ORIGINAL PAPER

Psychological Distress and Peer Dynamics in Adolescent Summer Care Programs: A Longitudinal Social Network Analysis

Tyler Prochnow[1] · Sara A. Flores[1] · Laurel Curran[1] · Emily Howell[1] · Deja T. Jackson[1] · Meg S. Patterson[1]

© The Author(s) 2025

Abstract

Background Summer care programs provide important developmental contexts for adolescents, yet little is known about how psychological distress influences peer dynamics in these settings. Previous research has shown that mental health symptoms can affect social integration in school environments, but these patterns may differ in summer programs.

Objective This study aimed to examine the relationship between adolescent psychological distress and friendship network dynamics in a summer care program over time.

Methods Adolescents (n=47, ages 10-14) attending an 8-week summer program completed surveys at the start and end of the program, assessing friendships, negative interactions, and psychological distress. Exponential random graph modeling (ERGM) and separable temporal exponential random graph modeling (STERGM) were used to analyze friendship networks and their changes over time.

Results Adolescents with higher psychological distress were more likely to receive friendship nominations but less likely to initiate them at the end of summer. Friendships were more likely to form between adolescents similar in age and gender. Over time, adolescents with higher psychological distress scores were more likely to receive friendship nominations but also more likely to be nominated as someone others did not get along with.

Conclusions Psychological distress influences adolescents' social positions in summer program networks, with distressed youth receiving more friendship nominations but also experiencing more negative interactions. These findings highlight the complex social dynamics faced by adolescents with mental health symptoms in summer care settings and underscore the importance of monitoring social integration patterns to support all participants' well-being.

Keywords Social Connection · Mental health · Youth · Friends · Peers

✉ Tyler Prochnow
   tprochnow@tamu.edu

[1]   Texas A&M University, College Station, USA

🙋 Springer

Introduction

Adolescent mental health and peer relationship dynamics represent interconnected developmental processes with significant implications for long-term well-being (La Greca & Harrison, 2005; Tillfors et al., 2012), yet our understanding of these relationships remains largely confined to traditional school settings (Long et al., 2021). While research has extensively documented how psychological distress influences social integration and friendship formation in academic environments (Brendgen et al., 2016; Eugene et al., 2021; Long et al., 2021), substantially less is known about these dynamics in alternative contexts such as summer care programs, which serve millions of adolescents annually during critical out-of-school time periods (McCombs et al., 2019; Thurber et al., 2007). The present study addresses this knowledge gap by conducting a longitudinal social network analysis (SNA) to examine how psychological distress shapes friendship formation, maintenance, and negative peer interactions among adolescents participating in an eight-week summer care program. Understanding these social mechanisms is essential for developing interventions that leverage peer networks to support youth mental health (Baggio et al., 2016; Perry & Pescosolido, 2015) and optimize the developmental benefits of summer programming (McCombs et al., 2019). Through systematic examination of bidirectional relationships between psychological distress and social network position over time, this research aims to inform evidence-based practices for promoting positive peer climates and inclusive social environments in summer care settings.

Adolescent Mental Health and Psychological Distress

Adolescence represents a critical developmental period marked by heightened vulnerability to mental health challenges, with significant implications for both immediate functioning and long-term outcomes (Rapee et al., 2019). Many mental health disorders materialize in adolescence, with studies reporting that roughly half of mental health disorders were identified or had an onset by the age of 14 (Caspi et al., 2020; Kessler et al., 2007). Further, anxiety and depression are among the most diagnosed mental disorders in children, commonly cooccurring, and increasing over time (Bitsko et al., 2022; Cree et al., 2018; Ghandour et al., 2019). These disorders affect children's ability to learn, cope with stress, interact with others, and adopt healthy behaviors (Avenevoli et al., 2013; McLeod et al., 2012). While this developmental stage presents unique risks, it also offers significant opportunities for building coping skills, developing emotional regulation abilities, and establishing healthy social relationships that serve as protective factors throughout the lifespan (Iwahori et al., 2022; Lombardi et al., 2019; Oberle et al., 2024). Understanding both the challenges and strengths inherent in adolescent development is essential for creating supportive environments that promote positive mental health outcomes.

Within this broader mental health landscape, psychological distress represents a particularly important construct for understanding adolescent functioning across multiple domains. Psychological distress can be operationally defined as a state of emotional suffering characterized by symptoms of depression and anxiety, including feelings of sadness, nervousness, restlessness, hopelessness, and worthlessness (Kessler et al., 2002). Unlike clinical diagnoses that require meeting specific diagnostic criteria, psychological distress captures

a continuum of emotional difficulties that may not reach clinical thresholds but nonetheless significantly impact daily functioning and social relationships (Keyes, 2002). Psychological distress often manifests through observable changes in social behavior, academic performance, and peer interactions, making it a critical factor to consider when examining adolescent social networks (Brady & Kendall, 1992; Konac et al., 2021). This broader conceptualization is particularly valuable in adolescent populations, where subclinical symptoms may fluctuate and evolve rapidly during this developmental period. The co-occurrence of depressive and anxiety symptoms within the psychological distress framework reflects the complex and interconnected nature of internalizing problems during adolescence, when youth are simultaneously navigating identity development, academic pressures, and evolving social relationships (Rapee et al., 2019).

Peer Interactions and Mental Health

As children age, their interactions with peers and friends become increasingly important for social development and mental health (La Greca & Harrison, 2005; Tillfors et al., 2012). Both positive and negative peer interactions can influence children's psychosocial adjustment. Close friendships provide companionship and support which benefit self-esteem, social skills, and emotional adjustment (Glick & Rose, 2011; Kim et al., 2017). In contrast, problematic peer interactions like bullying and peer victimization are risk factors for internalizing problems such as depression and anxiety (Eugene et al., 2021; Mullan et al., 2023). Peer harassment and exclusion predict increases in childhood depression over time, even when controlling for prior symptoms (Brendgen et al., 2016). Recent meta-analytic evidence demonstrates that peer victimization predicts subsequent depression, while depressive symptoms predict decreases in positive friendship quality and increases in negative peer interactions, creating reinforcing feedback loops that are particularly pronounced during early-to-mid adolescence when peer relationships become central to identity development (Christina et al., 2021; Schwartz-Mette et al., 2020).

Mental health problems can lead adolescents to withdraw from social relationships and become increasingly isolated from their peers (Schwartz-Mette et al., 2020). Young people experiencing depression and anxiety often lose interest in social activities and find less enjoyment in spending time with friends, a phenomenon researchers term social anhedonia (Setterfield et al., 2016). These adolescents may actively avoid social situations, spend more time alone, and gradually reduce their contact with peers (Barzeva et al., 2019). Depression and anxiety also affect how young people interpret social situations, leading them to perceive social interactions as more threatening or negative than they actually are (Platt et al., 2013). This withdrawal from social activities means that adolescents miss important opportunities to develop and practice social skills, which can make future social interactions more difficult and reinforce their tendency to avoid peers.

Peer rejection and social isolation can also contribute to the development of mental health problems in adolescents (Schwartz-Mette et al., 2020). When young people experience bullying, exclusion, or rejection from their peer group, it creates significant stress that can trigger depression and anxiety symptoms (Rudolph et al., 1994). Research shows that social rejection activates similar brain regions as physical pain, highlighting how emotionally painful these experiences can be for adolescents (Eisenberger et al., 2003). Peer

harassment and exclusion predict increases in childhood depression over time, even when researchers account for existing mental health symptoms (Brendgen et al., 2016). The timing of these experiences is particularly important during adolescence, when peer relationships are central to identity development and self-worth (Christina et al., 2021; Oberle et al., 2024). Early experiences of social rejection can have lasting effects, with childhood social withdrawal predicting higher rates of anxiety and depression in adulthood (Rubin et al., 1995). This creates a concerning pattern where early peer difficulties lead to ongoing social and emotional challenges throughout development.

Summer Care Programs

The influence of peer interactions on adolescent health has been studied intensively within the school setting, which is commonly regarded as a critical context for public health efforts (Long et al., 2021). However, there has been limited examination of the social dynamics occurring between children at summer programs and how said dynamics may relate to mental health. Like the school setting, summer care programs (e.g., camps, recreation centers, and summer schools) are critical contexts for child development by providing structured enrichment activities as well as opportunities for social connection (McCombs et al., 2019; Michalski et al., 2003; Thurber et al., 2007) that might otherwise be absent over the summer. In addition to structured activities, summer programs allow children to form new friendships and peer relationships outside of the school setting. Attendance at summer programs has been associated with improved academic, socioemotional, and health outcomes for youth (Michalski et al., 2003; Thurber et al., 2007). While summer programs may offer similar benefits as school attendance, the interaction opportunities and grouping patterns can differ substantially between these contexts (Steinberg & Morris, 2001), making it important to understand social network findings unique to summer care programs. While extensive research has examined the relationship between psychological distress and peer dynamics within school environments, a significant gap exists in our understanding of these dynamics within summer care programs. This gap is particularly concerning given that mental health disorders often materialize in adolescence and this significant amount of time away from traditional school supports may exacerbate these conditions.

Theoretical Considerations

The Network Episode Model (Perry & Pescosolido, 2015; Pescosolido, 1992, 2006) and Ecological Systems Theory (Bronfenbrenner, 1979) provide valuable frameworks for understanding the bidirectional relationship between psychological distress and social environments. The Network Episode Model posits that individuals' mental health trajectories are influenced by their social networks, which either facilitate or impede access to resources and support (Perry & Pescosolido, 2015; Pescosolido, 1992, 2006). Similarly, Ecological Systems Theory emphasizes that development occurs within nested social contexts, with microsystems like summer programs serving as important environments where peer interactions directly influence adolescent well-being (Eriksson et al., 2018; Mutumba & Harper, 2015). Together, these theories suggest that summer programs represent distinct microsys-

tems where unique social dynamics may emerge, potentially buffering against or exacerbating psychological distress through peer acceptance or rejection. Understanding these dynamics is critical for developing targeted interventions that leverage social networks to promote positive mental health outcomes.

Social Network Analysis (SNA)

SNA provides a methodology for capturing detailed friendship networks and peer interactions (Valente, 2010). SNA allows researchers to examine the overall structure of a network and how individual attributes and relationships contribute to this structure (Valente, 2010). Further, identifying network factors linked to poorer psychosocial outcomes can ultimately inform efforts to foster more positive, inclusive peer climates and healthier social development for all children participating in these programs (Baggio et al., 2016; Falci & McNeely, 2009). For example, SNA could determine if children experiencing psychological distress were more peripherally positioned in a summer program peer network or less likely to receive friendship nominations compared to peers reporting better mental health (Lusher et al., 2013; Prochnow, et al., 2021a; Prochnow, et al., 2020a; Prochnow et al., 2023). SNA can also enable comparing the relative importance of different variables to connection formation (Lusher et al., 2013; Valente, 2010). This can elucidate the degree to which mental health versus other factors like gender or age influence children's social embeddedness. Understanding the interplay between whole social network structures, negative interactions, and mental health symptoms can provide broader insight into peer relationship patterns at summer programs beyond examining isolated dyads.

Purpose

This study employs a whole network approach to examine the bidirectional relationship between psychological distress and social network dynamics among adolescents attending a summer care program. Guided by Network Episode Model and Ecological Systems Theory, we hypothesize that: (1) youth with greater psychological distress will send and receive fewer friendship nominations from peers; (2) adolescents will demonstrate homophily based on psychological distress, forming and maintaining friendships with peers exhibiting similar symptom levels over time; and (3) adolescents with higher psychological distress will experience more negative peer interactions. By tracking these relationships longitudinally over an eight-week summer program, this study aims to elucidate social mechanisms influencing adolescent mental health in summer care settings and identify potential pathways for network-based interventions to support youth experiencing psychological distress.

Methods

Participants

Adolescents aged 10–14 years old who attended a summer care program (i.e., Boys & Girls Club) in central Texas were invited to participate in researcher administered surveys at the start (time 1) and end (time 2) of summer (8 weeks between time points). A research assistant used a computer to facilitate the survey on site, during normal program hours, in a room away from main activities. Parents were informed of the study and could withdraw their child at any time without any interruption of care or benefit. Adolescents were asked to provide written assent prior to participating in each survey. This study was approved by the Institutional Review Board of the referent University prior to initiation.

Adolescents ($n=47$; $M=11.0$ years old; $SD=1.3$; 51.1% female) in this sample primarily identified as Black or African American ($n=19$, 40.4%) and White ($n=22$, 46.8%). Additionally, 44.7% of the sample identified as Hispanic ($n=21$). Adolescents were primarily in grades 5 ($n=20$) and 6 ($n=15$). See Table 1 for demographic information.

Measures

Adolescents were asked to report their age, sex, race, and ethnicity at both survey timepoints.

Table 1 Sample demographics

Variable	n	%	Time 1 mean (SD)	Time 2 mean (SD)
Sex				
Girl	24	51.1%		
Boy	23	48.9%		
Grade level				
4th	1	2.1%		
5th	20	42.6%		
6th	15	31.9%		
7th	6	12.8%		
8th	2	4.3%		
9th	3	6.4%		
Race				
American Indian or Alaska native	3	6.4%		
Black or African American	19	40.4%		
White	22	46.8%		
Mixed race	3	6.4%		
Ethnicity				
Hispanic	21	44.7%		
Non-Hispanic	26	55.3%		
Age			11.00 (1.27)	11.05 (1.27)
Psychological distress			20.33 (8.34)	18.82 (7.52)
Friendship connections			4.08 (2.83)	6.85 (5.77)
Dislike connections			0.64 (1.42)	1.70 (2.21)

Mental Health

Psychological distress was chosen as a primary dependent variable because of the co-occurrence of depressive and generalized anxiety symptoms in adolescence and the association between depressive symptoms and physical symptoms of anxiety (Brady & Kendall, 1992; Konac et al., 2021). We measured psychological distress using the 10-item Kessler Psychological Distress Scale (i.e., the K-10) (Kessler et al., 2002), a scale that has historically yielded valid and reliable data (Cronbach's alpha=0.92) (Larzabal-Fernandez et al., 2023). In the current study, the K-10 demonstrated good internal consistency reliability at both time points, with Cronbach's alpha coefficients of 0.76 at Time 1 and 0.72 at Time 2. The K-10 assesses non-specific psychological distress based on the frequency in which adolescents endorse symptoms of depression and anxiety over a 30-day period (e.g., In the past 30 days, how often did you feel so nervous that nothing could calm you down) on a 5-point Likert response scale ranging from 1 (none of the time) to 5 (all of the time). All items are then summed to create a scale score based on the original scale instructions ranging from 10 to 50 (Kessler et al., 2002). Further, previous work also suggested cut-off scores based on the likelihood of mental disorder or psychological distress. These cut-offs include: 10–19 Likely to be well; 20–24 Likely to have a mild disorder; 25–29 Likely to have a moderate disorder; 30–50 Likely to have a severe disorder (Kessler et al., 2002).

Network Data

Based on a network-generator question used in a study investigating adolescent health and social networks in summer care programs (Prochnow et al., 2022a, b; Prochnow, et al., 2020b; Prochnow et al., 2021a, b, c, 2022a, b; Prochnow et al., 2021, adolescents were asked to report the names of peers with whom they hung around with, talked to, and/or did things with the most at the summer care program with no limit on the number of peers they could nominate. Said connections between adolescents will be referred to as friendships from this point on. Adolescents were also asked to report who in the program they did not get along with. While it is understood that bullying is multifaceted and can be a complex dynamic, this negative tie generating question was used as a proxy to better understand how psychological distress might influence negative relationships among adolescents. This negative peer interaction will be termed "dislike". Peer nominations were coded as a directed tie (1=tie, 0=no tie) for each specific time point. Adolescents were provided a full roster (i.e., a list of names) of all 10–14 year-olds at the summer care program they could nominate. If an adolescent was enrolled in the program after time 1, they were added to the list for the second time point.

Data Analysis

Means, standard deviations, frequencies, and percentages for demographics were calculated using SPSS v. 26 (IBM, 2018). Network visuals were generated using Gephi 0.10 with the ForceAtlas Layout tool. Exponential random graph models (ERGM) were used to explore friendship existence, formation, and maintenance in these networks. Specifically, ERGMs were used to estimate factors important to friendship presence at each time point, and sepa-

rable temporal exponential random graph models (STERGM) were used to model changes to the network over time.

Cross-sectional ERGMs determined significant factors associated with the presence of friendship connections between adolescents in the networks at each independent time point (Lusher et al., 2013). ERGMs approximate the maximum likelihood estimates for the log-odds of associations between factors related to network structure or characteristics of the individuals in the network and tie presence (Lusher et al., 20given13). Significant parameter estimates suggest the specific network configuration is observed in the empirical network more than would be expected by chance, the other effects modeled in the network. Similarly, STERGMs were used to model changes in the network over time (Krivitsky & Handcock, 2014). A positive significant parameter in the formation model would suggest the given parameter configuration was more likely to form from time one to time two. Conversely, a negative parameter would suggest less likelihood of the configuration forming over time. A positive significant parameter in the dissolution model would suggest the given parameter configuration was more likely to be *maintained* between time points. On the contrary, a negative significant parameter in the dissolution model would suggest the given parameter configuration was less likely to be maintained between time points. A factor is deemed significant at a $p < 0.05$ level if the parameter estimate (PE) is greater than twice the standard error (SE). Friendship nominations of children who were not included in the study (participating child nominated a child not participating) were removed prior to analysis. Cleaning and management of network data, along with ERGM and STERGM analyses, were completed using statnet package in R Studio (Hunter et al., 2008).

Model Specification

The same parameters were used in all ERGMs and STERGMs in this study. Network structure parameters were added to model density (edges or connections in the network), reciprocated friendships (connections that are mutually shared between two individuals), and transitive triads (three individuals connected to each other). These parameters provide a control basis for the network structure to ground the data in what was recorded empirically. Parameters were added to understand the role of homophily (sameness) related to sex, age, and race/ethnicity. Similarly, an absolute difference in mental health parameter was added to understand if adolescents were friends with others who reported similar psychological distress scores. Sender and receiver covariates were added for sex, age, and psychological distress to determine significant associations between those variables and either sending or receiving a friendship nomination. For example, separate parameters were included to identify the difference between sending and receiving a friendship nomination in the network based on mental health. All parameters were added to the model in a stepwise fashion and then adjusted for degeneracy. Degeneracy, in this case, is when the addition of a parameter to the model creates network simulations which are unstable. If a control variable caused degeneracy in the model, it was dropped from that network model. All models converged, suggesting the empirical networks were representative enough to be successfully analyzed via permutation tests in ERGMs and STERGMs.

Results

Adolescents (n=47; M=11.0 years old; SD=1.3; 51.1% female) reported mild levels of psychological distress (M=20.33; SD=8.34) at time one, indicating they were "likely to have a mild disorder" and low levels of psychological distress (M=18.82; SD=7.52) at time two, indicating they were "likely to be [psychologically] well." However, this difference was not statistically significant, t(46)=0.85, p=.20. Adolescents reported significantly more friendship connections at time two (M=6.85; SD=5.77) compared to time one (M=4.09; SD=2.83) t(46)=4.01, p<.001. Similarly, adolescents reported significantly more dislike connections at time two (M=1.70; SD=2.21) compared to time one (M=0.64; SD=1.42) t(46)=3.68, p<.001. See Table 1 for more information. Friendship networks are visually represented in Fig. 1 while dislike networks are visually represented in Fig. 2.

Cross Sectional

At both time points, adolescents were significantly more likely to be friends if they were (a) part of a reciprocated connection; (b) part of a transitive structure; (c) similar in age; (d) the same sex; and (e) older. Girls were significantly more likely to be in friendships as compared to boys at time one. Adolescents were significantly less likely to send friendship connections if they reported higher psychological distress scores. Conversely, adolescents were significantly more likely to receive friendship connections if they reported higher psychological distress. Adolescents were significantly more likely to report not getting along at time one and two if they were different in age. Further, adolescents were significantly more likely to report not getting along with someone of the same gender at time two. Adolescents
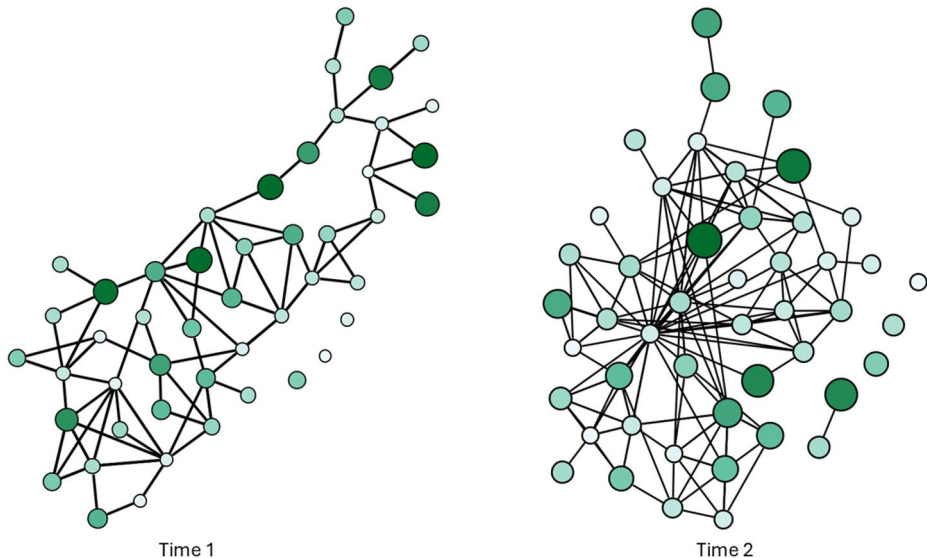
Fig. 1 Friendship networks at both time points. Note: Circles represent youth and are sized and colored based on psychological distress scores with larger and darker circles representing higher distress scores; lines represent friendship nominations
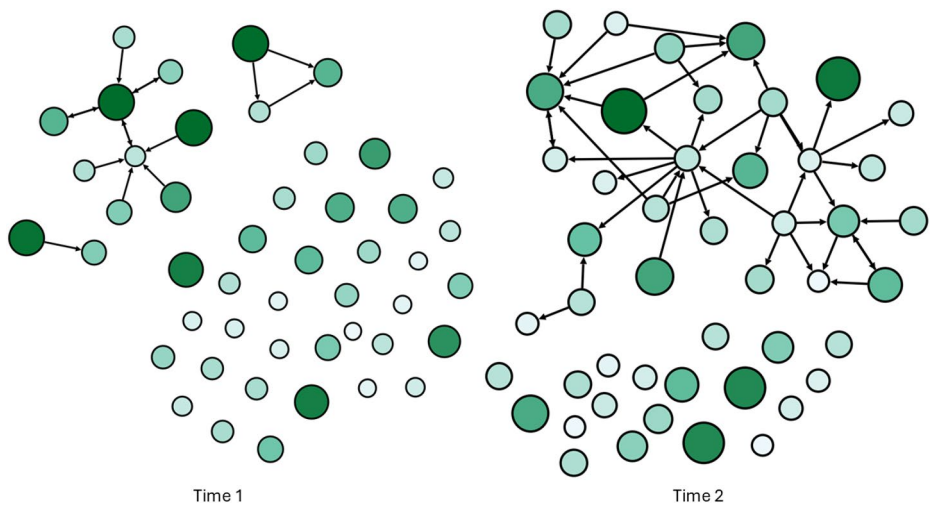
Fig. 2 Dislike networks at both time points. Note: Circles represent youth and are sized and colored based on psychological distress scores with larger and darker circles representing higher distress scores; lines represent dislike nominations

were significantly more likely to be reported as someone that others did not get along with if they reported higher psychological distress at time two. See Table 2 for full ERGM results.

Longitudinal

In longitudinal modeling, adolescents were significantly more likely to form friendship connections overtime if they were (a) part of a reciprocated connection; (b) part of a transitive structure; (c) similar in age; (d) the same sex; and (e) were older. Adolescents were significantly more likely to receive friendship connections over time if they reported greater psychological distress scores; however, greater psychological distress scores were not significantly associated with reduced odds of sending new nominations. Similarity in psychological distress scores did not increase the odds of friendship connections forming or persisting between adolescents. Adolescent friendship connections were significantly more likely to persist if they were reciprocated. Further, adolescents were significantly more likely to form dislike connections overtime if they were part of a reciprocated connection, were part of a transitive structure, were similar in age, were the same sex, and were girls. Adolescents who reported greater psychological distress scores were significantly more likely to be nominated as someone others did not get along with over time. It should be noted that the persist model for dislike connections was not able to converge due to the limited number of dislike connections that persisted over time. See Table 3 for full STERGM results.

Table 2 Exponential random graph model results

Variable	Friendship			Dislike		
	PE	SE	*p*-val	PE	SE	*p*-val
Time 1						
Edges	−6.60	0.61	<0.001*	−8.47	2.35	<0.001*
Reciprocity	2.46	0.41	<0.001*	4.25	0.99	<0.001*
Transitivity	0.83	0.12	<0.001*	0.74	0.51	0.14
Similarity in age	−0.47	0.10	<0.001*	−1.02	0.41	0.01*
Similarity in sex	0.85	0.20	<0.001*	0.54	0.47	0.24
Age	0.11	0.02	<0.001*	0.11	0.10	0.25
Sex (referent: boy)	0.09	0.04	0.05*	–	–	–
Similarity in psychological distress	0.01	0.01	0.81	0.03	0.03	0.33
Psychological distress (sending)	−0.01	0.01	0.64	0.04	0.03	0.15
Psychological distress (receiving)	−0.01	0.01	0.92	0.007	0.03	0.82
Time 2						
Edges	−7.29	0.89	<0.001*	−4.73	2.40	0.04*
Reciprocity	2.96	0.30	<0.001*	1.40	0.85	0.10
Transitivity	0.88	0.10	<0.001*	0.85	0.46	0.06
Similarity in age	−0.51	0.08	<0.001*	−0.45	0.19	0.02*
Similarity in sex	1.03	0.17	<0.001*	0.94	0.33	0.001*
Age	0.18	0.04	<0.001*	0.01	0.11	0.91
Sex (referent: boy)	0.09	0.08	0.23	–	–	–
Similarity in psychological distress	−0.01	0.01	0.49	−0.01	0.02	0.48
Psychological distress (sending)	−0.03	0.01	0.02*	−0.01	0.02	0.58
Psychological distress (receiving)	0.02	0.01	0.04*	0.04	0.02	0.03*

Note: *PE* Parameter Estimate, *SE* Standard Error, *—Indicates significance at $p < 0.05$; - Variable was removed based on depreciation in the model

Discussion

The purpose of this study was to examine social network dynamics occurring in a summer care program in relation to symptoms of psychological distress and peer interaction among adolescents. Results indicate that at the end of summer, adolescents with greater psychological distress were more likely to receive friendship nominations but less likely to initiate them. Over the summer, friendships were more likely to form between adolescents who were similar in age, gender, and mental health status. In terms of negative interactions, adolescents with greater psychological distress were more likely to be nominated by others as someone they did not get along with. These results suggest adolescents are able to identify those within their social circles that are struggling, and that symptoms of psychological distress may influence adolescents' positions within summer care program social networks.

Results of adolescents reporting more friendships and more negative interactions from the start to end of summer align with previous research suggesting peer interactions increase in salience and complexity across childhood development, and as they have time to develop relationships within the program over the course of the summer. As youth get older, they spend more time interacting with peers independently from adults, allowing opportunities for both prosocial bonding and negative interactions like bullying to emerge (Brendgen et al., 2016). The current study provides initial evidence that similar developmental patterns may occur in the condensed timeframe of summer care programs. The increase in total

Table 3 Separable Temporal exponential random graph model results

Variable	Friendship			Dislike		
	PE	SE	p-val	PE	SE	p-val
Formation						
Edges	−7.77	0.90	<0.001*	−6.11	2.19	<0.001*
Reciprocity	1.83	0.31	<0.001*	1.63	0.74	0.03*
Transitivity	1.28	0.15	<0.001*	0.79	0.29	<0.001*
Similarity in age	−0.27	0.08	<0.001*	−0.40	0.19	0.04*
Similarity in sex	0.475	0.17	<0.001*	0.71	0.35	0.04*
Age	0.13	0.04	<0.001*	0.05	0.10	0.58
Sex (referent: Boy)	−0.04	0.07	0.56	0.42	0.20	0.03*
Similarity in psychological distress	−0.02	0.02	0.17	−0.02	0.03	0.36
Psychological distress (sending)	−0.02	0.02	0.12	−0.01	0.02	0.67
Psychological distress (receiving)	0.04	0.01	0.01*	0.04	0.02	0.04*
Persistence						
Edges	class="convertMinus"ID="MN24">−0.50	2.42	0.83	–	–	–
Reciprocity	2.28	0.66	<0.001*	–	–	–
Transitivity	0.38	0.25	0.12	–	–	–
Similarity in age	0.06	0.31	0.84	–	–	–
Similarity in sex	0.79	0.51	0.12	–	–	–
Age	−0.03	0.10	0.74	–	–	–
Sex (referent: boy)	−0.11	0.24	0.65	–	–	–
Similarity in psychological distress	0.01	0.04	0.82	–	–	–
Psychological distress (sending)	−0.01	0.03	0.71	–	–	–
Psychological distress (receiving)	−0.01	0.04	0.93	–	–	–

Note: *PE* Parameter Estimate, *SE* Standard Error, * - Indicates significance at $p<.05$

friendships reported suggests adolescents were actively forming social connections over the summer. However, the simultaneous increase in dislike nominations indicates negative peer dynamics emerged as well. Although adolescents reported slightly lower psychological distress at the end of summer, the difference was non-significant, perhaps due to the competing positive and negative effects of the changing peer experiences. In addition, it is possible that the negative influence of one person can impact much of the network in its entirety, and a child who bullies is oftentimes a child dealing with external traumas and stressors that could benefit from individual, tailored support (Arseneault et al., 2010; Mishna, 2012). Previous network interventions have leveraged network data to identify change agents and opinion leaders within adolescent friendship networks (Valente & Pumpuang, 2007; Waterman et al., 2022). In the same way, using data from negative tie networks, it is possible to provide tailored support and assistance to children who could fall more central in a negative interaction network, with the potential to offset ripple effects of bullying over the course of the summer. It will be important for future research to delineate developmental trajectories of peer interactions and mental health across an entire summer and to determine predictors of positive versus negative pathways. This can inform efforts to structure summer care programs to maximize friendship building while minimizing problematic social behaviors.

Previous research has also reported on homophily in children's peer relationships (i.e., similarity in age, gender, and mental health status predicted friendship selection). Studies

have shown that children tend to become friends with peers who are like themselves in terms of demographics, attitudes, and behaviors (McPherson et al., 2001; Prochnow et al., 2021a, b, c, 2022a, b). The present results build on this prior work by demonstrating homophily effects longitudinally within the context of a summer program peer network. Similarity typically facilitates positive relationships, but can also increase friction when youth compete for social status (Flashman, 2012). Adolescents in this sample were also more likely to report not getting along with those similar in age and gender, aligning with previous research. The increase in negative interactions among same-gender peers may reflect competition for popularity, which accelerates in early adolescence, especially among girls (LaFontana & Cillessen, 2010). It will be important for future research to investigate what factors predict whether homophily has positive or negative implications for socioemotional development. Implementing active inclusion policies, cooperating learning groups, and relationship-building curricula could help counteract age- and gender-based peer divides that contribute to negative interactions.

The present study contradicts previous peer network studies that observed homophily based on distress levels (i.e., distressed youth more likely to befriend other distressed youth (Baggio et al., 2016; Hogue & Steinberg, 1995). Previous studies have suggested co-rumination (excessive discussion dwelling on negative emotions) among adolescents may worsen distress levels and quicken the time to depressive episode onset (Rose et al., 2014; Stone et al., 2011). It is unclear why the current study did not find evidence for homophily based on psychological distress. One potential explanation is that the shorter duration of summer programs, compared to school settings where prior studies were conducted, did not allow sufficient time for strong homophily effects to emerge or for children to create bonds strong enough to entrust their struggles with one another, which would yield evidence of homophily. Additionally, the positive emotion-focused activities and supportive staff-participant relationships that are characteristic of many summer camps could discourage distressed youth from interacting with similarly distressed peers. More research is needed to understand factors that moderate homophily patterns related to internalizing symptoms in adolescent peer networks across different contexts. Another important consideration is that internalizing symptoms such as anxiety and depression are often less visible and observable to peers compared to externalizing behaviors that are more readily apparent in social interactions. This reduced visibility of psychological distress may have limited adolescents' ability to identify others with similar symptom levels, thereby preventing the formation of friendships based on shared internalizing experiences that would be necessary for homophily to emerge. More research is needed to understand factors that moderate homophily patterns related to internalizing symptoms in adolescent peer networks across different contexts.

The consistent pattern that higher psychological distress predicted fewer friendship nominations sent but more nominations received implies these distressed youth occupied peripheral network positions. This aligns with previous studies that found youth with worse mental health are less socially integrated (Falci & McNeely, 2009). However, the lack of an effect of mental health homophily on friendship persistence implies that distressed adolescents were not necessarily excluded from maintaining ties. There are different explanations for these social dynamics. Children experiencing psychological distress may withdraw from initiating interactions, perhaps due to anhedonia (i.e., lack of motivation) which is a characteristic of depression (Kupferberg et al., 2016; Zellner et al., 2011). However, peers may continue to nominate distressed adolescents due to empathy or pity. Over time, the passive

position could reinforce low self-esteem and social skills (Kupferberg et al., 2016). Alternatively, depression may result from feeling socially excluded (Kupferberg et al., 2016). Adolescents observing signs of isolation could nominate distressed peers in an effort to be more inclusive. Unfortunately, these efforts may be seen as rejecting by youth experiencing psychological distress who already feel disconnected. Summer care programs may consider routine monitoring of social integration and targeted interventions when children appear isolated.

Simultaneously, the tendency for distressed youth to be nominated by peers as bullies and as targets also mirrors patterns seen in prior work (Klomek et al., 2015). The increase in dislike nominations for distressed adolescents further illustrates integration challenges. Appearing distressed or socially anxious can signal a vulnerability that elicits victimization (Reijntjes et al., 2010). Early adolescent bullies often have high social status, so provoking reactions from marginalized peers may help to assert dominance (Juvonen & Graham, 2014). However, the reciprocal and transitory ties found here expand on static negative interaction measures, demonstrating these aggressive interactions can be bidirectional and dynamic. Considering reciprocal ties, bullies feeling distressed may also pick on others to alleviate their own distress. In either case, results suggest interventions should educate adolescents and counselors on recognizing social exclusion and its links to mental health. Teaching adolescents positive strategies to reach out to and include peers struggling to connect could help prevent victimization. Monitoring the social standings of both bullies and victims can identify those most in need of psychosocial support. Overall, results suggest summer programs should take care to monitor signs of exclusionary behavior starting from the first days.

Limitations

This study has several methodological constraints that warrant consideration. Our small sample size ($n=47$), while capturing the complete population at this summer program, still only represents one small network, potentially limiting our ability to detect smaller effects or complex structures. The exclusive reliance on adolescent self-reports and peer nominations introduces possible measurement biases stemming from social desirability concerns or perceptual inaccuracies, particularly for psychological distress measures. Additionally, although we collected data at two time points, the relatively brief timeframe (8 weeks) and concurrent collection of all variables limits causal inference regarding directionality between psychological distress and social network dynamics. Future research should address these limitations through multi-site studies with larger samples, incorporation of diverse measurement approaches including observational techniques and staff reports, and more frequent, strategically staggered assessment points to better establish temporal relationships between variables.

Implications

In terms of future directions, it would be informative to design intervention programs focused on inclusion at summer camps to determine impacts on network integration for adolescents experiencing psychological distress. Curricula teaching perspective taking and empathy could be promising for improving cross-group interactions. Examining social dynamics at summer care programs adopting formal inclusion practices compared to those without would reveal whether policies affect network homophily. For summer programs, results suggest value in considering how the peer culture and social dynamics influence adolescent developmental experiences. Staff training on identifying victimization and intervening in positive ways could help reduce negative peer interactions. Mixing up group activities more frequently could reduce possibilities for exclusion. Tracking and facilitating supportive relationships may promote skills that adolescents carry back to school settings. Just as academic learning has priority, summer programs should also make socioemotional learning a priority.

Conclusions

Study results show the interplay of peer relationships, negative interactions, and mental health at summer care programs, which aligns with previous research on the importance of peer interactions for adolescent psychosocial adjustment. For instance, research has demonstrated that friendships provide social support and benefits for adolescents' self-esteem and wellbeing (Iwahori et al., 2022). However, difficult peer interactions like exclusion and victimization are linked to internalizing problems like depression (Reijntjes et al., 2010). The current findings build on this knowledge by demonstrating these peer social dynamics longitudinally within the specific setting of a summer care program.

Declarations

Conflict of interest Authors have no conflicts to disclose.

Ethical Approval Study was approved by the Texas A&M University Institutional Review Board (IRB2023-0514D).

References

Arseneault, L., Bowes, L., & Shakoor, S. (2010). Bullying victimization in youths and mental health problems: 'much ado about nothing'? *Psychological Medicine*, *40*(5), 717–729.

Avenevoli, S., Baio, J., Bitsko, R. H., Blumberg, S. J., Brody, D. J., Crosby, A., Gfroerer, J., Ghandour, R. M., Hall, J. E., & Hedden, S. L. (2013). Mental health surveillance among children–United States, 2005–2011.

Baggio, S., Luisier, V., & Vladescu, C. (2016). Relationships between social networks and mental health. *Swiss Journal of Psychology, 76*, 5–11.

Barzeva, S. A., Meeus, W. H., & Oldehinkel, A. J. (2019). Social withdrawal in adolescence and early adulthood: Measurement issues, normative development, and distinct trajectories. *Journal of Abnormal Child Psychology,47*, 865–879.

Bitsko, R. H., Claussen, A. H., Lichstein, J., Black, L. I., Jones, S. E., Danielson, M. L., Hoenig, J. M., Jack, S. P. D., Brody, D. J., & Gyawali, S. (2022). Mental health surveillance among children—United States, 2013–2019. *MMWR. Recommendations and Reports,71*(2), 1.

Brady, E. U., & Kendall, P. C. (1992). Comorbidity of anxiety and depression in children and adolescents. *Psychological Bulletin*, *111*(2), 244.

Brendgen, M., Girard, A., Vitaro, F., Dionne, G., & Boivin, M. (2016). Personal and familial predictors of peer victimization trajectories from primary to secondary school. *Developmental Psychology,52*(7), 1103.

Bronfenbrenner, U. (1979). *The ecology of human development*. Harvard University Press.

Caspi, A., Houts, R. M., Ambler, A., Danese, A., Elliott, M. L., Hariri, A., Harrington, H., Hogan, S., Poulton, R., Ramrakha, S., Rasmussen, L. J. H., Reuben, A., Richmond-Rakerd, L., Sugden, K., Wertz, J., Williams, B. S., & Moffitt, T. E. (2020). Longitudinal assessment of mental health disorders and comorbidities across 4 decades among participants in the Dunedin birth cohort study. *JAMA Network Open,3*(4), e203221. https://doi.org/10.1001/jamanetworkopen.2020.3221

Christina, S., Magson, N. R., Kakar, V., & Rapee, R. M. (2021). The bidirectional relationships between peer victimization and internalizing problems in school-aged children: An updated systematic review and meta-analysis. *Clinical Psychology Review*, *85*, 101979. https://doi.org/10.1016/j.cpr.2021.101979

Cree, R. A., Bitsko, R. H., Robinson, L. R., Holbrook, J. R., Danielson, M. L., Smith, C., Kaminski, J. W., Kenney, M. K., & Peacock, G. (2018). Health care, family, and community factors associated with mental, behavioral, and developmental disorders and poverty among children aged 2–8 years—United States, 2016. *Morbidity and Mortality Weekly Report,67*(50), 1377.

Eisenberger, N. I., Lieberman, M. D., & Williams, K. D. (2003). Does rejection hurt? An fMRI study of social exclusion. *Science,302*(5643), 290–292.

Eriksson, M., Ghazinour, M., & Hammarström, A. (2018). Different uses of Bronfenbrenner's ecological theory in public mental health research: What is their value for guiding public mental health policy and practice? *Social Theory & Health,16*, 414–433.

Eugene, D. R., Crutchfield, J., & Robinson, E. D. (2021). An examination of peer victimization and internalizing problems through a racial equity lens: Does school connectedness matter? *International Journal of Environmental Research and Public Health,18*(3), 1085.

Falci, C., & McNeely, C. (2009). Too many friends: Social integration, network cohesion and adolescent depressive symptoms. *Social Forces*, *87*(4), 2031–2061.

Flashman, J. (2012). Academic achievement and its impact on friend dynamics. *Sociology of Education*, *85*(1), 61–80.

Ghandour, R. M., Sherman, L. J., Vladutiu, C. J., Ali, M. M., Lynch, S. E., Bitsko, R. H., & Blumberg, S. J. (2019). Prevalence and treatment of depression, anxiety, and conduct problems in US children. *The Journal of Pediatrics*, *206*, 256–267e253. https://doi.org/10.1016/j.jpeds.2018.09.021

Glick, G. C., & Rose, A. J. (2011). Prospective associations between friendship adjustment and social strategies: Friendship as a context for building social skills. *Developmental Psychology,47*(4), 1117.

Hogue, A., & Steinberg, L. (1995). Homophily of internalized distress in adolescent peer groups. *Developmental Psychology*, *31*(6), 897.

Hunter, D. R., Handcock, M. S., Butts, C. T., Goodreau, S. M., & Morris, M. (2008). ergm: A package to fit, simulate and diagnose exponential-family models for networks. *Journal of Statistical Software, 24*, 29.

IBM (2018). IBM SPSS Statistics for Windows Version 25. In IBM Corp

Iwahori, M., Oshiyama, C., & Matsuzaki, H. (2022). A quasi-experimental controlled study of a school-based mental health programme to improve the self-esteem of primary school children. *Humanities and Social Sciences Communications*, *9*(1), 1–10.

Juvonen, J., & Graham, S. (2014). Bullying in schools: The power of bullies and the plight of victims. *Annual Review of Psychology*, *65*, 159–185.

Kessler, R. C., Andrews, G., Colpe, L. J., Hiripi, E., Mroczek, D. K., Normand, S. L., Walters, E. E., & Zaslavsky, A. M. (2002). Short screening scales to monitor population prevalences and trends in nonspecific psychological distress. *Psychological Medicine*, *32*(6), 959–976.

Kessler, R. C., Amminger, G. P., Aguilar-Gaxiola, S., Alonso, J., Lee, S., & Ustün, T. B. (2007). Age of onset of mental disorders: A review of recent literature. *Current Opinion in Psychiatry*, *20*(4), 359–364. https://doi.org/10.1097/YCO.0b013e32816ebc8c

Keyes, C. L. (2002). The mental health continuum: From languishing to flourishing in life. *Journal of Health and Social Behavior*. https://doi.org/10.2307/3090197

Kim, H., Parker, J. G., & Marciano, A. R. W. (2017). Interplay of self-esteem, emotion regulation, and parenting in young adolescents' friendship jealousy. *Journal of Applied Developmental Psychology,52*, 170–180.

Klomek, A. B., Sourander, A., & Elonheimo, H. (2015). Bullying by peers in childhood and effects on psychopathology, suicidality, and criminality in adulthood. *The Lancet Psychiatry*, *2*(10), 930–941.

Konac, D., Young, K. S., Lau, J., & Barker, E. D. (2021). Comorbidity between depression and anxiety in adolescents: Bridge symptoms and relevance of risk and protective factors. *Journal of Psychopathology and Behavioral Assessment*, *43*, 583–596.

Krivitsky, P. N., & Handcock, M. S. (2014). A separable model for dynamic networks. *Journal of the Royal Statistical Society: Series B (Statistical Methodology)*, *76*(1), 29–46.

Kupferberg, A., Bicks, L., & Hasler, G. (2016). Social functioning in major depressive disorder. *Neuroscience and Biobehavioral Reviews,69*, 313–332.

LaFontana, K. M., & Cillessen, A. H. (2010). Developmental changes in the priority of perceived status in childhood and adolescence. *Social Development*, *19*(1), 130–147.

La Greca, A. M., & Harrison, H. M. (2005). Adolescent peer relations, friendships, and romantic relationships: Do they predict social anxiety and depression? *Journal of Clinical Child and Adolescent Psychology*, *34*(1), 49–61.

Larzabal-Fernandez, A., Pilco, K., Moreta-Herrera, R., & Rodas, J. A. (2023). Psychometric properties of the Kessler psychological distress scale in a sample of adolescents from Ecuador. *Child Psychiatry and Human Development*. https://doi.org/10.1007/s10578-023-01501-4

Lombardi, C. M., Coley, R. L., Sims, J., Lynch, A. D., & Mahalik, J. R. (2019). Social norms, social connections, and sex differences in adolescent mental and behavioral health. *Journal of Child and Family Studies*, *28*(1), 91–104. https://doi.org/10.1007/s10826-018-1253-7

Long, E., Zucca, C., & Sweeting, H. (2021). *School climate, peer relationships, and adolescent mental health: A social ecological perspective. Youth & Society*. https://doi.org/10.1177/0044118X20970232

Lusher, D., Koskinen, J., & Robins, G. (2013). *Exponential random graph models for social networks: Theory, methods, and applications*. Cambridge University Press.

McCombs, J. S., Augustine, C. H., Unlu, F., Ziol-Guest, K. M., Naftel, S., Gomez, C. J., Marsh, T., Akinniranye, G., & Todd, I. (2019). *Investing in successful summer programs*. RAND Corporation.

McLeod, J. D., Uemura, R., & Rohrman, S. (2012). Adolescent mental health, behavior problems, and academic achievement. *Journal of Health and Social Behavior*, *53*(4), 482–497.

McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology*, *27*(1), 415–444.

Michalski, J. H., Mishna, F., Worthington, C., & Cummings, R. (2003). A multi-method impact evaluation of a therapeutic summer camp program. *Child and Adolescent Social Work Journal*, *20*, 53–76.

Mishna, F. (2012). *Bullying: A guide to research, intervention, and prevention*. Oxford University Press.

Mullan, V. M., Golm, D., Juhl, J., Sajid, S., & Brandt, V. (2023). The relationship between peer victimisation, self-esteem, and internalizing symptoms in adolescents: A systematic review and meta-analysis. *PLoS One, 18*(3), e0282224.

Mutumba, M., & Harper, G. W. (2015). Mental health and support among young key populations: An ecological approach to understanding and intervention. *Journal of the International AIDS Society,18*, 19429.

Oberle, E., Ji, X. R., Alkawaja, M., Molyneux, T. M., Kerai, S., Thomson, K. C., Guhn, M., Schonert-Reichl, K. A., & Gadermann, A. M. (2024). Connections matter: Adolescent social connectedness profiles and mental well-being over time. *Journal of Adolescence,96*(1), 31–48. https://doi.org/10.1002/jad.12250

Perry, B. L., & Pescosolido, B. A. (2015). Social network activation: The role of health discussion partners in recovery from mental illness. *Social Science & Medicine,125*, 116–128. https://doi.org/10.1016/j.socscimed.2013.12.033

Pescosolido, B. A. (1992). Beyond rational choice: The social dynamics of how people seek help. *American Journal of Sociology*, *97*(4), 1096–1138. https://doi.org/10.1086/229863

Pescosolido, B. A. (2006). Of pride and prejudice: The role of sociology and social networks in integrating the health sciences∗. *Journal of Health and Social Behavior,47*(3), 189–208. https://doi.org/10.1177/002214650604700301

Platt, B., Kadosh, K. C., & Lau, J. Y. (2013). The role of peer rejection in adolescent depression. *Depression and Anxiety*, *30*(9), 809–821.

Prochnow, T., Patterson, M. S., Hamilton, B., Delgado, C. N., Craig, H., & Umstattd Meyer, M. R. (2020a). Network autocorrelation of perceived physical activity skill competence among adolescents at a summer care program: A pilot study. *American Journal of Health Promotion*. https://doi.org/10.1177/0890 117120958544

Prochnow, T., Patterson, M. S., Hartnell, L., & Umstattd Meyer, M. R. (2020b). Depressive symptoms associations with online and in person networks in an online gaming community: A pilot study. *Mental Health Review Journal*, *25*(1), 21–33.

Prochnow, T., Hartnell, L., & Patterson, M. S. (2021a). Depressive symptoms, developing friendships, and social support through online gaming: A mixed-method analysis of online gaming network communication. *Mental Health and Social Inclusion*, *25*(3), 243–253.

Prochnow, T., Patterson, M. S., Hamilton, B., Delgado, C. N., Craig, H., & Umstattd Meyer, M. R. (2021b). Sex differences in play networks and self-reported physical activity among children at summer care programs. *Child & Youth Services*. https://doi.org/10.1080/0145935X.2021.1926228

Prochnow, T., Patterson, M. S., Meyer, A. R., & Meyer, U. (2021c). MR Sport participation associations with child friend selection and physical activity while at summer care programs. *Research Quarterly for Exercise and Sport, 93*, 479.

Prochnow, T., Patterson, M., Umstattd Meyer, M. R., Lightner, J., Gomez, L., & Sharkey, J. (2022a). Conducting physical activity research on racially and ethnically diverse adolescents using social network analysis: Case studies for practical use. *International Journal of Environmental Research and Public Health,19*(18), 11545.

Prochnow, T., Patterson, M. S., & Hamilton, B. (2022b). MR summer friends and physical activity: Social network effects on child self-reported physical activity at summer care programs. *Health Educ Behav, 59*, 770.

Prochnow, T., Patterson, M. S., Hartnell, L., & Umstattd Meyer, M. R. (2023). Online gaming network communication dynamics, depressive symptoms, and social support: A longitudinal network analysis. *Sociological Focus*. https://doi.org/10.1080/00380237.2023.2199171

Rapee, R. M., Oar, E. L., Johnco, C. J., Forbes, M. K., Fardouly, J., Magson, N. R., & Richardson, C. E. (2019). Adolescent development and risk for the onset of social-emotional disorders: A review and conceptual model. *Behaviour Research and Therapy*, *123*, 103501. https://doi.org/10.1016/j.brat.2019.103501

Reijntjes, A., Kamphuis, J. H., Prinzie, P., & Telch, M. J. (2010). Peer victimization and internalizing problems in children: A meta-analysis of longitudinal studies. *Child Abuse & Neglect,34*(4), 244–252.

Rose, A. J., Schwartz-Mette, R. A., Glick, G. C., Smith, R. L., & Luebbe, A. M. (2014). *An observational study of co-rumination in adolescent friendships*. Developmental Psychology. https://doi.org/10.1037/a0037465

Rubin, K. H., Chen, X., McDougall, P., Bowker, A., & McKinnon, J. (1995). The Waterloo longitudinal project: Predicting internalizing and externalizing problems in adolescence. *Development and Psychopathology*, *7*(4), 751–764.

Rudolph, K. D., Hammen, C., & Burge, D. (1994). Interpersonal functioning and depressive symptoms in childhood: Addressing the issues of specificity and comorbidity. *Journal of Abnormal Child Psychology*, *22*, 355–371.

Schwartz-Mette, R. A., Shankman, J., Dueweke, A. R., Borowski, S., & Rose, A. J. (2020). Relations of friendship experiences with depressive symptoms and loneliness in childhood and adolescence: A meta-analytic review. *Psychological Bulletin*, *146*(8), 664–700. https://doi.org/10.1037/bul0000239

Setterfield, M., Walsh, M., Frey, A. L., & McCabe, C. (2016). Increased social anhedonia and reduced helping behaviour in young people with high depressive symptomatology. *Journal of Affective Disorders*, *205*, 372–377. https://doi.org/10.1016/j.jad.2016.08.020

Steinberg, L., & Morris, A. S. (2001). Adolescent development. *Annual Review of Psychology*, *52*(1), 83–110. https://doi.org/10.1146/annurev.psych.52.1.83

Stone, L. B., Hankin, B. L., Gibb, B. E., & Abela, J. R. Z. (2011). *Co-rumination* predicts the onset of depressive disorders during adolescence. *Journal of Abnormal Psychology*. https://doi.org/10.1037/a0023384

Thurber, C. A., Scanlin, M. M., Scheuler, L., & Henderson, K. A. (2007). Youth development outcomes of the camp experience: Evidence for multidimensional growth. *Journal of Youth and Adolescence*, *36*, 241–254.

Tillfors, M., Persson, S., Willén, M., & Burk, W. J. (2012). Prospective links between social anxiety and adolescent peer relations. *Journal of Adolescence*, *35*(5), 1255–1263.

Valente, T. W. (2010). *Social networks and health: Models, methods, and applications*. Oxford University Press.

Valente, T. W., & Pumpuang, P. (2007). Identifying opinion leaders to promote behavior change. *Health Education & Behavior,34*(6), 881–896.

Waterman, E. A., Edwards, K. M., Keyes, A. B., Zulfiqar, H., Banyard, V. L., & Valente, T. W. (2022). The stability of youth popular opinion leaders selected over time using social network analysis. *American Journal of Community Psychology*, *70*(1–2), 202–210.

Zellner, M. R., Watt, D. F., Solms, M., & Panksepp, J. (2011). Affective neuroscientific and neuropsychoanalytic approaches to two intractable psychiatric problems: Why depression feels so bad and what addicts really want. *Neuroscience and Biobehavioral Reviews,35*(9), 2000–2008.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.