

EMPIRICAL ARTICLE

Timing matters: A multi-contextual, within-individual approach to understanding age-related changes in psychopathology in the ABCD Study

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1L40MH131146-01**Abstract**

Psychopathology is associated with features of the family, neighborhood, and school environments. During adolescence, increased autonomy and novel social relationships may influence the strength of these associations over time. Characterizing these processes is key to understanding how and when different factors may contribute to psychopathology. Participants in the Adolescent Brain Cognitive Development (ABCD) Study ($n = 11,823$) were 9–10 years old at baseline and 12–13 years old at the three-year follow-up. At each time point, internalizing symptoms (INT) and externalizing symptoms (EXT), family features (e.g., conflict, parental monitoring, acceptance, and financial hardship), neighborhood safety, and school supportiveness were assessed. Fixed effect regression models were estimated separately for male and female youth to examine the age-varying, within-individual associations between symptoms and family, neighborhood, and school factors. INT and EXT significantly decreased among male adolescents over time, while female adolescents exhibited increases in INT and decreases in EXT. Family conflict, financial hardship, neighborhood safety, and school support predicted INT and EXT, with some variation by sex (e.g., neighborhood safety only predicted INT and EXT for male adolescents). Many of these associations were consistent over time. However, for male adolescents, the association between financial hardship and EXT weakened over time, while the family conflict and EXT association strengthened. Understanding how timing and specific environmental factors interact to shape adolescent mental health is critical to identifying periods of heightened sensitivity to risk or protective influences.

KEY WORDS

age-varying, externalizing, family, internalizing, neighborhood, school, sex

INTRODUCTION

Adolescence is a developmental period marked by fluctuating socio-cultural influences (Blakemore & Mills, 2014). During this time, adolescents undergo family, neighborhood, and school changes that coincide with mental health shifts. Mental health disorders often emerge and peak during adolescence, with one in five adolescents developing a disorder that persists into adulthood (Lee et al., 2014; Uhlhaas

et al., 2023). Individual differences in mental health trajectories are shaped by a wide range of experiences across family, school, and neighborhood contexts. Attention to each of these domains is crucial to obtaining a holistic picture of the different factors that may affect adolescent mental health.

Extant research on the development of psychopathology reinforces that adolescence is a period of fluctuation in internalizing and externalizing symptoms (Hafen & Laursen, 2009; Lee & Bukowski, 2012; Yoon et al., 2023).

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However, the specific nature and degree of change across different symptom domains seems contingent on various factors. The largest national study in the United States of youth development to date, the Adolescent Brain Cognitive Development (ABCD) Study (Casey et al., 2018), estimates that approximately 10% of adolescents at baseline (ages 9–10) met the criteria for a mental health disorder (Olfson et al., 2023). Notably, the prevalence was higher among males (11.48%) relative to females (8.68%), consistent with prior evidence of sex differences in adolescent psychopathology (Costello et al., 2003; Gong et al., 2022). Across time (from ages 9 to 13), adolescents in the ABCD Study have demonstrated significant mean changes in symptomatology with overall decreases in total problems and externalizing problems (Barch et al., 2021). This study also revealed preliminary associations between symptom trajectories and socioeconomic and racial factors (Barch et al., 2021). Additional research clarifying the broader environmental factors that may contribute to patterns of change in symptomatology and how the relative influence of these factors—such as the increasing salience of peer and school contexts and the potentially diminishing influence of family dynamics—may fluctuate across development is critical.

Developmental theory has long acknowledged the importance of the multiple levels of a child's environment on development (Bronfenbrenner, 1977; Cicchetti & Lynch, 1993). These levels encompass proximal factors in the microsystem, such as family and peers, and more distal factors, such as the school environment. Changes in adolescent psychopathology are cumulatively shaped by various factors across these interconnected systems, including family dynamics (e.g., Davies & Sturge-Apple, 2014), neighborhood conditions (e.g., Butler et al., 2012; Carroll et al., 2023), and school settings (e.g., Aldridge & McChesney, 2018; Diggs et al., 2024; Goetschius et al., 2023). Each of these environmental structures is nested and interdependent (Bronfenbrenner, 1977), and their interactions are shaped by the unique characteristics of the individual within them. For example, adolescent sex differences may influence the relative impact of different environmental factors (here, we refer to sex assigned at birth, which may be distinct from gender identity). Broadly, studies have tended to report stronger effects on mental health for female adolescents relative to males across various levels, including parenting (Aalsma et al., 2011; Suldo et al., 2012), school (Suldo et al., 2012), and neighborhood (King et al., 2022) effects.

Despite the inherently intertwined nature of these different levels of the environment, in practice, many studies limit the scope of analysis to singular contexts. Approaches that simultaneously account for the influence of multiple different contexts are better aligned with prevailing theoretical models and may more accurately reflect the complexity of adolescents' lived experiences. For example, Conley et al. (2023) examined adolescents' perceptions of threat across neighborhood, school, and family

contexts. Using latent profile analysis, they demonstrated that adolescents' perceived levels of threat may vary across contexts, with some individuals experiencing elevated family threat (but low neighborhood and school threat), some experiencing elevated neighborhood threat (but low school and family threat), and some experiencing elevated threat across all three domains. Importantly, these profiles were associated with distinct mental health outcomes 1 year later, and adolescents with elevated threat across all domains demonstrated higher internalizing and externalizing symptoms relative to the other profiles. These multi-contextual approaches can capture adolescent environments more holistically. However, most prior studies have not accounted for the protective aspects of these environments that contribute to mental health (Liu et al., 2020; Narayan et al., 2018), and have not examined how the relative influence of these factors may fluctuate over time as adolescents age.

Extant theoretical and empirical work emphasizes the importance of the developmental timing of risk and protective factors (Gee, 2021; Hambrick et al., 2019). Fluctuations in risk and protective factors across different levels of the environment can have unique implications for developmental outcomes (Darling, 2007; Oshri et al., 2018). For example, across adolescence, individuals gain increasing autonomy from their caregivers, and more distal influences beyond the family unit (e.g., peers, school) may become more salient (Buhrmester & Furman, 1987; Kerr et al., 2003; Soenens et al., 2007). At the same time, other studies have found stable effects of peers and parents on internalizing symptoms (Branje et al., 2010; Mak et al., 2021). Clarifying how timing and specific environmental factors interact to shape adolescent mental health outcomes is a critical step in identifying periods of heightened sensitivity when certain risk or protective factors may be particularly impactful.

Patterns of psychopathology and the relative influence of different environmental contexts may further vary by biological sex. In the ABCD sample, research indicates that male adolescents exhibited higher average levels of externalizing symptoms, while no differences between sexes were observed in internalizing symptoms (Barch et al., 2021). Additionally, there are indications of sex-specific variations in symptom changes over time. For instance, Lee and Bukowski (2012) observed increases in internalizing symptoms among male and female adolescents ages 10–13. However, male adolescents showed a decline in externalizing symptoms, whereas symptoms among female adolescents remained stable.

These differences may be partly attributable to underlying sex differences in pubertal maturation, neurodevelopment, and stress exposure. Neurobiological research has shown that females have stronger negative affective responses to stress relative to males (Ordaz & Luna, 2012). Further, female adolescents tend to report greater exposure to interpersonal stressors and, in turn, exhibit greater depression symptoms as compared to male adolescents (Hankin et al., 2007). Gendered expectations and socialization may further contribute to sex differences in how different types

of environmental influences shape adolescent mental health, as emotional expression is typically more socially acceptable for females than males (Rudolph, 2002). These findings point to the potential importance of examining environmental influences on symptom trajectories separately by sex.

Current study

The present study had three primary aims: (1) Examine within-individual changes in externalizing and internalizing symptoms among female and male adolescents, (2) Determine how risk and protective factors present in the family, neighborhood, and school context predict changes in symptoms, and whether these associations are stronger at different points in development, and (3) Evaluate how these associations vary depending on sex. We expected higher levels of protective factors (parental monitoring, parental acceptance, neighborhood safety, and school supportiveness) would be associated with lower internalizing and externalizing symptoms across time. In contrast, higher levels of risk factors (family conflict, financial hardship) would be associated with higher symptoms. Given increases in autonomy and changes in social contexts across adolescence, we hypothesized that the strength of associations between school and neighborhood factors and symptoms would increase over time while the impact of family-level factors would remain constant across different stages of adolescence. The prospective, longitudinal design, large sample size, and measurement of different facets of adolescent environments in the ABCD Study make it particularly well-suited to test these hypotheses and clarify the timing-related nature of multi-contextual influences on adolescent mental health.

METHOD

Sample

Participants were recruited from 21 sites across the United States as part of the ABCD Study, a longitudinal study of nearly 12,000 adolescents (Casey et al., 2018). The current study used data provided by the ABCD consortium in the 5.0 annual release (DOI:10.15154/z563-zd24), which includes data from the first 4 years of the study (i.e., baseline through year 3 follow-up) for the majority of the sample ($n = 11,823$). Adolescents (48% female) were 9–10 years old at the beginning of the study ($M = 9.91$, $SD = 0.62$) and completed follow-up assessments annually for 3 years (12–13 years old at the year 3 follow-up). The median household income for the sample was between \$75,000 and \$99,999, which is above the national median during the study period. Adolescent participants identified as Asian (2%), Black (15%), Hispanic (20%), White (51%), and Other Race (10%). Missing data patterns are reported in Table S6. Parent-informed consent and adolescent assent were obtained from all participants. Each site's Institutional Review Board approved procedures.

MEASURES

Demographic information

Parents completed a demographic interview and reported on factors including the child's race, biological sex, and family income.

Contextual risk and protective factors

We identified risk (family conflict, financial hardship) and protective (parental monitoring, parent acceptance, neighborhood safety, school supportiveness) factors across family, school, and neighborhood environments (see Gonzalez et al., 2021; Hoffman et al., 2019 for additional measure details and psychometrics). We included measures repeated at least three times across the first four time points of the study to ensure sufficient data to estimate within-person change over time.

Family environment

Parents and their children reported their perceived degree of family conflict using the Family Environment Scale (FES; Moos & Moos, 1976). The family conflict subscale includes nine true/false items, such as “We fight a lot in our family.” Items are summed such that higher scores indicate greater conflict. Parent-report ($\alpha_{\text{male}} = .66$; $\alpha_{\text{female}} = .66$) and adolescent-report ($\alpha_{\text{male}} = .67$; $\alpha_{\text{female}} = .69$) were treated as distinct variables to account for differences in perceptions of conflict and to minimize single-informant bias.

Adolescents also completed the Child Report of Parental Behavior Inventory (CRPBI), which includes a parental acceptance subscale (Schaefer, 1965). This subscale includes five items rated on a scale from 0 = not like him/her to 3 = a lot like him/her. Children are asked to report on their primary caregiver (i.e., the caregiver participating in the study with them; $\alpha_{\text{male}} = .70$; $\alpha_{\text{female}} = .71$) as well as their secondary caregiver ($\alpha_{\text{male}} = .77$; $\alpha_{\text{female}} = .78$), if applicable. We computed an average across primary and secondary caregiver scores, with higher scores indicating greater parent acceptance.

Adolescents completed the Parental Monitoring Scale (Karoly et al., 2016; Zucker et al., 2018), which includes five items about the degree to which parents know where their child spends their time and who they are with (e.g., “How often do your parents/guardians know where you are?”). Each item is rated on a Likert scale from “1 = Never” to “5 = Almost always or always,” with higher scores indicating higher parental monitoring ($\alpha_{\text{male}} = .46$; $\alpha_{\text{female}} = .43$).

To index family economic hardship, parents responded to 7 yes/no questions from the demographic interview about the ability to pay for food, rent, utility bills, seek necessary medical care, etc. We created a sum score such that higher values represent greater economic hardship ($\alpha_{\text{male}} = .89$; $\alpha_{\text{female}} = .88$).

Neighborhood environment

At each time point, parents and their children each responded to items from the PhenX Neighborhood Safety protocol (Zucker et al., 2018). Parents responded to 3 items, and adolescents responded to one item (“My neighborhood is safe from crime.”) on a scale from “1 = Strongly Disagree” to “5 = Strongly Agree.” Higher values indicate higher levels of perceived safety ($\alpha_{\text{male}} = .88$; $\alpha_{\text{female}} = .88$). Parent-report and adolescent-report were treated as distinct variables to account for differences in perceptions of safety and minimize single-informant bias.

School environment

At each time point, adolescents completed the School Risk and Protective Factors Survey, a 12-item measure of perceptions of the school environment and involvement (Arthur et al., 2007). The school environment subscale includes six items, such as “I get along with my teachers” and “I feel safe at my school,” rated on a 4-point Likert-type scale. Higher values indicate higher levels of perceived support in the school environment ($\alpha_{\text{male}} = .55$; $\alpha_{\text{female}} = .55$).

Psychopathology

At each time point, parents completed the Child Behavior Checklist (CBCL; Achenbach & Rescorla, 2001). Symptoms and behaviors were rated on a 3-point Likert-type scale: “0 = Not True,” “1 = Somewhat or Sometimes True,” and “2 = Very True or Often True.” Example items include, “Breaks rules at home, school, or elsewhere” and “Too fearful or anxious”. The CBCL has demonstrated strong psychometric properties in the ABCD Study (see Stewart et al., 2024). We used raw scores from the internalizing and externalizing symptom subscales at each time point. Raw scores were preferred because they capture the full range of symptom variability, allowing for a more sensitive assessment of changes over time within individuals. Since our primary interest was examining within-person changes rather than comparing individuals to normative age or gender-based groups, raw scores provided a more accurate reflection of symptom fluctuations without the adjustments inherent in standardized scores.

ANALYTIC PLAN

All analyses were conducted in R (v4.3.0; R Core Team, 2023). Means and standard deviations by age for all key psychopathology and environmental variables are available in Tables S1 and S2. Correlations between psychopathology and the environmental predictors are available in Figures S1 and S2. First, the data were transformed to align by age rather than time point (e.g., internalizing

symptoms at age 11 vs. at the 1-year follow-up) to more closely examine the associations between the environmental factors and psychopathology as a function of age. Second, fixed effect regression models were estimated using the “fixest” package (Bergé, 2018) to investigate the age-varying associations between adolescent psychopathology and environmental factors. Fixed effects regressions were ideal for the current study because they focus exclusively on understanding within-person variability, thus reducing the potential impact of selection effects, shared risk factors, and confounding variables, and offering a stronger test of environment-psychopathology associations than traditional between-individual models (Allison, 2009). We chose fixed effects regression models because they control for all time-invariant characteristics, thereby minimizing confounding from stable individual factors, such as genetic predispositions or early life experiences. This approach allows us to rigorously test our hypotheses by isolating the impact of time-varying predictors on changes in symptomatology. This approach also accounts for time-invariant characteristics at the individual level, including factors related to site and familial dependencies (e.g., shared sibling influences). Importantly, fixed effects models also handle missing data efficiently by using all available within-person observations, as long as each individual has at least two time points of data. This maximizes the use of the available data without requiring imputation or case deletion. Focusing exclusively on within-person change, our analysis sought to understand whether environmental factors predicted changes in externalizing and internalizing symptomatology from year to year. This is a fundamentally different question than one that asks whether individuals exposed to environmental risk exhibit higher internalizing symptoms than individuals not exposed to environmental risk (e.g., the type of question that is typically answered in between-individual models).

Unconditional models with age as the only predictor were first estimated to examine within-individual changes in externalizing and internalizing symptoms. Conditional models, including all of the environmental factors as predictors, were next estimated to determine how risk and protective factors present in the family, school, and neighborhood context predict changes in symptoms. Given that our focus was on understanding the independent, age-varying associations between each environmental factor and psychopathology within individuals, all environmental variables (i.e., family conflict, parental monitoring, parental acceptance, financial hardship, neighborhood safety, and school support) were included as time-varying predictors in the same model to assess their unique contributions to changes in internalizing and externalizing symptoms over time. Age was coded such that 9 years old was the reference point (coded as 0), with subsequent ages coded incrementally (e.g., age 10 as 1, age 11 as 2, etc.). This coding scheme allowed us to test both linear and nonlinear (e.g., age²) effects. The regression equation used was:

$$Y_{it} = \beta_0 + \beta_1(\text{Family Conflict})_{it} + \beta_2(\text{Parental Monitoring})_{it} \\ + \beta_3(\text{Parental Acceptance})_{it} + \beta_4(\text{Financial Hardship})_{it} \\ + \beta_5(\text{Neighborhood Safety})_{it} + \beta_6(\text{School Support})_{it} + \beta_7(\text{Age})_{it} \\ + \beta_8(\text{Age}^2)_{it} + u_i + e_{it}$$

where Y_{it} represents the internalizing or externalizing symptoms for individual i at time t , β denotes the fixed effect for individual u_i , and e_{it} is the error term.

Finally, conditional models with each of the predictors interacted with age (e.g., family conflict \times age, family conflict \times age²) were estimated to determine whether the strength of these associations varied as adolescents aged. Each model was estimated separately for male and female adolescents to examine potential sex differences in these associations. The models were estimated for each sub-sample (split by sex assigned at birth) to ensure that the within-individual estimates were unconfounded by between-individual variance (Shaver, 2019). All significant predictor \times age/age² interactions were further probed using the “marginaleffects” (Arel-Bundock et al., 2023) package. Specifically, we examined whether the strength of the association changed as a function of time (i.e., slope) and identified the ages at which the predictors had a significant effect.

RESULTS

Patterns of change in internalizing and externalizing symptoms

The results of the unconditional fixed effect models examining within-individual changes in internalizing and externalizing symptoms from ages 9 to 13.5 indicated that both symptoms significantly decreased among male adolescents (Figure 1a,b, Table 1). For female adolescents, externalizing symptoms decreased and internalizing symptoms increased.

Main effects of family factors

Results of the conditional fixed effect models examining the environment-symptomology associations indicated that higher financial hardship and parent-report of family conflict predicted higher internalizing and externalizing symptoms in both female and male adolescents.

Age-varying effects of family factors

Results of the conditional models examining family-age interactions indicated that some associations varied significantly across adolescence (Tables S3 and S4).

For male adolescents, the association between financial hardship and externalizing symptoms increased initially, then decreased and became non-significant by age 11.5 (Figure 2, Table S5). The association between family conflict and externalizing symptoms among male adolescents

also significantly varied over time (Figure 3, Table S4), with the strength of the association slightly reducing between ages 9 and 11 before strengthening in later years (Table S5). There were no significant age-varying effects for female adolescents.

Main effects of neighborhood and school factors

Higher neighborhood safety and school support predicted lower internalizing and externalizing symptoms among female and male adolescents (Table 2). The strength of these associations did not vary over time for either female (Table S3) or male adolescents (Table S4).

DISCUSSION

Examining how environmental influences on adolescent mental health change over time is essential, as it can illuminate periods of heightened sensitivity where specific risk or protective factors exert significant impacts. The present study investigated the age-varying associations between psychopathology and environmental risk and protective factors among adolescents, focusing on the roles of family, neighborhood, and school contexts. Consistent with previous studies (Barch et al., 2021; Briant et al., 2025; Yoon et al., 2023), distinct patterns of change in internalizing and externalizing symptoms dependent on sex were observed. Male adolescents exhibited significant decreases in both internalizing and externalizing symptoms, whereas female adolescents showed a decrease in externalizing symptoms but an increase in internalizing symptoms. Numerous theories emphasize that developmental outcomes are influenced by the interactions between an individual and their immediate environment (e.g., family) as well as the distal ecological systems surrounding them (e.g., neighborhoods) (Bronfenbrenner & Morris, 2007; Cicchetti & Lynch, 1993; Cicchetti & Rogosch, 2002). By simultaneously considering the characteristics of family, neighborhood, and school environments, the current study revealed their nuanced associations with internalizing and externalizing symptoms over time.

Our findings highlight the crucial role of family dynamics in the development of mental health problems among female and male adolescents. Notably, consistent with past research (Santini et al., 2021), higher family conflict and financial hardship were associated with an increase in both symptom types for both sexes. Tests of the age-varying effects of family factors indicated there were sex-specific interactions. For male adolescents, the negative association between financial hardship and internalizing symptoms diminished through adolescence, while the strength of the relationship between family conflict and externalizing symptoms decreased initially but ultimately strengthened after early adolescence. These findings underscore the importance of addressing socioeconomic

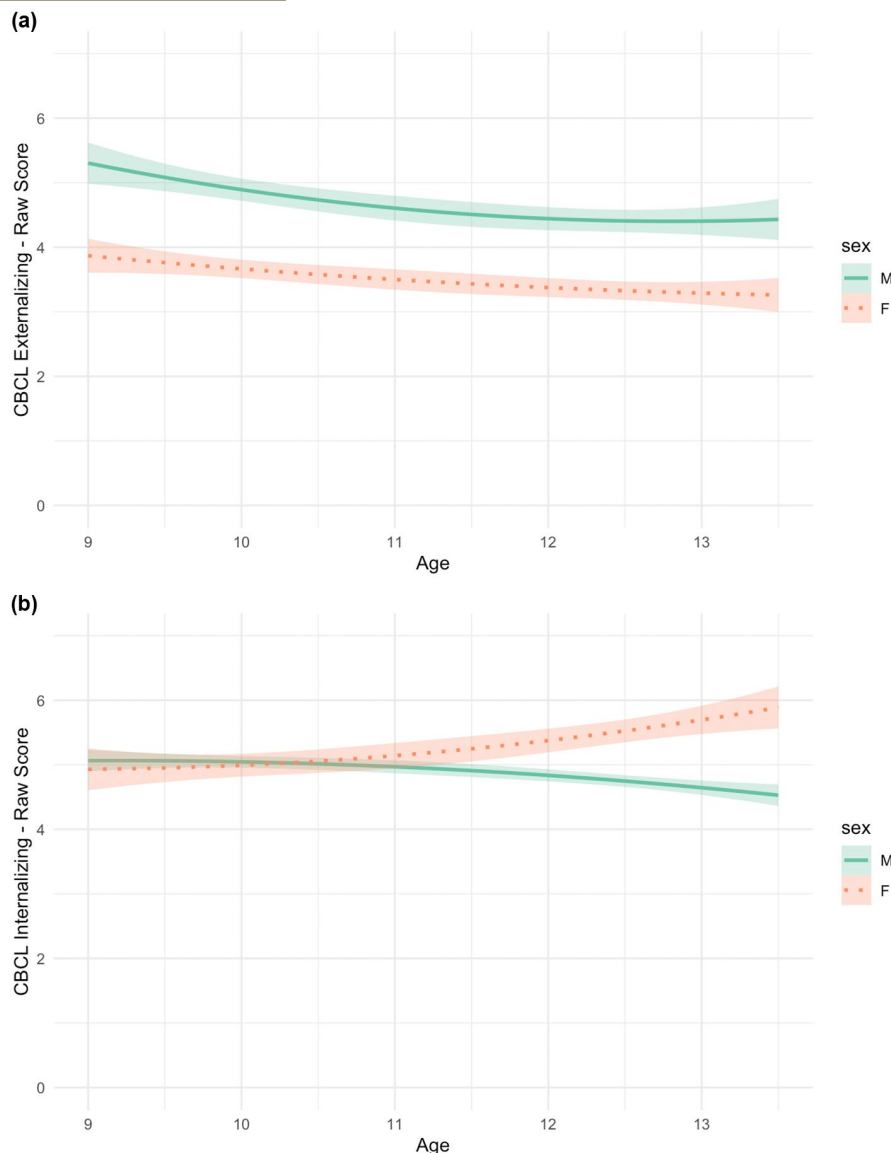


FIGURE 1 Internalizing (a) and externalizing (b) symptoms in female ($n = 5657$) and male ($n = 6166$) adolescents by age.

challenges in interventions aimed at promoting adolescent mental health, especially for female youth. Taken together, our results suggest that the relationship between internalizing and externalizing symptoms and different facets of the family and parent-child relationship is persistent but varies in strength over time, broadly consistent with findings from recent studies (e.g., Hochgraf et al., 2021; Mak et al., 2021; Morelli et al., 2022). Further longitudinal research is needed to comprehensively assess the contribution of different features of the family environment to adolescent mental health over time.

Beyond family factors, our study also found that higher neighborhood safety and school support consistently predicted lower internalizing and externalizing symptoms among adolescents, irrespective of sex. Intriguingly, the strength of these associations did not significantly vary over time, suggesting that environmental conditions more distal to adolescents can provide stable protective effects

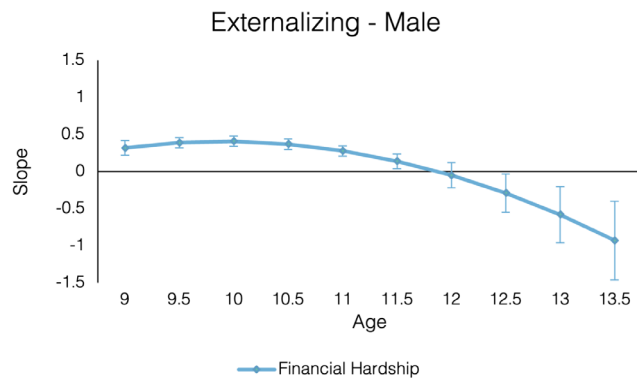
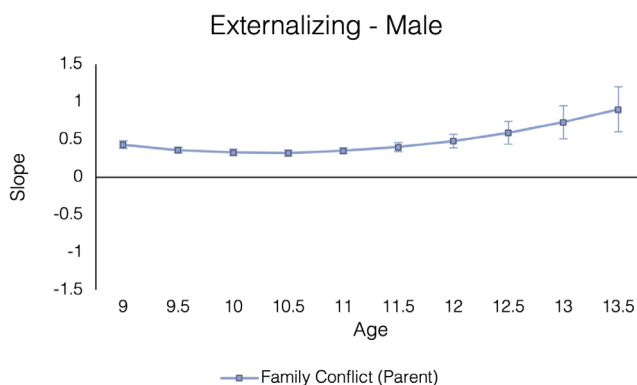
against symptom development. Indeed, past research has highlighted the unique contribution of neighborhood and school conditions to externalizing and internalizing symptoms, above and beyond the effects of parenting (Aldridge & McChesney, 2018; Conley et al., 2023; Mrug & Windle, 2010). Our findings emphasize that multiple environmental contexts influence adolescent mental health. Continuing to clarify how timing and specific environmental factors interact to shape adolescent mental health outcomes is critical to identifying periods of heightened sensitivity when their protective or risk influence may be particularly impactful.

Several limitations should be noted. First, the relatively large sample size provided greater statistical power to detect small, though potentially spurious, effects. However, it is important to note that previous studies with smaller sample sizes may have overestimated effect sizes or lacked sufficient power to detect small effects (Dick et al., 2020) that have

TABLE 1 Unconditional fixed effect models predicting within-individual changes in externalizing and internalizing symptoms among female and male adolescents.

	Internalizing					<i>p</i>	Externalizing					<i>p</i>
	β	<i>b</i>	SE	95% CI	β		<i>b</i>	SE	95% CI			
Female (<i>n</i> = 5657)												
Model 1												
Age	.04	0.10	0.01	0.08	0.13	<.001	−.02	−0.03	0.01	−0.05	−0.01	.004
Model 2												
Age	.04	−0.06	0.05	−0.15	0.04	.23	−.02	−0.13	0.04	−0.21	−0.05	.001
Age ²	.02	0.02	0.00	0.01	0.02	<.001	.01	0.01	0.00	0.00	0.02	.01
Male (<i>n</i> = 6166)												
Model 1												
Age	−.03	−0.06	0.01	−0.09	−0.04	<.001	−.03	−0.08	0.01	−0.11	−0.06	<.001
Model 2												
Age	−.03	0.00	0.04	−0.08	0.08	.97	−.04	−0.28	0.04	−0.36	−0.20	<.001
Age ²	−.01	−0.01	0.00	−0.01	0.00	.10	.02	0.02	0.00	0.01	0.03	<.001

Note: β , standardized regression coefficient; *b*, unstandardized regression coefficient. Significant effects ($p < .05$) are bolded.

**FIGURE 2** Associations between financial hardship and externalizing symptoms in male adolescents (*n* = 6166) by age. The figure depicts the predicted unstandardized regression coefficients and 95% confidence intervals for financial hardship (solid blue line) predicting externalizing symptoms at each age.**FIGURE 3** Associations between family conflict and externalizing symptoms in male adolescents (*n* = 6166) by age. The figure depicts the predicted unstandardized regression coefficients and 95% confidence intervals (solid purple line) for family conflict predicting externalizing symptoms at each age.

clinical or practical significance (Rosenthal et al., 2000). Second, several important environmental and experiential factors were omitted due to inconsistencies in data availability across time points (e.g., peer relationships), which may result in overestimating the environmental effects considered in this study. Most notably, negative life events (e.g., familial losses, crime victimization), which play a critical role in shaping mental health outcomes, were not assessed during the baseline data collection phase. As a result, we could not account for the initial level of exposure to these stressors, which may have predated changes in internalizing and externalizing symptoms. Additionally, absent from our study are cultural values, experiences of discrimination, and community resources, all of which can vary significantly by race and ethnicity and alter the influence of family, neighborhood, and school environments on psychopathology (Neblett, 2023). A dual-informant approach (parent and youth) was used to assess the environmental variables, enhancing our findings' reliability and validity, as it allows for a more comprehensive understanding of the environmental factors and psychopathology outcomes. Nonetheless, it is important to acknowledge that biases can still influence self-reports and may not fully capture objective environmental conditions. To better assess the complex interplay between environment and mental health outcomes, future studies should strive to include a broader range of relevant environmental and experiential factors from the outset.

Third, while our fixed effects models are well-suited for addressing within-person variability and controlling for all time-invariant characteristics, they do not account for random variation in growth trajectories across individuals. Thus, our models may overlook important individual differences in how adolescents develop over time. Future research could benefit from using mixed-effects modeling, which would allow for the simultaneous modeling of both fixed and random effects to capture these individual differences

TABLE 2 Conditional fixed effect models predicting within-individual changes in externalizing and internalizing symptoms among female and male adolescents.

	Internalizing						Externalizing					
	β	<i>b</i>	SE	95% CI		<i>p</i>	β	<i>b</i>	SE	95% CI		<i>p</i>
Female (<i>n</i> = 5657)												
Age	.05	0.09	0.10	−0.10	0.28	.35	−.01	−0.10	0.08	−0.26	0.06	.23
Age ²	.002	0.002	0.01	−0.02	0.03	.90	.01	0.01	0.01	−0.01	0.03	.53
Family conflict-parent	.07	0.21	0.03	0.14	0.28	<.001	.11	0.28	0.03	0.23	0.34	<.001
Family conflict-youth	.004	0.01	0.03	−0.05	0.08	.71	.02	0.05	0.03	−0.01	0.10	.08
Parent acceptance-youth	.01	0.24	0.23	−0.22	0.69	.31	.01	0.09	0.20	−0.29	0.48	.64
Parental monitoring-youth	.01	0.09	0.13	−0.17	0.34	.51	−.01	−0.07	0.11	−0.29	0.14	.51
Financial hardship	.06	0.33	0.06	0.21	0.45	<.001	.04	0.18	0.05	0.08	0.28	<.001
Neighborhood safety-parent	−.02	−0.10	0.07	−0.25	0.05	.18	−.02	−0.09	0.06	−0.21	0.04	.18
Neighborhood safety-youth	−.02	−0.11	0.06	−0.21	0.003	.06	−.02	−0.08	0.05	−0.18	0.01	.07
School supportiveness-youth	−.02	−0.04	0.02	−0.08	0.0001	.05	−.01	−0.02	0.02	−0.06	0.02	.27
Male (<i>n</i> = 6166)												
Age	.02	0.04	0.03	−0.02	0.09	.21	−.02	−0.15	0.09	−0.33	0.02	.09
Age ²	−	−	−	−	−	−	.01	0.01	0.01	−0.01	0.03	.42
Family conflict-parent	.09	0.24	0.03	0.18	0.30	<.001	.12	0.36	0.03	0.30	0.42	<.001
Family conflict-youth	.01	0.03	0.03	−0.02	0.09	.24	.02	0.08	0.03	0.03	0.13	.004
Parent acceptance-youth	−.005	−0.08	0.18	−0.44	0.27	.64	−.01	−0.16	0.18	−0.53	0.20	.37
Parental monitoring-youth	−.01	−0.08	0.10	−0.28	0.13	.46	−.01	−0.17	0.11	−0.38	0.04	.11
Financial hardship	.08	0.45	0.06	0.33	0.56	<.001	.06	0.35	0.06	0.23	0.46	<.001
Neighborhood safety-parent	−.03	−0.17	0.07	−0.31	−0.04	.01	−.02	−0.16	0.07	−0.29	−0.02	.03
Neighborhood safety-youth	−.01	−0.03	0.05	−0.12	0.06	.55	.00	−0.02	0.05	−0.12	0.07	.61
School supportiveness-youth	−.03	−0.06	0.02	−0.09	−0.02	.002	−.03	−0.07	0.02	−0.11	−0.03	<.001

Note: β , standardized regression coefficient; *b*, unstandardized regression coefficient. Significant effects ($p < .05$) are bolded.

and provide a more nuanced understanding of developmental trajectories.

Fourth, while the study provides a foundation for understanding how environmental factors affect different symptoms, it does not directly assess the comorbidity between internalizing and externalizing symptoms. Though each of our models predicting externalizing symptoms accounts for the contemporaneous effect of internalizing symptoms and vice versa, further research that examines the relation between environmental factors and patterns of comorbidity (e.g., through person-centered or clustering models) is needed to improve our understanding of the complexities of adolescent mental health. For example, Briant et al. (2025) characterized five patterns of co-developing internalizing and externalizing symptoms in the ABCD Study, which were associated with distinct risk and protective factors. In this way, researchers can better identify underlying risk factors that may increase or decrease the likelihood of different comorbidity profiles.

Finally, the current study's insights into the effects of family dynamics, neighborhood safety, and school support on adolescent mental health emphasize the necessity for future research that further explores interactions among these factors over time and across different developmental

stages. Although our fixed effects models provided a rigorous test of the independent associations between each environmental factor and psychopathology, they did not examine potential interactions among these factors. Future research should consider using models that explicitly test how different environmental influences may interact with one another to shape mental health trajectories. Additional work that utilizes longitudinal mixed-methods or structural equation modeling to disentangle the complex interactions between different environmental factors and their cumulative or antagonistic effects on adolescent mental health may help us better understand how these influences interact and potentially offset or amplify each other. These analytic approaches may also facilitate the examination of nonlinear associations between risk/protective factors and mental health, which have recently been demonstrated in the ABCD Study (Oshri et al., 2024).

Despite these limitations, the findings from the current study have important implications for parents, educators, policymakers, and professionals as they develop strategies to support adolescent mental health. For example, our findings suggest that instead of solely focusing on a single developmental context, a more developmentally-accordant approach would be to evaluate and target risk and protective

factors across families, neighborhoods, and schools. Such an approach would better align with adolescents' lived experiences, where various factors simultaneously shape their outcomes. Furthermore, recognizing that the impact of certain factors (e.g., family conflict, financial hardship) varies with age and sex, interventions should be developmentally tailored. Additionally, our findings indicate sex-specific associations between environmental factors and mental health, suggesting that interventions could be further tailored based on the adolescents' sex. For example, increasing support for coping with internalizing symptoms, especially during transitions into late adolescence, and addressing the sources and effects of family conflict and financial hardship may be prioritized for female adolescents. For younger male adolescents, mitigating the impacts of financial hardship might be more pressing, whereas for older male adolescents, addressing the effects of family conflict could be more critical. Moreover, recognizing the stable, protective effects of neighborhood safety and school support for male adolescents suggests that consistent efforts in these areas could universally benefit their mental health.

We note that comprehensive strategies may be limited due to challenges presented by a lack of resources (i.e., funding, time, personnel) and stakeholder coordination (e.g., parents, teachers, community leaders). To overcome these limitations, it may be necessary to prioritize flexible interventions that address risk or promote strengths across two or three environmental domains. For example, policies and funding supporting community-based approaches involving free mental health services and family support programs can effectively create safe and supportive adolescent spaces. This comprehensive approach aligns more closely with the real-life experiences of adolescents, where various factors simultaneously shape their mental health outcomes. Incorporating these practical implications into existing programs and policies could significantly enhance the effectiveness of efforts aimed at preventing and addressing mental health issues among adolescents.

Overall, this study highlights the complexity of adolescent mental health and the need for continued research that acknowledges the evolving contexts of adolescents' lives. By exploring the nuanced relationships among family dynamics, neighborhood safety, and school support, our findings illuminate how these contexts collectively influence trajectories of internalizing and externalizing symptoms in adolescents, revealing significant sex differences and age-varying effects. Such insights are critical for developing targeted interventions sensitive to the timing and nature of these environmental influences, enhancing the potential for mitigating risk and bolstering protective factors during critical periods of adolescent development. By refining our understanding of how specific environmental factors and their interactions affect adolescents at different stages of development, we can better tailor interventions and policies to meet the diverse needs of this population, ultimately contributing to more effective support systems and healthier developmental trajectories.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are openly available in the National Data Archive at <https://DOI.org/10.15154/z563-zd24>.

PATIENT CONSENT STATEMENT

All participants provided written assent, and parent/guardian consent was acquired.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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