear Family	19581	69.0	Exposure 2: Verbal CMC		
Non-Nuclear Family	8796	31.0	Non-daily User	20984	74.1
<i>Missing</i>	<i>1740</i>		Daily User	7338	25.9
Frequency of Contacting Friends			<i>Missing</i>	<i>1795</i>	
Weekly or more	13688	50.9	Exposure 3: Messaging CMC		
Less than weekly	13204	49.1	Non-daily User	14897	53.7
<i>Missing</i>	<i>3225</i>		Daily User	12856	46.3
Peer Support			<i>Missing</i>	<i>2364</i>	
High	22896	83.6	Exposure 4: Social Media CMC		
Low	4496	16.4	Non-daily User	19243	68.7
<i>Missing</i>	<i>2725</i>		Daily User	8784	31.3
			<i>Missing</i>	<i>2090</i>	

Table 3.2 Profile of daily users of verbal, messaging and social media CMC among Canadian adolescents by socio-demographic, family and peer characteristics.

Characteristic	Verbal CMC Daily Users N (%)	Messaging Daily Users N (%)	Social Media Daily Users N (%)
Biological Sex			
Male	3286 (45.3)	5001 (38.1)	3821 (41.3)
Female	3966 (54.7)	8128 (61.9)	5430 (58.7)
Family Communication Quality			
Q1 (highest)	1638 (23.0)	2853 (22.1)	2117 (23.5)
Q2	2408 (33.9)	4380 (33.9)	3013 (33.4)
Q3	1199 (16.9)	2337 (18.1)	1469 (16.3)
Q4 (lowest)	1862 (26.1)	3332 (25.8)	2417 (26.8)
School Grade			
6-8	3313 (46.00)	5966 (45.8)	4531 (49.4)
9-10	3890 (54.0)	7068 (54.2)	4630 (50.5)
Feeling Sad or Hopeless			
Yes	2410 (34.4)	4157 (32.6)	3003 (33.4)
No	4591 (65.6)	8599 (67.4)	5975 (66.5)
Family Structure			
Nuclear Family	4793 (67.4)	9002 (69.6)	6154 (67.8)
Non-Nuclear Family	2317 (32.6)	3927 (30.4)	2922 (32.2)
Frequency of Contacting Friends			
Weekly or more	3976 (58.6)	7624 (60.9)	5205 (59.2)
Less than once per week	2806 (41.4)	4887 (39.1)	3583 (40.8)
Peer Support			
High	5905 (86.8)	11063 (88.7)	7643 (87.3)
Low	894 (13.1)	1409 (11.3)	1107 (12.6)
Perceived Family Wealth			
High	3739 (53.1)	7086 (55.5)	4899 (54.9)
Average	2538 (36.0)	4499 (35.2)	3125 (35.0)
Low	767 (10.9)	1190 (9.3)	905 (10.1)
Involvement in Group Activities			
3+	1891 (27.2)	3505 (27.5)	2419 (27.1)
2	1942 (28.0)	3599 (28.2)	2511 (28.1)
1	2031 (29.3)	3893 (30.6)	2623 (29.4)
None	1073 (15.5)	1741 (13.7)	1381 (15.4)
Loneliness			
Yes	1832 (26.5)	3302 (26.1)	2415 (27.2)
No	5081 (73.5)	9354 (73.9)	6456 (72.8)

Table 3.3 Prevalence of loneliness among Canadian adolescents by socio-demographic, family and peer characteristics (row%)¹.

Characteristic	No.	Lonely n = 6897		p-value*
		No.	row% (95% CI)	
Biological Sex				
Male	13466	2562	19.0 (17.8-20.2)	<.0001
Female	14438	4313	29.9 (28.4-31.3)	
Family Communication Quality				
Q1 (highest)	6,499	855	13.1 (11.6-14.7)	<.0001
Q2	9,380	1641	17.5 (16.2-18.8)	
Q3	4,960	1305	26.3 (24.2-28.4)	
Q4 (lowest)	6,459	2914	45.1 (43.1-47.1)	
School Grade				
6-8	15153	3263	21.5 (20.3-22.8)	<.0001
9-10	12555	3524	28.1 (26.7-29.4)	
Feeling Sad or Hopeless				
Yes	7404	3964	53.6 (51.3-55.7)	<.0001
No	19568	2651	13.5 (12.7-14.4)	
Family Structure				
Nuclear Family	19330	4174	21.6 (20.5-22.7)	<.0001
Non-Nuclear Family	7984	2545	31.9 (30.1-33.6)	
Frequency of Contacting Friends				
Weekly or more	12303	2809	22.8 (21.5-24.1)	<.0001
Less than once per week	13781	3627	26.3 (24.9-27.7)	
Peer Support				
High	22900	5108	22.3 (21.1-23.5)	<.0001
Low	4381	1560	35.6 (33.0-38.2)	
Perceived Family Wealth				
High	15138	2870	19.0 (17.9-20.1)	<.0001
Average	9337	2702	28.9 (27.3-30.5)	
Low	2517	1086	43.1 (39.5-46.7)	
Involvement in Group Activities				
3+	7126	1810	25.4 (24.0-26.8)	<.0001
2	7503	1620	21.6 (19.9-23.2)	
1	8403	1893	22.5 (21.0-24.0)	
None	4317	1417	32.8 (30.2-35.5)	
Email Use				
Non-daily User	25715	6293	24.5 (23.4-25.6)	0.4594
Daily User	778	206	26.5 (21.1-31.8)	
Verbal CMC				
Non-daily User	20338	4859	23.9 (22.7-25.0)	0.0017
Daily User	6914	1832	26.5 (24.9-28.1)	
Messaging CMC				
Non-daily User	14188	3308	23.3 (22.0-24.7)	0.0023
Daily User	12655	3302	26.1 (24.7-27.5)	
Social Media CMC				
Non-daily User	18276	4267	23.3 (22.2-24.5)	<.0001
Daily User	8871	2415	27.2 (25.5-29.0)	

¹ Adjusted for school-level clustering and weighted for population representativeness

* p value for the Rao Scott chi-square test between each characteristic and loneliness

Table 3.4 The association between family communication quality and loneliness by non-daily and daily CMC use as reported by Canadian adolescents.

Frequency of CMC Use	RR _{adj} (95% CI) of Loneliness by Quartile of Family Communication Quality ^{1,2}				P-value for interaction ³
	Q1 (highest)	Q2	Q3	Q4 (lowest)	
Verbal CMC (n= 23146)					
Non-daily User	1.00	1.39 (1.24-1.55)	1.77 (1.57-1.98)	2.20 (1.98-2.45)	0.011
Daily User	1.00	0.98 (0.82-1.17)	1.37 (1.15-1.65)	1.75 (1.49-2.05)	
Messaging CMC (n= 22851)					
Non-daily User	1.00	1.35 (1.19-1.54)	1.79 (1.56-2.05)	2.19 (1.93-2.48)	0.201
Daily User	1.00	1.13 (0.99-1.30)	1.47 (1.28-1.69)	1.92 (1.69-2.17)	
Social Media CMC (n= 23017)					
Non-daily User	1.00	1.36 (1.21-1.53)	1.82 (1.61-2.05)	2.23 (1.99-2.50)	0.008
Daily User	1.00	1.05 (0.91-1.22)	1.31 (1.12-1.54)	1.71 (1.49-1.96)	

¹ Adjusted for school-level clustering and weighted for population representativeness

² Multilevel Poisson regression controlling for biological sex, school grade, feeling low or depressed, family structure, frequency of face-to-face contact with peers, involvement in group activities, perceived family wealth, and peer support

³ Interaction of CMC*family communication quality

Table 3.5 The association between non-daily and daily CMC use and loneliness by each quartile of self-perceived family communication quality as reported by Canadian adolescents.

Quartile of Family Communication Quality	RR _{adj} (95% CI) of Loneliness by Frequency of CMC User ^{1,2}			
	Non-daily User	Daily Verbal CMC User (n= 23146)	Daily Messaging CMC User (n= 22851)	Daily Social Media CMC User (n= 23017)
Q1 (highest)	1.00	1.29 (1.09-1.52)	1.11 (0.96-1.30)	1.34 (1.15-1.56)
Q2	1.00	0.91 (0.80-1.03)	0.93 (0.84-1.03)	1.05 (0.94-1.17)
Q3	1.00	1.00 (0.87-1.15)	0.92 (0.81-1.03)	0.98 (0.86-1.11)
Q4 (lowest)	1.00	1.02 (0.93-1.11)	0.98 (0.90-1.06)	1.03 (0.95-1.12)
Interaction <i>p</i> -value ³		0.009	0.201	0.012

¹ Adjusted for school-level clustering and weighted for population representativeness

² Multilevel Poisson regression controlling for biological sex, school grade, feeling low or depressed, family structure, frequency of face-to-face contact with peers, involvement in group activities, perceived family wealth, and peer support

³ Interaction of CMC*family communication quality

Table 3.6 Hierarchical Poisson regression predicting the relative risk of loneliness among Canadian adolescents.

Relative risk of Canadian adolescents feeling lonely¹			
Exposure:	<i>Model 1:</i> Verbal CMC² (n= 23146) RR (95% CI)	<i>Model 2:</i> Messaging CMC³ (n= 22851) RR (95% CI)	<i>Model 3:</i> Social Media CMC² (n= 23017) RR (95% CI)
Biological Sex			
Female	(ref)		
Male	0.81 (0.77-0.86)	0.82 (0.77-0.87)	0.82 (0.77-0.86)
School Grade			
6-8	(ref)		
9-10	1.09 (1.03-1.16)	1.10 (1.04-1.17)	1.09 (1.03-1.16)
Feeling Sad or Hopeless			
No	(ref)		
Yes	3.01 (2.84-3.19)	3.03 (2.86-3.22)	3.03 (2.86-3.22)
Family Structure			
Nuclear	(ref)		
Non-Nuclear	1.07 (1.01-1.13)	1.08 (1.02-1.14)	1.07 (1.01-1.13)
Frequency of Contacting Friends			
Weekly or more	(ref)		
Less than weekly	1.18 (1.12-1.25)	1.16 (1.10-1.23)	1.18 (1.12-1.25)
Peer Support			
High	(ref)		
Low	1.27 (1.19-1.35)	1.26 (1.18-1.35)	1.27 (1.19-1.36)
Perceived Family Wealth			
High	(ref)		
Average	1.10 (1.04-1.17)	1.10 (1.04-1.17)	1.10 (1.03-1.16)
Low	1.25 (1.15-1.35)	1.24 (1.14-1.34)	1.24 (1.15-1.35)
Involvement in Group Activities			
3+	(ref)		
2	0.86 (0.80-0.93)	0.87 (0.81-0.93)	0.87 (0.81-0.93)
1	0.89 (0.83-0.96)	0.91 (0.84-0.97)	0.90 (0.84-0.97)
None	1.02 (0.94-1.10)	1.03 (0.95-1.11)	1.02 (0.95-1.11)

¹ Adjusted for clustered nature of data and weighted for population representativeness, ² Adjusted for all other variables in the model and the interaction between CMC and family communication, ³ Adjusted for all other variables in the model and family communication quality

Chapter 4

Perceptions of the Perceived Influence of Computer-Mediated Communication on the Health and Well-being of Early Adolescents

Abstract

Recent technological advancements have provided many youth with daily, almost continuous cell and Internet connectivity through portable devices. Young people's experiences with computer-mediated communication (CMC) and their views about how this form of communication impacts their health have not yet been fully explored in scientific literature. A purposeful maximum variation sample of young people (aged 11-15 years) across Ontario was identified using key informants for recruitment. Youth participated in seven focus groups (involving a total of 40 youth), and discussed various aspects of health including the health impacts of CMC. Inductive content analysis of the focus group transcripts revealed two overarching concepts- first, that health impacts are multidimensional and second, that there exists a duality of both positive and negative influences of CMC on health. Within this framework, four themes were identified including CMC and: (1) physical activity, (2) negative mental and emotional disturbance, (3) mindfulness, and (4) relationships. With this knowledge, targeted strategies for healthy technology use can be developed, drawing on the perspectives of young people, to be implemented by parents, teachers and youth themselves.

Key words: Adolescent health, computer-mediated communication, well-being, social health, screen time

Introduction

Canadian adolescents have become more and more connected via the Internet over the last ten years, first through the medium of the desktop computer and now more commonly, through the use of a compact device such as a cellphone or tablet. Using these devices in daily, and sometimes continuous, communication with friends is common (Steeves, 2014). Use of computer-mediated communication (CMC) allows youth to connect with their friends or family members regardless of physical distance. In a recent study of Canadian youth, 99% had access to the internet in some fashion and by fourth grade approximately 50% had their own cellphone (Steeves, 2014). With this high level of potential connectivity, the impacts of CMC on health are important to investigate.

Conflicting findings about the impact of CMC on health outcomes exist between scholars. Some scholars identify CMC as an opportunity for self discovery, trying on different personas outside of the physical world (Turkle, 1999). Others explain the vast number of opportunities to communicate and build social supports with others (Greenhow & Burton, 2011; Kraut et al., 2002) allowing for the creation of diverse social networks (Hlebec, Manfreda, & Vehovar, 2006). These speculations are challenged with suggestions that use of CMC has reduced face-to-face contact, influencing feelings of loneliness and perception of social support (Kraut et al., 1998; Moody, 2001; Prezza, Pacilli, & Dinelli, 2004; van den Eijnden et al., 2008; Vergeer & Pelzer, 2009). Further, issues exist around young people's sedentary screen time associated with CMC engagement, along with anxiety provoking pressures for youth to always be accessible online (Bond, 2010; Leatherdale, 2010), perfecting their online persona and being

digitally connected but unconnected to those in their physical environment (Turkle, 2008, 2012).

The aforementioned potential benefits and potential drawbacks of using CMC among youth influence diverse aspects of their overall health.

There is little scientific literature examining how young people experience, perceive or assess the impact of CMC on their health. Youth likely have a unique perspective on the emerging phenomenon of CMC and it is important to understand their perspectives about the benefits and drawbacks of these activities (Herring, 2008). This study investigates how the use of CMC could impact the health of young people in the early adolescent period, between the ages of 11 and 15 years, a stage of life when CMC is becoming increasingly common. We have gathered the opinions and experiences of CMC among Canadian young people and explored their thoughts on how CMC affects their health. In doing so, we hope to highlight the youth perspective as well as to develop a framework outlining the potential influence that this exposure may have on the health of young people overall. We also hope to explore and inform concrete ways we can promote healthy technology use for overall health benefits among early adolescents.

Methods

Data Source and Sample

This study utilized transcript data from seven youth focus groups conducted in 2014, involving 40 adolescents. Purposeful, maximum variation sampling was achieved using key informants to identify youth. These well-situated people in the community were able to contact potential participants according to the purposeful sampling plan and disseminate the study information (including informed parental consent forms). The final focus groups involved an Ontario based, geographically diverse sample of youth 11-15 years of age, further detail about the focus groups have been previously provided (Michaelson, Mckerron, & Davison, 2015). Participants were recruited based on the characteristics of age, sex, rural/urban residence and length of time living in Canada. A purposeful sample selects participants based on strong ability to contribute to understanding the overall phenomenon (Mayan, 2009). Within each focus group, participants were of homogeneous demographic characteristics as they had one or more of the sampling characteristics in common. This was done in order to aid in facilitating conversation and comfort among youth as they shared similarities. The maximum variation was achieved through heterogeneity *between* all focus groups to create comparisons between groups and represent an overall diverse sample. Participants were sampled from eastern Ontario (Hastings and Frontenac Counties), northern Ontario (Sudbury), western Ontario (Bruce County) and the Greater Toronto Area in central Ontario.

Data Collection

This study is inspired by grounded theory methodology put forth by Glaser and Strauss (1967) in that rather than applying a predetermined theoretical perspective throughout data collection, an area of interest was identified, thus allowing for findings to emerge “from the ground up” (Charmaz, 2014, p. 125). Data were generated through asking youth broad questions around their perceptions of health. Themes that emerged early in the study helped to shape questions in subsequent focus groups (Michaelson et al., 2015). All audio from focus groups were recorded and transcribed verbatim for analysis. Focus groups were utilized for data collection as large amounts of information can be collected in a short period of time (Berg, 2009; Morgan, 1997). Further, this method allows for open discussion of items and issues and for themes to emerge organically from the discussion (Berg, 2009). In addition, focus groups also allow for the interactions and comparisons made between the young participants engaging with one another to be captured (Morgan, 1997; Raby, 2010). Using focus groups for adolescent research specifically allows for the “shared culture” of this demographic to be revealed and insight gained about their health behaviours and practices from a youth perspective (Raby, 2010). Potential challenges with focus groups involve the tendency for conformity amongst peers in a group setting or sharing extreme ends of opinion (Morgan, 1997). There is also a potential challenge of domination of the group by a select participant (Berg, 2009). These challenges were mediated by the use of trained moderators along with research topics pertinent to the lives of youth for ease of sharing and discussion (Morgan, 1997).

To initiate discussion in the focus groups, photo elicitation techniques were used. Generic photos depicting aspects of social, physical, mental and spiritual health to which the youth could relate, as well as images depicting youth, their friends and their family members utilizing technological devices were introduced. This was undertaken to stimulate discussion beyond use of probing questions and because “images evoke deeper elements of human consciousness than do words” (Harper, 2002, p. 13) and so could further stimulate discussion beyond use of probing questions. The inclusion of images allowed for added ease of discussion during the focus group as the conversation was rooted in an image that both researcher and participant recognized (Harper, 2002). This technique allows not only for the topic of interest to be presented but unveils the relationships of participants to the image selected (Harper, 2002). Given that preselected photos were utilized in the focus groups, thus incorporating preconceived ideas about health into the discussion, this study was not grounded theory in its purest form. Rather, it was inspired by grounded theory and utilized many elements of this method.

Analysis Strategy

Discussions of CMC within the transcript were abstracted with 2-3 line buffers outside of the CMC discussion to ensure context was available for the text of interest. Extraction excluded reference to video games, surfing the Internet, and general media. This allowed for the focus to be on communication technology. Inductive content analysis was undertaken on the remaining CMC-related focus group transcript data as per a method outlined by Elo and Kyngäs (2007). This is a method of qualitative analysis used to obtain an overall objective description of the

phenomenon under study through the process of identifying categories that emerge from the transcript (Elo & Kyngäs, 2007). An inductive content analysis refers to the fact that the categories emerge to describe overarching concepts (Elo & Kyngäs, 2007).

The first level of coding involved line-by-line open coding in order to describe the explicit content of the text. This process involved reading each focus group transcript and tagging the meaning or content of each line briefly in the margins (Elo & Kyngäs, 2007). This level of coding allowed us to gain an early understanding of the basic content of the data (Mayan, 2009). Second and third authors co-coded two transcripts independently then all three authors compared and discussed individual coding in order to be explicit about personal biases, and to allow for triangulation and transparency of codes. After these discussions, a consolidated code list was created and code definitions written to ensure rigorous and streamlined labeling across all remaining focus groups. The total first order code list consisted of 79 codes or tags.

Following first order coding, all codes were grouped into meaningful units called categories (Forman, Damschroder, & Content, 2015). Categories were based on commonality among codes or identified links between codes in order to reduce the overall quantity of codes and to develop meaningful units (Elo & Kyngäs, 2007; Graneheim & Lundman, 2004; Hsieh & Shannon, 2005). Formation of categories is a form of data simplification and brings added understanding to the text to begin describing the overall phenomenon (Elo & Kyngäs, 2007). In this second round of coding, ten categories were established. Once all of the categories were identified, the internal homogeneity of each category was checked through ensuring each transcript section, the selected quotation, corresponded to the category chosen (Mayan, 2009).

After developing the ten main categories within the data, axial coding involved generating higher order themes (Mayan, 2009). The themes linked multiple categories together and explicitly quantified an intertwined thread that existed within the categories, to integrate them at a higher level (Graneheim & Lundman, 2004; Mayan, 2009). This third stage of analysis resulted in four themes. Following this, two overarching concepts were identified that linked all higher order themes and categories together at the highest level of analysis. Themes uncovered were assessed for strength based on the depth, consistency and frequency of occurrence in all focus groups along with the plethora and richness of examples reflected depicting the higher order concepts.

Academic Rigour

To enhance trustworthiness of findings, strong rigour was achieved in various ways. First, credibility was considered when selecting diverse participants based on demographics such as age, sex, urban/rural and how long a young person has lived in Canada. This provided richness to the data gathered on the topic of interest (Graneheim & Lundman, 2004). Second, approaching the data through line-by-line open coding allowed the researchers to remain close to the data. Finally, constant collaboration with principal investigators involved in focus group data collection was maintained to provide triangulation between researchers and to verify analysis (Graneheim & Lundman, 2004). Code descriptions and frameworks were part of the audit trail necessary for rigorous and trustworthy qualitative work, ensuring dependability and credibility in this study (Graneheim & Lundman, 2004). Concurrent memos, in the form of technical or academic notes, were continuously created in order to document thoughts, first impressions of the text and early connections made by the researchers. These memos prevented loss of ideas,

provided explicit information about personal biases, maintained the audit train and enhanced reflexivity. The memos served as a map of the early analytic process and support the overall inference (Forman et al., 2015). Transferability of findings can be assessed through the presentation of descriptions of participants and all analysis procedures along with inclusion of rich quotations generated by participants (Graneheim & Lundman, 2004).

Ethical Considerations

Prior to participation in the focus groups, written and verbal information was given to parents and youth participants. The written consent of parents and written assent of participants were collected before participation in the study. At the start of each focus group all youth participants also gave verbal informed assent. The Queen's Health Sciences and Affiliated Teaching Hospitals Ethics Board approved the focus group protocol (EPID-447-13; Romeo approval number #6011166) and this specific study (EPID-520-15; Romeo approval number #6016097).

Results

Youth participants are described in Table 4.1. All participants (n=40) were students attending public schools throughout Ontario and spoke fluent English.

Table 4.1 Demographic characteristics of study participants.

Characteristic	N
Sex	
Male	13
Females	27
Age	
12-13	22
14-15	18
Residence in Ontario	
Rural	9
Rural/urban	17
Urban	14
Total participants	40

The content analysis of the CMC specific sections of the transcript revealed a framework that included multiple themes around CMC use and the health of Ontario young people (Figure 4.1).

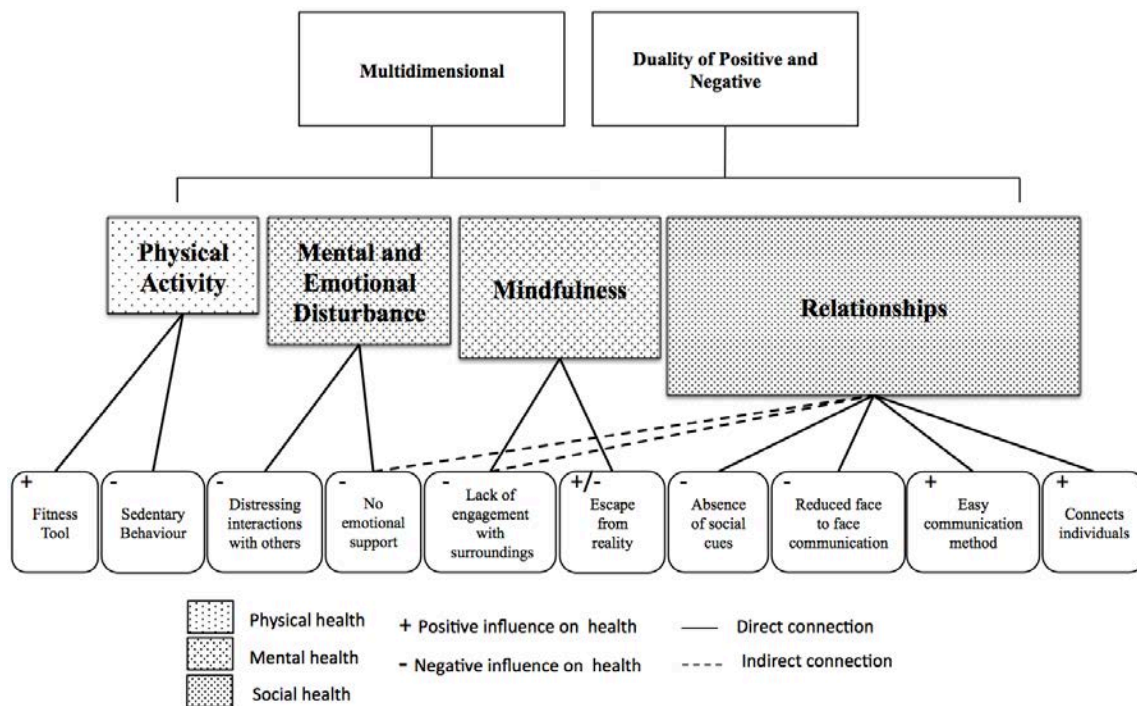


Figure 4.1 Categories, themes and overarching concepts of the relationship between CMC and the health of young people.

Overall, this analysis identified two overarching concepts: (1) the multidimensional relationship between CMC and health along with (2) duality of positive and negative potential influences of CMC to health. The multidimensional relationship refers to the fact that engagement in CMC does not only affect one domain of health. CMC can potentially influence social, mental and emotional health along with aspects of physical health. The second overarching concept of both positive and negative aspects, suggests that the influence of CMC is two sided. There exists an element of duality, as there are benefits along with drawbacks to use in regards to health. These two overarching concepts describe four themes including: (1) physical activity, (2) emotional and mental disturbance, (3) mindfulness, and (4) relationships (Figure 1).

Examples of physical activity

Sedentary screen time behavior. Use of CMC was identified as having an impact on the time that youth remain sedentary, as it is a part of overall daily screen time. One youth expressed, “I think that is a big thing affecting health. Everyone now has a cell phone and computer and so people are less active....” Further, it was clear that the youth identify use of cellphones as the opposite of a healthy and active lifestyle through stating that “they prevent us from going out and having [physical] activity.”

Regulator of fitness. With smartphone technology and the advancement of digital applications (apps) for health, the relationship between our devices and health is extended beyond communication. Individual ownerships of cell phones and devices can aid us in regulating our fitness:

Some phones or devices you can get a fitness set for it if you want. That could keep track of your weight or how much time you work out or what you have eaten and if it is healthy or not.

This comment highlights the knowledge that youth recognize the capacity of these devices beyond a communication method and as a tool to monitor fitness trajectories.

Examples of emotional and mental disturbance

Engaging in distressing interactions with others. Use of CMC to connect with others evoked distressing negative emotions for some focus group members. One youth articulated that consistent engagement in CMC provided access to continuous negative and emotionally distressing interactions with peers:

I used to have it all of the time and I would [get] really angry and stuff. There was a lot of drama that was involved with it. People say stuff over text that they wouldn't necessarily say in person. It made me more stressed and when I didn't have it I felt better.

With use of CMC, the ease of conversation resulted in hurtful interactions. Through constant connection through CMC, distance from their device was required to offer relief from their negative emotions.

Beyond the "drama" that occurs with friends, the youth indicated that cyber bullying was a potential source of emotional distress in their lives as well. During the focus groups one participant noted the influence of cyber bullying on youth, "she is looking at her phone sort of mad or sad maybe because of something like cyber bullying." Further, the lag time in messaging can be concerning, as there are breaks in communication that may leave questions unanswered and issues unresolved. One participant shared:

Text messages I find that I don't know the person might feel okay but they are actually not. But when you text a message at 10:00 am and then again at noon hour that says yeah I am fine. And it is like well thanks for telling me hours later. I have been worrying.

CMC allows for connection at any point but also lag time between connections when messages go unanswered. This break in communication can result in youth experiencing distressing emotions. CMC can actively promote hurtful interactions among youth along with passively impacting them from waiting for responses from their peers.

No emotional support provided. Not only did negative communication cause mental distress for participants, but it was also not always felt to be effective for providing support to others. This is illustrated by the following comment by a participant:

...if it is a personal conversation you are there to comfort them. If you are talking to someone on the phone or you are texting them and they start crying you can't do anything. You are just there and the most you can tell them is that it is all right. That does not always work for people.

Without being in the physical presence of one another, the innate features of text based CMC provide a barrier in communication. This young person felt that they would be unable to offer the proper support to a friend who is in need.

Examples of mindfulness

Lack of engagement with surroundings. When this population of youth engaged in CMC, they often referred to experiencing a passive disengagement from the present moment. They displayed a lack of mindful behavior or focus on other tasks after receiving influential news through methods such as text messaging. One youth shared a bad experience by saying, "I got a phone call at my school saying that a family member passed away and I had to wait a couple of hours for my mom to get me and then I'd sit there and think...I can't focus on what is going on right now." Further, there was an observed lack of awareness of the external environment when engaging in this method of communication. One participant stated that being completely engaged in CMC "is not healthy because they are not paying attention to what is around them." It was voiced strongly that individuals fully engrossed in their technology are "hypnotized" with their

own thoughts influenced by technology as “you don’t really think or anything and that is all you know after awhile.” These statements suggest that youth have insight into the ability of communication technologies both to transport them from the present moment and to influence their ability to focus on present tasks.

Escape from reality. Another way this theme was discussed amongst the youth was in reference to opportunities for youth to actively “escape through electronics” and remove themselves from a situation or environment if they perceive it to be unhealthy or distressing. It can be their time to check out and not have to deal with negative situations of the present:

I feel that technology that we have can be a stress and at the same [time] it can bring you in to escaping what is going on around you and be an escape...Say if a kid is going through a tough time and it is not the greatest time and they are getting picked on at school. Or grandpa or grandma or mother or father is not doing so good... they escape what is going on around them and they are just into it and they are having a good time.

Disengaging from the present moment is utilized in this manner as a way to cope and to bring joy or a sense of calm to the youth when their environment is unhealthy or painful.

Examples of relationships

Easy communication method. Youth value the influence of CMC in their lives. They articulated that CMC “is easier to communicate” as the innate features of CMC support quick and direct exchanges of communication between individuals.

Connects individuals. Use also provides benefits through allowing them to “keep in contact with family who does not live close”, through allowing communication when physical distance would traditionally keep individuals distant. Further, these modern mediums allow connection to others

beyond the young person's physical social network. When asked if a technology medium such as YouTube was a barrier to real life, one youth responded:

Yes and no. You are really getting to know that person. When they get big on the YouTube they would [share] things about their personal life. They share positive and negative stuff. So it is kind of both. You can connect with them also.

CMC mediums allow for youth to connect to others who are physically distant or to those whom they know solely from online platforms. This connection bridges social interactions from many points around the globe.

Absence of social cues. Another dimension to this theme related to the innate qualities of CMC that are lacking in comparison to face-to face contact. One youth spoke to the fact that "by text message...you don't know what their voice is like." This was a direct reference to the inability to hear auditory content in some mediums of CMC such as text messaging and social media.

Without these important social cues, "you don't get to know what people are feeling and don't see their emotions and all that stuff." Further, social cues are important for understanding the overall interaction:

When you are texting someone it is hard...when you talk to someone the tone of voice really tells what you are saying. You can say sorry genuinely or you can say, oh sorry. Over text it is hard to perceive what the person says. And that can cause drama because you can misunderstand things and there is miscommunication and stuff. It is good to have a balance.

Without hearing tone of voice, a barrier is created in effectiveness of overall communication and support given to one another. With the potential for misunderstanding when engaging in CMC, this method of communication makes conversation more difficult.

Reduced face-to-face communication. Not only do the features of these devices reduce closeness and interactions between people while engaging in contact through CMC, but it was discussed to reduce social interactions with those around you face-to-face: “It takes away from communication. You don’t communicate with people and you lose your ability to converse and ...now-a-days most people can’t hold a proper conversation and it affects how you speak to people.” Youth identify that face-to-face conversations have been negatively impacted with adoption of CMC based communication.

Lack of conversing with those in the physical environment can potentially influence the relationships between individuals and your ability to connect. Use of devices and not communicating was identified as an obstacle to growing closer and building relationships. One participant noted that,

Electronics have become a big part of our lives and stuff. A lot of teenagers use them a lot. I am not saying that it is bad to go on electronics because it has helped a lot. But around a dinner table I feel like you should be more with your family and talking to them. A lot of the time you are at school and your parents are at work and you won’t be able to see them until dinner. So that is a time to catch up with them.

Through this observation, youth recognize that even though we live in a world surrounded by technology and CMC, there are certain times to connect with those around you, not through CMC.

The importance of technology-free family time was a theme that emerged throughout all focus groups. One participant expressed, “If we are at the dinner table and we are on our phones, we are not talking about our day. So we don’t get closer as a family.” Another voiced that, “There are times when you have to put it down and just talk to your family and not bring it to the

dinner table.” From all focus groups, there was strong recognition that family time should be a time to converse together and build strong family relationships, without the distraction of technology use by themselves or by their parents.

Discussion

This qualitative study addresses CMC use and the health of young people. In particular, the experiences and perceptions of young people are reviewed. Two overarching concepts emerged with respect to the potential impact of CMC on the lives of young people. The first is that the relationship between CMC and health is multidimensional relating, for example, to aspects of social, physical, mental and emotional health. The second is the duality of influence as use of CMC can result in both positive and negative influences to health. Furthermore, four specific themes emerged from discussions with youth around CMC. These focused on (1) physical activity, (2) mental and emotional disturbance, (3) mindfulness, and (4) relationships. In this discussion section, the four specific themes and the two overarching concepts are explicated in greater depth and related to existing literature. The aim is to reflect on the perceptions of youth populations specifically, and to explore their ideas about the relationship between CMC and health.

The young people in our study sample recognized the probable impact of CMC devices on their overall physical activity, in both positive and negative manners. The youth expressed strong insight into the ability of CMC use to increase their sedentary behaviour. This finding accords with previous research. For instance, in Canada, it is recommended that youth spend less

than two hours per day sedentary, including time spent using CMC (Tremblay et al., 2011). Among an Ontario-based sample of adolescents, 25% of these young people used social networking sites for more than two hours per day, not including additional time spent using other methods of CMC (Koivusilta, Lintonen, & Rimpela, 2007). Sedentary behaviour, apart from physical activity, is linked to poor physical health outcomes such as higher BMI along with low self-esteem and poor academic success (Tremblay et al., 2011). Findings suggest that youth are aware of how CMC increases time spent sedentary and how this is not beneficial for health. Even with this awareness, youth remain high users of CMC. Therefore, this knowledge does not appear to translate into behaviour change for this population of users.

The second manner of probable influence of CMC use on physical activity, according to the youth, is in opposition to sedentary behaviour. Youth acknowledge the potential of CMC devices to facilitate physical activity through fitness applications downloadable to mobile devices. Adoption of this method to increase physical activity is suggested by Nicole, Evan, and Derikk (2015) for individual and school-based physical activity programs, but evidence of the effectiveness of these applications on health remains mixed (Quelly, Norris, & Dipietro, 2015). With diversity in applications directed to fitness, heterogeneous findings have emerged. Use is found to increase enjoyment and motivation for fitness (Turner, Spruijt-Metz, Wen, & Hingle, 2015) but to produce insignificant changes to fitness and body composition (Quelly et al., 2015). Although participants suggested these apps were beneficial, the clinical efficacy of these applications remains unclear. Given this, the influence of CMC devices on physical activity is not one-dimensional. There are possible benefits such as fitness applications and connecting

individuals to active peers groups. However, with mixed findings, the utility of these devices for physical fitness and health is unclear. Even though the youth may see these devices as promoters of physical fitness in some situations, they may not be providing an overall benefit to health. The discussion among the youth in this study regarding the impact of CMC on physical activity was dominant towards sedentary influences. They are aware of a stronger pull of CMC to promote sedentary behaviours rather than activity; some youth may overestimate the fitness potential of their devices.

Another category that emerged was the potential for negative emotional and mental health disturbances when engaging in CMC. The negative emotions such as stress, anger, and sadness that, according to the youth, result from engaging in CMC are also mentioned in previous research linking CMC with poor mental health outcomes. Use of CMC is associated with outcomes such as loneliness and low self-esteem (Chen & Lee, 2013; Sampasa-Kanyinga & Lewis, 2015) along with mental health issues such as depression, and feelings of anxiousness (Riedl, Köbler, Goswami, & Krcmar, 2013; Sampasa-Kanyinga & Lewis, 2015). Cyber bullying was also mentioned as a concern eliciting distressing emotions. Experiencing cyber bullying is consistently associated with rates of depression among young people (Hamm et al., 2015). This form of bullying can have more traumatic influences on young people as the public platform allows for an unlimited number of viewers and constant engagement at any point throughout the day. The link between distressing emotions experienced by youth and cyber bullying has been described in previous research, emphasizing the strong mental and emotional health components. Youth are aware that use of CMC has the potential to negatively impact their mental and

emotional health. Even with this awareness, youth still utilize this method of communication often to contact their peers. This method of communication has often become a social norm amongst groups of young people, even in early adolescence. The young people in our study indicated that negative emotional impacts did not lead to withdrawal from use. This finding points to the need for regulation of use in order to support strong emotional or mental health in young people.

In the focus groups, the youth spoke of multiple situations at home, with their family, at school, or generally in their lives in which attention is taken from the present with use of technology. Mindfulness is being attentive to the present moment through being open, accepting and curious about current experience (Hassed & Hassed, 2016). Innate traits of mindfulness (Curtiss & Klemanski, 2014) along with mindfulness based training (Hofmann, Sawyer, Witt, & Oh, 2010) benefit mental health through improving situations of depression and anxiety among adults and youth (Kuyken et al., 2013). Our technology rich society does not always support mindfulness or developing mindfulness skills among youth as there exists a technology “co-presence” in which we are often removed from the present moment through technology (Turkle, 2008, p. 2). This allows for adoption of the “default mode”; characteristic of distraction, lack of attention and preoccupation in thoughts (Hassed & Hassed, 2016, p.53) as technology promotes multitasking and divided attention of the virtual and physical world (Turkle, 2008). These ideas are well illustrated by the results of our own study, which indicate youth being removed from the present while engaging in CMC. Given that mindfulness is a skill that is beneficial to health

(Hassed & Hassed, 2016), it is important for youth to limit distraction through CMC in order to support overall mental health and well-being.

Youth also expressed distraction as a method of coping with poor current family or life situations. While many youth identified this emotion-focused repression coping style (Compas, 1987) to be beneficial, literature does not point to an overall advantage of this coping style (Herman-Stabl, Stemmler, & Petersen, 1995; Mahmoud, Staten, Hall, & Lennie, 2012).

Adolescents who cope using avoidant behaviours have significantly higher self-reported rates of depression (Herman-Stabl et al., 1995), anxiety and stress (Mahmoud et al., 2012). Lack of awareness is linked to mental illnesses, such as depression, through allowing the mind to ruminate on negative thoughts in a passive manner instead of drawing awareness to them (Ciesla, Reilly, Dickson, Emanuel, & Updegraff, 2012; Curtiss & Klemanski, 2014). Specifically among youth, the association between low mindfulness based traits, or inability to focus on the present moment, and low mood was mediated by rumination (Ciesla et al., 2012). Therefore, youth may not recognize the negative implications to their health in choosing to use CMC and technology as a distraction from real issues they are experiencing. They see self-removal from the present negative situation as a solution for short-term cessation of difficult emotions. This Band-aid like approach of removal from the present situation, through the use of technology, may result in poor long-term influences and adoptions of unhealthy coping behaviours early on in adolescence, which can influence coping and emotion regulation abilities in the future.

Modern technology devices have allowed for communication between individuals to transpire regardless of physical distance (Monge & Contractor, 2003). Further, these technologies have connected individuals who are separated by physical distance to the same virtual space, creating a sense of real gathering in a virtual world (Monge and Contractor, 2003). The youth in this study recognized and noted this benefit by referencing the ability of these technologies to bridge them to family and friends even when they are apart. These findings are consistent with views that CMC benefits connection by allowing for an expansion of one's social network and continuous interactions with those whom they do not come across face-to-face (Hlebec et al., 2006; Lin, Sun, Lee, & Wu, 2007). This continuous connection can allow youth to feel closer to their friends (Valkenburg, Sumter, & Peter, 2011), benefiting their social relationships and perceived social support. With the popularity of use, youth use CMC often to connect with friends. Therefore, communication with others regardless of physical distance has become a part of their social norm as they value this ability to connect when apart.

In contrast to the aforementioned benefits, CMC also poses barriers to social health. Through the depth, consistency and frequency of occurrence in all focus groups, along with the plethora of examples and situations of impact, the largest potential influence of CMC on overall health are the possible negative implications of use to social health. Use of CMC was discussed to negatively influence social health through impacting communication with others and consequently our relationships. Both communication and relationships have been altered through adoption of CMC in society and work hand in hand to impact our social networks and support from peers. These two aspects will be discussed further below.

Youth acknowledged some innate and non-modifiable features of CMC that act as a barrier to communication. For example, the lack of social cues present when using this method of communication affects the depth of connection possible. Previous research has identified that vocal cues are important for conversation, since without hearing a voice there is a high threat of perceived insincerity and conflict through misunderstanding someone's true intention (Park, Chung, & Lee, 2012). The youth also recognized that CMC reduced time spent engaging in face-to-face communication with others. In the past, it would be impolite to stop a face-to-face conversation with someone to check messages on your device or sit next to someone in a public space and not acknowledge the other person (Turkle, 2011, 2012). With individual technological devices, this has become accepted behaviour for many people (Turkle, 2011, 2012). This phenomenon can be explained through the displacement of social interaction hypothesis put forward by Kraut et al. (1998). This hypothesis outlines that through integration of CMC in society, less communication is taking place face-to-face and, therefore, less satisfying relationships between individuals are being produced (Kraut et al., 1998; Turkle, 2011). With this displacement we have "confused connection with conversation" as small CMC based interactions are not able to replace connection through conversation (Turkle, 2012). Warnings made by scholars regarding the reductions in conversation and poor communication quality associated with CMC are reflected in the perceptions of the youth in our focus groups. Even with these cautions by scholars and youth recognizing limitations as well, CMC continues to be used frequently for communication.

In addition to the other social related influences already mentioned, it was also identified that use of CMC influenced not only communication potential and relationship initiation between individuals, but also the quality of our relationships. Youth strongly referenced negative implications of CMC use while with their family members as it prevented them from engaging with one another and in turn they “don’t get closer as a family.” Research indicates that we do not have to be using our CMC device for it to influence relationships. The presence of a cellphone alone while individuals are interacting prevents meaningful conversation among individuals, reducing their perceived closeness to one another (Przybylski & Weinstein, 2012). In situations with strangers or even with family members, CMC provides a strong distraction to communication and building relationships. The youth in this study recognized communication as an important ingredient for strong relationships, especially with family. Strong family relationships can protect youth from engaging in risky behaviours such as alcohol use, smoking, and early sexual initiation as well as providing support for youth experiencing mental health challenges (Viner et al., 2012). With concern over potential loss of connection due to CMC use, movement towards device limited time with family members and friends may be one avenue for intervention that may be adopted by youth and support them in building strong relationships and social support.

Two overarching concepts identified through building upon the perspectives of CMC use among youth include: (1) the multidimensional relationship between CMC and health and (2) the duality of positive and negative potential influences for health. The way in which the youth express the influences of CMC is consistent with a holistic view of health as it consists of

multiple domains. This holistic view of health is reflected in the World Health Organization definition of health as it identifies health as “...a state of complete physical, mental, and social well-being...” (World Health Organization, 1948). Since youth expressed experiencing the potential influences of CMC in this holistic way, continued adoption of these domains in regards to youth health promotion initiatives is supported. In addition, the dual impact of both positive and negative elements is in line with the inconsistency shown in the literature. It showcases how this complex issue does not hold consensus in terms of CMC use being only harmful or only hurtful to health. The conflicting health beliefs around the influences of CMC present a barrier to behaviour change of withdrawing use, as there are not solely negative implications. This poses a challenge for health promotion efforts in the future.

Current literature supports the youth perspective of the relationships between CMC and health. Even with recognition of harm on physical, mental and social health, use of CMC devices remains high amongst this cohort (Steeves, 2014). It is important to recognize that youth are aware of the potential detrimental health effects of CMC but also value the benefits. In conclusion, CMC can potentially influence health but the active choices we make about the frequency and manner of use ultimately determines the overall health influence. These choices can allow space for balance and control of the positive and negative potential influences to our health.

Limitations

This study has specific limitations. The data are limited in scope since data collection was only conducted in Ontario, and these findings might not be transferable to all Canadian young people of this age bracket. Focus groups were conducted with grounded theory inspired methodology (Michaelson et al., 2015), with a focus on holistic health. Therefore, CMC use by youth surfaced early on and was probed for in subsequent focus groups but was not an initial focus of data collection. This may reduce depth of data regarding CMC, as it was not an initial aim of the focus groups. Limitations also exist within the focus group format itself. The groups were conducted at one point in time and, therefore, do not reflect changes in opinions or perspectives. With this method of data collection there is the potential for a few youth to dominate the discussion and data collection, preventing all opinions to surface within the group. This limitation was minimized through the involvement of trained facilitators who moderated all sessions. Finally, researcher biases have been introduced into this study as it was conducted following a quantitative investigation. Potential biases involve the assumed directionality of CMC use influencing health outcomes along with an interest on social implications of the relationship between CMC use and the health of youth.

Strengths

The strengths of this qualitative study are in the depth and richness of the data collected from the youth. The diverse male and female participants were recruited from a variety of ages, geographic areas throughout Ontario, and with different amounts of time spent living in Canada. All youth were engaged during the focus groups, eager to share their voice and contribute to

health science research. These data are their opinions and experiences, adding strength and trustworthiness to findings. Trustworthiness is further supported by strong rigour, achieved through line-by-line coding, development of an audit trail along with triangulation of researchers to verify analysis.

Implications for Interventions and Further Research

This study reveals that multiple domains of health are related to CMC use in both positive and negative ways. There is a need to recognize the potential impact of CMC and technology use on health in a more holistic way. This study on CMC use and the health of young Canadians advances our awareness of possible health impacts that could be considered in future research in order to advance the discussion beyond youth safety while engaging with others online. Currently, there are limited resources for parents to support them in encouraging healthy and safe use of digital technology. This study promotes adoptions of health promotion practices recognizing all aspects of health that CMC influences. Additionally, recognition of both the negative and the positive likely impacts of CMC on health will allow youth, parents and teachers, to identify these influences and perhaps identify ways to take steps in regulating CMC use in order to maximize the beneficial aspects for health and control the negative ones. One way to do so is to restore time for conversation such as the dinner table, car rides, or times spent with friends (Turkle, 2012). The American Academy of Pediatrics (2013) released a policy statement offering recommendations for parents regarding media use (American Academy of Pediatrics, 2013). They suggest limiting screen time to no more than two-hours per day through strategies such as no Internet connected device in the bedroom along with developing a family plan for

media use that establishes rules for using of cell phones and Internet for all family members. These rules can include “curfews” for use around dinners and bedtime (American Academy of Pediatrics, 2013). Youth in our focus groups recognized that use of CMC should be limited both in terms of length of time as well as activities engaged in. Having these discussions around setting limits to CMC use will promote healthy CMC practices and best serve overall physical, mental and social health.

Conclusion

From the perspectives and opinions of Ontario youth, computer-mediated communication has a diverse relationship with health. For these young people, engagement in CMC can potentially influence physical, mental and social domains of overall health in both positive and negative ways. The discussed negative implications of CMC for social health were most dominant. This method of communication connects us but poses limitations to our relationships through absence of social cues and reducing face-to-face engagement with others. The youth themselves strongly identified the need for face-to-face communication, not just CMC, to grow closer to individuals. Based on these findings, we recognize the need for actively choosing to step away from our devices and encourage the reintroduction of face-to-face discussions in the schoolyards and in our homes, where these may have been lost. This action will reduce screen time and distraction, allowing for the promotion of relationships with one another in the present moment, and support building of social supports. Even though the dominant potential influence was negative, we recognize that there are beneficial aspects of CMC that need to be captured and enhanced to support the overall well-being of youth.

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References

- American Academy of Pediatrics. (2013). *Children, Adolescents, and the Media. Pediatrics* (Vol. 132). doi:10.1542/peds.2013-2656
- Berg, B. (2009). *Qualitative Research Methods* (7th ed.). Boston, MA: Pearson Education Inc.
- Bond, E. (2010). Managing mobile relationships: Children's perceptions of the impact of the mobile phone on relationships in their everyday lives. *Childhood: A Global Journal of Child Research*, 17(4), 514-529. doi: 10.1177/0907568210364421.
- Charmaz, K. (2014). *Constructing grounded theory*. London: Sage Publications.
- Chen, W., & Lee, K.-H. (2013). Sharing, liking, commenting, and distressed? The pathway between Facebook interaction and psychological distress. *Cyberpsychology, Behavior and Social Networking*, 16(10), 728–34. doi:10.1089/cyber.2012.0272
- Ciesla, J. A., Reilly, L. C., Dickson, K. S., Emanuel, A. S., & Updegraff, J. A. (2012). Dispositional mindfulness moderates the effects of stress among adolescents: Rumination as a mediator. *Journal of Clinical Child and Adolescent Psychology : The Official Journal for the Society of Clinical Child and Adolescent Psychology, American Psychological Association, Division 53*, 41(6), 760–70. doi:10.1080/15374416.2012.698724
- Compas, B. E. (1987). Coping with stress during childhood and adolescence. *Psychological Bulletin*, 101(3), 393–403.
- Curtiss, J., & Klemanski, D. H. (2014). Teasing apart low mindfulness: Differentiating deficits in mindfulness and in psychological flexibility in predicting symptoms of generalized anxiety disorder and depression, 166, 41–47. doi:10.1016/j.jad.2014.04.062

- Elo, S., & Kyngäs, H. (2007). The qualitative content analysis process. *Journal of Advanced Nursing*, 62(1), 107–15. doi:10.1111/j.1365-2648.2007.04569.x
- Forman, J., Damschroder, L., & Content, Q. (2015). Qualitative content analysis. *Empirical Methods for Bioethics*, 39–62.
- Glaser, B. ., & Strauss, A. (1967). *The discovery of grounded theory*. Chicago, IL: Aldine.
- Graneheim, U. H., & Lundman, B. (2004). Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Education Today*, 24(2), 105–112. doi:10.1016/j.nedt.2003.10.001
- Greenhow, C., & Burton, L. (2011). Help from my “friends”: Social capital in the social network sites of low-income students. *Journal of Educational Computing Research*, 45(2), 223–245. doi:10.2190/EC.45.2.f
- Hamm, M. P., Newton, A. S., Chisholm, A., Shulhan, J., Milne, A., Sundar, P., ... Hartling, L. (2015). Prevalence and effect of cyberbullying on children and young people. *JAMA Pediatrics*, 169(8), 770–777. doi:10.1001/jamapediatrics.2015.0944
- Harper, D. (2002). Talking about pictures: A case for photo elicitation. *Visual Studies*, 17(1), 13–26. doi:10.1080/14725860220137345
- Hassed, C., & Hassed, C. (2016). Mindful learning: Why attention matters in education mindful learning: Why attention matters in education, 3603(February). doi:10.1080/21683603.2016.1130564

- Herman-Stabl, M. A., Stemmler, M., & Petersen, A. C. (1995). Approach and avoidant coping: Implications for adolescent mental health. *Journal of Youth and Adolescence*, 24(6), 649–665. doi:10.1007/BF01536949
- Herring, S. C. (2008). Questioning the generational divide: Technological exoticism and adult constructions of online youth identity. *Youth, Identity, and Digital Media*, 71–94. doi:10.1162/dmal.9780262524834.071
- Hlebec, V., Manfreda, K. L., & Vehovar, V. (2006). The social support networks of internet users. *New Media & Society*, 8(1), 9–32.
- Hofmann, S. G., Sawyer, A. T., Witt, A. a, & Oh, D. (2010). The effect of mindfulness-based therapy on anxiety and depression: A meta-analytic review. *Journal Consulting Clinical Psychology*, 78(2), 169–183. doi:10.1037/a0018555.
- Hsieh, H.-F., & Shannon, S. E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, 15(9), 1277–1288. doi:10.1177/1049732305276687
- Koivusilta, L. K., Lintonen, T. P., & Rimpela, A. H. (2007). Orientations in adolescent use of information and communication technology: A digital divide by sociodemographic background, educational career, and health. *Scandinavian Journal of Public Health*, 35(1), 95–103.
- Kraut, R., Kiesler, S., Boneva, B., Cummings, J., Helgeson, V., & Crawford, A. (2002). Internet paradox revisited. *Journal of Social Issues*, 58(1), 49–74. doi:10.1111/1540-4560.00248

- Kraut, R., Patterson, M., Lundmark, V., Kiesler, S., Mukopadhyay, T., & Scherlis, W. (1998). Internet paradox. *American Psychologist*, *53*(9), 1017–1031. doi:10.1037//0003-066x.53.9.1017
- Kuyken, W., Weare, K., Ukoumunne, O. C., Vicary, R., Motton, N., Burnett, R., ... Huppert, F. (2013). Effectiveness of the mindfulness in schools programme: Non-randomised controlled feasibility study. *British Journal of Psychiatry*, *203*(2), 126–131. doi:10.1192/bjp.bp.113.126649
- Leatherdale, S. T. (2010). Factors associated with communication-based sedentary behaviors among youth: Are talking on the phone, texting, and instant messaging new sedentary behaviors to be concerned about? *Journal of Adolescent Health*, *47*(3), 315–318. doi:10.1016/j.jadohealth.2010.02.012
- Lin, C.-H., Sun, Y.-C., Lee, Y.-C., & Wu, S.-C. (2007). How instant messaging affects the satisfaction of virtual interpersonal behaviour of Taiwan junior high school students. *Adolescence*, *42*(166), 417–430.
- Mahmoud, J., Staten, R., Hall, L., & Lennie, T. (2012). The relationship among young adult college students' depression, anxiety, stress, demographics, life satisfaction, and coping styles. *Issues in Mental Health Nursing*, *33*(2006), 149–156. doi:10.3109/01612840.2011.632708
- Mayan, M. (2009). *Essentials of Qualitative Inquiry*. Walnut Creek, California: Left Coast Press.

- Michaelson, V., Mckerron, M., & Davison, C. (2015). Forming ideas about health: A qualitative study of Ontario adolescents. *Qualitative Studies on Health and Well-Being*, 10.
- Monge, P., & Contractor, N. (2003). *Theories of Communication Networks*. New York: Oxford University Press.
- Moody, E. (2001). Internet use and its relationship to loneliness. *Cyberpsychology Behavior*, 4(3), 393–401.
- Morgan, D. L. (1997). *Focus Groups as a Qualitative Method* (Second.). Thousand Oaks California: Sage Publications.
- Nicole, J., Evan, J., & Derikk, M. (2015). Innovative ways to use modern technology to enhance, rather than hinder, physical activity among youth. *Journal of Physical Education, Recreation & Dance*, 86(4), 46–53.
- World Health Organization. (1948). *Constitution of the World Health Organization*. Geneva. Available at: http://www.who.int/governance/eb/who_constitution_en.pdf
- Park, N., Chung, J. E., & Lee, S. (2012). Explaining the use of text-based communication Media: An examination of three theories of media use. *Cyberpsychology, Behavior and Social Networking*, 15(7), 357–363. doi:10.1089/cyber.2012.0121
- Park, N., Chung, J. E., & Lee, S. (2012). Explaining the use of text-based communication media: An examination of three theories of media use. *Cyberpsychology, Behavior and Social Networking*, 15(7), 357–363. doi:10.1089/cyber.2012.0121
- American Academy of Pediatrics. (2013). *Children, Adolescents, and the Media*. (Vol. 132). doi:10.1542/peds.2013-2656

- Prezza, M., Pacilli, M. G., & Dinelli, S. (2004). Loneliness and new technologies in a group of Roman adolescents. *Computers in Human Behavior, 20*(5), 691–709.
doi:10.1016/j.chb.2003.10.008
- Przybylski, a. K., & Weinstein, N. (2012). Can you connect with me now? How the presence of mobile communication technology influences face-to-face conversation quality. *Journal of Social and Personal Relationships, 30*(3), 237–246. doi:10.1177/0265407512453827
- Quelly, S. B., Norris, A. E., & Dipietro, J. L. (2015). Impact of mobile apps to combat obesity in children and adolescents: A systematic literature review. *Journal for Specialists in Pediatric Nursing, 5*–17. doi:10.1111/jspn.12134
- Raby, R. (2010). Public selves, inequality, and interruptions: The creation of meaning in focus groups with teens. *International Journal of Qualitative Methods, 9*(1), 1–15.
- Riedl, C., Köbler, F., Goswami, S., & Krcmar, H. (2013). Tweeting to feel connected: A model for social connectedness in online social networks. *International Journal of Human-Computer Interaction, 29*(10), 670–687. doi:10.1080/10447318.2013.768137
- Sampasa-Kanyinga, H., & Lewis, R. F. (2015). Frequent use of social networking sites is associated with poor psychological functioning among children and adolescents. *Cyberpsychology, Behavior, and Social Networking, 18*(7), 380–385.
doi:10.1089/cyber.2015.0055
- Steeves, V. (2014). Young Canadians in a wired world, phase III: Life online. *MediaSmarts, 1*–60.

- Tremblay, M., LeBlanc, A., Kho, M., Saunders, T., Larouche, R., Colley, R., ... Connor Gorber, S. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, 8(1), 98–119. doi:10.1186/1479-5868-8-98
- Tremblay, M. S., Leblanc, A. G., Janssen, I., Kho, M. E., Hicks, A., Murumets, K., ... Duggan, M. (2011). Canadian sedentary behaviour guidelines for children and youth. *Applied Physiology, Nutrition, and Metabolism = Physiologie Appliquee, Nutrition et Metabolisme*, 36(1), 59–64; 65–71. doi:10.1139/H11-012
- Turkle, S. (1999). Cyberspace and Identity. *Contemporary Sociology*, 28(6), 643–648.
- Turkle, S. (2008). Always-On/Always-On-You: The Tethered Self. In *Handbook of Mobile Communication Studies* (p. 472). University Press Scholarship Online. doi:10.1201/9781420053890
- Turkle, S. (2011). *Alone Together*. New York, NY: Basic Books.
- Turkle, S. (2012, April 21). The flight from conversation. *The New York Times*, p. 1–5.
- Turner, T., Spruijt-Metz, D., Wen, C. K. F., & Hingle, M. D. (2015). Prevention and treatment of pediatric obesity using mobile and wireless technologies: A systematic review. *Pediatric Obesity*, 403–409. doi:10.1111/ijpo.12002
- Valkenburg, P. M., Sumter, S. R., & Peter, J. (2011). Gender differences in online and offline self-disclosure in pre-adolescence and adolescence. *British Journal of Developmental Psychology*, 12, 253–269. doi:10.1348/2044-835X.002001

- Vergeer, M., & Pelzer, B. (2009). Consequences of media and Internet use for offline and online network capital and well-being. A causal model approach. *Journal of Computer-Mediated Communication*, *15*(1), 189–210. doi:10.1111/j.1083-6101.2009.01499.x
- van den Eijnden, R. J. J. M., Meerkerk, G.-J., Vermulst, A. A., Spijkerman, R., Engels, R. C. M. E. (2008). Online communication, compulsive Internet use, and psychosocial well-being among adolescents: A longitudinal study. *Developmental Psychology*, *44*(3), 655–65. doi:10.1037/0012-1649.44.3.655
- Viner, R. M., Ozer, E. M., Denny, S., Marmot, M., Resnick, M., Fatusi, A., & Currie, C. (2012). Adolescence and the social determinants of health. *The Lancet*, *379*(9826), 1641–1652. doi:10.1016/s0140-6736(12)60149-4

Chapter 5

General Discussion

5.1 Integration of Quantitative and Qualitative Findings

The aim of this thesis was to investigate the potential health impacts of CMC use by Canadian youth. We undertook two independent yet complimentary investigations. Manuscript 1 estimated risks for loneliness in association with verbal, text messaging and social media CMC use reported by Canadian young people, and studied these relationships via interactive models that considered family communication quality as well as potential confounders. Manuscript 2 qualitatively assessed the potential influence of CMC on the health of Ontario youth, using a broad and holistic view of health. Both manuscripts contribute new understanding about the complex nature of the influence that CMC has on the health of Canadian youth.

Summary of Quantitative Findings

The quantitative findings identified that the relationship between CMC use and adolescent loneliness is not uniform for all youth, as it depends on the perceived quality of family communication that youth experience. Overall, loneliness is more frequently reported with lower relative levels of family communication. However, in this group CMC was not related to loneliness. Conversely, among a specific group of youth who reported experiencing high relative family communication quality, daily use of CMC was associated with reporting “often feeling lonely”. This highlights that family factors *along with use* of CMC use are essential to consider.

Summary of Qualitative Findings

Our qualitative analyses provided indication of a strong and diverse potential influence of CMC on physical activity, mental health, mindfulness and relationships. Positive and negative influences on health are considered. For example, engagement in CMC is positive when it connects youth to those who are physically distant, but acts as a barrier to face-to-face conversations and relationships, especially amongst family members. High technology and CMC use within the home is an important concern for youth and they recognized and endorsed a need for regulation and technology-free family time in order to remain connected with one another. With these findings, the extent of time spent using CMC along with the ways in which it is being used are deemed important for the nature of their health impact.

Integration of Findings from Both Research Approaches

Both quantitative and qualitative research approaches provide new evidence that could assist in the development and targeting of public health policies and programs. These approaches have inherent strengths and weaknesses [1–5], though the strengths of one method can address the weaknesses of the other when used in combination to address a research question [6]. Utilization of both approaches provides additional depth and breadth of interpretation. Findings from both studies suggested, for example, that CMC has non-uniform possible influences on social health. Both studies also indicated that health is significantly associated with family characteristics. The impact of traditional factors, such as the family unit, should not be ignored when considering the relationship between modern exposures such as CMC and health.

Both manuscripts and research approaches highlight the unique and non-uniform relationship between CMC and the health of youth, particularly in the areas of social health. The qualitative findings indicated that CMC is linked to elements of social health. This is also reflected in the quantitative analyses of loneliness, as loneliness can result through poor quality or quantity of social interactions. Furthermore, the quantitative analysis highlights how CMC use can be harmful for some sub-groups of youth but not for others. The qualitative analysis also indicates a diverse relationship between CMC and health, particularly through the positive and negative potential influences on social health. Lack of conversing with family members and ineffective communication with others through CMC may negatively impact social relationships. In contrast, when CMC is used to engage with those who are physically distant and is actively regulated in terms of choosing technology-free family time, not only is use not solely negative, but it could have beneficial implications to social health. The health impact of CMC may be different based on regulation of use or by the rules set at home by parents to encourage healthy usage boundaries and healthy relationships with others. Situational factors such as family communication quality and the different ways that CMC can be used, are important to capture in order to fully understand the diverse influence of CMC on the health of young people.

Importantly, both the quantitative and qualitative analyses highlight the potential influence of family communication quality on the health of young people. The quantitative findings show that irrespective of CMC use, lower relative levels of family communication quality were strongly associated with loneliness among youth. Further, as compared to non-daily users, daily use of CMC in youth from families with high relative family communication quality was

associated with often feeling lonely. This can be explained through our understanding of the displacement theory [7] and the parallel qualitative findings from this study. Young people often engage in CMC in the home when surrounded with family members. They may be together in the presence of their family but displace time spent interacting with them, to instead engage in CMC with their friends. With this, youth may perceive their family to have a supportive family environment but experience loneliness from reduced family interactions due to CMC use.

The potential negative effect of displacing family interactions for CMC use is consistent with previous research. Teppers et al. (2014), identified that the time youth spent on Facebook per day was positively correlated to loneliness originating from the relationships that youth have with their parents ($p= 0.21$, $p<0.001$) [8]. Additionally, loneliness can result from the withdrawal of parent relationships in exchange for peer socialization [9]. This shift may be more impactful for youth who experience strong family communication as youth who are not close with their family have more to gain from online conversation. Overall, these complementary qualitative and quantitative findings tell a similar story: CMC potentially influences health in different ways among sub-groups of youth and that the relationship is dependent on external and contextual factors, including family communication quality.

Integration of findings from both methods yields a more clearly defined interpretation regarding the complex influences of CMC on health. Qualitative findings speak to a desire for youth to regulate CMC use and engage in communication with family members. This is supported with quantitative findings of more loneliness reported by youth of families of low relative family communication. Given this, reduced CMC use provides an opportunity to

increase time spent engaging with family members and to prevent the development of loneliness among young people. Promotion of technology-free family time could minimize the potential negative implications of CMC on adolescent health, and also promote strong communication and relationships within the family [10]. These modifications lack testing of effectiveness but are not limited by economic or family structure. Further, they promote reduced screen-time, allowing families to move closer to the screen-time recommendations of less than two hours per day [11]. Last, building strong social supports within the family will further protect youth from other compromising health behaviours and outcomes such as externalizing and internalizing behaviours, and benefit self-reported quality of life, well-being and life satisfaction [12–14].

Together both investigations provide insight to various elements of young people's lives that must be considered when investigating the relationships between CMC and health. Factors such as family characteristics, how youth are using their device, along with the activities missed when engaging in CMC should be considered when investigating the relationship between CMC use and health outcomes. All of these factors would not have been identified from a quantitative or qualitative investigation alone. Furthermore, the added depth and breadth brought to overall findings would otherwise be missing without the adoption of a mixed methods design.

5.2 Validity of the Epidemiological Investigation

Epidemiological studies that are exploring associations aim for precise and valid estimates of effect between exposures and a health outcome [15]. Achieving precision of effect estimates involves limiting random errors in sampling or measurement, while accuracy denotes a lack of systematic biases within a study in order to ensure that findings are valid [15]. Internal validity ensures that effect estimates for the population under study are accurate, whereas external validity identifies the ability of study findings to be applied to a larger population outside of the specific study [15].

5.2.1 Internal Validity

Confounding

Confounding occurs when the risk estimate identified between an exposure and outcome does not result, in whole or in part, because of the presence of a primary exposure variable, but is attributable to a third or additional variable [15]. A confounding variable, or confounder, must be independently associated with both the exposure and outcome of interest and not lie on the causal pathway [15]. To adjust for confounding in this study, a multilevel Poisson regression [5] was conducted adjusting for covariates identified a priori, utilizing backwards selection procedures with a liberal p-value of 0.20. All potential confounders meeting the conservative criterion were forced into the model. To identify which potential confounders displayed a true confounding effect on the association of interest, a change in estimate approach was also conducted with a true confounder exhibiting a 10% change in effect when added into the model [15]. Covariates of interest including: “biological sex”, “school grade”, “family structure”,

“frequency of contacting friends”, “peer support”, “perceived family wealth, and “involvement in group activities” did not lead to a 10% change in risk for all CMC types, and therefore they remained potential confounders based on theoretical as opposed to statistical criteria [15].

Presence of mental health concerns through “feeling low or depressed” confounded the relationship between loneliness and all three methods of CMC investigated. This item impacted the risk estimates by 12.8% to 14.6%, satisfying the above criteria for confounding.

Residual confounding in analyses can potentially remain, even when utilizing this two-step process of identifying and adjusting for confounding. Residual confounding occurs when confounders of the association of interest are not adequately controlled for [16]. Uncontrolled confounding can also occur when confounders of the relationship of interest are unavailable [16]. Both residual and uncontrolled confounding can result in a biased measured of effect [16]. There is potential for uncontrolled confounding as the HBSC survey does not assess personality traits such as shyness or introverted personality that can influence communication with friends through CMC and the self-identification of loneliness [17,18].

Information Bias

Incorrect measurement of either exposure, outcome, or confounders is referred to as information bias in epidemiological studies, if ascertainment is related to outcome status or vice versa [19]. This type of bias is important to consider as it can influence the accuracy of effect estimates. In the quantitative manuscript, it was improbable that measurement bias occurred, as any errors in exposure ascertainment are not likely to be related to the outcome of loneliness. Exposure to CMC, ascertained through the HBSC survey, could potentially be misclassified as

the examples provided for each CMC type are not necessarily reflective of popular current platforms in this age group (i.e., MySpace, BlackBerry Messenger) [20]. With the ability for youth to download communication-based applications to their mobile devices, the technology mediums that they utilize have changed rapidly. Further, misclassification of exposure could occur through errors in reporting the high frequency of daily use. Youth could have responded by indicating the number of individual messages sent or the number of interactions with peers that transpire through CMC, which could involve multiple messages per interaction. Additionally, the seven-day recall period may not be representative of their overall CMC use, misclassifying their typical exposure to CMC. These mechanisms of CMC exposure misclassification would likely result in non-differential misclassification, since the level of misclassification is uniform amongst all youth and not based on outcome status [15]. Non-differential misclassification would bias the effect estimate towards no effect [15].

Recall bias is a form of information bias in which accuracy of information reported to identify exposure or outcome status is different amongst participants in comparison groups based on their ability to recall their exposure status [19]. Recall bias is often an issue in survey data involving a long period of recall to ascertain exposure status [21]. In the quantitative analysis, recall bias is not a concern, as reporting was unlikely to differ between comparison groups. Since CMC has become ubiquitous in society, there would not likely be any systematic bias resulting in over or under reporting of CMC exposure. Further, recall error is likely to be minimal as exposure to CMC is based on a short recall period (i.e., seven days).

Error in measurement can also occur through social desirability bias, as individuals report what they feel may be expected or desired of them, instead of a response reflective of their true status or experience [22]. This is likely based on their perception of desired traits reflective of their society or culture [22]. Pressures to conform to socially desired characteristics might influence the findings of both qualitative and quantitative studies. First, youth may be hesitant to report their feelings of loneliness when completing the HBSC survey, as there may be negative connotations associated with feeling isolated and lacking social support. Second, loneliness is strongly linked to mental health issues [23], which hold a negative stigma in society [24]. In the qualitative focus groups, pressures related to social desirability may have surfaced, resulting in youth being reluctant to share differences in experience or opinions that do not conform to those being reflected by other participants. Additionally, youth may not wish to share experiences of negative family dynamics and CMC use, as it would result in them speaking poorly of their family. With recognition of potential social desirability, this bias is minimized in the qualitative study through the experience of trained facilitators along with developing a comfort level and rapport with youth in each focus group before discussion begins.

Selection Bias

Selection bias can occur when those who participate in the study differ, based on exposure and outcome of interest, from the population of individuals who do not participate or have different factors influencing the participation in the study [19]. This selection must lead to bias in the effects estimated in the exposure-outcome relationship [19] which can occur when there is insufficient heterogeneity of exposure among those selected for study. Selection bias becomes a

concern when inferring results to the general population of Canadian youth, namely those not specifically involved in the Canadian HBSC or focus groups directly. This may have occurred because the HBSC study in Canada does not include students who attend private schools, who live on reserves, are home schooled or incarcerated, for example, and these are sub-populations within the broader Canadian youth population who would not be represented in the sample [25]. The focus groups were limited to young people who live in Ontario, and as is normative in qualitative research, this small sample was not intended to be generalizable to all Canadian youth.

The quantitative and qualitative study participants could also have been influenced by selection bias, in terms of representativeness of participants, through the requirement of active parent consent. This form of consent was required for participation in the HBSC study for some school jurisdictions and was a requirement for participation in all of the qualitative focus groups [3]. With this requirement, youth involved may experience differences in exposure and outcome status in comparison to those who would not be able to provide this type of consent and therefore were unable to participate. For example, participants may experience different family dynamics and relationships influencing their loneliness and different family rules regarding CMC use within the home compared to the general population of youth. Different family dynamics such as stronger parent child relationships, and increased parent involvement may allow for successful parental consent and participation, in opposition to those who do not experience these family relationships and therefore unable to participate.

Additionally, both the HBSC survey and the focus groups were conducted at one point in time. The HBSC survey was administered in the classroom during one scheduled period of class

time and the focus groups were conducted in one sitting at each location [25]. Those absent from school on the day of the survey or unable to attend the focus groups could have different experiences compared to youth that were in attendance. Mental health issues or issues within families present key reasons for absences from school or activities such as the focus group for youth. With frequent absences, these youth may also use CMC to contact friends at different frequencies to remain in contact. Hence, experiences of loneliness and CMC may potentially be different among those who were in attendance versus those who were not. The presence of selection bias may be present.

Chance (Type I Errors) and Statistical Power (Type II Errors)

Random error that occurs throughout the study by chance alone, threatens the overall precision of study findings [15]. Random error in a study could lead to findings that arise due to a type I error or concluding an association existed when in truth it does not [21]. To address this, concern both confidence intervals and p-values were reported in order identify precision, random error and any uncertainty of findings [15]. Utilizing p-values and confidence intervals, statistical criteria for significance was set at an alpha level of 0.05. At this level, there was a 5% chance of type I error in this study.

A type II error involves a failure to identify an association when in truth, an association exists [21]. Power calculations [26] were conducted for all three CMC exposures, considering effect modification by family communication quality. The large sample size of the HBSC study (n=30,117) permitted sub group differences of 2% to 4% to be detected with 80% power, when testing for effect modification by family communication quality. The smallest detectable

differences in the proportion of youth who identify as lonely in the lowest quartile of family communication, between non-daily and daily CMC users and reach 80% power ranged from 3.2% to 4.3%. For example, there is 83% power to detect a difference of 4.3% in the proportion of lonely daily-users of verbal and non-daily users of verbal CMC in the lowest quartile of family communication. This corresponds to a RR of 1.09. The relative risk of loneliness for verbal CMC users in the lowest quartile of family communication is 1.75 in this study.

Therefore, there was adequate power in this study to detect the aforementioned differences. If the true differences were less than what was detectable with 80% power, there is potential for a type II error as there would be inadequate power to detect the true minimal differences of effect present in this study.

5.2.2 External Validity

External validity refers to the generalizability of research findings outside of the sample under study [15]. Biologically rooted associations have greater potential to be externally valid compared to socially generated associations [15]. The generalizability of socially generated associations are often limited to populations reflective of similar social, cultural or environmental conditions [15]. Investigation of the health impacts of CMC among young Canadians illustrates a socially determined phenomenon, and is therefore applicable to those populations who exhibit similar adoptions of CMC practices. In a sub-group of 30 participating HBSC countries, reported frequency of CMC use was similar to that identified in our Canadian study [4]. With the popularity of smart phones, tablets and laptops in many parts of the world,

these findings could be externally valid and generalizable to many populations of youth living in similar technology rich societies.

5.3 Potential for Causation in the Quantitative Study

Observational epidemiological studies can investigate potential associations between exposures and outcomes of interest. To further understand the relationships of interest, one must determine if the association found is causal in nature [21]. The presence of an association does not imply causation. The following criteria were established in order to guide interpretation of a potential causal effect between exposure and outcome [21].

Temporality

An important criteria to support causation is temporality- ensuring that the exposure precedes outcome development [21]. Reverse causality is possible in the current cross-sectional analysis. Either exposure or outcome could have occurred first in progression. Conceptually, use of CMC methods can influence feelings of loneliness in youth but it is also possible that feeling lonely impacts the frequency of engaging in various CMC methods with friends. With the potential for reverse causality, the criterion of temporality was not completely met.

Biological Plausibility

Biological plausibility outlines the biological or social framework that links exposure to outcome status [21]. For this study, social and conceptual theories link use of CMC to various health outcomes including loneliness. The Theory of Physical Proximity [27,28] and Social Presence Theory [27,28] each frame CMC as bridging contact between people who are distant,

and notes this as vital for relationship building. Without being physically present, the experience of conversation may not be as rich [27,28]. Further, the quantitative study utilizes a population health approach drawing from a model of the social determinants of health [29], which outlines that CMC use can influence the health of young people through providing social support and social networks for youth. Furthermore, the family environment also influences this relationship through the social support provided by the family. Given these underlying theoretical constructs, there is social plausibility for CMC use to impact loneliness among youth.

Strength of Association

A strong measure of effect is an additional factor that supports causality [21]. In the quantitative study, strength of association is measured through estimates of relative risk. The relative risk of loneliness among daily users of verbal CMC is 1.28 (95% CI=1.09-1.52) and 1.34 (95% CI= 1.15-1.56) for daily users of social media at the highest relative quartile of family communication. Therefore, a significant but weak association was identified with daily use of CMC, therefore the criterion of strength of association was not met.

Consistency

When the results of a study are consistent with previous findings in the field, this supports a true effect existing between the exposure and outcome of interest [21]. Findings in this thesis are somewhat different than reported in the existing literature [30–35]. Early studies with this focus demonstrated negative impacts related to a decrease in social support and face-to-face engagement with others [30,35]. Due to the ever-changing nature of technology and widespread adoption of CMC in the last 15 years, the social potential of these devices has changed. More

recent studies have identified beneficial effects of CMC on social networks and support [31,32]; however, there is inconsistency in the field as caution still exists regarding negative implications of our technology rich society [33,34]. Investigating the literature alone, there is not support for consistency in the association of interest.

The quantitative analysis shows a consistent association between loneliness and family communication quality that does not vary by CMC type. On the other hand there is an inconsistent relationship between CMC use and loneliness when investigated at quartiles of family communication separately. Considering both the field of literature along with the quantitative findings, there is inconsistency in the relationship of interest in this study.

Dose-Response Relationship

If an association is truly causal, higher duration or quantity of exposure should correspond to a greater risk for the outcome [21]. The current investigation compares daily use of the three CMC methods to non-daily use, which is comprised of “never”, “less than weekly”, and “weekly use”. When this variable is considered in its original form in a subsequent sensitivity analysis, the findings remained consistent. Therefore, classifying CMC broadly to include “less than weekly” and “weekly use” does not change the associations present. It is possible that there is the potential for a dose response relationship to emerge with additional data regarding higher frequency or “extreme” daily use of CMC. Without data regarding more frequent use for this population of youth, this remains uncertain. A dose-response relationship does not exist for the association of interest using the data that are currently available.

5.4 Rigour and the Qualitative Analysis

Conducting a study with rigour helps to ensure that findings are worthy of attention and consideration [36]. To establish rigorous qualitative work, trustworthiness is established based on assessing the credibility, transferability, dependability and confirmability of findings [36]. Details on how each criterion is met in the qualitative manuscript are provided below.

Creditability

Creditability of findings can be compared to a quantitative assessment of internal validity, as it ensures that study findings accurately represent reality for study participants [37,38]. We established creditability through triangulation of researchers, gaining familiarity with youth culture, and utilizing purposeful sampling procedures [36,37]. Three researchers who independently coded and then actively discussed overall findings throughout all stages of analysis achieved triangulation. Involving multiple researchers, in opposition to one individual drawing conclusions independently, allowed for individual biases to be explicit, resulting in greater transparency in the summary and interpretation of the findings [36]. Further, receipt of input from a youth advisory group who reflect opinions from the same age cohort permitted us to gain a better understanding of youth culture, behaviours, thoughts, and opinions. Lastly, purposeful sampling allowed for recruitment of youth in diverse areas throughout Ontario based on demographics such as age, sex, urban/rural status and length of time since immigration to Canada. By selecting homogenous groups, but sampling for heterogeneity across the groups, the study includes a range of opinions and perspectives, adding richness to the overall data collected

and the phenomenon uncovered. This diversity allows findings to reflect a broader range of experiences of youth within the age group.

Transferability

Transferability is conceptually similar to the quantitative idea of external validity as it assesses the extent that findings can be applied more generally to different settings or participants [37–39]. While qualitative research is not meant to be generalizable, by providing details on the geographical locations of sample recruitment, demographics of participants, and detailed descriptions of the study findings [36–38], readers are able to make their own judgments about potential transferability of qualitative findings to other groups or contexts. We believe these results are likely relevant for other groups of similar-aged young people in Canada, outside niche cultural or geographic groups, but these assessments would be done on a case-by-case basis.

Dependability

Dependability refers to overall reliability of study findings [37]. It is assessed through reviewing the analysis post hoc to determine how decisions were made [37]. Dependability was ensured through developing an audit trail which includes memos created through early coding procedures, code descriptions and notes of the early analytic process [36,37,39]. The audit trail allows for a stepwise outline of progression from raw data to the development of key themes, explicitly displaying the entire research project along with details to allow for repetition of the work [38]. Maintaining a clear record of the analytic process supports dependability of the main findings.

Confirmability

Confirmability relates to the findings in being a reflection of the experiences of study participants and not simply those of the researcher or research team [38]. The researcher is to remain reflexive about personal biases through discussion of various aspects of findings that may not come directly out of the data [38]. Triangulation of researchers to mitigate individual investigator bias along with a strong audit trail helps to ensure confirmability [36–38]. These results were also discussed with a youth advisory group who deemed them to be plausible thus helping support confirmability.

5.5 Additional Strengths

Strengths of this thesis include the mixed methods, qualitative and quantitative, design to explore the influence of CMC on adolescent health. Through this research approach, both epidemiological associations and the close narrative of individuals with personal knowledge of the topic helped to inform conclusions. Integration of both methods added depth and detail to the overall conclusions as the qualitative analysis added depth to the quantitative analysis and the quantitative analysis added breadth to the qualitative analysis [6]. In isolation, the quantitative study allows for specific insight into the issue of loneliness with respect to use of CMC and the qualitative study examined CMC with a broad view of its health impact. By integrating both study methods, the strengths of both methods worked together to enhance the overall understanding of the topic area.

The quantitative study has a number of strengths. First, it employed a large nationally representative sample of Canadian young people. Not only are all provinces and territories sampled in the 2014 HBSC study, but application of sample weights support generalization of the sample to the population of Canadian youth. Further, the large sample size of the HBSC study allows for sub-group comparisons to be made, even with the presence of missing data. A complete case analysis [40] was done in order to address missing data. Since low amounts of missing data were observed (less than 10%) for all exposures and the outcome variable, it is assumed that a complete case analysis will not bias effect estimates [41]. Removal of all missing values did result in a greater proportion of females and high school students (grade 9 to 10), but the proportions of the main exposure and outcome remained the same. Given this, it is likely that the data are missing at random as missing data are related to both sex and school grade. A methodological strength of the quantitative study was our use of a multilevel Poisson regression analysis to control for clustering. Since sampling occurred through a two-stage clustering design, independence of participants cannot be assumed since students within the school may hold higher similarities than between different schools. The random-effects multilevel Poisson regression accounts for the clustered binary data without the wide confidence intervals produced through traditional Poisson regression models for dichotomous outcomes [42].

The qualitative analysis has specific strengths inherent to the research approach and quality of data collected. First, the qualitative approach allows for the voices of youth to be highlighted, upholding the rights of Ontario youth to participate in research pertaining to them [3]. Further, the youth were sampled from diverse age groups and geographic areas within Ontario, providing

potentially some diversity in experiences with CMC. All participants openly shared their experiences with trained facilitators, producing richness to the data that is rooted in the experiences of the youth participants [3].

5.6 Future Research Directions

The findings of this thesis suggest numerous opportunities to further investigate the effect of CMC on the etiology of loneliness. First, family and peer support characteristics along with being female were strong risk factors for loneliness among Canadian youth. Since loneliness is strongly linked to mental health outcomes [23], future research should continue to investigate the origins of loneliness development, especially among youth of relative high family communication. Second, there are opportunities to investigate high frequency CMC use by including extreme CMC users. This study identified users as being “daily users”, without insight into frequency of use throughout one day. Extreme users may exhibit different measures of effect in comparison to daily users. Beyond investigating frequency of CMC use, it may also be important to consider particular reasons why and how a young person is using CMC. This may uncover issues such as addictive behaviours or cyber bullying. Current etiological research often quantifies use as Internet alone, which captures multiple CMC methods, producing an imprecise measure of effect [43–47]. Future investigations of the etiology of loneliness and utilization of specific and distinct definitions of CMC use will further advance the field.

The qualitative analysis showed that use of CMC impacts various domains of health including physical, mental and social elements. Moving forward, a holistic and diverse lens should be utilized when addressing the influence of CMC on health. Adoption of multiple

measures or items assessing holistic health in studies of CMC would allow for this complicated impact to be assessed in a more all-encompassing manner. Second, since these findings were assessed qualitatively, a quantitative study exploring the influence of CMC use on each domain of health would enrich the literature on the diverse impacts of CMC. Investigating these associations through the use of longitudinal or experimental studies would also further advance the field. Knowledge gained regarding the diverse impact of CMC on the multiple domains of health came directly from the experiences of youth, therefore, continued investigations on CMC among this population should consider integrating youth in the research process.

5.7 Public Health and Policy Implications

Findings from this study provide evidence in support of family-based health promotion initiatives and also address the diverse impact of CMC use on health outcomes. These results indicate various areas for implementation and topics of interest for public health and policy interventions moving forward.

The results of this thesis highlight that a key point of intervention is within the family home. Low relative levels of family communication showed a strong association with loneliness among Canadian youth. CMC use was associated to loneliness among families of high relative communication and was expressed as a barrier to strong family relationships in the qualitative findings. The family home provides the most proximal place for promotion interventions for overall health, healthy technology use, and building strong family relationships. The American Academy of Pediatrics [48] and Public Health Ontario [49] have developed guidelines for parents to promote healthy technology use that involve recommendations including: enforcement

of rules regarding limitations to use, removal of devices from the bedroom along with monitoring use through engaging in the technology-based activity together [48,49]. In support of these guidelines, greater technology-free family time was suggested as an intervention option by the youth directly. Technology-free family time, such as sharing dinner together 5-7 times per week, increases the odds of family support (OR=3.7, 95% CI=3.38-3.94), positive family communication (OR=2.8, 95% CI=2.58-3.04), and self-esteem (OR=2.1, 95% CI=1.98-2.24) [14]. Therefore, specifically among families that communicate well, simple changes at meal times or during car rides to engage with one another and reduce CMC would allow for promotion of healthy relationship, and potentially reduce rates of loneliness [10,50]. Furthermore, these intervention strategies apply to all socioeconomic positions and family structures, as they are flexible in nature. Small changes within the family home to promote technology-free time, especially among families of high communication quality, would support healthy practices for youth and all family members.

Another potential opportunity for interventions to promote healthy technology use is at school. Youth spend a large portion of their day at school and they identified many situations involving CMC use in school environments. The qualitative findings do not support a full ban on CMC devices at school but indicate a strong directive as to the way technology could be used to support positive health outcomes. First, school-wide policies supporting limited or no use of personal devices during class time are suggested as youth spoke to high distraction and lack of attention during school when being contacted by individuals through their device during school time. Second, since youth are high users of CMC and other digital technologies, initiatives to

integrate their use of technology during school hours, in a constructive way, can occur. An example of this is through use as physical activity promotion tools [51]. Third, youth should be educated on the diverse and non-uniform influence of CMC on health. Media literacy education programs positively effect media knowledge, criticism, influence, and attitudes among youth when the program includes multiple sessions covering few concepts in detail [52]. Adding updated media literacy education to schools would allow for an understanding of not only how to use CMC and other forms of digital technology safely but strategies to gain benefits and reduce risks present in our technology rich world [53].

There are also opportunities for action at the public health level. Given the diverse impact of CMC on multiple domains of health shown in the qualitative results, future promotional messaging around reducing screen time and CMC use should adopt an holistic approach to address multiple domains of health. Current messaging does not take a holistic approach, as there is a strong focus on sedentary behaviour alone [48,49]. Further, public health derived family-based health promotion programs should continue to focus on family communication quality, as this is identified as a strong risk factor for loneliness among Canadian youth. These interventions could work collectively with those implemented at the family level and others at the school level to support youth and their families in building healthy behaviours around CMC and technology.

5.8 Summary

This thesis explored the potential impact of verbal, messaging and social media CMC by Canadian youth through a quantitative and qualitative lens. The quantitative study focused on loneliness as one health outcome, while the qualitative study used a broad conceptualization of

health. CMC is associated with self-reported loneliness among youth when considering other factors, such as family communication quality. Further, CMC use is related to multiple domains of health in both positive and negative ways. These results highlight the relationship between CMC and health is diverse and complicated in nature as external factors, such as the social climate of the family, along with the context of how CMC is used, determines the overall connection to health. Programs aimed at healthy CMC use should consider not only the apparent ways that screen-based CMC negatively influences health but also the ways to foster the benefits of these methods of communication. Developing a balance between the inherent benefits and drawbacks of this prevalent exposure will best support overall health and well-being.

5.9 References

- [1] Morgan DL. Focus Groups as a Qualitative Method. 2nd ed. Thousand Oaks California: Sage Publications; 1997.
- [2] Berg B. Qualitative Research Methods. 7th ed. Boston, MA: Pearson Education Inc; 2009.
- [3] Michaelson V, Mckerron M, Davison C. Forming ideas about health: A qualitative study of Ontario adolescents. *Qual Stud Heal Well-Being* 2015;10.
- [4] Boniel-Nissim M, Lenzi M, Zsiros E, et al. International trends in electronic media communication among 11- to 15-year-olds in 30 countries from 2002 to 2010: Association with ease of communication with friends of the opposite sex. *Eur J Public Health* 2015;25:41–5.
- [5] Yelland LN, Salter AB, Ryan P. Practice of epidemiology performance of the modified poisson regression approach for estimating relative risks from clustered prospective data 2011;174:984–92.
- [6] Teddie C, Tashakkori A. Foundations of Mixed Methods Research: Integrating Quantitative and Qualitative Approaches in the Social and Behavioural Sciences. Thousand Oaks, California: Sage Publications; 2009.
- [7] Subrahmanyam K, Smahel D. Internet use and well-being: Physical and psychological effects. *Digit. Youth Role Media Dev.*, London: Springer Science and Business Media; 2011.

- [8] Teppers E, Luyckx K, A Klimstra T, et al. Loneliness and Facebook motives in adolescence: A longitudinal inquiry into directionality of effect. *J Adolesc* 2014;37:691–9.
- [9] Laursen B, Hartl AC. Understanding loneliness during adolescence: Developmental changes that increase the risk of perceived social isolation. *J Adolesc* 2013;36:1261–8.
- [10] Turkle S. *Reclaiming Conversation: The Power of Talk in a Digital Age*. New York, NY: Penguin Press; 2015.
- [11] Tremblay MS, Leblanc AG, Janssen I, et al. Canadian sedentary behaviour guidelines for children and youth. *Appl Physiol Nutr Metab* 2011;36:59–64; 65–71.
- [12] Jiménez-iglesias A, Moreno C, Ramos P, et al. What family dimensions are important for health-related quality of life in adolescence? *J Youth Stud* 2015;18:37–41.
- [13] Elgar FJ, Craig W, Trites SJ. Family dinners, communication, and mental health in Canadian adolescents. *J Adolesc Health* 2013;52:433–8.
- [14] Fulkerson JA, Story M, Mellin A, et al. Family dinner meal frequency and adolescent development: Relationships with developmental assets and high-risk behaviors. *J Adolesc Health* 2006;39:337–45.
- [15] Rothman K, Greenland S, Lash T. *Modern Epidemiology*. 3rd ed. Philadelphia, PA: Pippincott Williams & Wilkins; 2008.
- [16] Fewell Z, Davey Smith G, Sterne JAC. The impact of residual and unmeasured confounding in epidemiologic studies: A simulation study. *Am J Epidemiol* 2007;166:646–55.

- [17] Marangoni C, Ickes W. Loneliness: A theoretical review with implications for measurement. *J Soc Pers Relat* 1989;6:93–128.
- [18] van der Al N, Overbeek G, Engels R, et al. Daily and compulsive internet use and well-being in adolescence: A diathesis-stress model based on big five personality Traits. *Youth Adolesc* 2009;38:765–76.
- [19] Aschengrau A, Seage G. *Essentials of Epidemiology in Public Health*. 3rd ed. Burlington, MA: Jones & Bartlett Learning; 2014.
- [20] Steeves V. Young Canadians in a wired world, phase III: Life online. *MediaSmarts* 2014:1–60.
- [21] Webb P, Bain C. *Essential Epidemiology: An introduction for students and health professionals*. 2nd ed. Cambridge, New York: Cambridge University Press; 2011.
- [22] Fisher RJ, Katz JE. Social-Desirability bias and the validity of self-reported values. *Psychol Mark* 2000;17:105–20.
- [23] Schinka KC, Van Dulmen MHM, Mata AD, et al. Psychosocial predictors and outcomes of loneliness trajectories from childhood to early adolescence. *J Adolesc* 2013;36:1251–60.
- [24] Stuart H, Chen S, Christie R, et al. Opening minds in Canada: Background and rationale. *Can Journal Psychiatry* 2014;59:S8–12.
- [25] Freeman J, King M, Pickett W. *Health Behaviour in School-aged Children (HBSC) in Canada: Focus on relationships*. 2016.

- [26] Kelsey J. *Methods in Observational Epidemiology*. USA: Oxford University Press; 1996.
- [27] Monge P, Contractor N. *Theories of Communication Networks*. New York: Oxford University Press; 2003.
- [28] Walther JB. Theories of computer-mediated communication and interpersonal relations. In: Knapp, M L, Daly, J A, editors. *Handb. Interpers. Commun.* 4th ed., Thousand Oaks California: Sage Publications; 2011, p. 443–79.
- [29] Last J. *A dictionary of public health*. New York: Oxford University Press; 2007.
- [30] Lin C-H, Sun Y-C, Lee Y-C, et al. How instant messaging affects the satisfaction of virtual interpersonal behaviour of Taiwan junior high school students. *Adolescence* 2007;42:417–30.
- [31] Riedl C, Köbler F, Goswami S, et al. Tweeting to feel connected: A model for social connectedness in online social networks. *Int J Hum Comput Interact* 2013;29:670–87.
- [32] Brandtzæg PB. Social networking sites: Their users and social implications - A longitudinal study. *J Comput Commun* 2012;17:467–88.
- [33] Turkle S. *Always-On/Always-On-You: The Tethered Self*. *Handb. Mob. Commun. Stud.*, University Press Scholarship Online; 2008, p. 472.
- [34] Turkle S. *Alone Together*. New York, NY: Basic Books; 2011.

- [35] Vergeer M, Pelzer B. Consequences of media and Internet use for offline and online network capital and well-being. A causal model approach. *J Comput Commun* 2009;15:189–210.
- [36] Lincoln Y, Guba E. *Naturalistic Inquiry*. Beverly Hills, California: Sage Publications; 1985.
- [37] Mayan M. *Essentials of Qualitative Inquiry*. Walnut Creek, California: Left Coast Press; 2009.
- [38] Shenton A. Strategies for ensuring trustworthiness in qualitative research projects. *Educ Inf* 2004;22:63–75.
- [39] Graneheim UH, Lundman B. Qualitative content analysis in nursing research: Concepts, procedures and measures to achieve trustworthiness. *Nurse Educ Today* 2004;24:105–12.
- [40] Finch WH. Imputation methods for missing categorical questionnaire data: A comparison of approaches. *J Data Sci* 2010;8:361–78.
- [41] Langkamp D, Lehman A, Lemeshow S. Techniques for handling missing data in secondary analyses of large surveys. *Acad Pediatr* 2011;10:205–10.
- [42] Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–6.
- [43] Espinoza G, Juvonen J. The pervasiveness, connectedness, and intrusiveness of social network site use among young adolescents. *Cyberpsychology, Behav Soc Netw* 2011;14:705–9.

- [44] Farber B a., Shafron G, Hamadani J, et al. Children, technology, problems, and preferences. *J Clin Psychol* 2012;68:1225–9.
- [45] Hlebec V, Manfreda KL, Vehovar V. The social support networks of internet users. *New Media Soc* 2006;8:9–32.
- [46] Przybylski K. A, Weinstein N. Can you connect with me now? How the presence of mobile communication technology influences face-to-face conversation quality. *J Soc Pers Relationships* 2013;30:237–46.
- [47] Wolak J, Mitchell KJ, Finkelhor D. Escaping or connecting? Characteristics of youth who form close online relationships. *J Adolesc* 2003;26:105–19.
- [48] American Academy of Pediatrics. Children, adolescents, and the media. vol. 132. 2013.
- [49] Public Health Ontario. Screen time: Parental support for child health. Toronto, ON: 2015. Available at:
https://www.publichealthontario.ca/en/eRepository/Parental_Support_Screen_Time_2015.pdf
- [50] Turkle S. The flight from conversation. *New York Times* 2012:1–5.
- [51] Nicole J, Evan J, Derikk M. Innovative ways to use modern technology to enhance, rather than hinder, physical activity among youth. *J Phys Educ Recreat Danc* 2015;86:46–53.
- [52] Jeong SH, Cho H, Hwang Y. Media literacy interventions: A Meta-Analytic Review. *J Commun* 2012;62:454–72.

- [53] Hoechsmann M, DeWaard H. Mapping digital literacy policy and practice in the Canadian educational landscape. Media Smarts 2015.

Appendix A

The Health Behaviour in School-aged Children Survey

History and Theory of the HBSC study

The HBSC study began in 1982 with involvement of three European countries [1]. Canada joined the HBSC network in 1990. Internationally, the HBSC study collaborates with the World Health Organization and at the national level, with the Public Health Agency of Canada [1,2]. Currently, 44 countries and regions participate in the HBSC study every four years [1]. With large international involvement, national and international comparisons are possible across time [1]. In Canada, the HBSC research team works with individuals from the Public Health Agency of Canada, the Joint Consortium of School Health and Health Canada in partnership [2]. The HBSC survey views health in a broad and holistic manner as elements of social, physical, emotional and spiritual health are assessed [1]. Risk factors for poor health outcomes along with positive elements that contribute to the health are investigated for a full encompassing view of the health of young people [1,2]. Further, the HBSC takes a population-based approach, investigating determinants of health such as home life, school, neighbourhood, peer groups along with socio-economic and behavioural impacts to health [1]. This framework involves individual and environmental factors and how these different elements interact to influence the health of school-aged children [1–3].

Purpose and Objectives

The goal of the HBSC study is to further knowledge and understanding of the health of young people and inform health promotion, policy, education and decisions by collecting data regarding their well-being, various health behaviours, and social influences [1,4,5]. The objectives of the HBSC include not only data collection but dissemination of findings to researchers, policy makers and health promoters along with teachers, parents and young people themselves [1]. Since the HBSC involves international collaboration, developing a strong international network of researchers is important [1]. This allows for the development of a multi-disciplinary group of expertise on adolescent health to positively impact public health and health education efforts moving forward [1].

Sampling Strategy

In Canada, two-stage cluster sampling is utilized for sample accrual [1]. First, participating schools are randomly selected from a list of consenting school jurisdictions organized by school jurisdiction, language, religion, size of surrounding community [1]. The number of classes per selected school is estimated based on: grade levels of the school, number of teachers, overall population and population of students per grade [1]. Administration of the school selects classes to participate within each selected school. Often two classes per grade participate from each selected school [1,2]. The primary sampling unit is the classroom. Within selected schools all students within the class complete the questionnaire upon consent [1,2,4]. For smaller provinces, such as Prince Edward Island, all students in the selected schools participate within grade 6 to 10 and in the Northern Territories, all students in all schools participate [1]. Non-participation in the

study involves absence of school on day of administering the survey, lack of parent active consent, student refusal and purposeful spoiling of the survey [1]. The largest influence to non-participation is failure to return consent forms from home [1]. Schools that are not included in this cycle include private and special schools including those located on reserves to maintain consistent comparisons with previous cycles of the Canadian HBSC survey population [1].

Student Questionnaire

Content of the HBSC is a combination of: (1) mandatory items that are included across all countries involved in order to investigate cross country differences, (2) optional sections including specific aspects of adolescent health that are included in some participating countries and finally (3) additional items that are unique to Canada, developed by collaborations with the Public Health Agency of Canada and the Joint Consortium of School Health [2]. The mandatory questions involve demographic information, social contexts of family and peers, health outcomes and behaviours including physical activity, eating patterns etc., along with risk behaviors such as drug and alcohol use [4]. Students in grade 6 to 8 complete a different survey as the grade 9 and 10 students complete a longer survey with added health behaviours including drug use etc. [1]. Students complete the questionnaire in the classroom during a 45-70 minute interval [1]. In Canada, it can be completed through traditional pen and paper methods or through an online interface [1]. To combat literacy issues, teachers are able to go through the survey question by question with their students to aid them in their responses [2].

Ethics

Clearance was given by the Queen's University and the Public Health Agency of Canada/Health Canada Research Ethics Board [1]. Following this, three levels of consent are necessary for student participation [1]. Consent is first given by the school jurisdiction, and secondly, the principles of the selected schools provide permission for students attending their school to participate [1]. The last level of consent is that of the parents of student participants through active or passive consent [1]. Active consent involves students returning signed consent forms whereas passive consent allows students to participate if consent forms are not returned indicating refusal to participate from parents [1,2]. The method of parent consent is determined by the current policies of each school jurisdiction [1]. Identity remains anonymous by students placing the survey in a sealed envelop upon completion and students are aware at all stages they can refuse to answer questions on the survey or withdrawal their participation without repercussion [2].

Survey Weights

Weights are applied to the sample in order to obtain a nationally representative sample for males and females in each grade grouping and province or territory surveyed. If the sample of youth that participate is less than the grade group of a certain biological sex that attends school in that province or territory, a weight greater than 1 is applied [4]. A weight less than 1 is applied if oversampling was done on a certain sex specific grade group [4]. This adjustment allows for a nationally representative sample of youth across the country (excluding those who attend private schools or schools on reserves).

- [1] Freeman J, King M, Pickett W. Health Behaviour in School-aged Children (HBSC) in Canada: Focus on relationships. 2016.
- [2] Freeman J, King M, Pickett W, et al. The health of Canada's young people: A mental health focus. 2011.
- [3] Currie C, Nic Gabhainn S, Godeau E, et al. The Health Behaviour in School-aged Children: WHO collaborative cross-national (HBSC) study: Origins, concept, history and development 1982-2008. *Int J Public Health* 2009;54.
- [4] Roberts C, Freeman J, Samdal O, et al. The Health Behaviour in School-aged Children (HBSC) study: Methodological developments and current tensions. *Int J Public Health* 2009;54:140–50.
- [5] Currie C, Aleman-Diaz a. Y. Building knowledge on adolescent health: Reflections on the contribution of the Health Behaviour in School-aged Children (HBSC) study. *Eur J Public Health* 2015;25:4–6.

Appendix B

Variables of Interest from the HBSC Survey

Main Exposure: Computer-mediated Communication

In the 2013-2014 cycle 7 of the HBSC study, the item assessing CMC use by adolescents to contact friends was replaced by the new item utilized in this study. The new item separated overall use into the following five domains: (1) phone, FaceTime or Skype, (2) instant messaging, (3) text messaging, (4) email and (5) other social media [1]. The above items were separated in order to identify different mechanisms that may exist among different CMC uses on health outcomes [1]. Three key methods of CMC use were identified for this study. Verbal CMC indicated use of phone or visual communication methods such as Skype or FaceTime whereas messaging CMC involves text messaging and SMS along with instant messaging through various programs such as BBM and Facebook chat. Any other use of social media remained a separate exposure. For all items the responses ranged from “daily use” (response option 4) to “hardly ever or never” (response option 1). “Non-daily users” indicated inconsistent or little use of CMC (weekly through to hardly ever or never use).

Test-retest reliability has been established for the above HBSC items with correlation coefficients as follows: email, phone and Face Time $\rho=0.52$ ($p<0.001$), texting and SMS $\rho=0.76$ ($p<0.001$), instant messaging $\rho=0.75$ ($p<0.001$), other social media $\rho=0.64$ ($p<0.001$). Further, correlation of these new items to previous HBSC CMC items resulted in medium to strong correlations except with email use [(phone and face time $\rho=0.48$ ($p<0.001$), texting and SMS

$\rho=0.71$ ($p<0.001$), instant messaging $\rho=0.63$ ($p<0.001$), other social media $\rho=0.52$ ($p<0.001$), and email $\rho=0.11$ ($p<0.001$) [1].

Effect Modifier: Family Communication Quality

In 2013-2014, the addition of a question addressing family communication in isolation was put forth and the short version of the Family Dynamics Measure II (FDM II) was selected for inclusion. The FDM II was created by and developed to quantify overall family functioning. This scale has been used to identify constructs such as individual/enmeshment, mutuality/isolation, flexibility/rigidity, stability/disorganization, clear communication/distorted communication and role reciprocity/role conflict [2]. The short four-item scale that is used in the Canadian HBSC survey identifies the clear communication/distorted communication element of the longer FDM II scale. Along with validation work, focus groups with adolescents support the use of the question in terms of identifying what each family is like [1]. The family communication quality scale was generated through the sum of all four individual items. This scale was divided into quartiles for analysis.

Feeling Sad or Hopeless

Youth respond “yes” or “no” to: “During the past 12 months, did you ever feel so sad or hopeless almost everyday for two weeks or more in a row”. This item is also used in the CDC Youth Risk Behaviour Survey as part of a five item scale that assessed overall suicidal ideation of youth [3] and independently to assess feeling sad or hopeless [4]. Additionally, this item has been used to indicated symptoms of depression by youth [5]. Those indicating, “yes” to this inquiry were identified as feeling sad or hopeless.

Family Structure

The HBSC survey assessed those who young people live with to identify their experience of family. This question can now reflect non-nuclear family structures involving grandparents, stepparents, other adult figures and different combinations of such. With diverging outcomes in areas such as mental health among those who live with both parents, step parents or in one parent homes [6], this variable was categorized to identify different family structures of youth. In the 2013-2014 cycle, the mandatory question was changed to include only the main house where adolescents reside for ease of understanding.

Frequency of Contacting Friends

In the 2013-2014 cycle 7 of the HBSC survey, the item to indicate peer contact was updated to minimize cultural interpretations. The new items changed from frequency of contact right after school and in the evening to the current time points of before and after 8 p.m. Responses ranged from “hardly ever or never”(1) to “daily”(4) contact with friends. This item is currently not part of the ongoing validation work being conducted for the HBSC items [1].

Perceived Family wealth

Measuring family wealth in terms of perception of socioeconomic position of the family in relation to others was added to the HBSC survey in 1993-1994. It was added to the study to introduce ways of quantifying social inequalities. Since its induction into the survey, this measure of affluence has predicted health along with socioeconomic status objectively. This item has a strong response rate and shows socioeconomic status in Canada and other countries [1]. It has been found to correlate to both father and mother occupation [7] and be associated to self-

rated health among youth [8]. A limitation of this item that is applicable to Canada is students not answering the question due to feeling uncomfortable when answering and not having a predefined comparator for adolescents to mark their wealth in relation to [1]. Further, this item has shown differences in wealth in Canada that material ownership does not, as a high proportion of youth hold the same material assets [9]. Responses ranged from “very well off” to “not well off at all” on a 5-point likert scale. In this study, high affluence indicates those who classify their family as “very well off” and “quite well off”. Average affluence indicates those that respond their family to be of “average” affluence and low affluence includes responses of their family being “not very well off” or “not at all well off”.

Peer Support

Peer support is a multi-item measure that is a section of the Multidimensional Scale of Perceived Social Support (MSPP) that was first developed with a group of university students to quantify their subjective experience of social support [10]. This four item scale assesses agreement to the following statements: “My friends really try to help me”, “I can count on my friends when things go wrong”, “I have friends with whom I can share my joys and sorrows”, “I can talk about my problems with my friends”. Factor analyses have shown three first-order factors from the overall MSPP item which identify peer support, family support, and support from others [11]. The items were developed with university students and validated on samples including adolescents. The items do not indicate social desirability bias and are acceptable for low literacy levels [1]. Validation work has show strong internal validity for the peer support scale component of the MSPP (Chronbach’s $\alpha = 0.91$ and 0.90) [1]. Among high school students,

the reliability for the entire MSPP scale was 0.88 with the peer support sub scale was 0.75. Peer support also proved to be significantly correlated to expressing easiness to speak with friends, identifying with, being proud of and happy to be part of your friend group, along with high importance of belong to that friend group [1].

- [1] Wild F, Inchley J, Currie C, et al. HBSC Internal Protocol 2013/2014. St Andrews Scotland: HBSC International Coordinating Centre; 2014. iccadmin@hbsc.org
- [2] White MA, Sci H, Grzankowski J, et al. Family dynamics and child abuse and neglect in three finnish communities. *Issues Ment Health Nurs* 2003;24:707–22.
- [3] Shaffer D, Fisher P, Lucas C, et al. NIMH Diagnostic Interview Schedule for Children Version IV (NIMH DISC-IV): Description, differences from previous versions, and reliability of some common diagnoses. *J AM Acad Child Adolesc Psychiatry* 2000;39:28–38.
- [4] Zeller MH, Reiter-Purtill J, Jenkins TM, et al. Adolescent suicidal behavior across the excess weight status spectrum. *Obesity* 2013;21:1039–45.
- [5] Lippman LH, Anderson Moore K, Guzman L, et al. *Flourishing children: Defining and testing indicators of positive development*. Springer; 2014.
- [6] Arnold AL, Lucier-Greer M, Mancini JA, et al. How family structures and processes interrelate: The case of adolescent mental health and academic success in military families. *J Fam Issues* 2015.
- [7] Currie C, Hurrelmann K, Settertobulte W, et al. *Health and health behaviour among young people*. 2000.
- [8] Goodman E, Huang B, Schafer-Kalkhoff T, et al. Perceived socioeconomic status: A new type of identity that influences adolescents' self-rated health. *J Adolesc Heal* 2007;41:479–87.
- [9] Boyce W, Craig W, Elgar F, et al. *Healthy Settings for young people in Canada*. Public

Health Agency of Canada 2008.

- [10] Zimet G, Dahlem N, Zimet S, et al. The multidimensional scale of perceived social support. *J Pers Assess* 1988;52:30–41.
- [11] Cheng S-T, Chan ACM. The multidimensional scale of perceived social support: Dimensionality and age and gender differences in adolescents. *Pers Individ Dif* 2004;37:1359–69.

Table 1. Covariates to be tested from the 2013/2014HBSC Study

Covariate	Item(s) of HBSC	Coding
Biological Sex	Q4. “Are you male or female?”	0 = Female 1 = Male
School Grade	Q1. “What grade are you in?” 1= Grade 8 2= Grade 9 3= Grade 10 4= Grade 11 *from the 9-10 survey version	0= 6-8 1= 9-10
Feeling Sad or Hopeless	Q33. “ During the past 12 months, did you ever feel so sad or hopeless almost everyday for two weeks or more in a row that you stopped doing some usual activities?”	1=Yes 0= No
Family Structure	Q46. “People who live in the home where they live most of the time” 1= mother 2= father 3= stepmother 4=stepfather 5= grandmother 6= grandfather 7= I live in a foster home or children’s home 8= someone or somewhere else	0= Nuclear Family (Mother and father) 1 = Non-Nuclear Family
Family Communication Quality	Q49. “In my family... A. I think the important things are talked about B. When I speak someone listens to what I say C. We ask questions when we don’t understand each other D. When there is a misunderstanding we talk it over until it is clear 1 = Strongly agree 2 = Agree 3 = Neither agree or disagree 4 = Disagree 5 = Strongly disagree	Q4 = lowest 25% Q3- upper quartile Q2- median Q1- highest 25%
Frequency of Contacting Friends	Q55. “How often do you meet your friends...” a. outside school time before 8:00 in the evening b. outside school time after 8:00 in the evening 1= hardly ever or never 2= less than weekly 3= weekly 4= daily	2-4 = Less than weekly 5-8 = Weekly or more

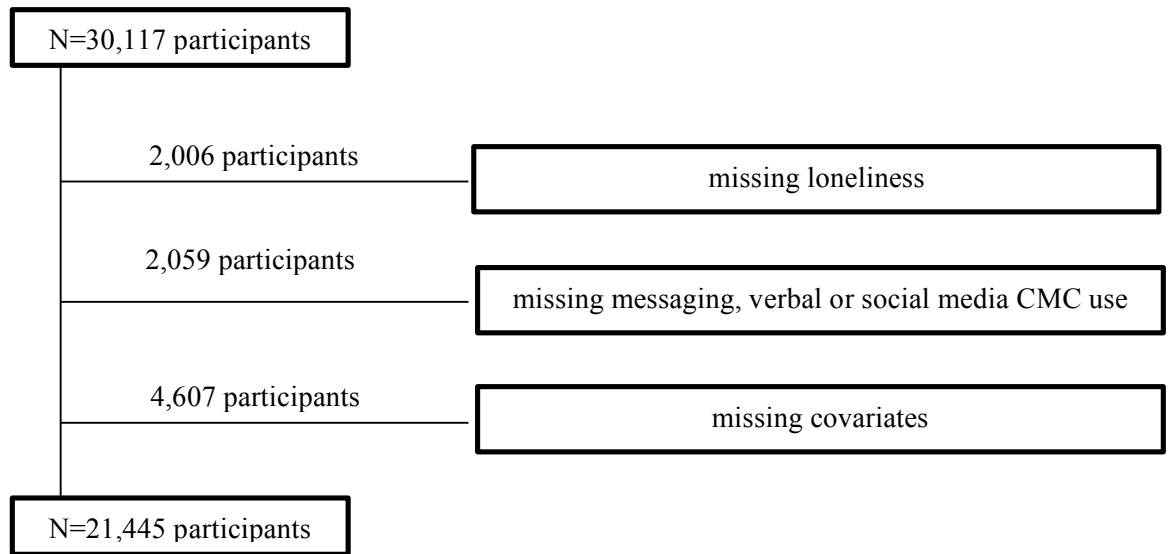
Involvement in Group Activities	<p>Q69. "Are you involved in any of these kinds of activities or groups?"</p> <ul style="list-style-type: none"> a. sports team b. volunteer work c. arts group d. community group e. church groups f. other activity or group <p>1= Yes 2= No</p>	<p>6-9 = 3+ activities 10 = 2 activities 11= 1 activity 12= None</p>
Perceived Family Wealth [197,198]	<p>Q47. "What well off do you think your family is?"</p> <p>1 = Very well off 2 = Quite well off 3 = Average 4 = Not very well off 5 = Not at all well off</p>	<p>1,2 = High 3 = Average 4 = Low</p>
Peer Support	<p>Q70. "Please show how much you agree with the following statements."</p> <ul style="list-style-type: none"> v. My friends really try to help me. w. I can count on my friends when things go wrong x. I have friends with whom I can share my joys and sorrows y. I can talk about my problems with my friends <p>1= Strongly agree 2= Agree 3= Neither agree nor disagree 4= Disagree 5= Strongly disagree</p>	<p>4-11 = High ("agree" to at least one of the statements through to "strongly agree" to all items)</p> <p>12-20 = Low ("neither agree" through to "strongly disagree" to all items)</p>
Primary Outcome: Loneliness	<p>Q70. "Please show how much you agree with the following statements."</p> <ul style="list-style-type: none"> l. I often feel lonely <p>1= Strongly agree 2= Agree 3= Neither agree nor disagree 4= Disagree 5= Strongly disagree</p>	<p>1-2 = Lonely 3-5= Not lonely</p>
Exposure 1: Email Use	<p>Q52b. "How often do you contact your friend(s) using email?"</p> <p>1 = Hardly ever or never 2 = Less than weekly 3 = Weekly 4 = Daily</p>	<p>1-3 = Non-daily User 4 = Daily User</p>

<p>Exposure 2: Verbal CMC Use</p>	<p>Q50. "How often do you talk to your friend(s) on the phone or internet based programs such as FaceTime or Skype?" 1 = Hardly ever or never 2 = Less than weekly 3 = Weekly 4 = Daily</p>	<p>1-3 = Non-daily User 4 = Daily User</p>
<p>Exposure 3: Messaging CMC Use</p>	<p>Q51. "How often do you contact your friend(s) using instant messaging?" Q52a. "How often do you contact your friend(s) using texting/SMS?" 1 = Hardly ever or never 2 = Less than weekly 3 = Weekly 4 = Daily</p>	<p>2-6 = Non-daily User 7-8 = Daily User</p>
<p>Exposure 4: Social Media CMC Use</p>	<p>Q52c. "How often do you contact your friend(s) using other social media?" 1 = Hardly ever or never 2 = Less than weekly 3 = Weekly 4 = Daily</p>	<p>1-3 = Non-daily User 4 = Daily User</p>

Appendix C

Sample Size Flow Chart

Figure 1 Missing data for key exposure and outcome variables along with potential confounders in the 2013-2014 HBSC sample.



Appendix D

Modeling Strategy

Health science research often reports odds ratios or relative risks of a dichotomous outcome of interest [1,2]. Odds ratio measures the ratio of the odds of an outcome in one group compared to a reference group [2]. Relative risk measures the ratio of the probability of observing an outcome in one group compared to the reference group [2]. Odds ratios are commonly misinterpreted as relative risks but under certain conditions, the odds ratio does not correspond to the risk [1]. With this, relative risks are most often reported [1].

Odds ratios are identified through logistic regression modeling procedures with dichotomous outcomes [1]. When an outcome is rare within the population of interest (<10%) the odds ratio is equivalent to the relative risk [2]. If this rare assumption is not met, the odds ratio will produce a relative risk that overestimates the true measure of effect if the relative risk is greater than 1 or underestimates the risk if the relative risk is less than 1 [2]. Since loneliness has been self-reported in 2010 by over 20% of Canadian youth [3], the rare outcome requirement will not be met. With this, utilizing logistic regression modeling procedures will not identify the relative risk of the association of interest [1].

In order to quantify the risk of adolescent loneliness when exposed to three different CMC methods, two modeling options were proposed. Log binomial regression is a generalized linear model where the link function is log and distribution is binomial which identifies the relative risk of association [2,4]. Utilizing log binomial models often have issues in convergence when the predicted probabilities are outside of the upper and lower boundaries of the binomial

distribution (0 to 1) [2,4,5]. Since issues of convergence arose in this study, multilevel Poisson regression was chosen as this common alternative when convergence is a problem [2,5]. Poisson distribution models the outcome involving a count of events over a time period [4]. To generate accurate confidence intervals and overcome the increased variance that occurs when applying a poisson distribution to the data, adjustments are made by accounting for the clustered nature of the data [6]. Log-Binomial and poisson models have been found to product similar relative risks. A poisson modeling approach is suggested when convergence issues arise with clustered data therefore this method was chosen for this study [5,6].

- [1] Zhang J, Yu KF. What's the relative risk? A method of correcting the odds ratio in cohort studies of common outcomes. *JAMA* 1998;280:1690–1.
- [2] Lee J, Tan CS, Chia KS. A practical guide for multivariate analysis of dichotomous outcomes n.d.:714–9.
- [3] Freeman J, Coe H, King M. Health Behaviour in School-aged Children trends report 1990-2010. 2014.
- [4] Barros AJD, Hirakata VN. Alternatives for logistic regression in cross-sectional studies: An empirical comparison of models that directly estimate the prevalence ratio. *BMC Med Res Methodol* 2003;3:21.
- [5] Yelland LN, Salter AB, Ryan P. Practice of epidemiology performance of the modified poisson regression approach for estimating relative risks from clustered prospective data 2011;174:984–92.
- [6] Zou G. A modified poisson regression approach to prospective studies with binary data. *Am J Epidemiol* 2004;159:702–6.

Appendix E

Intraclass Correlation Coefficient

Since the HBSC study collects data through a clustered design, the amount of variance that occurs at the group level of school is important to consider [1]. Intra class correlation coefficient (ICC) is the ratio of the variance between groups at the second level (school) to the variance within the group (among students) [1,2]. It identifies the proportion of variance between clusters or at the group level to identify the level of dependence among the clusters of schools [2]. A high ICC value shows that the errors are correlated and therefore, there is a difference in loneliness among the group level of schools [2]. To quantify the ICC value, the null poisson regression model with log link was conducted using the PROC GLIMMIX procedure.

$$ICC = \frac{\tau_{00}}{\tau_{00} + 3.29}$$

τ_{00} = group level unexplained covariance parameter estimate[203]

Table 1. Intraclass correlation coefficient for loneliness in the 2013-2014 HBSC study.

Outcome of Interest	Covariance Parameter Estimate	Variance at the School Level
Loneliness	0.05271	0.01577

- [1] Gulliford MC, Adams G, Ukoumunne OC, et al. Intraclass correlation coefficient and outcome prevalence are associated in clustered binary data. *J Clin Epidemiol* 2005;58:246–51.
- [2] Tabachnick B, Fidell L. *Using Multivariate Statistics*. 5th ed. Boston, MA: Pearson Education Inc; 2007.

Appendix F

Cronbach's Alpha

When using survey data it is beneficial to utilize multi-item scales to measure a certain construct among the population of interest [1]. Through the use of multi-items, the random error of each item is averaged across all individual items and the scope of the construct being measured increases beyond what one would be able to capture with a single item response. Cronbach's alpha is utilized to determine the reliability of each multi-item scale and the internal consistency of the scale [1]. Cronbach's alpha coefficients range from zero to one with 0.70 or higher indicating acceptable reliability [2].

Construct	Variables	Correlation with Total	Alpha	Cronbach's Coefficient Alpha
Family Communication Quality	a	0.711773	0.852789	0.877289
	b	0.745920	0.839477	
	c	0.732901	0.845448	
	d	0.755692	0.835973	
Peer Support	v	0.772174	0.902472	0.915526
	x	0.823806	0.884525	
	x	0.814168	0.888479	
	y	0.817877	0.886609	
Frequency of Contacting Friends	a	0.575205		0.730291
	b	0.575205		
Messaging	51	0.566379		0.722780
	52a	0.566379		

[1] Gliem J, Gliem RR. Calculating, interpreting, and reporting cronbach's alpha eeliability coefficient for kikert-type scales,. 2003 Midwest Res to Pract Conf Adult, Contin Community Educ 2003:82–8.

[2] Santos R. Cronback's alpha: A tool for assessing the reliability of scales. J Ext 1999;37.

Appendix G

Power Calculations

Power was calculated based on the standard equation for cross-sectional study designs. With the clustered nature of data collection, the overall sample size is adjusted for inflation by a design factor of 1.2 [1]

$$\text{Power} = \phi Z_{(1-\beta)} = \phi [n(d)^2 r / (r+1)p(1-p)]^{1/2} - z_{\alpha/2}$$

Table 1. Identification of key symbols utilized in the power calculation.

Symbol	Definition
n	Sample size of HBSC cycle 7
%exp	Proportion of the population with the exposure
%unexp	Proportion of the population without the exposure
N _{exp}	Number of adolescent participants of the HBSC cycle 7 with the exposure
N _{unexp}	Number of adolescent participants of the HBSC cycle 7 without the exposure
r	Ratio of exposed adolescents to unexposed adolescents in the BHSC
RR	Relative risk of outcome based on that exposure
p	Prevalence of loneliness
p _o	Proportion of adolescents who are unexposed who experience the outcome
p ₁	Proportion of adolescents who are exposed who experience the outcome
d	Difference of proportions (p ₁ -p _o)
Z _{α/2}	Level of significance (α=0.05)
Z _(1-β)	Level of power

- [1] Roberts C, Freeman J, Samdal O, et al. The Health Behaviour in School-aged Children (HBSC) study: Methodological developments and current tensions. *Int J Public Health* 2009;54:140–50.
- [2] Kelsey J. *Methods in observational epidemiology*. USA: Oxford University Press; 1996.

Outcome: Loneliness among young people experiencing Q1 family communication quality

Exposure	n_{exp}	%exp	n_{adj.}	r	RR	p	p_o	p₁	Smallest detectable difference	Z_{α/2}	Z_(1-β)	Power (%)
Exposure 1: Verbal CMC Daily users vs. Non User	1648	26.68	1373	2.75	0.79	0.1428	0.1513	0.1195	0.0318	1.96	0.90	82.12
Exposure 2: Messaging Use Daily users vs. Non User	2733	45.28	2278	1.21	0.82	0.1428	0.1555	0.1275	0.0280	1.96	0.87	80.78
Exposure 3: Social Media Use Daily users vs. Non User	1901	31.28	1584	2.20	0.80	0.1428	0.1523	0.1219	0.0304	1.96	0.91	81.86

Outcome: Loneliness among young people experiencing Q2 family communication quality

Exposure	n_{exp}	%exp	n_{adj.}	r	RR	p	p_o	p₁	Smallest detectable difference	Z_{α/2}	Z_(1-β)	Power (%)
Exposure 1: Verbal CMC Daily users vs. Non User	2334	24.94	1945	3.01	0.85	0.1814	0.1889	0.1587	0.0302	1.96	1.03	84.85
Exposure 2: Messaging Use Daily users vs. Non User	4127	45.12	3439	1.22	0.89	0.1814	0.1909	0.1699	0.0210	1.96	0.93	82.38
Exposure 3: Social Media Use Daily users vs. Non User	2754	29.92	2295	2.34	0.85	0.1814	0.1882	0.1600	0.0282	1.96	0.97	83.40

Outcome: Loneliness among young people experiencing Q3 family communication quality

Exposure	n_{exp}	%exp	n_{adj.}	r	RR	p	p_o	p₁	Smallest detectable difference	Z_{α/2}	Z_(1-β)	Power (%)
<i>Exposure 1: Verbal CMC</i> Daily users vs. Non User	1235	23.60	1029	3.24	1.18	0.2786	0.2672	0.3154	0.0482	1.96	1.05	85.31
<i>Exposure 2: Messaging Use</i> Daily users vs. Non User	2324	45.25	1937	1.21	1.15	0.2786	0.2609	0.3000	0.0391	1.96	0.88	81.06
<i>Exposure 3: Social Media Use</i> Daily users vs. Non User	1499	29.05	1249	1.83	1.18	0.2786	0.2648	0.3124	0.0476	1.96	1.06	85.54

Outcome: Loneliness among young people experiencing Q4 family communication quality

Exposure	n_{exp}	%exp	n_{adj.}	r	RR	p	p_o	p₁	Smallest detectable difference	Z_{α/2}	Z_(1-β)	Power (%)
<i>Exposure 1: Verbal CMC</i> Daily users vs. Non User	1939	23.60	1616	2.56	1.09	0.4628	0.4741	0.5167	0.0426	1.96	0.95	82.89
<i>Exposure 2: Messaging Use</i> Daily users vs. Non User	3381	50.35	2818	0.99	1.09	0.4628	0.4427	0.4826	0.0319	1.96	1.04	85.08
<i>Exposure 3: Social Media Use</i> Daily users vs. Non User	2403	35.30	2003	1.83	1.09	0.4628	0.4485	0.4889	0.0404	1.96	0.93	82.38

Appendix H

Additional Analyses

Table 1 Description of the sample in the 2013-2014 HBSC study for Canada

Characteristic	HBSC Sample		Complete Case Analysis	
	N (n= 30,117)	%	N (n=21,445)	%
Biological Sex				
Male	14,784	49.34	10,162	47.39
Female	15,178	50.66	11,283	52.61
<i>Missing</i>	<i>115</i>			
Family Communication Quality				
Q1	6303	22.35	4735	22.12
Q2	9554	33.88	7263	33.87
Q3	5333	18.91	4080	19.03
Q4	7012	24.86	5359	24.99
<i>Missing</i>	<i>1915</i>			
School Grade				
6-8	16,273	54.62	11,137	51.93
9-10	13,520	44.38	10,308	48.07
<i>Missing</i>	<i>324</i>			
Feeling Sad or Depressed				
No	20,489	71.62	15,391	71.77
Yes	8,118	28.38	6,054	28.23
<i>Missing</i>	<i>1,510</i>			
Family Structure				
Nuclear Family	19,581	69.00	15,075	70.30
Non-Nuclear Family	8,796	28.38	6,370	29.70
<i>Missing</i>	<i>1,740</i>			
Frequency of Contacting Friends				
Weekly or more	13,688	50.90	10,870	50.69
Less than weekly	13,204	49.10	10,575	49.31
<i>Missing</i>	<i>3,225</i>			
Involvement in Group Activities				
3+	8,313	29.68	6,428	29.97
2	7,397	26.41	5,794	27.02
1	8,232	29.39	6,246	29.13
None	4,071	14.53	2,977	13.88
<i>Missing</i>	<i>2,104</i>			
Perceived Family Wealth				
High	15,120	53.47	11,560	53.91
Average	10,456	36.97	7,913	36.90
Low	2,703	9.56	1,972	9.20
<i>Missing</i>	<i>1,838</i>			
Peer Support				
High	22,896	83.59	18,022	84.04
Low	4,496	16.41	3,423	15.96
<i>Missing</i>	<i>2,725</i>			

Table 2 Prevalence of exposure and outcome variables in the sample population of the 2013-2014 HBSC study for Canada. (n= 30,117)

Characteristic	HBSC Sample		Complete Case Analysis	
	N (n= 30,117)	%	N (n= 21,445)	%
Primary Outcome: Loneliness				
No	20,735	73.76	15,840	73.86
Yes	7,376	26.24	5,605	26.14
<i>Missing</i>	<i>2,006</i>			
Exposure 1: Email Use				
Non User	26,549	97.50	20,562	97.87
Daily User	681	2.50	448	2.13
<i>Missing</i>	<i>2,887</i>			
Exposure 2: Verbal CMC Use				
Non User	20,984	74.09	15,985	74.54
Daily User	7,338	25.91	5,460	25.46
<i>Missing</i>	<i>1,795</i>			
Exposure 3: Messaging Use				
Non User	14,897	53.68	11,338	52.87
Daily User	12,856	46.32	10,107	47.13
<i>Missing</i>	<i>2,364</i>			
Exposure 4: Social Media Use				
Non User	19,243	68.66	14,739	68.73
Daily User	8,784	31.34	6,706	31.27
<i>Missing</i>	<i>2,090</i>			

Table 3 Verbal, messaging and social media CMC exposures, socio demographic, family and peer characteristics predicting the relative risk of loneliness among Canadian adolescents based on the 2013-2014 HBSC study.

Risk of Canadian adolescents often feeling lonely¹				
		Unadjusted RR (95% CI)	Unadjusted RR (95% CI)	
Males			Females	
Family Communication Quality			Family Communication Quality	
Q1		1.00	Q1	1.00
Q2		1.04 (0.93-1.17)	Q2	1.40 (1.26-1.55)
Q3		1.43 (1.26-1.63)	Q3	2.13 (1.92-2.38)
Q4		2.54 (2.27-2.84)	Q4	3.42 (3.10-3.76)
School Grade			School Grade	
6-8		1.00	6-8	1.00
9-10		1.23 (1.12-1.35)	9-10	1.28 (1.19-1.38)
Feeling Sad or Depressed			Feeling Sad or Depressed	
No		1.00	No	1.0
Yes		3.80 (3.51-4.12)	Yes	3.75 (3.51-4.00)
Family Structure			Family Structure	
Nuclear		1.00	Nuclear	1.00
Non Nuclear		1.46 (1.34-1.59)	Non Nuclear	1.43 (1.34-1.52)
Family Communication Quality			Family Communication Quality	
Low		1.00	Low	1.0
High		2.42 (2.22-2.64)	High	2.39 (2.25-2.55)
Frequency of Contacting Friends			Frequency of Contacting Friends	
Weekly or more		1.00	Weekly or more	1.0
Less than weekly		1.25 (1.15-1.36)	Less than weekly	1.08 (1.01-1.15)
Involvement in Group Activities			Involvement in Group Activities	
3+		1.0	3+	1.0
2		0.83 (0.74-0.93)	2	0.88 (0.81-0.96)
1		0.82 (0.74-0.91)	1	1.02 (0.94-1.11)
None		1.22 (1.09-1.37)	None	1.37 (1.25-1.50)
Perceived Family Wealth			Perceived Family Wealth	
High		1.00	High	1.00
Average		1.35 (1.24-1.47)	Average	1.55 (1.45-1.66)
Low		2.05 (1.82-2.31)	Low	2.28 (2.09-2.48)
Peer Support			Peer Support	
High		1.00	High	1.00
Low		1.41 (1.29-1.54)	Low	1.96 (1.82-2.11)
Verbal CMC Use			Verbal CMC Use	
Non User		1.00	Non User	1.00
User		1.13 (1.03-1.24)	User	1.06 (0.99-1.13)
Messaging Use			Messaging Use	
Non User		1.00	Non User	1.00
User		0.98 (0.90-1.06)	User	1.02 (0.96-1.09)
Social Media Use			Social Media Use	
Non User		1.00	Non User	1.00
User		1.06 (0.97-1.16)	User	1.11 (1.04-1.19)

¹ Adjusted for school-level clustering and weighted for population representativeness

Table 4 Change in estimate approach to confounder selection

Potential Confounder	RR_{unadjusted} of Loneliness	RR_{adjusted} of Loneliness	Absolute difference (%)
Verbal CMC			
Biological Sex	1.1021	1.0843	1.78
Family Communication Quality	1.1021	1.0734	2.87
School Grade	1.1021	1.1128	1.07
Feeling Sad or Hopeless	1.1021	0.9724	12.97
Family Structure	1.1021	1.0743	2.78
Frequency of Contacting Friends	1.1021	1.1311	2.9
Peer Support	1.1021	1.1289	2.68
Perceived Family Wealth	1.1021	1.0803	2.18
Involvement in Group Activities	1.1021	1.102	0.01
Messaging CMC			
Biological Sex	1.0856	1.0007	8.49
Family Communication Quality	1.0856	1.0499	3.57
School Grade	1.0856	1.0625	2.31
Feeling Sad or Hopeless	1.0856	0.939	14.66
Family Structure	1.0856	1.0823	0.33
Frequency of Contacting Friends	1.0856	1.1398	5.42
Peer Support	1.0856	1.1459	6.03
Perceived Family Wealth	1.0856	1.0855	0.01
Involvement in Group Activities	1.0856	1.1014	1.58
Social Media CMC			
Biological Sex	1.0921	1.1432	1.84
Family Communication Quality	1.1046	1.1432	3.86
School Grade	1.1387	1.1432	0.45
Feeling Sad or Hopeless	1.015	1.1432	12.82
Family Structure	1.1264	1.1432	1.68
Frequency of Contacting Friends	1.1879	1.1432	4.47
Peer Support	1.1827	1.1432	3.95
Perceived Family Wealth	1.1248	1.1432	1.84
Involvement in Group Activities	1.1477	1.1432	0.45

Appendix I

Ethic Clearance



QUEEN'S UNIVERSITY HEALTH SCIENCES & AFFILIATED TEACHING HOSPITALS RESEARCH ETHICS BOARD (HSREB)

HSREB Initial Ethics Clearance

August 04, 2015

Miss Lindsay Favotto
Department of Public Health Sciences
Queen's University

ROMEO/TRAQ: #6016097

Department Code: EPID-520-15

Study Title: Connection with a Screen: The Impact of Computer-Mediated Communication on the Health of Canadian Adolescents

Co-Investigators: Dr. V. Michaelson, Dr. C. Davison

Review Type: Delegated

Date Ethics Clearance Issued: August 04, 2015

Ethics Clearance Expiry Date: August 04, 2016

Dear Miss Favotto,

The Queen's University Health Sciences & Affiliated Teaching Hospitals Research Ethics Board (HSREB) has reviewed the application and granted ethics clearance for the documents listed below. Ethics clearance is granted until the expiration date noted above.

- Protocol

Documents Acknowledged:

- CORE Certificate – L. Favotto
- HSREB renewal – EPID-447-13 #6011166
- GREB approval – GMISC-062-13 #6010236

Amendments: No deviations from, or changes to the protocol should be initiated without prior written clearance of an appropriate amendment from the HSREB, except when necessary to eliminate immediate hazard(s) to study participants or when the change(s) involves only administrative or logistical aspects of the trial.

Renewals: Prior to the expiration of your ethics clearance you will be reminded to submit your renewal report through ROMEO. Any lapses in ethical clearance will be documented on the renewal form.


Completion/Termination: The HSREB must be notified of the completion or termination of this study through the completion of a renewal report in ROME0.

Reporting of Serious Adverse Events: Any unexpected serious adverse event occurring locally must be reported within 2 working days or earlier if required by the study sponsor. All other serious adverse events must be reported within 15 days after becoming aware of the information.

Reporting of Complaints: Any complaints made by participants or persons acting on behalf of participants must be reported to the Research Ethics Board within 7 days of becoming aware of the complaint. **Note:** All documents supplied to participants must have the contact information for the Research Ethics Board.

Investigators please note that if your trial is registered by the sponsor, you must take responsibility to ensure that the registration information is accurate and complete.

Yours sincerely,



Chair, Health Sciences Research Ethics Board

The HSREB operates in compliance with, and is constituted in accordance with, the requirements of the TriCouncil Policy Statement: Ethical Conduct for Research Involving Humans (TCPS 2); the International Conference on Harmonisation Good Clinical Practice Consolidated Guideline (ICH GCP); Part C, Division 5 of the Food and Drug Regulations; Part 4 of the Natural Health Products Regulations; Part 3 of the Medical Devices Regulations, Canadian General Standards Board, and the provisions of the Ontario Personal Health Information Protection Act (PHIPA 2004) and its applicable regulations. The HSREB is qualified through the CTO REB Qualification Program and is registered with the U.S. Department of Health and Human Services (DHHS) Office for Human Research Protection (OHRP). Federalwide Assurance Number: FWA#:00004184, IRB#:00001173

HSREB members involved in the research project do not participate in the review, discussion or decision.