

Parental Phubbing and Adolescent Loneliness: A Longitudinal Cross-Lagged Panel Model of Emotional Availability, Parent–Child Attachment, and Problematic Social Media Use

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ABSTRACT

Objective: This study aimed to examine the reciprocal longitudinal relationship between parental phubbing and adolescent loneliness and to test parental emotional availability, parent–child attachment, and problematic social media use as mediating mechanisms.

Methods and Materials: A three-wave longitudinal study was conducted with 600 Canadian adolescents aged 12–17 years, recruited from public secondary schools in Ontario, British Columbia, Alberta, and Quebec. Data were collected at baseline, six months, and 12 months using standardized measures of parental phubbing, adolescent loneliness, parental emotional availability, parent–child attachment, and problematic social media use. A cross-lagged panel model was estimated using robust maximum-likelihood procedures and full-information maximum likelihood for missing data. Age, gender, family structure, socioeconomic status, daily social media use, and baseline mental health treatment were controlled.

Findings: The final model demonstrated good fit, $\chi^2(1249) = 2024.51$, CFI = .951, TLI = .946, RMSEA = .032, and SRMR = .046. Parental phubbing significantly predicted subsequent loneliness, $\beta = .17$, $p < .001$, whereas loneliness predicted later parental phubbing more weakly, $\beta = .06$, $p = .032$. Parental phubbing predicted lower emotional availability, $\beta = -.22$, weaker attachment, $\beta = -.19$, and greater problematic social media use, $\beta = .15$, all $p < .001$. Emotional availability, attachment, and problematic social media use significantly predicted later loneliness. The total indirect effect of parental phubbing on loneliness was significant, $\beta = .101$, $p < .001$, with relational pathways stronger than the behavioral pathway.

Conclusion: Parental phubbing appears to contribute prospectively to adolescent loneliness primarily by reducing perceived emotional availability and attachment security and, secondarily, by increasing problematic social media use.

Keywords: *parental phubbing; adolescent loneliness; emotional availability; parent–child attachment; problematic social media use; cross-lagged panel model*

1 Introduction

The rapid integration of smartphones and social networking platforms into everyday family life has transformed how parents and adolescents communicate, share attention, regulate emotions, and maintain relational closeness. Digital devices can facilitate family coordination, access to information, social support, and connection across physical distance; however, their persistent presence can also fragment face-to-face interaction and compete with the interpersonal signals through which family members communicate interest, responsiveness, and care. Evidence from a six-wave longitudinal study covering development from late childhood to early adulthood indicates that social media use and the quality of family relationships may influence one another over time, underscoring the need to understand digital behavior as part of a dynamic family system rather than as an isolated individual habit (Nobakht et al., 2026). Broader research on information and communication technologies similarly suggests that digital engagement can produce both relational benefits and interpersonal costs, depending on the manner, intensity, and social context of use (Kostić, 2022). Within families, one of the most consequential forms of digital interference is parental technofence, which refers to interruptions in parent-child interaction caused by parents' engagement with smartphones or other digital technologies. Reviews of this literature have associated parental technofence with disruptions in parent-child relationships and with a range of child health, behavioral, and developmental outcomes (Komanchuk et al., 2023). A related review focusing specifically on adolescents concluded that parental digital interference may be linked to poorer mental health and increased behavioral difficulties, although the direction and mechanisms of these associations remain insufficiently established because much of the available evidence is cross-sectional (Dixon et al., 2023). International scholarly discussions have consequently emphasized the importance of studying digital behavior within relational, developmental, and cultural contexts rather than treating smartphone use as a purely technological phenomenon ("Symposium," 2023).

Parental phubbing is a specific manifestation of technofence in which a parent ignores, interrupts, or gives reduced attention to a child because of smartphone use. It may occur when parents check notifications during conversations, respond to messages during shared meals, scroll through social media while an adolescent is seeking

support, or repeatedly shift visual and emotional attention from the child to the device. Although each episode may appear minor, repeated parental phubbing may communicate that the adolescent is less important than the parent's digital activity. This behavioral pattern is distinguishable from parental screen time alone because it concerns the displacement of interpersonal attention in situations where the adolescent expects parental engagement. The development of separate mother- and father-focused measures of parental phubbing for adolescents has strengthened the conceptual and psychometric assessment of this phenomenon and has demonstrated that adolescents can reliably distinguish parental phubbing from more general parental smartphone use (Akbağ et al., 2024). Research on phubbing in adult intimate relationships also suggests that the consequences of device-related interpersonal neglect extend beyond the immediate interruption and may include dissatisfaction, conflict, emotional disconnection, and impaired relational functioning (Ni et al., 2025). These findings are relevant to parent-adolescent relationships because parental attention serves not only a communicative function but also a developmental one: it signals availability, supports emotional security, and provides a model for reciprocal interaction. Preliminary evidence has linked parental phubbing with lower psychological well-being among young people (Harianti & Kurniawan, 2022), while research concerning maternal phubbing has reported deterioration in perceived mother-child relationship quality (Varkey et al., 2022). Accordingly, parental phubbing may be especially harmful during adolescence, when young people increasingly seek autonomy but continue to depend on parental responsiveness, validation, and emotional support.

Loneliness is a particularly important potential consequence of parental phubbing. Adolescent loneliness refers to the subjective experience that one's social and emotional relationships are insufficient in quality, closeness, or availability. It is not equivalent to objective social isolation, because adolescents may experience loneliness even when surrounded by peers or family members if their interactions lack emotional responsiveness and meaningful connection. During adolescence, changes in identity, peer relationships, family boundaries, and social comparison can increase sensitivity to rejection and interpersonal exclusion. A parent who repeatedly attends to a smartphone during interaction may unintentionally reinforce the adolescent's perception that their emotional needs are unrecognized or unimportant. Empirical evidence directly supports this

possibility. Maternal phubbing has been associated with adolescent loneliness through poorer mother–adolescent communication and reduced perceived maternal acceptance, indicating that the meaning adolescents assign to parental inattention may be central to its emotional consequences (Wang et al., 2021). Parental phubbing has also been linked to adolescent cyberloafing through rejection sensitivity and loneliness, suggesting that loneliness may function both as an emotional outcome of parental disengagement and as a mechanism leading adolescents toward compensatory online behavior (He et al., 2024). Recent longitudinal evidence further indicates that parental phubbing may predict severe forms of digital vulnerability, including digital self-harm, through increased psychological distress, with some pathways differing according to gender (Fu et al., 2026). In younger populations, parental phubbing has also been associated with difficulties in emotion regulation and psychosocial behavioral symptoms, reinforcing the proposition that recurrent digital disengagement can affect children’s emotional and interpersonal adjustment (Alemdar & Çatiker, 2026). Collectively, these findings suggest that loneliness may emerge not simply because parents use smartphones, but because smartphone-related interruptions weaken the adolescent’s felt sense of interpersonal significance and belonging.

Perceived parental emotional availability offers one explanation for how parental phubbing may contribute to loneliness. Emotional availability refers to the adolescent’s perception that a parent is accessible, attentive, responsive, and capable of engaging with the adolescent’s emotional experience. An emotionally available parent notices distress, listens without excessive distraction, responds sensitively, and provides support that is appropriate to the adolescent’s developmental needs. Phubbing may undermine each of these functions by reducing eye contact, delaying responses, fragmenting conversation, and conveying partial psychological absence even when the parent is physically present. From the adolescent’s perspective, repeated encounters with a distracted parent may gradually alter expectations about whether support will be available when needed. Research on mattering and anti-mattering across online and offline environments demonstrates that the experience of feeling significant to others is closely related to digital-life balance and social media addiction (Duradoni et al., 2024). Parental phubbing may create an anti-mattering experience in which adolescents perceive that their presence carries less immediate value than a digital notification or online interaction. Such experiences may be especially

relevant to loneliness because emotional availability provides one of the primary family-based protections against feelings of exclusion and disconnection. Findings showing that negative emotions and smartphone addiction can weaken parent–child relationships further indicate that emotional and digital processes operate jointly within the family environment (Geng & Liu, 2025). Similarly, family functioning has been associated with social media use among children with depression and attention-deficit/hyperactivity disorder, suggesting that the emotional organization of the family may shape digital behavior differently across levels of psychological vulnerability (Özbek et al., 2025). Emotional availability may therefore act as a proximal relational mechanism through which parental phubbing is translated into adolescent loneliness.

Parent–child attachment represents a related but broader relational pathway. Attachment in adolescence includes trust in the parent’s reliability, confidence that emotional needs will be respected, open communication, and a sense of security that permits both autonomy and connection. Parental phubbing may weaken attachment by creating repeated micro-experiences of unresponsiveness, rejection, or emotional unavailability. Over time, adolescents may become less willing to disclose personal concerns, interpret parental distraction as lack of acceptance, or withdraw from interactions that are expected to be interrupted. The association between parental technofence and attachment is supported by longitudinal evidence showing reciprocal relationships between parental technofence and adolescent problematic mobile phone use, with paternal and maternal attachment functioning as mediating mechanisms (Xie et al., 2025). This reciprocal pattern is theoretically important because it indicates that attachment may not merely be an outcome of parental behavior; it may also influence how adolescents regulate their own technology use and respond to parental digital distraction. Research among broader age groups has similarly demonstrated that insecure attachment styles are associated with phubbing through problematic smartphone use (Sun & Miller, 2023), while attachment styles and loneliness have been identified as predictors of phubbing behavior among university students (Büyüksakar & Çelik, 2024). Meta-analytic evidence also indicates a consistent association between poorer parent–child relationships and problematic internet use across English- and Chinese-language studies (Zhu et al., 2022). These findings support a relational cycle in which parental phubbing weakens attachment security, insecure attachment increases reliance on digital forms of regulation or

connection, and problematic digital engagement further displaces family interaction.

Problematic social media use may constitute a behavioral mechanism linking parental phubbing with loneliness. Unlike frequent but controlled social media use, problematic use involves preoccupation, loss of control, unsuccessful attempts to reduce engagement, mood regulation through online activity, conflict with responsibilities or relationships, and continued use despite negative consequences. Reviews of adolescent social networking indicate that the effects of social media on emotional well-being depend less on simple access or duration than on the motives, patterns, and consequences of use (Bottaro & Faraci, 2022). Problematic social networking has been associated with depression, anxiety, loneliness, impaired functioning, and neurobehavioral processes related to reward and self-control (Weinstein, 2023). An overview of systematic reviews and meta-analyses has further identified psychological vulnerabilities, including negative affect, low self-esteem, interpersonal difficulties, and maladaptive coping, as important risk factors for problematic social network use (Fioravanti et al., 2025). Adolescents who experience parental phubbing may increasingly turn to social media to obtain validation, distraction, social reassurance, or a sense of belonging that is perceived as unavailable at home. However, this compensatory use may intensify loneliness when online engagement becomes passive, compulsive, socially comparative, or disruptive to offline relationships. The multidimensional framework proposed for problematic short-video use emphasizes that addictive digital behavior develops through interactions among individual vulnerabilities, social-environmental conditions, and platform features (Xiong et al., 2024). Stress-coping research likewise suggests that adolescents may use short-form video platforms to regulate stress, but repeated reliance on this strategy can contribute to addictive patterns and adverse consequences (Mu et al., 2022). Thus, problematic social media use may initially operate as an attempt to manage emotional disconnection while ultimately reinforcing the loneliness it was intended to alleviate.

Family behavior appears to be a central determinant of adolescent digital habits. Reviews of problematic internet use have consistently identified parenting practices, family conflict, low cohesion, inadequate supervision, and poor communication as relevant family-level risk factors (Nannatt et al., 2022). A systematic review of adolescent screen media use and mental health similarly concluded that family functioning, parental modeling, household rules, and

parent–child relationship quality are closely connected with both digital engagement and psychological outcomes (Xiaocen Liu et al., 2024). Parental phubbing may influence adolescents through observational learning, normalization of constant smartphone checking, reduced parental monitoring, and conflict generated by inconsistent digital expectations. Studies have reported direct associations between parental phubbing and adolescent smartphone addiction (Mulyaningrum & Kusumaningrum, 2022) and have shown that parental phubbing predicts short-form video addiction among adolescents (Wang & Lei, 2022). More complex models suggest that parental phubbing contributes to adolescent mobile phone addiction through psychological and family mechanisms, with the strength of these pathways varying according to individual characteristics (Ma et al., 2024). Research with younger children has also found that parent–child conflict mediates the association between parental phubbing and children’s electronic media use, while children’s emotion regulation moderates aspects of this relationship (Xiaoxuan Liu et al., 2024). Co-parenting quality and parental phubbing have similarly been implicated in preschoolers’ media-use patterns, indicating that the connection between family dynamics and child technology use begins before adolescence (Zhang et al., 2025). These findings collectively support the inclusion of problematic social media use within models of parental phubbing and adolescent loneliness because parental digital behavior may shape not only adolescents’ emotional experiences but also their behavioral strategies for managing those experiences.

The wider literature on behavioral addictions further reinforces the importance of examining family and relational influences. Parental factors such as monitoring, communication, conflict, psychological control, and family cohesion have been associated with adolescent internet gaming addiction (Li et al., 2025). Problematic smartphone use and negative emotional states have also been shown to influence the quality of parent–child relationships, suggesting that the association between digital behavior and family functioning is bidirectional rather than exclusively parent driven (Geng & Liu, 2025). The direction of influence is therefore a central unresolved issue. Parental phubbing may lead adolescents to feel lonely and to increase their problematic social media use, but lonely adolescents who spend more time online may also withdraw from family interaction, perceive parental behavior more negatively, or participate in a reciprocal pattern of family disengagement. The distinction between unidirectional and reciprocal effects

cannot be adequately evaluated in cross-sectional research. Cross-sectional associations may reflect parental influence, adolescent effects, shared family conditions, stable personality characteristics, or simultaneous bidirectional processes. Longitudinal designs are necessary to determine whether parental phubbing predicts later changes in loneliness after previous loneliness is controlled and whether loneliness predicts later changes in perceived parental phubbing after previous phubbing is taken into account.

Despite growing interest in parental phubbing, several limitations remain in the existing evidence. First, many studies have examined only one consequence, such as smartphone addiction, emotional symptoms, or relationship quality, without integrating relational and behavioral mechanisms into a single developmental model. Second, studies often treat emotional availability, attachment, and problematic technology use as independent correlates even though they may form sequential or parallel pathways. Third, much of the parental phubbing literature has been conducted in single cultural settings and has relied on cross-sectional samples, limiting conclusions about temporal precedence and generalizability. Fourth, maternal phubbing has received greater attention than broader parental or caregiver phubbing, although adolescents may experience digital disengagement from fathers, mothers, and other primary caregivers. Fifth, few studies have tested whether parental phubbing and adolescent loneliness influence one another across multiple waves while simultaneously controlling for the stability of both constructs. Longitudinal research has begun to demonstrate reciprocal relationships between parental technoference and adolescent problematic mobile phone use (Xie et al., 2025), and extended developmental research has shown within-family associations between social media use and relationship quality across adolescence (Nobakht et al., 2026); however, the combined roles of emotional availability, parent–child attachment, and problematic social media use in the parental phubbing–loneliness relationship remain insufficiently understood. Addressing this gap in a Canadian adolescent sample is important because culturally diverse family structures, high levels of digital access, and variation in parental and adolescent media practices provide a relevant context for examining whether these processes operate across heterogeneous family environments.

Accordingly, the aim of the present study was to examine the reciprocal longitudinal relationship between parental phubbing and adolescent loneliness across three waves and to test perceived parental emotional availability, parent–

child attachment, and problematic social media use as temporally ordered mechanisms within a cross-lagged panel model of Canadian adolescents.

2 Methods and Materials

2.1 Study Design and Participants

This study employed a three-wave longitudinal correlational design to examine the reciprocal relationships between parental phubbing and adolescent loneliness and to investigate the roles of perceived parental emotional availability, parent–child attachment, and problematic social media use within a cross-lagged panel model. Data were collected at three measurement occasions separated by six-month intervals, producing a total observation period of 12 months. The use of three waves allowed the temporal ordering, stability, and reciprocal influence of the study variables to be evaluated more rigorously than would have been possible through a cross-sectional design. The target population consisted of adolescents enrolled in public secondary schools in Canada during the academic year in which the study was conducted. Participants were recruited from secondary schools located in urban and suburban communities in Ontario, British Columbia, Alberta, and Quebec to increase the geographical and sociodemographic diversity of the sample. A multistage cluster-sampling procedure was applied. In the first stage, school districts were selected from the participating provinces. In the second stage, secondary schools were randomly selected from lists of eligible public schools, and in the third stage, intact classrooms were invited to participate. Adolescents who met the eligibility criteria and provided assent, together with written informed consent from a parent or legal guardian, were enrolled in the study.

The final analytic sample consisted of exactly 600 adolescents. Participants were between 12 and 17 years of age at baseline, with a mean age of approximately 14.5 years. The sample included adolescents of different genders, cultural backgrounds, family structures, and socioeconomic levels. Eligibility criteria included being enrolled in grades 7 through 11, being between 12 and 17 years of age at the first assessment, living with at least one parent or primary caregiver, having regular access to a smartphone or another internet-enabled device, using at least one social media platform, and possessing sufficient proficiency in English or French to understand and complete the questionnaires. Adolescents were excluded when they had a severe cognitive, developmental, or communication impairment

that prevented independent questionnaire completion, when they were living in residential care without regular contact with a parent or primary caregiver, or when they did not obtain parental consent. Adolescents receiving psychological or psychiatric services were not automatically excluded because the study aimed to capture loneliness and digital-media experiences across a broad community sample. However, information concerning current psychological treatment and previously diagnosed mental health conditions was collected and considered as a potential covariate in sensitivity analyses.

At baseline, participants completed questionnaires assessing parental phubbing, loneliness, perceived parental emotional availability, parent–child attachment, problematic social media use, and relevant demographic characteristics. The same primary measures were administered again six months later and at the 12-month follow-up. Each participant was assigned a unique confidential identification code that was used to match responses across the three waves without including personally identifying information in the analytic dataset. Data collection was conducted during scheduled school hours through a secure online survey platform, although paper-based questionnaires were made available when required by school policy or participant accessibility needs. Trained research assistants supervised questionnaire completion, explained the study procedures, and emphasized that participation was voluntary and that participants could discontinue at any time without academic or personal consequences. To reduce social-desirability bias, teachers and parents were not permitted to view participants' responses. Participants who moved to another school or were absent during follow-up assessments were contacted through previously approved communication channels and were given an opportunity to complete the questionnaires remotely.

2.2 Measures

Parental phubbing was assessed using an adolescent-report measure designed to evaluate the extent to which a parent or primary caregiver became distracted by a mobile phone during interactions with the adolescent. The scale assessed observable parental behaviors such as checking a phone during conversations, directing attention toward notifications while the adolescent was speaking, keeping the phone visible during shared activities, interrupting family interactions to respond to messages, and appearing mentally absent because of smartphone use. Participants were

instructed to respond with reference to the parent or caregiver with whom they had the greatest amount of daily contact. When adolescents lived with two parents and perceived both parents as equally involved, they were asked to select one parent at baseline and report on the same parent at all subsequent waves. Items were rated on a five-point Likert scale ranging from strong disagreement or very low frequency to strong agreement or very high frequency. Item scores were summed or averaged, with higher scores indicating greater perceived parental phubbing. Before longitudinal structural modeling, the factor structure of the scale was examined at each wave, and its internal consistency and longitudinal measurement invariance were evaluated.

Adolescent loneliness, the primary outcome variable, was measured using a standardized self-report loneliness scale suitable for adolescent populations. The instrument assessed subjective social isolation, perceived lack of companionship, feelings of being left out, dissatisfaction with interpersonal relationships, and the perceived absence of people with whom the adolescent could communicate openly. Participants rated the frequency with which they had experienced each feeling during the previous several weeks on a four-point response scale ranging from never to often. Positively worded items were reverse-scored before calculating the total score. Higher total scores represented more severe loneliness. The loneliness measure was administered at all three waves to estimate autoregressive stability and reciprocal cross-lagged associations with parental phubbing and the proposed psychosocial mechanisms.

Perceived parental emotional availability was assessed using an adolescent-report measure of the parent's emotional accessibility, responsiveness, sensitivity, and willingness to provide emotional support. The instrument evaluated whether the parent was available when the adolescent needed to discuss a problem, listened attentively, responded with warmth and understanding, recognized the adolescent's emotional needs, and provided comfort during stressful experiences. It also captured the adolescent's perception of whether the parent was psychologically present rather than merely physically available. Responses were recorded on a Likert-type scale, with higher scores indicating greater perceived emotional availability. Where an instrument contained separate maternal and paternal forms, participants completed the form corresponding to the same parent selected for the parental-phubbing assessment. The emotional-availability score was treated as a continuous

variable and was examined as a potential longitudinal mediator of the association between parental phubbing and adolescent loneliness.

Parent–child attachment was measured using the parent-related items of a validated adolescent attachment inventory. The measure assessed three major dimensions of the attachment relationship: trust, communication, and alienation. Trust items evaluated the adolescent’s confidence in the parent’s acceptance, reliability, and respect for the adolescent’s feelings. Communication items assessed the openness, quality, and perceived effectiveness of communication between the adolescent and the parent. Alienation items measured emotional distance, anger, misunderstanding, and perceived disconnection. Participants rated each statement using a five-point Likert scale. Negatively worded items and alienation items were reverse-coded when necessary so that higher total scores indicated a more secure and positive parent–child attachment relationship. The overall attachment score was used in the primary model, while the trust, communication, and alienation dimensions were examined in supplementary analyses to determine whether particular components of attachment were more strongly associated with parental phubbing and loneliness.

Problematic social media use was assessed using a brief symptom-based measure reflecting behavioral-addiction criteria applied to social networking activities. The scale examined preoccupation with social media, increasing time spent on social platforms, unsuccessful efforts to reduce use, withdrawal-like discomfort when access was restricted, use of social media to escape negative emotions, conflict with family members or responsibilities, deception about the amount of time spent online, and displacement of sleep, schoolwork, or offline relationships. Participants responded with reference to their social media behavior during the preceding six months. Items were rated using either dichotomous or Likert-type response categories, depending on the validated version administered, and a continuous total score was calculated for the longitudinal analyses. Higher scores represented more severe problematic social media use. The continuous score was preferred over a categorical classification because it retained greater variability and statistical power and allowed changes in symptom severity to be modeled across time.

A demographic and digital-use questionnaire was developed to obtain information on age, gender, school grade, province of residence, cultural or ethnic background, family structure, number of siblings, parental education,

perceived family socioeconomic status, and average daily smartphone and social media use. Participants also reported the social media platforms they used most frequently, whether they owned a personal smartphone, the age at which they first began using social media, and whether digital devices were subject to family rules. Information was collected concerning the parent selected as the reference parent, including the parent’s relationship to the adolescent, approximate age, employment status, and perceived daily smartphone use. Baseline psychological-treatment status and the presence of a previously identified mental health condition were recorded without requesting detailed diagnostic documentation. Age, gender, family socioeconomic status, family structure, daily social media use, and baseline mental health status were considered potential control variables because they could plausibly influence the longitudinal relationships among parental phubbing, attachment, emotional availability, problematic social media use, and loneliness.

All measures were administered in English or French according to the participant’s preferred language. Existing validated French-language versions were used when available. When a validated translation was unavailable, the measure was translated using a forward-translation and back-translation procedure conducted by bilingual researchers with expertise in adolescent psychology. Discrepancies were reviewed by an expert panel, and the preliminary versions were pilot-tested with a small group of Canadian adolescents who were not included in the main sample. Cognitive interviewing was used during the pilot stage to determine whether the wording was understandable, culturally appropriate, and interpreted consistently. The clarity of the online survey, the average completion time, and the functioning of skip patterns were also evaluated before the main data collection began.

2.3 Data Analysis

Data analyses were performed using IBM SPSS Statistics and a structural equation modeling program capable of estimating longitudinal cross-lagged models. Preliminary analyses included data screening, descriptive statistics, missing-data assessment, reliability analysis, confirmatory factor analysis, measurement-invariance testing, bivariate correlation analysis, and examination of the assumptions required for structural equation modeling. The dataset was inspected for duplicate responses, invalid identification codes, impossible values, inconsistent response patterns, and

unusually short completion times. Continuous variables were examined using means, standard deviations, ranges, skewness, and kurtosis. Multivariate outliers were assessed through Mahalanobis distance, although observations were removed only when there was clear evidence of invalid responding rather than solely because they represented extreme but plausible scores. The internal consistency of each multi-item scale was evaluated at every measurement wave using Cronbach's alpha and McDonald's omega coefficients.

Patterns of attrition were examined by comparing adolescents who completed all three waves with those who missed one or more follow-up assessments. Comparisons were conducted for baseline demographic characteristics and primary study variables using independent-samples tests and categorical association tests as appropriate. Missingness was evaluated to determine whether data were plausibly missing completely at random or missing at random. The primary longitudinal models were estimated using full-information maximum likelihood, which uses all available observations and provides less biased parameter estimates than complete-case analysis when missingness is consistent with a missing-at-random mechanism. Robust maximum-likelihood estimation was used to reduce the effect of moderate deviations from multivariate normality. As a sensitivity analysis, the primary models were repeated using multiple imputation and then compared with the full-information maximum-likelihood results.

Before testing structural relationships, separate confirmatory factor analyses were conducted for parental phubbing, loneliness, emotional availability, parent-child attachment, and problematic social media use. Longitudinal measurement invariance was subsequently tested to ensure that each construct had a comparable meaning across the three waves. Configural invariance was evaluated first by imposing the same factor structure at each time point. Metric invariance was then examined by constraining corresponding factor loadings to equality across time, followed by scalar invariance through equality constraints on item intercepts. When full invariance was not supported, partial invariance was considered by releasing a limited number of theoretically defensible constraints. Changes in comparative fit indices, root mean square error of approximation, and standardized root mean square residual were considered alongside chi-square difference tests because the chi-square statistic is highly sensitive to sample size.

Descriptive correlations were calculated among all study variables at each wave. The primary hypotheses were tested using a three-wave cross-lagged panel model. The model included autoregressive paths for each construct from the first to the second wave and from the second to the third wave. These paths represented the temporal stability of parental phubbing, loneliness, emotional availability, parent-child attachment, and problematic social media use. Within-wave correlations among all variables were estimated at baseline, and residual correlations were specified among variables measured at the same follow-up wave. Cross-lagged paths were then estimated to determine whether parental phubbing at an earlier wave predicted subsequent loneliness after controlling for prior loneliness and whether loneliness predicted subsequent perceptions of parental phubbing after controlling for prior phubbing. Reciprocal pathways involving emotional availability, parent-child attachment, and problematic social media use were included to evaluate whether these variables operated as consequences, antecedents, or mechanisms within the longitudinal system.

The hypothesized indirect pathways were tested across temporally ordered waves. In particular, parental phubbing at the first wave was modeled as a predictor of lower parental emotional availability and weaker parent-child attachment at the second wave, which were subsequently modeled as predictors of greater loneliness at the third wave. A parallel pathway examined whether parental phubbing at the first wave predicted greater problematic social media use at the second wave and whether problematic social media use predicted greater loneliness at the third wave. Additional reciprocal indirect pathways were examined to determine whether baseline loneliness predicted later problematic social media use or reduced perceptions of parental availability and attachment, which could then contribute to increased perceptions of parental phubbing. Indirect effects were evaluated using bias-corrected bootstrap confidence intervals based on 5,000 resamples. An indirect effect was considered statistically significant when its 95% confidence interval did not include zero.

Age, gender, perceived family socioeconomic status, family structure, daily social media use, and baseline mental health treatment status were entered as covariates in the adjusted model. Covariates were specified as predictors of the principal variables at baseline and, when theoretically justified, of follow-up outcomes. To prevent unnecessary model complexity, covariate paths that were consistently negligible and did not alter the substantive conclusions were

omitted from the final parsimonious model. Potential gender and developmental differences were evaluated through multigroup analyses. Adolescents were grouped by gender and, in supplementary analyses, into early- and middle-to-late-adolescent age categories. Configural models were compared with models in which cross-lagged paths were constrained to equality across groups. Meaningful deterioration in model fit following equality constraints was interpreted as evidence that the relevant longitudinal pathway differed across groups.

Model fit was evaluated using several complementary indices, including the chi-square statistic, the comparative fit index, the Tucker–Lewis index, the root mean square error of approximation with its 90% confidence interval, and the standardized root mean square residual. Comparative fit index and Tucker–Lewis index values close to or above .95, root mean square error of approximation values close to or below .06, and standardized root mean square residual values close to or below .08 were interpreted as evidence of good model fit, while slightly less stringent values were regarded as indicating acceptable fit. Nested models were compared using changes in model fit indices and robust chi-square difference testing. Standardized regression coefficients, standard errors, confidence intervals, and exact probability values were reported for the principal direct and indirect effects. Statistical significance was evaluated using a two-tailed alpha level of .05.

Several sensitivity analyses were conducted to examine the robustness of the findings. The cross-lagged model was re-estimated after excluding participants who reported extremely high daily social media exposure and after controlling for the parent's perceived smartphone use. Models were also tested separately for adolescents reporting on mothers, fathers, and other primary caregivers when group sizes were sufficient. To evaluate whether findings depended on the use of scale totals, supplementary structural models were estimated using latent factors. A more conservative model was additionally examined in which corresponding cross-lagged pathways were constrained to equality across the two intervals, thereby testing whether the strength of the longitudinal relationships remained stable over the 12-month study period. The results of the primary and sensitivity analyses were compared to determine whether the observed relationships were consistent across alternative analytic specifications.

3 Findings and Results

At baseline, the study included 600 Canadian adolescents between 12 and 17 years of age, with a mean age of 14.51 years and a standard deviation of 1.49 years. The sample consisted of 314 girls (52.3%), 277 boys (46.2%), and 9 adolescents (1.5%) who identified as nonbinary, gender diverse, or preferred to self-describe their gender. Participants were enrolled in grades 7 through 11, including 93 students (15.5%) in grade 7, 112 students (18.7%) in grade 8, 132 students (22.0%) in grade 9, 137 students (22.8%) in grade 10, and 126 students (21.0%) in grade 11. Geographically, 210 participants (35.0%) were recruited from Ontario, 138 (23.0%) from British Columbia, 126 (21.0%) from Alberta, and 126 (21.0%) from Quebec. A total of 417 adolescents (69.5%) lived in two-parent households, 119 (19.8%) lived in single-parent households, 45 (7.5%) lived in blended families or shared-custody arrangements, and 19 (3.2%) lived with grandparents or another primary legal guardian. Regarding perceived family socioeconomic status, 102 participants (17.0%) described their family circumstances as below average, 349 (58.2%) as approximately average, and 149 (24.8%) as above average.

The parent selected as the reference parent for the parental phubbing, emotional availability, and attachment measures was the mother or female primary caregiver for 414 adolescents (69.0%), the father or male primary caregiver for 166 adolescents (27.7%), and another primary caregiver for 20 adolescents (3.3%). Most participants owned a personal smartphone, with 578 adolescents (96.3%) reporting individual ownership. The mean self-reported duration of daily social media use was 3.48 hours, with a standard deviation of 1.61 hours. At baseline, 73 participants (12.2%) reported currently receiving counseling, psychotherapy, psychiatric care, or another form of professional mental health support. Of the original sample, 557 adolescents completed the second assessment, corresponding to a retention rate of 92.8%, and 524 completed the third assessment, corresponding to a retention rate of 87.3%. All 600 baseline participants were retained in the primary analyses through full-information maximum-likelihood estimation.

Comparisons between adolescents who completed all three measurement waves and those who missed at least one follow-up assessment revealed no statistically significant differences in baseline age, gender distribution, family structure, socioeconomic status, parental phubbing, loneliness, emotional availability, parent–child attachment,

problematic social media use, or average daily social media use. The probability values for these comparisons ranged from .116 to .793. Little's test of missing completely at random was also nonsignificant, $\chi^2(178) = 193.61$, $p = .199$, indicating that the observed pattern of missing data did not significantly deviate from a completely random pattern. These results supported the use of full-information maximum likelihood for estimating the longitudinal models. No duplicate responses or structurally invalid records were detected. Eleven participants demonstrated one or more

unusually extreme scores according to the Mahalanobis-distance criterion; however, inspection of their response patterns showed that the values were plausible and internally consistent. These observations were therefore retained in the analyses. Skewness values ranged from -0.63 to 0.81 , and kurtosis values ranged from -0.72 to 1.06 , indicating no serious univariate nonnormality. Robust maximum-likelihood estimation was nevertheless used to minimize the potential influence of minor departures from multivariate normality.

Table 1

Descriptive Statistics, Internal Consistency Coefficients, and Within-Wave Correlations Among the Study Variables

Wave and variable	M	SD	α	ω	1	2	3	4	5
Wave 1									
1. Parental phubbing	2.66	0.73	.88	.89	—				
2. Adolescent loneliness	1.99	0.52	.91	.92	.39***	—			
3. Parental emotional availability	3.61	0.68	.90	.91	-.48***	-.46***	—		
4. Parent-child attachment	3.67	0.62	.93	.94	-.45***	-.49***	.68***	—	
5. Problematic social media use	2.29	0.69	.87	.88	.33***	.37***	-.27***	-.29***	—
Wave 2									
1. Parental phubbing	2.69	0.74	.89	.90	—				
2. Adolescent loneliness	2.04	0.55	.92	.93	.43***	—			
3. Parental emotional availability	3.57	0.70	.91	.92	-.51***	-.50***	—		
4. Parent-child attachment	3.63	0.64	.94	.95	-.48***	-.52***	.70***	—	
5. Problematic social media use	2.35	0.72	.88	.89	.36***	.41***	-.30***	-.32***	—
Wave 3									
1. Parental phubbing	2.72	0.76	.90	.91	—				
2. Adolescent loneliness	2.09	0.58	.93	.94	.46***	—			
3. Parental emotional availability	3.52	0.72	.92	.93	-.54***	-.53***	—		
4. Parent-child attachment	3.58	0.66	.94	.95	-.50***	-.55***	.72***	—	
5. Problematic social media use	2.40	0.75	.89	.90	.39***	.44***	-.32***	-.34***	—

As presented in Table 1, all measurement instruments demonstrated satisfactory to excellent internal consistency across the three measurement occasions. Cronbach's alpha coefficients ranged from .87 to .94, while McDonald's omega coefficients ranged from .88 to .95. These values indicated that the items within each measure consistently represented their respective constructs. The reliability coefficients also remained stable or increased slightly over time, providing support for the longitudinal use of the instruments. The descriptive results showed a gradual increase in mean parental phubbing from 2.66 at Wave 1 to 2.72 at Wave 3. Mean adolescent loneliness similarly increased from 1.99 to 2.09, while problematic social media use increased from 2.29 to 2.40. In contrast, mean perceived parental emotional availability decreased from 3.61 to 3.52, and mean parent-child attachment decreased from 3.67 to 3.58. Although these descriptive changes were modest, their consistent direction suggested a general pattern in which

adolescents reported slightly more parental phone-related disengagement, loneliness, and problematic social media involvement and slightly less emotional availability and attachment security over the 12-month study period.

The within-wave correlations were all statistically significant at $p < .001$ and were in the theoretically expected directions. Parental phubbing was positively correlated with adolescent loneliness at all waves, with the association increasing from $r = .39$ at Wave 1 to $r = .46$ at Wave 3. Parental phubbing was also positively associated with problematic social media use, with correlations ranging from .33 to .39. In contrast, parental phubbing was negatively related to parental emotional availability and parent-child attachment. The association between parental phubbing and emotional availability ranged from $-.48$ to $-.54$, while its association with attachment ranged from $-.45$ to $-.50$. Adolescents who perceived more frequent parental phone-related disengagement therefore tended to experience their

parents as less emotionally accessible and reported less secure attachment relationships.

Adolescent loneliness was negatively related to both parental emotional availability and parent–child attachment. These associations became moderately stronger over time, reaching $r = -.53$ for emotional availability and $r = -.55$ for attachment at Wave 3. Loneliness was also positively associated with problematic social media use, increasing from $r = .37$ at Wave 1 to $r = .44$ at Wave 3. Emotional availability and parent–child attachment were strongly positively correlated at all three waves, with coefficients

between .68 and .72. Although these correlations were substantial, they remained below levels generally associated with empirical redundancy, indicating that emotional availability and attachment represented related but distinguishable aspects of the parent–adolescent relationship. Both relational variables were negatively associated with problematic social media use, suggesting that adolescents who experienced lower parental responsiveness and weaker attachment were more likely to exhibit dysregulated or compulsive social media behavior.

Table 2

Fit Indices for the Longitudinal Measurement and Cross-Lagged Panel Models

Model	χ^2	df	CFI	TLI	RMSEA	90% CI for RMSEA	SRMR	Δ CFI
Configural invariance model	1816.24	1080	.953	.947	.034	[.031, .036]	.044	—
Metric invariance model	1853.19	1100	.952	.948	.034	[.031, .036]	.047	-.001
Scalar invariance model	1897.66	1120	.950	.947	.034	[.031, .036]	.050	-.002
Stability-only autoregressive model	2147.82	1185	.941	.936	.037	[.034, .039]	.062	—
Reciprocal direct-effects model	1981.36	1145	.949	.944	.035	[.032, .037]	.048	+.008
Mediated cross-lagged panel model	1912.74	1133	.953	.948	.034	[.031, .036]	.043	+.004
Time-invariant cross-lagged model	1935.68	1147	.952	.948	.034	[.031, .036]	.045	-.001
Final covariate-adjusted model	2024.51	1249	.951	.946	.032	[.030, .035]	.046	-.001

Table 2 presents the results of the longitudinal measurement-invariance tests and the sequential evaluation of the cross-lagged panel models. The configural invariance model demonstrated good fit, $\chi^2(1080) = 1816.24$, CFI = .953, TLI = .947, RMSEA = .034, and SRMR = .044, indicating that the same general factor structure was supported across the three measurement occasions. Imposing equality constraints on corresponding factor loadings produced a change in CFI of only -.001. The metric invariance model therefore remained acceptable, demonstrating that the relationships between the observed items and their underlying constructs were sufficiently stable over time. The scalar invariance model also demonstrated good fit, and the additional equality constraints on item intercepts produced a CFI reduction of only .002. Because the changes in CFI and the remaining fit indices were within acceptable ranges, scalar longitudinal measurement invariance was supported. This finding indicated that observed changes in the latent constructs could be interpreted as substantive changes rather than changes in the functioning or meaning of the measurement instruments.

The stability-only model, which contained autoregressive paths and within-wave associations but excluded cross-lagged effects, demonstrated acceptable but comparatively

weaker fit. Adding reciprocal cross-lagged paths significantly improved the model, $\Delta\chi^2(40) = 166.46$, $p < .001$. The improvement in CFI from .941 to .949 and the reduction in SRMR from .062 to .048 also indicated that the relationships among the study variables could not be adequately represented by temporal stability alone. The mediated cross-lagged model, which incorporated emotional availability, parent–child attachment, and problematic social media use as intervening variables, provided a further significant improvement relative to the direct-effects model, $\Delta\chi^2(12) = 68.62$, $p < .001$. This model demonstrated good fit across all indices, with CFI = .953, TLI = .948, RMSEA = .034, and SRMR = .043.

Constraining the corresponding cross-lagged paths to equality across the Wave 1–Wave 2 and Wave 2–Wave 3 intervals did not produce a statistically significant deterioration in fit, $\Delta\chi^2(14) = 22.94$, $p = .061$, and reduced the CFI by only .001. The longitudinal associations were therefore sufficiently stable across the two six-month intervals to support a time-invariant model. The final model included age, gender, family structure, perceived socioeconomic status, average daily social media use, and baseline mental health treatment as covariates. It continued to demonstrate good fit, $\chi^2(1249) = 2024.51$, CFI = .951, TLI

= .946, RMSEA = .032, and SRMR = .046. The addition of covariates did not materially alter the magnitude or significance of the principal structural paths, demonstrating

that the observed longitudinal relationships were not attributable solely to measured demographic or digital-use characteristics.

Table 3

Standardized Autoregressive and Cross-Lagged Effects in the Final Longitudinal Model

Structural path	Standardized β	SE	95% CI	p
Autoregressive stability paths				
Parental phubbing at an earlier wave $\rightarrow$ parental phubbing at the subsequent wave	.64	.025	[.591, .689]	<.001
Loneliness at an earlier wave $\rightarrow$ loneliness at the subsequent wave	.70	.022	[.657, .743]	<.001
Emotional availability at an earlier wave $\rightarrow$ emotional availability at the subsequent wave	.65	.024	[.603, .697]	<.001
Parent–child attachment at an earlier wave $\rightarrow$ attachment at the subsequent wave	.73	.020	[.691, .769]	<.001
Problematic social media use at an earlier wave $\rightarrow$ problematic use at the subsequent wave	.68	.023	[.635, .725]	<.001
Cross-lagged paths originating from parental phubbing				
Parental phubbing $\rightarrow$ subsequent loneliness	.17	.027	[.117, .223]	<.001
Parental phubbing $\rightarrow$ subsequent emotional availability	-.22	.026	[-.271, -.169]	<.001
Parental phubbing $\rightarrow$ subsequent parent–child attachment	-.19	.025	[-.239, -.141]	<.001
Parental phubbing $\rightarrow$ subsequent problematic social media use	.15	.027	[.097, .203]	<.001
Cross-lagged predictors of subsequent loneliness				
Emotional availability $\rightarrow$ subsequent loneliness	-.18	.030	[-.239, -.121]	<.001
Parent–child attachment $\rightarrow$ subsequent loneliness	-.21	.031	[-.271, -.149]	<.001
Problematic social media use $\rightarrow$ subsequent loneliness	.14	.026	[.089, .191]	<.001
Cross-lagged paths originating from loneliness				
Loneliness $\rightarrow$ subsequent parental phubbing	.06	.028	[.005, .115]	.032
Loneliness $\rightarrow$ subsequent emotional availability	-.09	.028	[-.145, -.035]	.001
Loneliness $\rightarrow$ subsequent parent–child attachment	-.11	.027	[-.163, -.057]	<.001
Loneliness $\rightarrow$ subsequent problematic social media use	.12	.026	[.069, .171]	<.001
Additional predictors of subsequent parental phubbing				
Emotional availability $\rightarrow$ subsequent parental phubbing	-.07	.029	[-.127, -.013]	.016
Parent–child attachment $\rightarrow$ subsequent parental phubbing	-.04	.028	[-.095, .015]	.154
Problematic social media use $\rightarrow$ subsequent parental phubbing	.09	.027	[.037, .143]	.001

As shown in Table 3, all five constructs demonstrated substantial temporal stability. Parent–child attachment had the strongest autoregressive coefficient, $\beta = .73$, $p < .001$, followed by adolescent loneliness, $\beta = .70$, $p < .001$, problematic social media use, $\beta = .68$, $p < .001$, emotional availability, $\beta = .65$, $p < .001$, and parental phubbing, $\beta = .64$, $p < .001$. These coefficients indicated that adolescents' relative positions on each construct remained moderately to strongly stable across the six-month intervals. Nevertheless, none of the coefficients approached unity, leaving sufficient within-person and between-person change to support the examination of longitudinal cross-lagged effects.

After controlling for prior loneliness and the stability of all other constructs, parental phubbing significantly predicted higher adolescent loneliness at the subsequent wave, $\beta = .17$, $p < .001$. This result supported the primary hypothesis that adolescents who perceived greater parental preoccupation with smartphones subsequently experienced greater loneliness. The reverse pathway from loneliness to

subsequent parental phubbing was also statistically significant, $\beta = .06$, $p = .032$, but was substantially smaller than the pathway from parental phubbing to loneliness. A comparison of these two coefficients showed that the predictive effect of parental phubbing on later loneliness was significantly stronger than the reverse effect, Wald $\chi^2(1) = 8.74$, $p = .003$. The relationship between parental phubbing and loneliness was therefore reciprocal but asymmetrical, with parental phubbing operating as the more influential longitudinal predictor.

Parental phubbing also predicted significant deterioration in each proposed psychosocial mechanism. Higher parental phubbing predicted lower perceived emotional availability at the following wave, $\beta = -.22$, $p < .001$, and weaker subsequent parent–child attachment, $\beta = -.19$, $p < .001$. Of the cross-lagged effects originating from parental phubbing, its effect on emotional availability was the strongest. This finding indicated that parental phone-related distraction was particularly consequential for adolescents' perceptions that

their parents were attentive, emotionally accessible, and responsive when needed. Parental phubbing also predicted increased problematic social media use, $\beta = .15$, $p < .001$, suggesting that exposure to parental phone-related disengagement preceded greater adolescent difficulty controlling or regulating social media behavior.

Each of the three proposed mediating variables independently predicted subsequent loneliness. Greater emotional availability predicted lower later loneliness, $\beta = -.18$, $p < .001$, and stronger parent–child attachment predicted lower later loneliness, $\beta = -.21$, $p < .001$. Attachment was the strongest psychosocial predictor of subsequent loneliness after accounting for prior loneliness, parental phubbing, problematic social media use, and the covariates. Problematic social media use predicted increased subsequent loneliness, $\beta = .14$, $p < .001$. Thus, adolescents who experienced their parents as emotionally unavailable, reported weaker attachment relationships, or demonstrated more problematic social media behavior were at increased risk of becoming lonelier over the following six months.

Loneliness also predicted changes in the proposed mediators. Higher loneliness predicted lower subsequent emotional availability, $\beta = -.09$, $p = .001$, weaker subsequent parent–child attachment, $\beta = -.11$, $p < .001$, and greater subsequent problematic social media use, $\beta = .12$, $p < .001$. These results suggested that loneliness was not exclusively an outcome of family and digital processes but could contribute to the continuation of those processes. Lonely adolescents may perceive less parental responsiveness, experience greater relational distance, or turn more strongly toward social media as a compensatory coping strategy. However, the paths originating from parental phubbing and

predicting the mediators were consistently larger than the corresponding paths originating from loneliness.

Greater emotional availability predicted a modest reduction in later perceptions of parental phubbing, $\beta = -.07$, $p = .016$, and problematic social media use predicted a modest increase in later parental phubbing, $\beta = .09$, $p = .001$. The direct path from parent–child attachment to later parental phubbing was not statistically significant after emotional availability, problematic social media use, and the autoregressive effects were controlled, $\beta = -.04$, $p = .154$. Although attachment was strongly correlated with parental phubbing within each wave, it did not independently predict changes in parental phubbing over time. This pattern suggested that the longitudinal component of the association was more directly represented by emotional responsiveness and family digital behavior than by global attachment security.

Among the covariates, older age predicted higher subsequent problematic social media use, $\beta = .11$, $p = .004$, and slightly higher loneliness, $\beta = .07$, $p = .041$. Greater average daily social media use predicted higher problematic social media use, $\beta = .24$, $p < .001$, and higher loneliness, $\beta = .08$, $p = .022$. Girls reported slightly higher loneliness than boys after controlling for the remaining variables, $\beta = .10$, $p = .008$. Higher perceived family socioeconomic status predicted slightly lower loneliness, $\beta = -.08$, $p = .019$. Family structure and baseline mental health treatment did not significantly predict changes in parental phubbing after the other variables were included. Importantly, controlling for these characteristics reduced the principal cross-lagged coefficients by no more than .02, and all hypothesized paths remained statistically significant.

Table 4

Standardized Three-Wave Indirect Effects of Parental Phubbing and Adolescent Loneliness

Temporally ordered indirect pathway	Standardized indirect effect	Bootstrap SE	Bias-corrected 95% CI	p
Parental phubbing at Wave 1 → emotional availability at Wave 2 → loneliness at Wave 3	.040	.010	[.023, .062]	<.001
Parental phubbing at Wave 1 → parent–child attachment at Wave 2 → loneliness at Wave 3	.040	.011	[.021, .064]	<.001
Parental phubbing at Wave 1 → problematic social media use at Wave 2 → loneliness at Wave 3	.021	.007	[.010, .038]	.001
Total indirect effect of parental phubbing on loneliness	.101	.018	[.069, .139]	<.001
Loneliness at Wave 1 → emotional availability at Wave 2 → parental phubbing at Wave 3	.006	.003	[.001, .014]	.018
Loneliness at Wave 1 → parent–child attachment at Wave 2 → parental phubbing at Wave 3	.004	.003	[–.001, .011]	.112
Loneliness at Wave 1 → problematic social media use at Wave 2 → parental phubbing at Wave 3	.011	.004	[.004, .021]	.003
Total indirect effect of loneliness on parental phubbing	.021	.006	[.010, .035]	<.001

Table 4 presents the temporally ordered indirect effects linking parental phubbing at Wave 1 with adolescent loneliness at Wave 3 through the three mediators measured at Wave 2. Parental phubbing had a significant positive indirect effect on later loneliness through reduced parental emotional availability, $\beta = .040$, 95% CI [.023, .062], $p < .001$. Thus, greater parental phubbing at baseline predicted lower emotional availability six months later, which subsequently predicted greater loneliness after an additional six months. The indirect effect through parent–child attachment was also significant and was identical in standardized magnitude, $\beta = .040$, 95% CI [.021, .064], $p < .001$. This pathway indicated that parental phubbing contributed to later loneliness partly by undermining adolescents' trust, communication, and perceived relational security with their parents.

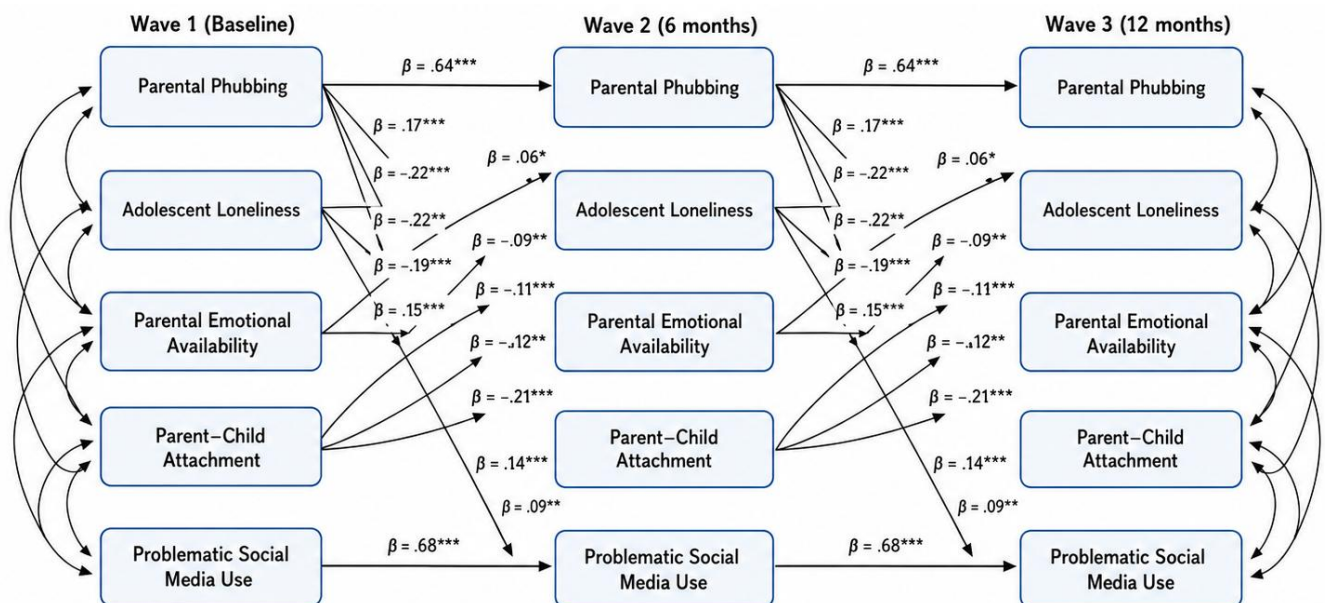
The indirect pathway through problematic social media use was smaller but remained statistically significant, $\beta = .021$, 95% CI [.010, .038], $p = .001$. Greater parental phubbing predicted an increase in problematic social media use at Wave 2, which in turn predicted greater loneliness at Wave 3. The combined indirect effect through all three mediators was $\beta = .101$, 95% CI [.069, .139], $p < .001$. Emotional availability and attachment together accounted for approximately 79% of the total estimated indirect

association, whereas problematic social media use accounted for approximately 21%. These findings indicated that relational mechanisms constituted the principal pathways connecting parental phubbing with later loneliness, although maladaptive adolescent social media involvement represented an additional and independent mechanism.

The reverse indirect pathways were smaller. Baseline loneliness predicted subsequent parental phubbing indirectly through reduced emotional availability, $\beta = .006$, $p = .018$, and increased problematic social media use, $\beta = .011$, $p = .003$. The reverse pathway through parent–child attachment was not significant because its bootstrap confidence interval included zero, $\beta = .004$, 95% CI [−.001, .011], $p = .112$. The total reverse indirect effect was statistically significant, $\beta = .021$, $p < .001$, but was substantially smaller than the total indirect effect of parental phubbing on later loneliness. A bootstrap comparison indicated that the difference between the forward and reverse total indirect effects was significant, $\Delta\beta = .080$, 95% CI [.049, .116]. The overall pattern therefore supported a predominantly parent-to-adolescent process while also identifying a weaker reciprocal process through which adolescent loneliness and problematic social media behavior could contribute to continuing family disengagement.

Figure 1

Final Three-Wave Cross-Lagged Panel Model of Parental Phubbing, Adolescent Loneliness, Parental Emotional Availability, Parent–Child Attachment, and Problematic Social Media Use



The final model represented the longitudinal relationships among the five constructs across the 12-month observation period while controlling for their baseline correlations, autoregressive stability, within-wave residual correlations, and demographic covariates. The model explained 45% of the variance in parental phubbing, 55% of the variance in loneliness, 49% of the variance in emotional availability, 57% of the variance in parent–child attachment, and 50% of the variance in problematic social media use at Wave 2. At Wave 3, the corresponding explained variances were 49% for parental phubbing, 63% for loneliness, 53% for emotional availability, 61% for attachment, and 55% for problematic social media use. The relatively high explained variance in Wave 3 loneliness indicated that prior loneliness, parental phubbing, emotional availability, attachment, problematic social media use, and the included covariates jointly provided a strong account of subsequent individual differences in adolescent loneliness.

The model showed that parental phubbing predicted later loneliness both directly and indirectly. The direct cross-lagged path remained significant after all three mediators were included, while the significant indirect effects demonstrated that part of the longitudinal association operated through reduced emotional availability, weakened attachment, and increased problematic social media use. The persistence of the direct path suggested partial rather than complete mediation. Consequently, parental phubbing may contribute to loneliness not only by changing broad perceptions of the parent–child relationship or adolescents' social media behavior but also through more immediate experiences of rejection, interruption, invalidation, or reduced interpersonal engagement that were not fully captured by the three mediators.

The strongest component of the model was the relational pathway. Parental phubbing predicted reductions in both emotional availability and attachment, and each construct independently predicted subsequent loneliness. Emotional availability reflected whether the parent was experienced as attentive and emotionally responsive in specific interactions, whereas attachment represented a broader sense of trust, communication, and relational security. Their simultaneous significance showed that parental phubbing was related to both immediate emotional accessibility and the more enduring quality of the parent–adolescent relationship. Although emotional availability and attachment were strongly associated, each contributed unique explanatory information.

Problematic social media use formed an additional behavioral pathway. Adolescents who perceived more parental phubbing subsequently reported greater difficulty regulating their own social media use, and greater problematic use predicted later loneliness. This pathway was smaller than the relational pathways but remained significant after controlling for daily social media duration, demonstrating that the result reflected problematic or dysregulated use rather than exposure time alone. The positive path from problematic social media use to later parental phubbing further suggested a possible family-level reinforcement process in which parental and adolescent digital disengagement intensified one another.

The final model also identified a reciprocal association between parental phubbing and adolescent loneliness. Loneliness predicted a small increase in subsequent perceptions of parental phubbing, even after prior parental phubbing was controlled. This reverse pathway may indicate that lonely adolescents become more sensitive to parental distraction, withdraw from family interactions in ways that reduce parental engagement, or participate in reciprocal family digital-use patterns. Nevertheless, the forward path from parental phubbing to loneliness was nearly three times as large as the reverse path, and the forward indirect effect was almost five times as large as the reverse indirect effect. The findings therefore supported reciprocity without implying equivalent causal influence in both directions.

Sensitivity analyses confirmed the robustness of the final model. Re-estimating the model after excluding adolescents who reported more than seven hours of daily social media use produced changes of less than .02 in all principal standardized coefficients. Multiple-imputation analyses yielded estimates closely comparable to those obtained through full-information maximum likelihood. The parental phubbing-to-loneliness path remained significant when perceived parental smartphone-use duration was entered as an additional covariate, indicating that adolescents' experiences of parental disengagement were more relevant than parental screen time alone. The substantive pattern was also maintained when the analyses were limited to adolescents reporting on mothers or female caregivers and when latent-variable scores were used instead of observed scale totals.

Multigroup analyses showed that the overall structural model was broadly similar across girls and boys. Constraining all principal cross-lagged paths to equality across gender produced a CFI reduction of .003, which did not indicate substantial gender noninvariance. The parental

phubbing-to-loneliness pathway was slightly stronger among girls, $\beta = .19$, $p < .001$, than among boys, $\beta = .15$, $p < .001$, but the difference did not reach statistical significance, Wald $\chi^2(1) = 2.41$, $p = .121$. The pathway from problematic social media use to loneliness was also comparable across gender. Analyses comparing early adolescents aged 12–14 years with adolescents aged 15–17 years showed that the parental phubbing-to-problematic-social-media-use path was stronger in the older group, but the central pathways from parental phubbing through emotional availability and attachment to loneliness remained stable across developmental groups. Overall, the sensitivity and multigroup analyses indicated that the principal findings were not dependent on a specific estimation method, extreme social media users, reference-parent category, gender group, or adolescent age category.

4 Discussion

The present study examined the reciprocal longitudinal relationship between parental phubbing and adolescent loneliness across three measurement waves and evaluated perceived parental emotional availability, parent–child attachment, and problematic social media use as temporally ordered explanatory mechanisms. The findings supported the proposed longitudinal model. Parental phubbing predicted higher adolescent loneliness six months later after controlling for prior loneliness, the temporal stability of all study variables, demographic characteristics, daily social media use, and baseline mental health treatment. Adolescent loneliness also predicted a small increase in subsequent perceptions of parental phubbing, demonstrating a reciprocal association; however, the parent-to-adolescent pathway was substantially stronger than the reverse pathway. Parental phubbing additionally predicted lower subsequent emotional availability, weaker parent–child attachment, and greater problematic social media use. Each of these variables independently predicted later loneliness, and all three mediated the relationship between baseline parental phubbing and loneliness at the 12-month follow-up. The relational pathways through emotional availability and attachment were stronger than the behavioral pathway through problematic social media use. These results indicate that parental phubbing is not merely an incidental family habit but a potentially meaningful interpersonal process through which repeated digital distraction can influence adolescents' perceptions of parental responsiveness,

relational security, digital coping behavior, and emotional isolation.

The direct prospective association between parental phubbing and adolescent loneliness is consistent with evidence that parental digital disengagement may communicate rejection, reduced acceptance, or diminished interpersonal significance. Earlier research showed that maternal phubbing was associated with adolescent loneliness through impaired mother–adolescent communication and lower perceived maternal acceptance (Wang et al., 2021). The current findings extend that work by demonstrating that parental phubbing predicted later loneliness even after prior loneliness and several relational and behavioral mechanisms were statistically controlled. Thus, the association cannot be explained entirely by adolescents who were already lonely reporting more negative perceptions of their parents. Parental phubbing may function as a recurring micro-level experience of exclusion in which the adolescent encounters a physically present but psychologically unavailable parent. Repeated interruption of conversations, delayed responses, and reduced eye contact may weaken the adolescent's expectation that emotional needs will be noticed and prioritized. This interpretation is consistent with evidence linking parental phubbing with reduced mental well-being (Harianti & Kurniawan, 2022) and with research indicating that maternal phubbing can damage the perceived quality of the mother–child relationship (Varkey et al., 2022). It also aligns with broader reviews showing that parental technoference is associated with adverse parent–child relationship characteristics and poorer developmental and health outcomes (Komanchuk et al., 2023). The present longitudinal results therefore strengthen the argument that the emotional consequences of parental smartphone use depend less on the device itself than on whether its use displaces meaningful interpersonal engagement.

The reciprocal pathway from adolescent loneliness to later parental phubbing was statistically significant but comparatively weak. This finding suggests that adolescents are not passive recipients of family digital behavior and that loneliness may contribute to interactional patterns that reinforce perceived parental disengagement. Lonely adolescents may withdraw from family conversations, communicate less openly, spend more time on personal devices, or become more vigilant toward signs of rejection. These responses may reduce opportunities for satisfying parent–adolescent interaction and may increase the likelihood that parental smartphone use is noticed or

interpreted as dismissive. Research identifying loneliness and attachment insecurity as predictors of phubbing behavior supports the possibility that emotional disconnection can contribute to technology-mediated interpersonal avoidance (Büyüksakar & Çelik, 2024). Similarly, insecure attachment has been linked to phubbing through problematic smartphone use, indicating that relational insecurity may encourage device use as an alternative means of affect regulation or disengagement (Sun & Miller, 2023). Nevertheless, the considerably stronger path from parental phubbing to loneliness indicates that the reciprocal relationship was asymmetrical. The results therefore do not support an interpretation in which adolescent loneliness and parental phubbing exert equivalent influence. Instead, they suggest a predominantly parent-initiated process accompanied by a weaker adolescent-driven feedback effect.

The first and strongest explanatory mechanism involved reduced parental emotional availability. Parental phubbing predicted lower emotional availability at the subsequent wave, and lower emotional availability independently predicted greater later loneliness. This pathway indicates that digital distraction may become psychologically consequential when adolescents interpret it as evidence that the parent is inaccessible, inattentive, or insufficiently responsive. Emotional availability involves more than physical proximity; it requires sustained attention, sensitivity to emotional cues, and willingness to engage with the adolescent's concerns. Smartphone interruptions may compromise these processes by fragmenting interaction and diminishing the quality of parental responses. Findings that parental phubbing is associated with children's emotion-regulation difficulties and psychosocial symptoms are compatible with the view that digitally interrupted parenting weakens emotional co-regulation (Alemdar & Çatiker, 2026). Research on mattering and anti-mattering also provides a useful explanation, as experiences of feeling unimportant to others have been associated with poorer digital-life balance and greater social media addiction (Duradoni et al., 2024). When a parent repeatedly attends to a device during emotionally relevant moments, the adolescent may infer that their needs matter less than the parent's online activity. Such anti-mattering experiences can plausibly intensify loneliness even when the adolescent has frequent contact with family and peers. The persistence of the direct parental phubbing-to-loneliness path after emotional availability was included indicates partial mediation, suggesting that other unmeasured processes, such

as perceived rejection, anger, reduced self-worth, or disrupted family routines, may also contribute.

The second relational pathway operated through parent-child attachment. Greater parental phubbing predicted weaker subsequent attachment, and weaker attachment predicted higher later loneliness. This result is consistent with attachment theory, according to which repeated experiences of parental responsiveness and availability contribute to internal expectations about whether close others are trustworthy and emotionally accessible. Phubbing may gradually undermine attachment security by reducing communication quality, increasing perceived alienation, and weakening confidence that the parent will respond when needed. The finding accords with longitudinal evidence showing that paternal and maternal attachment mediate reciprocal relationships between parental technofence and adolescent problematic mobile phone use (Xie et al., 2025). It is also supported by meta-analytic evidence that poorer parent-child relationships are associated with greater problematic internet use across cultural and linguistic settings (Zhu et al., 2022). In the current model, attachment was the strongest psychosocial predictor of subsequent loneliness, even after emotional availability and problematic social media use were considered simultaneously. This may reflect the broader scope of attachment, which encompasses trust, communication, acceptance, and enduring relational security rather than responsiveness in isolated interactions. Emotional availability and attachment were strongly correlated but remained empirically distinguishable, and each contributed independently to the prediction of loneliness. The findings therefore suggest that parental phubbing may influence both immediate perceptions of parental emotional presence and the adolescent's more general sense of security within the parent-child relationship.

Problematic social media use constituted a smaller but significant behavioral pathway. Parental phubbing predicted increased problematic social media use, which subsequently predicted greater loneliness. This pattern supports the possibility that adolescents respond to parental digital disengagement by seeking connection, distraction, validation, or emotional relief through social media. Such use may initially be compensatory but can become problematic when it is characterized by preoccupation, impaired control, conflict, or reliance on online engagement to regulate negative affect. Previous studies have found direct associations between parental phubbing and adolescent smartphone addiction (Mulyaningrum &

Kusumaningrum, 2022), mobile phone addiction (Ma et al., 2024), and short-form video addiction (Wang & Lei, 2022). Family-level reviews have likewise identified low cohesion, conflict, poor communication, inadequate monitoring, and parental modeling as risk factors for problematic internet use (Nannatt et al., 2022). The current results extend this literature by showing that problematic social media use partially explains how parental phubbing contributes to later loneliness. This finding is consistent with evidence that problematic social networking is associated with impaired emotional well-being and multiple mental health difficulties (Weinstein, 2023), as well as systematic evidence identifying interpersonal problems and negative affect as risk factors for problematic social network use (Fioravanti et al., 2025). The significant effect remained after daily social media duration was controlled, indicating that dysregulated patterns of use were more consequential than time online alone.

The association between problematic social media use and loneliness may reflect several processes. Adolescents who rely heavily on social media to compensate for unmet relational needs may engage in passive browsing, upward social comparison, reassurance seeking, or compulsive checking, all of which can intensify feelings of exclusion. Reviews of adolescent social networking have emphasized that emotional outcomes depend on the quality, motivation, and context of use rather than exposure alone (Bottaro & Faraci, 2022). The multidimensional model of problematic short-video use similarly indicates that individual vulnerabilities, social-environmental conditions, and platform characteristics interact to sustain compulsive engagement (Xiong et al., 2024). Stress-coping research suggests that digital platforms may provide temporary relief from distress while reinforcing avoidance-based coping and behavioral dependency (Mu et al., 2022). In the present study, problematic social media use also predicted later perceptions of parental phubbing, suggesting a family-level feedback loop. Adolescents who become increasingly absorbed in social media may participate less in family activities, elicit greater parental device use, or heighten reciprocal disengagement within the household. This interpretation is consistent with research showing that smartphone addiction and negative emotions can adversely affect parent-child relationships (Geng & Liu, 2025) and with longitudinal evidence that social media use and family relationship quality may influence each other across development (Nobakht et al., 2026).

The relative magnitude of the indirect effects is theoretically important. Emotional availability and attachment together accounted for most of the mediated association between parental phubbing and loneliness, whereas problematic social media use explained a smaller proportion. This pattern indicates that the principal consequences of parental phubbing are relational rather than merely imitative or behavioral. Adolescents may learn problematic smartphone habits by observing their parents, but the more influential process appears to involve the meaning assigned to parental distraction. When parental smartphone engagement occurs during moments in which attention, reassurance, or communication is expected, adolescents may experience it as a relational signal that affects their sense of acceptance and security. Reviews of family factors and adolescent screen use similarly indicate that family functioning and relationship quality are central to understanding digital behavior and mental health outcomes (Xiaocen Liu et al., 2024). Research with younger children has shown that parent-child conflict mediates the relationship between parental phubbing and children's electronic media use (Xiaoxuan Liu et al., 2024), while studies of preschoolers suggest that co-parenting and parental phubbing jointly shape children's media behavior (Zhang et al., 2025). The present findings suggest that by adolescence, these family processes have become intertwined with attachment, perceived emotional availability, and self-directed digital coping.

5 Conclusion

The robustness analyses further strengthened confidence in the findings. The principal pathways remained significant after excluding adolescents with extremely high social media exposure, controlling for perceived parental smartphone-use duration, applying multiple imputation, and estimating latent-variable models. This distinction between parental smartphone duration and parental phubbing is particularly important. A parent may use a smartphone frequently without disrupting emotionally meaningful interactions, whereas even shorter episodes of use may be harmful when they repeatedly occur during conversations or support-seeking moments. The results therefore suggest that interventions should focus on context-sensitive and relationship-sensitive use rather than emphasizing screen-time reduction alone. The broad stability of the model across gender and age groups also indicates that the central mechanisms may be relevant to a diverse range of

adolescents. Although the parental phubbing-to-loneliness association was slightly stronger among girls and the pathway to problematic social media use was somewhat stronger among older adolescents, these differences were not sufficiently large to alter the overall conclusions. This is compatible with evidence that some consequences of parental phubbing vary by gender (Fu et al., 2026), while also suggesting that disrupted emotional availability and attachment are broadly relevant developmental processes.

The study has several limitations. All principal variables were assessed through adolescent self-report, which may have increased shared-method variance and may not fully represent parents' actual smartphone behavior or the objective quality of family interactions. Adolescents' emotional states could also influence how they interpreted parental distraction, although the longitudinal design and control for prior levels reduced this concern. The sample was recruited from public schools in four Canadian provinces and may not represent adolescents who were not enrolled in school, lived in remote communities, attended private schools, or experienced substantially different family and cultural conditions. The six-month intervals were theoretically appropriate but may not capture shorter-term fluctuations or longer developmental processes. The study also focused on one nominated parent or caregiver, preventing detailed comparison of simultaneous maternal and paternal phubbing. Although the cross-lagged model established temporal precedence, it did not establish causality, and unmeasured factors such as parental stress, depression, occupational demands, family conflict, or adolescent temperament may have contributed to the observed associations.

Future research should combine adolescent reports with parental reports, passive smartphone-use indicators, ecological momentary assessments, and direct observation of family interactions. Studies with more frequent measurement occasions could distinguish immediate emotional responses to phubbing from cumulative effects on attachment and loneliness. Separate assessment of maternal, paternal, and other caregiver phubbing would clarify whether the meaning and consequences of digital distraction differ by caregiver role. Future models should examine additional mechanisms, including perceived rejection, mattering, social comparison, emotion regulation, family conflict, and parental psychological distress. Random-intercept cross-lagged panel models and intensive longitudinal designs could more clearly separate stable between-family differences from within-family changes.

Experimental and intervention research is also needed to determine whether reducing device-related interruptions improves emotional availability, attachment security, and adolescent well-being.

In practice, parents, schools, clinicians, and family-service providers should address parental phubbing as a relational behavior rather than only as excessive screen use. Parents can establish device-free periods during meals, transportation, family activities, and emotionally important conversations and can communicate explicitly when urgent smartphone use is necessary. Family-based interventions should emphasize attentive listening, eye contact, emotional validation, consistent availability, and mutually agreed digital boundaries. Clinicians working with lonely adolescents should assess patterns of family technology use alongside peer relationships and individual social media habits. Programs designed to reduce problematic social media use should involve parents and address modeling, communication, and family routines rather than focusing exclusively on adolescent self-control. Strengthening emotionally responsive interaction may reduce loneliness directly while also decreasing adolescents' need to seek compensatory connection through dysregulated social media use.

Authors' Contributions

All authors have contributed significantly to the research process and the development of the manuscript.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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