



Anger and associated risk and protective factors among rural American adolescents: Implications for violence prevention

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ABSTRACT

Background: Adolescent violence in the United States is a prevalent public health problem and is understudied in rural settings. Anger is a significant risk factor for adolescent violence. To better craft adolescent violence interventions, it is important to examine anger and identify its most significant associated factors.

Aims: This study examined (1) self-reported anger changes over time for rural American adolescents; and (2) structural, community, interpersonal, and individual level factors that may contribute to anger.

Methods: We analyzed self-reported survey data from West Virginian middle schoolers ($N = 2861$) with anger as the outcome. Data was collected twice yearly from October 2020 through April 2023. Independent variables included perceptions of inequality, individual socioeconomic status (SES), neighborhood characteristics, family structure, support from adults at home and school, and harsh parenting.

Analysis: Generalized estimating equation Poisson regression models for main effects and gender interaction were used. Parameter estimates were exponentiated and interpreted as Rate Ratios (RR). Self-reported gender was an effect modifier.

Results: Significant main effects included perceived inequality ($RR = 0.98$, 95 % CI = 0.97–0.99), SES ($RR = 0.99$, 95 % CI = 0.98–0.99), supportive adults at school ($RR = 0.99$, 95 % CI = 0.98–0.99), primary caregiver support ($RR = 0.99$, 95 % CI = 0.98–0.99), and harsh parenting ($RR = 1.10$, 95 % CI = 1.05–1.05). Significant gender interaction terms included perceived harsh parenting ($RR = 0.98$, 95 % CI = 0.97–0.99) and supportive adults at school ($RR = 1.01$, 95 % CI = 1.00–1.02) for ‘other’ genders (i.e., participants identifying as neither boy nor girl) compared to boys.

Conclusions: Findings underline the importance of examining rural adolescent anger development and associated risk factors for designing prevention approaches to curb downstream violent behavior.

1. Background

Adolescent violence is a prevalent public health issue in the United States (U.S.). Between 2019 and 2020 firearm-related homicides increased by 39 % for Americans aged 10–24 years; firearm suicide rates also increased by 15 % in the same age group (Harper et al., 2023; Kegler et al., 2022). Prevalence of dating violence among American adolescents ranges from 2.4 %–12.5 % (Kann et al., 2018; Krause et al., 2023).

Rural adolescent violence is far less studied compared to violence in urban settings. Rural youth are twice as likely as urban youth to experience physical dating violence (Emezue et al., 2021; Sianko et al., 2019). Adolescent handgun carrying is also more prevalent in rural U.S. communities, which have seen the largest increase in the prevalence of adolescent handgun carrying compared to urban and suburban communities, from 5.2 % in 2003 to 12.4 % in 2019 (Schleimer et al., 2023).

To combat rural violence it is imperative to examine its myriad

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upstream risk factors. While adolescent violence has several key drivers, this article focuses on adolescent anger as a primary risk factor, as anger directly precedes 90 % of aggressive acts and is directly associated with violence and aggression in rural youths (Kassinove and Sukhodolsky, 2018; Swaim et al., 2006). Adolescent anger has also been associated with bullying, homicide, aggression, and substance use (Swaim et al., 2006; Alaka Mani et al., 2018; Pullen et al., 2015).

In order to better craft anger and violence interventions for rural adolescents from an upstream, primary prevention perspective, it is imperative to identify the most significant and impactful factors associated with anger. This will allow the public health community to better tailor anger interventions for all rural youth.

Risk factors for adolescent anger are found at each level of the socioecological model (Bronfenbrenner, 1977). At the structural level, lower socioeconomic status (SES) and higher inequality are associated with greater levels of anger, violence, and negative affect (Gallo and Matthews, 2003; Hao et al., 2022). It is unknown, however, how these concepts relate to anger among rural adolescents or how subjective measures may affect findings. Given existing literature, we might presume to observe higher self-reported anger levels among participants reporting lower perceived SES and higher perceived inequality (Gallo and Matthews, 2003; Hao et al., 2022). At the environmental level, neighborhood characteristics such as higher neighborhood safety, collective efficacy, and neighborhood ties have been associated with lower anger in adolescent populations (Hackman et al., 2019; Hackman et al., 2012). We may hypothesize similar findings in our current sample. Factors at the interpersonal level, including harsh parenting and social support, are perhaps the most studied and discussed factors relating to both adolescent anger and violence (Wilkins et al., 2023; Brody et al., 2014; Taraban et al., 2019). Authoritarian parenting styles, characterized by a lack of affection and seeking to control adolescent attitudes, have direct relationships to adolescent anger and aggression (Dickson et al., 2019; Pinquart, 2017). We hypothesize similar results for the current sample of rural Appalachian adolescents.

While all the above factors have been studied, gender differences in their relationship to anger have been far less observed. While some prior research has found no significant differences in anger levels between genders, the majority of research has identified male gender as a significant risk factor for adolescent anger and aggression (Swaim et al., 2006; Edwards et al., 2017; Lamb et al., 2003; Mroczkowski et al., 2021).

Data on anger in rural American adolescent populations is lacking. While adolescent anger as an outcome has been studied internationally and among urban U.S. populations, it is rarely studied in rural American communities. No recent analysis exists on the gender differences in anger and/or change in anger over time among rural Appalachian adolescents. Additionally, few studies have examined anger and its related factors through a socioecological lens. This study will consider the myriad structural, environmental, interpersonal, and individual level factors that are known or speculated to be associated with anger and incorporate them into a single model and examine their associations with anger scores over time.

Theoretical Background:

Agnew's General Strain Theory (GST) supports our selection of covariates and our investigation of factors relating to the socioecological model. GST acknowledges a link between anger and delinquent behavior such as violence. Later work by Agnew recognized that only some individuals turn to delinquent behaviors because of their anger stemming from negative relationships. Different types of strain may play an important role. Agnew stated, "Strains are said to be most likely to result in crime when they are (1) seen as unjust, (2) seen as high in magnitude, and (3) associated with low social control" (Agnew, 2001). Negative perceptions of the covariates discussed above are salient examples of high-magnitude, unjust strains associated with low social control that may exacerbate anger already felt by adolescents. This concept emphasizes the importance of acknowledging a myriad of covariates as

they relate to downstream criminal/delinquent tendencies. Economic deprivation, for example, has been defined as a type of strain when examining delinquency through the lenses of GST (Sigfusdottir et al., 2012). As such, we may be able to identify a potential need for tailored interventions not only for specific demographics (e.g., rural/white adolescent populations), but for specific strains that lead to anger, such as perceived inequality and low SES.

GST was revised by Agnew in 1985 to address, in part, middle-class adolescent delinquency (Agnew, 2012; Agnew, 1985). The revised GST asserted that crime is caused by "the inability to escape from painful or aversive conditions." (Agnew, 2012; Agnew, 1985) Typically, there is little that adolescents can do to escape their current material conditions and lived experiences if those experiences are negative, thus potentially contributing to anger and downstream delinquency (Agnew, 2012).

Research Questions:

This study aims to assess the following research questions.

1. How does self-reported anger change over time for rural adolescents?
2. What subjective structural, interpersonal, and individual level factors have the strongest relationship to anger for rural adolescents?
 - a. How does gender modify these relationships?

2. Methods

2.1. Participants

The present analyses are based on six waves of survey data from the Young Mountaineer Health Study (YMHS), a prospective cohort study involving a single cohort of students enrolled in 20 public middle schools across five West Virginia counties (Kristjansson et al., 2022). Students in this cohort were surveyed twice per year from grades six through eight. The baseline assessment occurred in Fall 2020 (sixth grade, typically 11–12 years old), and the final wave occurred in Spring 2023 (eighth grade, typically 13–14 years old) (Kristjansson et al., 2022). Response rates ranged from 74.2 % to 87.0 % across six waves of survey data, totaling 2861 unique participants.

Procedure.

Students responded to a confidential, computer-based survey using Qualtrics software (Kristjansson et al., 2022). Survey data collection was confidential, and protocols ensured anonymity of participants. No identifying information was collected. The Institutional Review Board (IRB) of West Virginia University approved all study protocols (#1903499093A001). A detailed study protocol description has been published elsewhere (Kristjansson et al., 2022).

Measures:

Dependent Variable.

Anger was measured using five items from the Symptom Checklist 90 (SCL-90) scale (Derogatis et al., 1976; Schmitz et al., 2000), asking students to share the frequency of their experienced anger within the past week, including: "I was easily annoyed or irritated."; "I experienced outbursts of anger that I could not control."; "I wanted to break or damage things."; "I had an argument with someone."; "I yelled at somebody or threw things." Response options ranged from 1 = "Never" to 4 = "Often." Scores from each item were summed to form a scale ranging from 5 (lowest anger) to 20 (highest anger) ($\alpha = 0.90$, indicating excellent reliability).

Independent Variables.

Systemic factors.

Relative Family Income (RFI) was used to assess adolescent perceived inequality compared to other students, and has been used in prior studies (Quon and McGrath, 2014; Kristjansson et al., 2013). The single item read "How well off financially do you think your family is in comparison to other families in West Virginia?". Response options were 1 = "Much better off" to 7 = "Much worse off". Perceived RFI was treated as time-variant.

Subjective individual SES was measured by the Family Affluence

Scale (FAS) (Corell et al., 2021; Hobza et al., 2017), with six items including questions such as “Does your family own a car or another motorized vehicle?” and “How many bathrooms (room with a bath/shower or both) are there in your home?”. Some response options were measured with 0 = “No” and 1 = “Yes”, while others ranged from 0 = “None/Never” to 3 = “Three/More than two”. Scores from each item were summed to form a scale ranging from 0 (low SES) to 13 (high SES). The FAS has been identified as an adequate self-reported measure of SES among adolescents and as a possible alternative measure of parental earned income (Corell et al., 2021). For the present analysis, the highest individual FAS score for each participant was treated as a constant across all six waves.

Environmental / Community factors.

Neighborhood characteristics were measured using three concepts: Community safety, neighborhood ties, and collective efficacy.

Perceived community safety was assessed using the “Safety from Crime” measure from Echeverria et al (Echeverria et al., 2004). This measure consisted of two items asking respondents to rank their agreement/disagreement with each statement: “I feel safe walking in my neighborhood/community during the evening”; “My neighborhood/community is safe from crime”. Response options ranged from 1 = Strongly agree to 5 = Strongly disagree. Scores were summed to form a scale ranging from 2 (high safety) to 10 (low safety) ($\alpha = 0.73$, indicating good reliability). Subjective measures of community safety have been utilized in prior studies (Echeverria et al., 2004; Mayne et al., 2022).

Perceived neighborhood ties were part of the “Community Protective Factor” module used in previous studies (Bernburg et al., 2009). This scale included six items headed with the question “How much does the following apply to your situation?” with response options ranging from 1 = “Strongly disagree” to 5 = “Strongly agree”. Items included “My parents/caregivers have friends that live close to our home”; “My parents/caregivers know many of our neighbors by name”; “My parents/caregivers sometimes visit some of our neighbors”; “My neighbors sometimes visit my parents/caregivers”; “Sometimes we borrow things from our neighbors”; “Our neighbors sometimes borrow things from us”. Responses were summed to form a scale ranging from 6 (weak neighborhood ties) to 30 (strong neighborhood ties) ($\alpha = 0.91$, indicating excellent reliability).

Perceived collective efficacy was measured with five items from the validated subjective collective efficacy scale (Sampson et al., 1997), headed with the question “How likely or unlikely is it that your neighbors would do something about it if...?”. Items included: “the youths in the neighborhood were skipping school and hanging around”; “the youths were putting graffiti on houses in the area”; “the youths disrespected the adults”; “if a fight broke out in front of your house”; “somebody was breaking into a car or a house on your street”. Response options ranged from 1 = “Very unlikely” to 5 = “Very likely” and were summed to form a scale ranging from 5 (low collective efficacy) to 25 (high collective efficacy) ($\alpha = 0.95$, indicating excellent reliability). This subjective measure has been utilized in prior studies (Mayne et al., 2022; Fagan et al., 2014).

Interpersonal factors.

Family structure was categorized as “1: Lives with both biological parents” and “0: Other living arrangements”. As an approximate consistent measure, if ‘1’ was ever recorded, that was assumed constant among participants, otherwise it would be ‘0’.

Perceived social support from adults at school was assessed with five items from the first subscale of the School as a Protective Factor-Brief (SPF-Brief) instrument (Lilly et al., 2024), headed by the statement: “The following questions ask you to think about your school. Please select the response that best captures your experience.”: Each item is headed with “The adults at my school...” and is followed by “care about me”; “are fair and kind to me”; “are safe to be around”; “notice when I’m having a hard time and offer to help me”; “believe I can make the world a better place.” Response options ranged from 1 = “strongly disagree” to 5

= “strongly agree” and were summed to form a scale ranging from 5 to 25 ($\alpha = 0.91$, indicating excellent reliability).

Perceived primary caregiver support was measured in two steps. First, respondents were asked to identify their primary caregiver from a drop-down menu (for example; mother, father, stepmother, stepfather, etc.). Via computerized skip logic, the survey then automatically inserted the primary caregiver’s title (mother, father, etc.) into a five-item parental behavior inventory originally developed by Schaefer (Schaefer, 1965). The headlining question asked “Are the following statements not like your [primary caregiver], like your [primary caregiver], or a lot like your [primary caregiver]?”. The five items included “My [primary caregiver] is able to make me feel better when I am upset”; “my [primary caregiver] enjoys doing things with me”; “my [primary caregiver] cheers me up when I am sad”; “my [primary caregiver] gives me a lot of care and attention”; “my [primary caregiver] is easy to talk to.” Response options ranged from 1 = “not like” to 3 = “a lot like” and were summed to form a scale ranging from 5 to 15 ($\alpha = 0.91$, indicating excellent reliability).

Perceived harsh parenting was measured using a five-item Harsh Parenting scale (Arnold, and O’leary SG, Wolff LS, Acker MM., 1993), headed with the question: “When you do something wrong do any of your parents/caregivers do the following things?” and the five items included: “spank you”; “hit you with a belt, a paddle or something else?”; “Tell you to get out or lock you out of the house?”; “Raise their voice or yell?”; “insult or say mean things to you?”. Response options ranged from 1 = “Never” to 4 = “Always” and were summed to form a scale ranging from 4 (low harsh parenting) to 20 (high harsh parenting) ($\alpha = 0.77$, indicating good reliability).

Effect Modifier.

Self-reported gender was measured as a categorical variable and categorized as “Boy”, “Girl”, or “Other”. The “Other” category includes the survey answer options of “Gender non-confirming” and “Other (specify)”. For the present analysis, if at any wave a participant responded “Other”, their gender was coded as “Other” across all six waves of data.

Time.

Time was included in the analysis as a continuous variable ranging from 1 (baseline assessment) to 6 (final wave), with measurements taken approximately every six months.

Analysis:

We initiated our analyses with a breakdown of descriptive statistics by the full sample and stratified by gender in Table 1. Descriptive statistics included frequencies, valid percentages, means, and standard deviations. Next, due to a floor and ceiling effect within the dependent variable (i.e., a grouping of responses at the low end of the anger scale) and a violation of normality assumptions, we chose a generalized estimated equation (GEE) Poisson regression model with repeated measures. For the main effect model, we used a robust estimator assuming independent working correlation matrix. From the regression model, estimates were exponentiated and reported as Rate Ratios (RR). Time was treated as a continuous variable as it had the lowest Quasi Likelihood under Independence Model Criterion compared to time as a categorical variable. We then tested gender interaction terms with all covariates. The reported models included only significant interaction terms. Alpha is set to 0.05 unless otherwise stated. Pairwise deletion was generally used for missing data, as most data was expected to be missing at random or completely at random. For the GEE model analysis, all available pairs are used in estimating the working correlation matrix. Thus, as long as a participant contributed to at least one time point for the outcome, they are included in the analysis. Data were analyzed using SPSS Version 28.

3. Results

Table 1 shows descriptive statistics for this sample, comprised of 44.4 % girls, 42.9 % boys, and 12.7 % ‘other’ gender (neither boy nor

Table 1

Descriptive characteristics of rural American middle school students in the Young Mountaineer Health Study, West Virginia, 2020–2023 (*N* = 2861 unique cases).

	Time 1	Time 2	Time 3	Time 4	Time 5	Time 6
Categorical Variables at baseline: n (%) or mean (SD)						
Gender						
Girls	1202 (44.4)					
Boys	1162 (42.9)					
Other	345 (12.7)					
Family structure (Lives with both biological parents)	1442 (52.7)					
Family Affluence (Individual SES)	10.3 (2.2)					
Relative Family Income (economic inequality)	3.8 (1.3)					
Continuous Variable: Median (IQR)						
Anger Scale Score	8.0 (6.0)	9.0 (7.0)	9.0 (7.0)	9.0 (8.0)	9.0 (8.0)	9.0 (8.0)
Continuous Variables: Mean (SD)						
Neighborhood ties	19.4 (6.4)	19.7 (6.6)	19.6 (7.0)	19.7 (7.1)	19.3 (7.1)	19.5 (7.5)
Community safety	7.4 (2.4)	7.5 (2.5)	7.6 (2.4)	7.5 (2.4)	7.6 (2.4)	7.5 (2.5)
Collective efficacy	13.1 (7.5)	12.5 (7.3)	12.3 (7.1)	12.0 (6.9)	12.4 (7.0)	12.3 (7.1)
Supportive adults at school	21.0 (4.0)	20.2 (4.5)	19.4 (4.6)	18.8 (4.9)	18.6 (4.9)	18.2 (5.3)
Primary caregiver support	13.2 (2.4)	12.8 (2.7)	12.6 (2.8)	12.6 (2.9)	12.5 (2.9)	12.3 (3.2)
Harsh parenting	7.3 (2.3)	7.4 (2.5)	7.4 (2.6)	7.4 (2.7)	7.4 (26.7)	7.3 (2.9)

*Measures:

Anger: Self-reported anger on a scale of 5–20, with 20 as the highest anger score. Perceived family affluence: Scale of 0–13 with 13 as the highest family affluence. Perceived relative family income: Scale of 1–7 with 7 as the highest relative income. Perceived community safety: Scale of 2–10 with 10 as the highest perceived safety. Perceived neighborhood ties: Scale of 6–30 with 30 as the highest neighborhood ties. Perceived collective efficacy: Scale of 5–25 with 25 as the highest collective efficacy. Perceived support from adults at school: Scale of 5–25 with 25 as the highest support. Perceived support from primary caregiver: Scale of 5–15 with 15 as the highest support. Perceived harsh parenting: Scale of 4–20 with 20 as the highest level of harsh parenting.

girl). Of all participants in the study, 52.7 % lived with both biological parents. Our primary outcome, anger score, remained stable across all six timepoints with medians ranging from 8 to 9 on a scale of 5–20. RFI had a mean score of 2.79 (SD = 1.27) and FAS reflected a mean score of 10.28 (SD = 2.19).

The main effects model in Table 2 examines anger score (on a scale of 5–20) as the primary outcome. Time was not significantly associated with anger scores in this analysis; however, perceived SES (FAS, RR = 0.99, 95 % CI = 0.98–0.99) and inequality (RFI, RR = 0.98, 95 % CI = 0.97–0.99) each had significant inverse associations with anger over time. Significant interpersonal variables found to be inversely associated with anger included supportive adults at school (RR = 0.99, 95 % CI = 0.98–0.99), primary caregiver support (RR = 0.99, 95 % CI = 0.98–0.99), and family structure (RR = 0.94, 95 % CI = 0.92–0.97). Harsh parenting had a positive association with anger (RR = 1.05, 95 % CI = 1.05–1.05). Community and environmental variables with

Table 2

Generalized estimation equation (GEE) Poisson regression for main effects of independent variables on anger scores for rural American middle school students, West Virginia, 2020–2023 (*N* = 2594).

Outcome: Adolescent anger	RR	Lower 95 % CI	Upper 95 % CI
Gender			
Girl	1.15	1.12	1.19
Other	1.14	1.10	1.19
Boy (ref)	–	–	–
Family Structure			
Lives with both biological parents	0.94	0.92	0.97
Does not live with both biological parents (ref)	–	–	–
Time	1.01	1.00	1.01
Relative Family Income	0.98	0.97	0.99
Family Affluence	0.99	0.98	0.99
Neighborhood ties	1.00	1.00	1.00
Collective efficacy	1.00	1.00	1.01
Safety from crime	0.99	0.98	0.99
Supportive adults at school	0.99	0.98	0.99
Primary caregiver support	0.99	0.98	0.99
Harsh parenting	1.05	1.05	1.05

*Measures:

Anger: Self-reported anger on a scale of 5–20, with 20 as the highest anger score. Perceived family affluence: Scale of 0–13 with 13 as the highest family affluence. Perceived relative family income: Scale of 1–7 with 7 as the highest relative income. Perceived community safety: Scale of 2–10 with 10 as the highest perceived safety. Perceived neighborhood ties: Scale of 6–30 with 30 as the highest neighborhood ties. Perceived collective efficacy: Scale of 5–25 with 25 as the highest collective efficacy. Perceived support from adults at school: Scale of 5–25 with 25 as the highest support. Perceived support from primary caregiver: Scale of 5–15 with 15 as the highest support. Perceived harsh parenting: Scale of 4–20 with 20 as the highest level of harsh parenting.

significant positive relationships to anger included neighborhood ties (RR = 1.00, 95 % CI = 1.00–1.00) and collective efficacy (RR = 1.00, 95 % CI = 1.00–1.00), while perceived safety from crime reflected an inverse association with anger scores (RR = 0.99, 95 % CI = 0.98–0.99).

Table 3 includes interaction tests. Time was again not associated with the anger outcome. Significant gender interactions included harsh parenting (RR = 0.98, 95 % CI = 0.97–0.99) and supportive adults at school (RR = 1.01, 95 % CI = 1.00–1.02) for other genders relative to boys, and primary caregiver support (RR = 0.99, 95 % CI = 0.98–1.00) for girls relative to boys.

4. Discussion

This study had several impactful findings. Across six waves of data, we found no significant change in anger score among rural Appalachian early adolescents; although the statistical significance was 0.051, this could warrant future investigations in change of anger over time. While this analysis found no quantitatively significant change in anger score, it is possible that there could be a qualitative, meaningful difference in anger, if the SCL-90 indicated a clinical cutoff for “concerning” versus “not concerning” anger.

We also observed that both perceived RFI and perceived family affluence had inverse associations with anger. This underlines the importance of investigating the broader societal and structural forces that influence individual experiences that may contribute to anger development. Investigation of such structural forces may also lead to more advanced interventions that target factors on different levels of the

Table 3
Generalized estimation equation (GEE) Poisson regression with significant interaction terms for rural American middle school students, West Virginia, 2020–2023 (N = 2594).

Outcome: Adolescent anger	RR	Lower 95 % CI	Upper 95 % CI
Gender			
Girl	1.41	1.19	1.70
Other	1.21	0.99	1.47
Boy (ref)	–	–	–
Family Structure			
Lives with both biological parents	0.95	0.92	0.97
Does not live with both biological parents (ref)	–	–	–
Time	1.01	1.00	1.01
Relative Family Income	0.98	0.97	0.99
Family Affluence	0.99	0.98	0.99
Neighborhood ties	1.00	1.00	1.00
Collective efficacy	1.00	1.00	1.01
Safety from crime	0.99	0.98	0.99
Supportive adults at school	0.98	0.98	0.99
Primary caregiver support	0.99	0.99	1.00
Harsh parenting	1.06	1.05	1.07
Girl Gender (ref:boys) x Harsh Parenting	0.99	0.98	1.00
Other Gender (ref:boys) x Harsh Parenting	0.98	0.97	0.99
Girl Gender (ref:boys) x Primary caregiver support	0.99	0.98	1.00
Other Gender (ref:boys) x Primary caregiver support	1.00	0.98	1.01
Girl Gender (ref:boys) x Supportive adults at school	1.00	0.99	1.00
Other Gender (ref:boys) x Supportive adults at school	1.01	1.00	1.02

*Measures:

Anger: Self-reported anger on a scale of 5–20, with 20 as the highest anger score. Perceived family affluence: Scale of 0–13 with 13 as the highest family affluence. Perceived relative family income: Scale of 1–7 with 7 as the highest relative income. Perceived community safety: Scale of 2–10 with 10 as the highest perceived safety. Perceived neighborhood ties: Scale of 6–30 with 30 as the highest neighborhood ties. Perceived collective efficacy: Scale of 5–25 with 25 as the highest collective efficacy. Perceived support from adults at school: Scale of 5–25 with 25 as the highest support. Perceived support from primary caregiver: Scale of 5–15 with 15 as the highest support. Perceived harsh parenting: Scale of 4–20 with 20 as the highest level of harsh parenting.

socioecological model.

Significant gender differences were also found. Compared to boys, both girls and other-gendered adolescents reported significantly higher anger scale scores. This is surprising given previous literature showing that male gender is a risk factor for higher and more acute anger and aggression (Swaim et al., 2006; Edwards et al., 2017; Lamb et al., 2003; Kim et al., 2022). However, most previous studies were conducted in adult, international, or urban populations (Kim et al., 2022; Dey et al., 2014; Kucharska-Newton et al., 2014). It may also be important to distinguish between internalized and externalized anger when examining gender differences. Future studies measuring these two dimensions may find different gender variances.

Some effect modifiers were observed in our analysis. While harsh parenting had a significant and positive association with anger for all genders, harsh parenting had less of an impact on other-gendered adolescents compared to boys ($p < .001$). This further highlights the findings from Mills, et al (Mills et al., 2024), calling attention to the impact of harsh parenting on boys. It may be that parenting boys less harshly could have a bigger impact on reducing anger, particularly given that

male gender and anger are risk factors for aggression and violence in adulthood (Fahlgren et al., 2020).

This study had several limitations as well as some notable strengths. Firstly, the measure of anger utilized in this study is relatively simple and does not distinguish between State and Trait anger (Spielberger, 1988), which may have yielded different findings. Second, providing a separate measure for aggression versus anger would also lead to more generalizable results. Third, the self-reported aspect of this survey may be more accurate if paired with objective measures of certain factors such as inequality, SES, and neighborhood characteristics. Without objective measures, we have limited our analyses to only measure perceptions of adolescents' experiences rather than objective measures of these factors such as zip code data (measuring SES) or the Gini index (measuring equality). Fourth, the data for this study was collected in 20 schools in West Virginia which may not be generalizable to other rural environments. Finally, the issue of missing data may be considered a limitation. While there was a large cohort of students participating in this study, not all students completed all six waves of data. Due to the study IRB and collaboration with County Boards of Education and individual schools, participants were not followed with unique identifiers but rather invited to participate on the basis of their school's location and class attendance, and then self-reporting their student identification numbers, which may not always be accurate.

Notwithstanding the limitations, our study also has some notable strengths. We applied a rigorous study design in a rarely observed population; middle-school adolescents in rural Appalachia. We also employed self-reported, subjective measures for all factors we tested. This aspect of the study is a strength because we were able to measure exact perceptions of adolescents' feelings, behaviors and surroundings. Some subjective measures of factors like perceived inequality and SES have been found to be more closely related to health outcomes than objective measures of these factors (Quon and McGrath, 2014; Singh-Manoux et al., 2005).

This study emphasizes the importance of examining the myriad structural, community, interpersonal and individual-level factors that contribute to anger in adolescents, which is often a precursor to violent behavior. Addressing this public health issue through a socioecological lens is vital to help target upstream influences of anger and to craft interventions aimed at the primary prevention levels of anger and violence. Secondary and tertiary prevention approaches already exist for health outcomes associated with anger and violence, in the form of anger management workshops and regulating guns in schools, as well as disciplinary actions for angry, aggressive and violent students. However, there is a need for primary prevention strategies aimed at addressing the root systemic causes of anger and violence among adolescents. By identifying more comprehensive influences of anger such as perceived SES or inequality, interventions could be tailored that address these issues much earlier than most current approaches. Understanding the context and factors that influence adolescent anger development is essential for the advancement of effective primary prevention interventions to curb downstream violence.

CRedit authorship contribution statement

Rosalina Mills: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Christa L. Lilly:** Writing – review & editing, Methodology, Formal analysis, Data curation, Conceptualization. **Robin A. Pollini:** Writing – review & editing, Conceptualization. **Keith J. Zullig:** Writing – review & editing, Conceptualization. **Traci Jarrett:** Writing – review & editing, Resources, Conceptualization. **Alfgeir L. Kristjansson:** Writing – review & editing, Writing – original draft, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

The authors do not have permission to share data.

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