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# Friends, followers, peers, and posts: adolescents' in-person and online friendship networks and social media use influences on friendship closeness via the importance of technology for social connection

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**Introduction:** With the proliferation of smartphones, social media access and use is ubiquitous. As such, many adolescent friendships now comprise both in-person and online contexts. Our paper explores the relationship between these contexts in two parts: the first is an exploratory comparison of in-person and online friendship networks with peers at school using descriptive social network analysis; the second, an investigation of how the use of different social media platforms relates to the importance placed on social media for connectedness and friendship closeness.

**Methods:** Participants were 547 adolescents ( $M = 15.25$  years, 52% male, 55% white) from six schools in Southern Ontario, Canada. Participants completed a peer nomination survey on their relationships with peers at school and a self-report survey on social media use.

**Results:** While in-person and online networks are largely overlapping, there are important differences between the two. Results from the path analyses suggest that length of cell phone usage, Instagram, Snapchat, and YouTube were positively associated with the importance placed on technology for social connection and that this importance was also positively associated with feelings of friendship closeness. Daily cell phone usage, Instagram, and Snapchat use were positively indirectly associated with friendship closeness through the importance of technology for social connection.

**Discussion:** Our findings also suggest slight gender differences, with daily time spent on a smartphone only significantly positively associated with the importance of technology for social connection for girls. Implications for future study are discussed.

## KEYWORDS

peer relationships, adolescence, friendship, social media, friendship closeness

## Introduction

Canadian youth report that socialization is their number one reason for using the internet ([MediaSmarts, 2022](#)). Much of this internet use takes place on social media platforms such as YouTube, TikTok, and Instagram. Social media is ubiquitous and easily accessible, with almost 80% of adolescents owning their own smartphones ([Moreno et al., 2022](#); [Moreno and Radesky, 2023](#)). With friendships serving as the most important social

relationships for this developmental period (Bukowski et al., 1996), investigating the role of technologies (such as social media) as a context for friendship is critical.

Blakemore and Mills (2014) argue that not only is adolescence a developmentally sensitive period, but also a period during which individuals are particularly sensitive to cultural shifts, including those related to technology. Extant literature struggles to keep pace with the cultural shifts around adolescent social media use. For example, adolescents are slowly leaving platforms such as Facebook and moving on to other platforms (Van Zalk, 2020; MediaSmarts, 2022). As such, it is necessary that research investigates the use of social media platforms that contemporary youth are actually using in their day to day lives, such as TikTok and Snapchat, which are largely absent from the extant literature. By examining the platforms that adolescents are using with their friends, we aim to investigate how adolescents' friendships unfold, in-person and online, and how these dynamic friendship contexts may or may not overlap. Further, it is important to consider the role of the different social media platforms and how their use might be influenced by characteristics, such as gender and social connection, to influence their feelings of friendship closeness.

To investigate these questions, we must first discuss friendship and why it is particularly important in adolescence. Friendship is generally defined as a voluntary relationship predicated on liking, reciprocity, and commitment (e.g., Bukowski et al., 1996; Hartup, 1996; Bagwell et al., 2021). During adolescence there is a significant shift from the family to the peer group, with friends taking on the role of primary agents of socialization (Bukowski et al., 2011; Bagwell and Schmidt, 2013). Compared to childhood friendships, adolescent friendships are characterized by greater opportunities for intimacy and equality, and they take on a more abstract, relational quality, compared to earlier, more concrete, self-centered, and play-based relationships (Bukowski et al., 2011). In the adolescent years (13–19 years old), increasingly sophisticated relational capacities emerge, including those related to “sustained mutuality, perspective taking, intimacy, loyalty, reciprocity, commitment, and equality” (White et al., 2018, p. 270). Thus, the formation and maintenance of friendships is a key developmental task in adolescence (e.g., Bagwell and Schmidt, 2013).

It is not just the formation and maintenance of friendships that matter, but also the characteristics of those friendships. Across the lifespan, closeness is a key characteristic of friendships (Johnson et al., 2003; Rubin et al., 2006). Closeness refers to the modes of engagement, interaction, and expression between friends (Polimeni et al., 2002). Friendships throughout the life course exist on a continuum of intimacy (e.g., Jeske, 2019) and greater closeness is an important indicator of overall friendship quality (e.g., Johnson et al., 2003). Close friends are particularly important for wellbeing during adolescence, with the formation and maintenance of these close friendships considered a key developmental task during this period of life (e.g., Hartup and Stevens, 1999; Berndt, 2002; Raboteg-Saric and Sakic, 2013). Meta-analyses demonstrate that close friendships serve as a protective factor against morbidity and mortality and that these effects hold over both short (e.g., 3 months) and long (50 years) periods of time (Holt-Lunstad et al., 2010). The link between friendship closeness and wellbeing is thought

to be rooted in the support found within these relationships, especially during times of stress, when close friends can provide care, understanding, and validation, as well as by acting as a secure base for growth and exploration during happier times (Farrell et al., 2022). Increasingly, these close friendships are occurring on and over social media.

Social media can generally be described as online platforms that promote the interaction of individuals via the creation of, and interactions with, online content such as pictures, videos, and text posts (Carr and Hayes, 2015). The difficulty in defining what constitutes social media is in part due to its constantly evolving nature. For example, the last 20 years has borne witness to the emergence and proliferation of a variety of social media platforms, including but not limited to: Facebook (2004), YouTube (2005), Reddit (2005), Twitter (2006), Tumblr (2007), WhatsApp (2009), Instagram (2010), Snapchat (2011), Twitch (2011), and TikTok (2016).

Social media can be categorized by its various functions. For example, Facebook, Instagram, and Snapchat are primarily social networking sites, while Twitter, Tumblr, and Reddit function as micro- and macro- blogging sites, respectively (Ryan et al., 2017). Another example is WhatsApp, which acts as an instant messaging service (Ryan et al., 2017), serving a similar function to text messaging. Further, there are social media platforms such as TikTok, Twitch, and YouTube, which do not fall neatly into these pre-defined categories. To address the changing social media landscape, Obar and Wildman (2015) proposed that social media be characterized by four factors: (1) the use of Web 2.0 technology; (2) a basis of user-generated content; (3) individual members moderated by a larger organization; and (4) the facilitation of online social networks via the connection of individuals' profiles.

Research on adolescents and young adults suggests that social media use may be associated with friendship closeness; however, the extant literature suggests that this association may be mixed (Phua et al., 2017; Waterloo et al., 2017). On the one hand, some research showed that frequent social media use can augment feelings of friendship closeness in adolescence (Valkenburg and Peter, 2011; Uhls et al., 2017; Nesi et al., 2018). Baiocco et al. (2011) found that adolescent friendships that occurred in both on and offline spaces were more intimate than those that took place in only one setting or the other. Yau and Reich (2018) also reported that higher levels of social media use were associated with higher levels of friendship closeness in adolescence, with this association potentially built upon relational processes that occur both in-person and online, such as validation and self-disclosure (Yau and Reich, 2020). On the other hand, some research shows that while social media bolstered in-the-moment feelings of friendship closeness for adolescents, it actually contributed to long-term decreases in feelings of friendship closeness over the course of a few months (Pouwels et al., 2021; Dumas et al., 2023).

In contrast, a handful of studies with adult samples suggest that social media use can both help and hinder feelings of social connectedness (Sheldon et al., 2011; Ahn and Shin, 2013; Grieve et al., 2013; Ryan et al., 2017). Other adult studies suggest that the association is in fact neutral, showing no association between social media use and friendship closeness (e.g., Burke and Kraut, 2014;

McEwan et al., 2018). As such, it may be that social media use has effects on friendship closeness that are unique during adolescence.

While there is a foundational body of research to suggest that social media use is associated with friendship closeness during adolescence, there is less research examining potential associations between social media use and social connectedness during this life stage. Social connectedness is a multidisciplinary construct that encapsulates feelings of belongingness, support, and care, as well as the quantity, quality, and diversity of relationships (Centers for Disease Control Prevention, 2023). Compared to friendship closeness, social connectedness captures broader feelings around and across relational contexts (e.g., peers, family, community; Viner et al., 2012), while friendship closeness specifically describes feelings of intimacy within friendships (Polimeni et al., 2002). Social media can be viewed as a context that may potentially promote social connectedness in adolescence (Riley et al., 2023).

While the integration of social media into everyday life provides new opportunities for adolescent social connection (Riley et al., 2023), it also introduces new pressures that may negatively impact feelings of social connectedness. Its role in the social fabric of friendships makes disconnection from social media difficult: adolescents feel pressure to remain digitally connected (Popat and Tarrant, 2023). Physically disconnecting from social media accompanied by the aptly named feeling of “disconnection anxiety” (Popat and Tarrant, 2023). As such, adolescents feel compelled to continue engaging over social media, for fear of the social disconnectedness that may occur if they were to remove themselves from it (Thomas et al., 2017; Scott et al., 2019). Adolescents admit that the importance of social media to social connectedness may contribute to overuse, reliance, and decreased quality of offline interactions (Mulisa and Getahun, 2018; O’Reilly et al., 2019; Scott et al., 2019). Adolescents express that disconnecting from social media might make them ‘out of the loop’, risking offline exclusion, with the idea of disconnecting without informing their friends contributing to adolescents’ anxiety (Kennedy and Lynch, 2016; Thomas et al., 2017; Scott et al., 2019).

These studies highlight the potential importance of social media and technology for social connectedness, especially during adolescence. Work by Ryan et al. (2017) suggests that this importance lies in social media’s ability to enhance social capital, foster sense of community, and potentially combat loneliness. As such, an important factor to consider in relation to social media’s role in adolescent perceptions of friendship closeness—for better or for worse—is the degree to which adolescents place importance on social media for social connectedness.

Further, it seems that gender may influence the potential relationship between social media use, the importance of social media for social connection, and friendship closeness. This variation may be the result of gender’s influence on how youth engage with social media, particularly during adolescence when gendered affiliation and behavior can intensify (e.g., Hill and Lynch, 1983; Priess and Lindberg, 2014). Prominent theories of gender and friendship may support how girls and boys may use social media differently, especially when considering interactions with their friends. For example, Gender Socialization Theory posits that lifelong gendered socialization contributes to gender-types behavior and attitudes in interpersonal relationships, such that boys are socialized to be assertive and independent, with friendships

built around shared group activities, while girls are socialized to be cooperative and caring, with friendships built on intimacy, support, and self-expression (Maccoby, 1990; Rose and Rudolph, 2006). Similarly, Social Identity Theory suggests that adolescents reify their gendered identities through group membership with same gendered peers and in contrast with other gendered peers. As a result, adolescents engage in gendered patterns of behavior that reinforce their affiliation with their gender (Tajfel and Turner, 2004).

These theories of gendered behavior in friendship may also apply to the observed gender differences in adolescent social media use. Existing empirical research suggests that girls tend to spend more time on social media than boys do, and their use tends to be more frequent and intense compared to their male peers (Rideout and Robb, 2018; Su et al., 2020). Girls tend to favor visually oriented platforms, while boys are more drawn to platforms for video sharing and gaming (Pew Research Center, 2018). Girls also tend to engage in higher levels of social comparison, feedback seeking, and solicitation of help from friends over social media than boys (e.g., Nesi and Prinstein, 2015; Yau and Reich, 2019) and they seem to be more susceptible to negative outcomes associated with social media use, such as depression, anxiety, poor body image, and low self-esteem (Blomfield Neira and Barber, 2014). It is important to consider gender differences in relation to social media use and friendship because of these theoretical and empirical differences in usage and outcomes, and since most youth friendships occur with same gender peers (Rubin et al., 2016). As such, we also investigate whether social media’s influence on social connection and friendship closeness varies by gender.

## The current study

With all of this in mind, this study addresses four main gaps in the literature by: (a) providing an investigation of the overlap between the same participants’ in-person and online friendships with peers from school; (b) testing the association between social media use and friendship connection with the inclusion of up-to-date, popular social media platforms (i.e., TikTok, Snapchat); (c) building upon the prior research that examines the relationship between social media use and friendship closeness through the inclusion of a potentially important mediator, the importance of social media use for social connection; and (d) testing the differences in these relationships based on gender.

With these gaps in mind, our study investigates adolescents’ in-person and online friendships, with two main goals. First, we aim to understand the characteristics of adolescents’ in-person friendship networks and compare them to their online friendship networks (Objective 1). This first goal addresses the lack of social network research examining overlapping adolescent online and offline friendship networks (Van Zalk, 2020). To our knowledge, the comparison of adolescent friendship networks with the same participants in two different contexts (in-person and online) has yet to be explored in the literature. Thus, we aim to fill this gap by mapping these two contexts across all of the grade-level friendship networks in our sample and to explore some of the descriptive network statistics (e.g., density, reciprocity) of these networks. We anticipate that the social network characteristics of the offline and

online networks will overall display similarities across number of nominations and reciprocity, but the online networks may be less dense than the in-person ones, as per previous research on online relationships (e.g., Hampton et al., 2011).

Next, we explore links between online social media usage and adolescents' feelings of overall friendship closeness using a path model, considering whether this association may work indirectly through the importance of technology for social connection (Objective 2). Empirical evidence suggests that social media use is associated with friendship closeness in adolescence (sometimes positively, other times, negatively) and there is theoretical evidence (e.g., Popat and Tarrant, 2023) to suggest that social media use may also influence feelings of social connection. Thus, we aim to investigate the potential links between social media use, importance placed on social media for social connection, and feelings of friendship closeness. We expect that social media use will be positively associated with friendship closeness (in line with Uhls et al., 2017; Nesi et al., 2018), and that the hypothesized link between social media usage and friendship closeness will work indirectly through the importance of technology for social connectedness, an association that has yet to be empirically tested.

Finally, we explore potential gender differences in these associations using a multiple groups analysis, as previous research has established that there are differences in how boys and girls use social media (e.g., Su et al., 2020). We anticipate a positive association between social media and the importance of social media for social connection for girls, whose relationships (theoretically and empirically) tend to rely more heavily on feelings of intimacy and self-disclosure than boys' relationships. We hypothesize that this relationship will be stronger for girls than for boys. Further, we expect that more visually salient platforms such as Snapchat and Instagram will be more strongly, positively associated with girls' friendships and more activity-based platforms, such as Twitch and YouTube, might be more relevant for boys' friendships.

## Methods

### Participants

Participants were 547 adolescents between the ages of 13–18 years old ( $M = 15.25$  years,  $SD = 1.42$ ). Of the sample, 52% identified as boys, 44% identified as girls, 2% as *Other*, and 2% selected *Prefer not to say*. Participants identified as predominantly White (56%), in line with the overall racial demographics of the regional population. Participants also identified as Mixed (13%), Latin (11%), Black (7%), Southeast Asian (4.4%), Other (4.4%), West Asian (2%), East Asian (1.5%), and South Asian (1.1%). Most participants identified with average or above average socioeconomic status (74.4%), while just under one fifth of the participants identified as lower or much lower socioeconomic status compared to the average Canadian family (18.5%).

### Procedure

Data were collected as part of a larger, ongoing longitudinal investigation of youth peer relationships in schools (2019–2024;

see also Andrews et al., 2021; Kim et al., 2021; Dane et al., 2022; Lapierre and Dane, 2022; Spadafora et al., 2022; Prabakaran et al., 2024; Spadafora and Volk, 2024). Participants were drawn from five participating elementary schools (Grade 8) and one high school (Grades 9–12) in southern Ontario, Canada. These schools were assigned to our study by the local school board. Active parental consent and student assent was obtained for elementary student participants ( $n = 120$ ), with an overall consent rate of 89% and an overall participation rate of 83%. Passive consent procedures were employed for the high school participants, resulting in a consent and participation rate of 95% (10 participants opted out of participation).

The data for this study were drawn from the project's fourth wave of data collection in the Spring of 2023, when we added the specific questions to do with social media for the purposes of this current study. Over the course of 3 weeks, principal investigators and trained research assistants visited grade 8 classrooms at the five elementary schools and grades 9–12 homeroom classes at the one high school in Southern Ontario, Canada. Participants independently completed both a peer nomination and self-report Qualtrics (an electronic survey platform)-based surveys using Android tablets. Researchers were available to answer questions and assist students with language or reading comprehension difficulties, if needed.

## Measures

### Self-report

#### Cell phone use

Cell phone use was measured using two questions. The first, *Do you have your own cell phone?* identified which participants have their own cell phone (*Yes*) and which do not (*No*). Participants who answered *Yes* to the question on cell phone ownership were directed to a second question, which asked: *On average, how many hours per day do you spend on your cell phone?* with response options of: *Less than 1 h*, *1–2 h*, *2–3 h*, *3–4 h*, and *More than 5 h*.

#### Social media use

Social media use was measured by a scale adapted from the Pew Research Center (2022). This scale presents participants with the following social media platforms: Twitter, Instagram, Facebook, Snapchat, YouTube, Tumblr, Reddit, TikTok, Twitch, and WhatsApp. For each, participants were asked to indicate the frequency of their use on a 6-point Likert scaling ranging from 1 (*Never*) to 6 (*Almost Constantly*). As expected, the Cronbach's alpha for this scale is not high ( $\alpha = 0.59$ ), since it is capturing the frequency of social media use across 10 different, not necessarily associated platforms (e.g., it is reasonable that youth who use Snapchat frequently may not also use Reddit frequently).

#### Importance of social media and technology to social connection

The importance of social media and technology to social connection (hereafter referred to as "social connection" for simplicity) was assessed using the Social Connection subscale of the Adolescents' Digital Technology Interactions and Importance scale (Moreno et al., 2020). This five-item subscale captures adolescents'

perceptions of the role of social media in social connectedness by asking: *How important, if at all, is it for you to use media and technology platforms for the following purposes?* Participants respond on a 5-point Likert scale, ranging from 1 (*Not at all important*) to 5 (*Extremely important*), to 5 items, such as: *See what people are up to without asking them about it* or *Contribute to a private conversation*. The sample derived reliability was 0.80.

### Friendship closeness

Friendship closeness was measured using the question: *How close to your friends do you feel right now?* (Pouwels et al., 2021). Participants responded using a 5-point Likert scale ranging from 1 (*Not at all*) to 5 (*Extremely close*).

## Peer nomination

### In-person and online friendship

Both in-person and online friendships were measured using peer nomination items. For in-person friendships, participants were asked: *Who are your best or closest friends?* For online friendships, participants were asked: *Which friends do you interact with most on social media?* For both in-person and online friendships, participants were limited to the peers with whom they share a school and grade. As such, participants were only able to select peers within their grade level who attended the same school (e.g., students in Grade 8 at School A could only nominate students in Grade 8 from School A). Elementary school participants were instructed to select as many individuals as they thought met the description from a provided roster of all grade-level peers who had parental consent ( $n = 12\text{--}39$ ). High school participants were instructed to select from 0 to 7 individuals in their grade that matched the description by typing responses into dialogue boxes on the survey, which offered autocomplete responses of the names of the students in their grade. Only those with consent (95% of high school population) were included in the analyses; if a student who had revoked consent or assent ( $n = 10$ ) was nominated in the free response box, their nomination was removed during data cleaning.

## Data analysis

To address our first research question, we applied principles of social network analysis to our peer nomination data. Social network analysis refers to a range of theoretical and methodological tools for examining connections between entities—in this case, the entities are individual adolescents, but social network analysis has been used in other social sciences and public health research to track a variety of relationships, including economic trade, disease transmission, and social capital (Luke and Harris, 2007). The use of Social Network Analysis is an increasingly popular and nuanced way of approaching large, relational data sets in developmental psychology (Neal, 2020). Social network analysis can be particularly helpful for investigating youth peer relationships and their structures in school settings (e.g., Sijtsema and Lindenberg, 2018; Neal and Veenstra, 2021).

We employed three specific social network methodologies: network visualization, network descriptive statistics, and Quadratic Assignment Procedure (QAP) autocorrelations. Exploring the

composition of adolescents' in-person and online networks is the first objective of this paper; as such, we begin with an examination of network visualizations, which offer clear, visual representations of complex relational patterns and offer insight into relational structures that might not be otherwise visible (Freeman, 2000; Scott, 2017). From here, we explored two important network descriptives: density and reciprocity. Density and reciprocity provide information on the level of cohesion within a group, as well as the degree to which relationships within a network are balanced or unbalanced (Knoke and Yang, 2008). Lastly, we explored the degree to which our in-person and online networks overlap using QAP autocorrelations. QAP autocorrelations employ simulated permutations of the provided data structures (much like bootstrapping) to test whether two structures are significantly related to one another and addresses the non-independence of overlapping network's observations (Krackhardt, 1987; Borgatti et al., 2018). In this case, it tests whether the friendship ties in the in-person network are significantly associated with the friendship ties in the online network.

All procedures were conducted in RStudio (R Version 3.2.1), a free online software for statistical computing and data visualization (<https://cran.r-project.org/>). All analyses utilized the statnet suite of packages (Statnet Development Team, 2003–2023). Edgelists based on friendship nominations were uploaded to RStudio and statnet syntax was utilized to generate the network visualizations, density, and reciprocity scores, and QAP autocorrelation values.

To address our second research question, we utilized SPSS Version 29 and MPlus software version 8.6 (Muthén and Muthén, 2021) to run path analyses using Maximum Likelihood Estimation (Kline, 2016).

## Results

### Descriptive statistics

Just under half of the participants (45%) reported spending more than 4 h on their cell phone daily (28% 3–4 h, 17% 2–3 h, 10% 2 h or less). Participants used TikTok and Snapchat most frequently, with 43%–44% of participants reporting using these platforms “almost constantly.” Participants' platform use seemed to be split: there were some platforms that most participants reported using (YouTube, Snapchat, Instagram, TikTok); and some platforms that were less frequently used (WhatsApp, Twitter/X, Facebook, Twitch, Reddit, Tumblr; for complete breakdown of reported social media use frequencies, see Table 1). Participants indicated an overall moderate importance of social media for social connection ( $M = 2.90$ ,  $SD = 0.94$ ). On average, most items were regarded as “slightly” or “moderately” important, with using platforms to “direct message, converse, chat, or talk with another person one on one” deemed the most important to social connection ( $M = 3.83$ ,  $SD = 1.20$ ).

Participants nominated and were nominated by around three peers ( $M = 3.22$  and  $2.95$ , respectively) as their best or closest friends in their grade. Of these nominations, on average, 1.36 were mutual. Participants nominated  $M = 2.19$  peers as friends they interact with often online and were nominated by  $M = 2$  peers. For online friendships, an average of 0.65 nominations were mutual. In

TABLE 1 Reported frequency of social media use by platform (%).

Platform	Sample use	Almost constantly	Several times a day	Several times a week	Once a week	Less than once a week	Never
YouTube	91%	20%	26%	25%	10%	10%	9%
Snapchat	87%	43%	29%	9%	4%	3%	13%
Instagram	84%	14%	32%	24%	7%	6%	16%
TikTok	82%	44%	24%	8%	4%	3%	18%
WhatsApp	35%	5%	5%	9%	7%	9%	65%
Twitter	33%	3%	2%	7%	8%	13%	67%
Facebook	29%	3%	3%	5%	7%	12%	71%
Twitch	28%	2%	2%	5%	7%	12%	72%
Reddit	24%	2%	3%	3%	5%	9%	78%
Tumblr	9%	1%	1%	2%	1%	3%	91%

this sample, 22% of participants reported feeling “extremely close” to their friends right now. Most participants reported either feeling “very close” (40%) or “moderately close” (27%) to their friends, with smaller percentages of participants feeling “slightly close” (7%) or “not at all” close to their friends (4.5%).

## Research objective 1: exploring and comparing in-person and online friendship networks using social network analysis

To investigate the first research objective, we utilized Social Network Analysis to explore the nine complete networks that make up our sample. These networks reflect the pre-determined boundaries selected by the authors: that one network is comprised of one grade-level at one school (e.g., two grade 8 classes at School A would be one network; one grade at class at School B would be another network, etc; Marsden, 2011; Neal, 2020). Our sample is thus comprised of five grade 8 networks and four secondary/high school networks, one network for each grade for grades 9–12. The grade 8 elementary school networks ranged in size from 12 to 39 participants ( $M = 23$ ); the high school grade level networks ranged from 130 to 154 participants ( $M = 142$ ). All nine, self-contained networks in our sample had consent and participation rates of 80% or higher.

### Network visualizations and descriptives

Network visualizations were constructed, with one in-person friendship network and one online friendship network created for each of the nine networks (see Figure 1 for an example; see Supplementary material for a compilation of all 18 networks). Nodes represent individual participants and arrows indicate the relationship from nominator to nominatee. Ties represented by double headed arrows are reciprocal. These diagrams visually map the friendships of participants, offering descriptive insight

as well as opportunities for comparison between in-person and online networks.

Comparing each in-person network visualization to its online counterpart, there was overall consistency in the friendship ties that youth report in both contexts. However, there was not complete overlap in the two networks—some in-person friendships did not translate to online ones and vice versa. There were at least one to two examples of this difference for each set of networks. Further, it appeared that certain individuals who were isolates in their in-person networks were connected to others in online settings (see Figure 1 and Supplementary material).

To further compare these two social contexts, we explored two network level descriptive statistics: network density and network reciprocity (see Supplementary material, Table 1). Density represents the proportion of friendships that exist within the network, given the number of potential friendships that could exist in those same networks (Agneessens, 2023). In-person network densities ranged between 0.02 and 0.30, while online network densities ranged between 0.02 and 0.36. In general, the five elementary school networks were denser than the four high school networks. In other words, more of the *potential* friendships in the elementary school networks were reflected as *actual* friendships than in the high school networks. There did not appear to be a clear pattern of difference or similarity when comparing the densities of the in-person networks to the online ones.

Reciprocity captures the degree to which ties in a network tend toward or away from being reciprocated (Agneessens, 2023). As would be expected of friendship networks, both the in-person and online networks displayed levels of reciprocity higher than chance. There did not seem to be any meaningful differences between in-person and online rates of reciprocity across these networks.

### Quadratic assignment procedure autocorrelations

A series of QAP correlations were conducted to determine the degree to which the existence of in-person friendships is associated with the existence of online friendships, based on 1,000

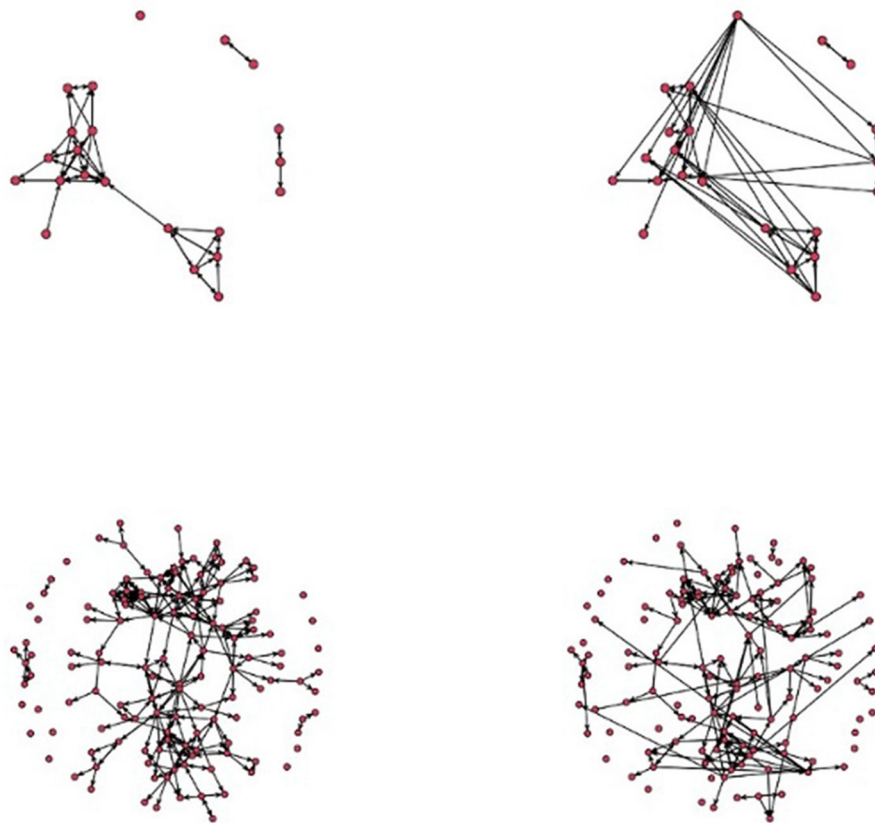


FIGURE 1

In-person and online friendship network visualizations. From left to right, top to bottom: Grade 8 In-person network, Grade 8 online network, Grade 12 In-person network, Grade 12 online network.

TABLE 2 Reported frequency of social media platform use by gender.

	Overall ( <i>n</i> = 535)	Boy ( <i>n</i> = 285)	Girl ( <i>n</i> = 242)
YouTube	91%	95%	86%
Snapchat	87%	85%	92%
Instagram	84%	79%	91%
TikTok	82%	79%	87%
WhatsApp	35%	30%	40%
Twitter	33%	42%	22%
Facebook	29%	27%	28%
Twitch	28%	42%	13%
Reddit	24%	35%	9%
Tumblr	9%	10%	6%

replications. The QAP test results indicated that in-person and online friendships were positively correlated with one another, with test values ranging from 0.50 to 0.69. Thus, as expected, networks were strongly correlated, though test values also indicate variation between the two contexts (see [Supplementary material, Table 2](#)).

## Research objective 2: the association between social media use and friendship closeness

### Preliminary analyses

The second objective of this study was to explore how social media might relate to feelings of friendship closeness and to investigate how the influence of social media might vary based on usage effects, such as different platform use, and user effects, such as age and gender. Variables met all assumptions (e.g., normality, multicollinearity). All bivariate correlations, means, and standard deviations for observed variables are presented in [Table 3](#).

Overall, participants' time spent on cell phones was positively associated with both technology use for social connection and friendship closeness but not related to reported number of friends in either context. Snapchat and TikTok use were positively associated with friendship closeness. Instagram and Snapchat use were positively associated with importance placed on technology for social connection, as well as number of in-person (for Snapchat only) and online friendships. In contrast, Facebook use was negatively associated with number of friends in-person and online. Number of in-person and online friends were positively associated with the importance of technology for social connection and with one another. Age was negatively associated with all measures of

TABLE 3 Descriptive statistics and bivariate correlations for observed variables.

Observed variable	M (SD)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1.Age	15.25 (1.42)	-	-0.006	0.041	-0.103*	0.138**	0.260**	0.142**	-0.082	-0.079	0.123**	0.137**	-0.023	0.023	0.182**	0.011	-0.243**	-0.278**	-0.140**	-0.258**	-0.258**	-0.175**
2.Gender	N/A		-	0.148**	-0.062	-0.142**	0.119**	0.016	0.029	-0.164**	-0.042	-0.249**	0.066	-0.195**	0.075	0.085*	0.013	-0.068	-0.074	0.006	-0.012	-0.026
3.Daily time on cell phone	4.04 (1.07)			-	0.117**	0.093*	0.238*	0.127**	0.223*	0.063	-0.059	-0.085	0.286**	-0.007	0.089*	0.225**	-0.002	-0.003	-0.016	0.013	0.041	0.049
4.Friendship closeness	3.68 (1.03)				-	-0.055	0.055	-0.013	0.187**	-0.015	-0.010	-0.026	0.144**	0.023	-0.024	0.199**	0.253**	0.256**	0.269**	0.154**	0.215**	0.240**
5. Twitter	1.73 (1.28)					-	0.114**	0.317**	-0.036	0.213**	0.360**	0.347**	0.106*	0.365**	0.169**	0.067	-0.097*	-0.060	-0.048	-0.90*	-0.088*	-0.005
6.Instagram	3.93 (1.63)						-	0.222**	0.347**	-0.057	0.064	-0.079	0.348**	0.000	0.193**	0.306**	-0.021	-0.018	0.000	0.062	0.030	0.137**
7.Facebook	1.63 (1.21)							-	0.102*	-0.005	0.327**	0.198**	0.136**	0.204**	0.313**	0.072	-0.104*	-0.100*	-0.013	-0.089*	-0.099*	-0.003
8.Snapchat	4.67 (1.69)								-	-0.133**	-0.068	-0.164**	0.563**	0.005	0.032	0.385**	0.113**	0.162**	0.121**	0.228**	0.198**	0.239**
9. YouTube	4.07 (1.54)									-	0.074	0.202**	-0.122**	0.259**	0.075	0.046	0.037	0.035	0.105*	-0.006	-0.055	0.030
10. Tumblr	1.23 (0.86)										-	0.426**	-0.002	0.312**	0.240**	0.010	-0.118*	-0.060	-0.019	-0.105*	-0.053	0.002
11. Reddit	1.52 (1.15)											-	-0.117**	0.467**	0.130**	-0.041	-0.086	-0.057	0.006	-0.058	-0.101*	0.020
12. TikTok	4.48 (1.88)												-	0.020	0.039	0.259**	0.071	0.067	0.062	0.081	0.121**	0.125**
13. Twitch	1.61 (1.17)													-	0.104*	-0.010	-0.095*	-0.008	0.048	-0.118**	-0.053	0.032
14. WhatsApp	1.94 (1.51)														-	0.042	-0.162**	-0.142**	-0.078	-0.106*	-0.113**	-0.016
15. Overall social connection	2.93 (0.94)															-	0.095*	0.119**	0.173**	0.184**	0.177**	0.286**
16. Mutual in-person friendships	1.36 (1.64)																-	0.707**	0.708**	0.577**	0.550**	0.476**
17. Received in-person friendships	2.95 (2.48)																	-	0.428**	0.529**	0.697**	0.340**
18. Sent in-person friendships	3.22 (3.02)																		-	0.360**	0.330**	0.582**
19. Mutual online friendships	0.65 (1.18)																			-	0.643**	0.501**
20. Received online friendships	2.01 (2.23)																				-	0.291**
21. Sent online friendships	2.19 (2.81)																					-

\*p &lt; 0.05.

\*\*p &lt; 0.001.



friends and friendship closeness, and positively associated with Twitter, Instagram, Facebook, Tumblr, Reddit and WhatsApp use.

Descriptive statistics also suggest that gender was associated with social media use. Girls reported more time spent on their cell phones, with 51.7% of girls in the sample reporting spending 4 or more hours on their cell phones per day, compared to 35.8% of boys. Girls also reported higher rates of Instagram use, with 19% of girls reporting using Instagram “almost constantly,” compared to 9% of boys, as well as higher rates of Snapchat use, with 55% of girls reporting using Snapchat and TikTok “almost constantly,” compared to 33 and 34% of boys respectively. Girls also reported placing greater importance on the role of technology in social connection. Boys reported greater overall use of Twitter, YouTube, Reddit, and Twitch (see [Table 2](#)).

### Path model of social media use and friendship closeness

The relationship between social media use, technology for social connection, and friendship closeness was investigated using a structural path model with gender and age as a covariate (see [Figure 2](#)). Direct and indirect effects were estimated with Maximum Likelihood estimation, with indirect effects using bootstrapped confidence intervals of 10,000 replications (95% bias corrected). For the sake of parsimony, the model did not contain social media platforms that were deemed less prevalent to adolescents' lives based on theory and the extant literature (Facebook, Twitter, Tumblr, Reddit, Twitch, or WhatsApp). The omission of these platforms from the overall model was further supported by their empirical lack of statistical significance in preliminary analyses. The model included age, gender, daily cell phone time, and social media platform use (Instagram, Snapchat, TikTok, YouTube) as independent variables predicting levels of friendship closeness. The model also included the association between these variables working indirectly through the importance of technology for social connection.

Due to the exploratory nature of these analyses, we tested all direct paths from social media platforms to social connection, as well as all direct paths to friendship closeness. With a fully saturated model, global fit indices are not interpretable ([Field, 2018](#)). There was a direct positive association between cell phone time and the importance of technology for social connection, with those that reported more daily time on their cell phone also placing more importance on the role of technology for social connection. Similarly, there were significant direct paths from Instagram, Snapchat, and YouTube use to the importance of technology for social connection. Greater importance of using technology for social connection was positively associated with friendship closeness (see [Figure 2](#) and [Table 4](#) for full direct effects).

There was a direct negative association between age and friendship closeness, with reports of friendship closeness decreasing as participant age increased. There were significant positive indirect effects from daily cell phone use and friendship closeness via social connection (see [Table 5](#) for indirect effects). There were also significant positive indirect effects from Instagram, Snapchat, and YouTube to friendship closeness through social connection. These indirect associations indicate that social media

for social connection may be an important mechanism influencing how young people use social media, integrate it in their friendships, and how social media use may be playing a role in young people's perceptions of friendship closeness in contemporary contexts.

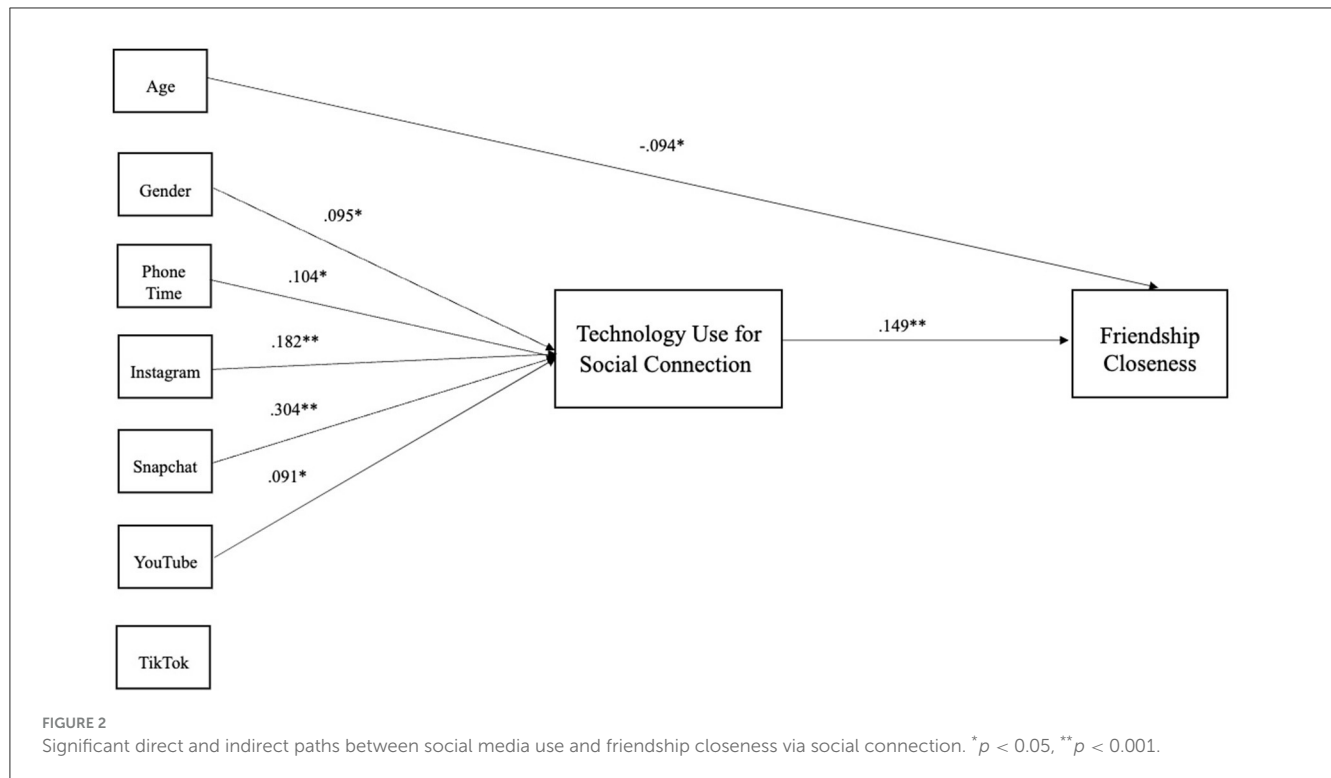
### Multiple groups analysis by gender

We conducted a multiple groups analysis to determine if the relationships between social media use and friendship closeness would vary based on gender (boys vs. girls). First, we compared two models: one with direct paths fully constrained to gender invariance, the other with direct paths free to vary across gender (testing all direct paths from age, daily cell phone time, and the social media platforms Instagram, Snapchat, YouTube, and TikTok to the importance of technology for social connection). The fully constrained model indicated worse fit than the unconstrained model [ $\Delta\chi^2(44) = 188.76, p < 0.000$ ], indicating gender variance in one or more of the direct paths. As such, each path of interest was systematically constrained by gender and compared to a less constrained model, using a chi-square difference test to determine which path(s) varied significantly by gender. This process indicated that while there were no gender differences in the association between social media use and friendship closeness, gender did seem to significantly influence the association between some social media platform use (time spent on a smartphone, Snapchat, and TikTok) and the importance of technology for social connection. Daily time spent on a smartphone was only significantly positively associated with the importance of technology for social connection for girls, not boys [ $\Delta\chi^2(43) = 4.09, p = 0.04$ ]. For both boys and girls, Snapchat use was associated with placing importance on the role of technology for social connection [ $\Delta\chi^2(43) = 7.63, p = 0.006$ ]; however, this relationship appeared to be stronger for girls than for boys. See [Figure 3](#) for final, partially constrained model with significant paths that varied by gender [ $\chi^2(4) = 171.22, p < 0.001$ ; RMSEA = 0.112 (0.095, 0.130); CFI = 0.064; SRMR = 0.186].

## Discussion

The first goal of this study was addressed using descriptive statistics and social network analysis. Consistent with other reports of North American adolescent cell phone ownership (e.g., [Statistics Canada, 2016](#)), 97% of this sample reported owning a cell phone. Social media use was also consistent with contemporaneous North American samples (e.g., [Moreno et al., 2022](#)). Participants' platforms of choice, however, continue to illustrate how quickly trends move. Our sample reported TikTok and Snapchat as the two most frequently used platforms, and Instagram still maintained a degree of popularity (84% of our sample). Facebook, however, seems to have fallen out of popularity with adolescents, with only 29% of our sample reporting its use.

Our results suggest some age-related differences in social media platform use, with older participants reporting greater use of Twitter, Instagram, Facebook, Tumblr, Reddit, and WhatsApp, reflecting the potential increased online autonomy that may come with time over the course of adolescence (e.g., access to cell phones may increase, while parental monitoring may decrease, with age). Older participants also reported fewer friends, both in-person and



**TABLE 4** Unstandardized and standardized direct and total effects.

Variable	Social connection				Friendship closeness			
	<i>B</i>	SE	$\beta$	95% CI	<i>B</i>	SE	$\beta$	95% CI
Age	-0.007	0.027	-0.010	-0.091, 0.071	-0.069	0.032	-0.094*	-0.181, -0.007
Gender	0.177*	0.079	0.095*	0.011, 0.179	-0.015	0.093	-0.007	-0.097, 0.083
Time on phone	0.091*	0.037	0.104*	0.021, 0.187	0.064	0.044	0.067	-0.023, 0.157
Instagram	0.105**	0.026	0.182**	0.095, 0.270	-0.018	0.031	-0.029	-0.124, 0.067
Snapchat	0.170**	0.027	0.304**	0.212, 0.397	0.057	0.033	0.094	-0.012, 0.200
YouTube	0.055*	0.024	0.091*	0.013, 0.168	-0.011	0.029	-0.016	-0.101, 0.068
TikTok	0.004	0.025	0.007	-0.089, 0.103	0.019	0.029	0.035	-0.069, 0.139
Social connection					0.163	0.051	0.149**	0.058, 0.240

\* $p < 0.05$ .  
\*\* $p < 0.001$ .

online, perhaps indicating a pruning of friendships as adolescence progresses and individuals perhaps invest more time in increasing intimacy with smaller numbers of individuals.

Our findings also support gender differences in platform choice. Girls reported spending more time on their phones and were more likely to use Instagram (an app based on the social presentation of self-curated images). This is in line with previous research suggesting girls' preference toward visually oriented social media (Dumas et al., 2023). In contrast, boys were more likely to use either text-based platforms (e.g., Reddit, Twitter) or video and video-game related platforms (e.g., YouTube, Twitch) (see also Lenhart, 2015). It is important to consider these gendered patterns of use, as evidence suggests that not only are there gendered patterns in friendship structure and behavior, but also

gendered patterns in the associated outcomes of those friendships (Rose, 2002; Rubin et al., 2008). Our findings generally support how gendered socialization influences engagement with social media platforms.

The descriptive findings offer continued support for the potential differences that social media introduces to adolescent friendships. On average, participants indicated that social media was moderately important to social connection, placing the greatest emphasis on social media platforms' ability to facilitate direct conversations with others one-on-one. The importance of social media for facilitating direct conversations could be attributed to various functional, emotional, and cognitive affordances associated with social media (Moreno and Uhls, 2019).

## Comparing in-person and online friendship networks

To our knowledge, this study is the first to compare the in-person and online friendship networks of adolescents' school-based peer networks. Network visualizations indicated a high degree of overlap between adolescents' friendships in person and online; however, the two contexts did not completely overlap. While certain dyads, trios, and smaller friend groups seemed to exist across both contexts, there were, for instance, examples of isolates in one network not being isolates in the other. The test values for the bivariate and QAP correlations indicate a degree of overlap ( $r = 0.4\text{--}0.6$ ), but these relationships were not as high as expected, considering the networks are comprised of the same individuals across both contexts, surveyed at the same point in the school year.

Why might there be a high degree, but not complete, overlap? One explanation is logistical: if an individual is included as a friend in-person but not online, it may reflect their access (or lack thereof) to a personal cell phone, cellular data, or social media accounts that would facilitate their nomination as an online friend. Another explanation is that social media may allow adolescents to interact with, and become close to, a variety of peers online, not necessarily limiting youth to their close, in-person friendships. For example, an adolescent's best friends in-person may be those that they share classes with, but their best friend online may be a peer from a previous semester with whom they maintain contact online. The large overlap between friendships in both contexts, however, suggests that friendships are co-constructed across contexts and that many of them can be understood as conjoint (in-person and online) friendships (Subrahmanyam et al., 2006; Van Zalk, 2020).

Network reciprocity values supported that both in-person and online networks were mostly reciprocal: this is unsurprising considering some degree of reciprocity is often considered a central tenet of friendship (White et al., 2018). When comparing the densities of in-person and online networks, there was not a clear pattern of difference or similarity. This finding could reflect that in-person and online social networks are so entangled that there would be no observable patterns of difference between the two—or it could reflect that the densities of these networks are not particularly relevant or meaningful.

## Social media use, friendship closeness and social connection

The second aim of the study was to explore the interplay between specific social media platform use, reported importance of social media for social connection, and friendship closeness. Overall, age was negatively associated with friendship closeness, such that the older participants were, the lower their reported levels of friendship closeness. These lower levels of friendship closeness for older participants may be attributable to the developmental differences between early and later adolescence. These results may highlight the heightened importance of friendship and group membership in early adolescence, an emphasis that may wane as individuals approach later adolescence, feel potentially more self-assured in their social identity, or begin the transition to emerging

TABLE 5 Indirect effects from social media use to friendship connection via importance of technology for social connection.

	<i>B</i>	SE	$\beta$	95% CI
Age	0	0.006	0	−0.013, 0.012
Gender	0.027*	0.017	0.014*	0.002, 0.037
Time on phone	0.015*	0.009	0.016*	0.002, 0.038
Instagram	0.017*	0.008	0.027*	0.005, 0.036
Snapchat	0.028*	0.010	0.045*	0.010, 0.051
YouTube	0.009*	0.006	0.014*	0.001, 0.024
TikTok	0.001	0.004	0.001	−0.008, 0.010

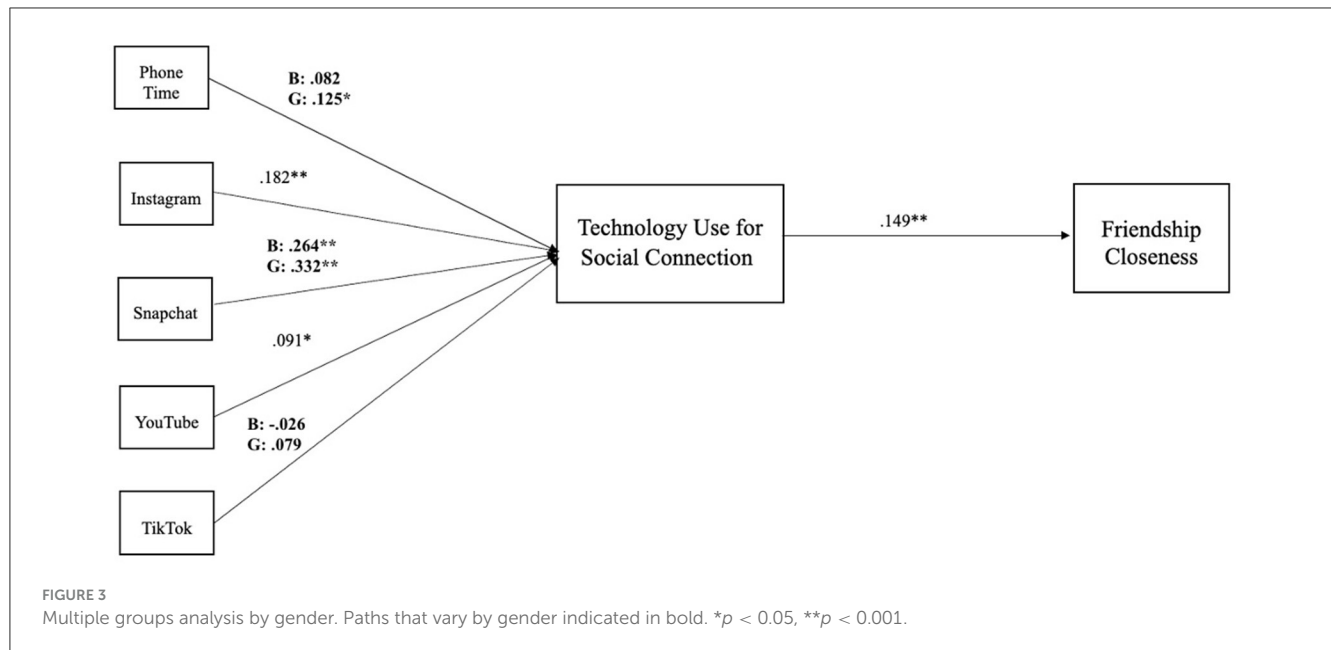
\*Significance determined by 95% CIs that do not include 0.

adulthood. Age was not, however, related to the importance of technology for social connection, suggesting that social media may play a relatively stable role in its importance to young people's social lives over the course of adolescence.

The associations between cell phone use, Instagram, Snapchat, YouTube, and social connection suggest that those who use these technologies more often may place greater importance on the role of technology in their social lives—or vice versa. The indirect association between social media use and friendship closeness through the importance of technology for social connection may also be the result of the ways in which social media might change the social norms and expectations around friendship (Nesi et al., 2018). For example, Instagram and Snapchat offer interfaces that make use of affordances that might be particularly salient for adolescents' sense of social connection. On Instagram, posts made on the main feed (pictures and/or videos) remain on an individual's profile and pop up on their followers' (friends'?) homepages, relying heavily on the quality of visibility (Nesi et al., 2018). The posting of new stories is signaled to others by a change in the perimeter color of one's profile picture. Posts and stories make use of a "tagging" system, allowing individuals to indicate who is in the post and who can re-share it. As such, belongingness can be indicated to the broader peer group through these public displays of friendship, perhaps enhancing feelings of closeness.

Instagram and Snapchat also make use of a direct message function, which takes advantage of the importance of self-disclosure in fostering intimate friendships (Valkenburg and Peter, 2009) and the affordance of immediacy provided by social media (Nesi et al., 2018; Moreno and Uhls, 2019). The direct message function might be important for enhancing feelings of closeness, since it is removed from the public-facing pressure that likes, comments, and shares on the newsfeed may produce (Kennedy and Lynch, 2016; Moreno and Uhls, 2019). Snapchat is particularly designed to promote self-disclosure in real-time: adolescents can take a picture or video of an experience as it's happening, caption it, and start an immediate dialogue with the receiver. Snapchat offers extrinsic motivation to constantly share with friends over the platform via the function of "streaks" that record consistent reciprocal communication between two users.

What remains unclear, however, is if the significant effects associated with these platforms are due to affordances inherent



and/or unique to these two interfaces specifically, or if these effects are just greater for some platforms because they are the platforms of choice for adolescents at this moment in time. We suggest that both hypotheses may be true. Platforms such as Facebook serve similar functions and make use of similar affordances as Instagram and Snapchat; however, the former has lost favor among adolescents. TikTok and YouTube, on the other hand, fit different niches. Both are video based and allow for sharing and bonding over content via direct messaging. Yet while TikTok use was reported frequently, it was not significantly associated with social connection or friendship closeness (whereas YouTube was). YouTube offers longer and more varied content than TikTok but is a generally more passive platform akin to traditional television and may thus appeal to more boys who might be relatively less interested in direct social interactions than in shared experiences of watching sports, comedy, music, or video gameplay. Its links to friendship closeness and connectedness might thus reflect its reinforcement of common interests between friends who can strengthen their friendship by sharing mutually interesting social media.

## The role of gender

The association between social media use for social connection and friendship closeness did not vary based on gender. The use of specific social media platforms and the importance of social media for social connection, however, varied. These differences may lie in the opportunities some platforms offer for consistent self-disclosure and co-rumination (Desjarlais and Joseph, 2017), aspects of friendships more commonly considered characteristic of girls' friendships than boys' friendships. This reasoning may also explain why time spent on cell phones was significantly associated with social connectedness for girls and not boys, since this variable may also capture non-social media cell phone usage for social purposes,

such as text messaging, video calls, and phone calls (e.g., Liu and Yang, 2016).

## Limitations and future directions

There are a few important limitations to this study. First, its cross-sectional design means that while we can comment on apparent associations, we cannot make causal claims. This aspect of the study's design is especially important to consider when interpreting the association between social media use and the importance placed on technology for social connection. To offer greater clarity and provide evidence for causal claims, future work should investigate this association longitudinally to better understand whether social media use augments the importance placed on it, or vice versa.

It is also important to note whose information is not captured by this study, but who theory and research suggest would engage in unique social media use: namely, adolescents who identify as non-binary (Allen et al., 2021). In this sample, we were limited by the small number of adolescents who identified as non-binary (<10). It is also important to note that this study focuses on in-person and online friendships amongst peers at school; as such, it does not capture how the associations between these variables may be similar or different for friendships in different contexts including in-person settings such as extra-curricular activities, sports, or the neighborhood, as well as online settings such as online gaming, long-distance friendships, or online communities that are explicitly fostered between youth who feel othered in their physical settings but are able to seek out communities with similar others in online settings (e.g., nonbinary youth).

Future work is needed to investigate how these different settings may influence our results, particularly as they might apply to minoritized youth. Future research should also gather

more detailed information around the nature of platform use (i.e., specific functions—posting, direct messaging, scrolling). Future work may also utilize more specific measures of friendship and friendship closeness via ranking nomination of friends or identifying which friends one would turn to in different scenarios.

## Conclusion

This study explores an adolescent peer context of emerging importance: the potential overlap between adolescents' friendships in-person and online. Modern life occurs increasingly in digitally mediated spaces and there is no generation for whom this is truer than today's adolescents; the first generation to come of age as "digital natives" (Prensky, 2001). The integration of smartphones in adolescents' lives means that their friendships—arguably the quintessential peer context in adolescence (Bukowski et al., 2011)—plays out not only in both physical and online spaces, but also across the two. Investigating the effects of social media on adolescent friendships can aid our understanding of friendship in-person, online, and across these two contexts. This study indicates that though there appears to be overlap between in-person and online peer contexts, especially in relation to peers at school, there is also something unique to friendships in online spaces.

It is imperative to consider how social media inadvertently alters adolescent friendships, as well as the ways in which social media platforms influence friendships *by design*, as interfaces are intended to encourage both use and reliance. The extant literature emphasizes the largely negative developmental impacts of social media, which the authors do not deny; however, this study also suggests that social media can be a tool for supporting the development and maintenance of friendship closeness, a finding that may be of particular importance to youth who might otherwise feel isolated from (or by) their peers. With its current cultural hold and lack of constraints for young people, it is important to consider how adolescent relationships may have changed to incorporate the use of social media and how this incorporation could be used to bolster protective factors (such as friendship closeness) and combat the risk factors that social media produces (e.g., cyberbullying, low self-esteem). Thus, understanding the ramifications of adolescents' social media use on their friendships—namely, to better understand who is using what platforms, for what purposes, and how this may impact their social relationships and overall wellbeing—can provide critical insights into the importance of peers.

## Data availability statement

The datasets presented in this article are not readily available because, given that we are working with minors in a dataset that could potentially allow for individual identification, we do not have ethical approval from our university or school board REBs to share

our data. Requests to access the datasets should be directed at: AV, [tvolk@brocku.ca](mailto:tvolk@brocku.ca).

## Ethics statement

The studies involving humans were approved by Brock University Research Ethics Board. The studies were conducted in accordance with the local legislation and institutional requirements. Written informed consent for participation in this study was provided by the participants' legal guardians/next of kin.

## Author contributions

EA-J: Conceptualization, Formal analysis, Funding acquisition, Investigation, Methodology, Visualization, Writing – original draft, Writing – review & editing. AV: Funding acquisition, Investigation, Supervision, Writing – review & editing. NS: Conceptualization, Investigation, Supervision, Writing – review & editing. NA: Supervision, Writing – review & editing.

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## Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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## Supplementary material

The Supplementary Material for this article can be found online at: <https://www.frontiersin.org/articles/10.3389/fdyps.2024.1419756/full#supplementary-material>

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