

Garnering Resilience in Traumatized Youth and Families (GRIT): A Pilot Feasibility Study

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Abstract

Adverse Childhood Experiences (ACEs) impact almost half of youth and approximately 60% of adults in the United States. ACEs exposure may result in self-dysregulation and lead to harmful biopsychosocial stress responses, including alcohol and substance use. Garnering Resilience in Traumatized youth and families (GRIT) is a community health worker (CHW)-delivered psychoeducational, health coaching intervention. GRIT uses 'Shift and Persist' strategies associated with improving self-regulation and mitigating cardiometabolic risks in adversity-impacted communities. We developed the GRIT intervention to systematically teach self-regulation skills using a health coaching model that incorporates cognitive behavioral therapy (CBT) principles in combination with heart rate variability biofeedback (HRV-BF). A feasibility pilot study of GRIT (n = 23 adolescent-caregiver dyads) is described.

Introduction

Adverse Childhood Experiences (ACEs) impact almost half of children and adolescents (Sacks & Murphey, 2018) and approximately 60% of adults in the United States (US) (Giano, Wheeler, & Hubach, 2020; Nelson et al., 2020). ACEs are potentially traumatic events that occur during childhood, and which may negatively impact long-term health (Felitti et al, 1998). ACEs were initially categorized as abuse, neglect, and family dysfunction (Anda et al, 2006; Felitti et al, 1998; Merrick et al., 2018; Panisch et al, 2020) but have since been expanded to include experiences of bullying, discrimination, and exposure to community violence (Children's Safety Network, 2024). ACEs exposure may result in self-dysregulation and lead to early initiation of alcohol and substance use and other harmful biopsychosocial stress responses, such as cardiometabolic risks (e.g., lowered heart rate variability [HRV], increased weight and blood pressure, and sleep disturbance) (Lloyd et al., 2022; Suglia et al., 2018; Nelson et al., 2020). Relative to children and adolescents with no ACEs, those with four or more ACEs have an odds ratio of 6.2 for early initiation of alcohol, defined as first use before age 14; those with five or more ACEs have an odds ratio of 9.1 for illicit drug initiation before the age of 14 (Nelson et al., 2020). These risks continue into adulthood with an odds ratio of 11 for cannabis use, 6.9 for alcohol use, 6.1 for cigarette use, and 10.2 for injected drugs, crack cocaine, or heroin use (Nelson et al., 2020). In our previous work exploring risk for future alcohol, cigarette, and cannabis use in a US sample of adolescents enrolled in the Adolescent Brain Cognitive Development (ABCD) Study®, we found significant positive associations between ACEs score at ages 9 - 10 years (baseline; 2016 - 2018) and risk for future alcohol ($b = 0.03$, $p < 0.001$), cigarette (including e-cigarette) ($b = 0.04$, $p < 0.001$), and cannabis use ($b = 0.06$, $p < 0.001$) at ages 12 - 13 years at year three follow-up (n = 10,213) (Blinded for Review, 2025).

Family relationships are known to have both positive and negative influences on adolescent substance use (Eiden, et al., 2020). Enhancing positive family relationships is particularly critical for children and adolescents impacted by ACEs, as safe, stable, and nurturing relationships have been identified as key to preventing or mitigating the harmful effects of ACEs exposure (CDC, 2024). Positive family relationships have been found to be protective factors against adolescent use of cigarettes, alcohol, and cannabis (Afifi, et al., 2022). Nurturing caregiving environments have been found to prevent alcohol and substance

misuse, promote prosocial behaviors, and reduce stress symptoms among adversity-impacted children and adolescents (Garner, Yogman, & Health, 2021). Emerging research also supports the moderating potential of co-regulation, particularly among adversity-impacted children and adolescents (herein referred to as youth), wherein caring adults (e.g., parents, supportive adults; herein referred to as caregivers), provide supportive relationships and structured environments and interactions to intentionally build youth self-regulation (Murray et al., 2023).

Including families in prevention interventions and fostering protective factors such as youth-caregiver trust, connection, and co-regulation may be key to preventing alcohol and cannabis initiation during adolescence (Community Preventive Services Task Force, 2023). However, existing prevention interventions for adolescents that incorporate caregivers have primarily been universal and school-based, have had challenges with caregiver participation, and have delivered sessions to caregivers and adolescents individually rather than jointly as a dyad (Newton et al, 2017). Additionally, many adolescent-focused prevention interventions lack internet-based delivery methods (Newton et al, 2017), which may increase accessibility by reducing barriers related to in-person sessions, such as a need for transportation to and from sessions (Blinded for Review, 2024). This paper describes a feasibility pilot of the ***Garnering Resilience in Traumatized youth and families*** (GRIT) intervention conducted with 23 adolescent-caregiver dyads. Our specific aims were to determine: 1) if GRIT can be delivered to adversity-impacted adolescents and their caregivers and 2) to what degree are adversity-impacted adolescents and their caregivers experience mental health, substance use, and family functioning challenges that warrant intervention.

Recognizing that the deleterious impacts of ACEs on health and wellbeing are lifelong, strengthens the potential for approaches that span across generations (Cowan et al., 2016; Rothenberg et al., 2002). Currently as a primary means of intervention, universal ACEs screening has been recommended in primary care health settings (Glowa et al., 2016). This has resulted in improved detection of ACEs exposure; however, interventions for intervening with adversity-impacted youth and their families (i.e., those at high risk for toxic stress due to having 4 or more ACEs or an ACE-related condition) once identified are lagging. GRIT was created to address this gap. GRIT leverages health coaching to regulate the stress response by facilitating self-regulation and healthy habit development recommended by the California Surgeon General (supportive relationships with caregivers, high-quality sufficient sleep, balanced nutrition, regular physical activity, mindfulness and meditation, and mental health care) in combination with heart rate variability biofeedback (HRV-BF) (Office of the Surgeon General, n.d.). This intervention specifically targets the intergenerational transfer (or nature) of TSA by focusing dyadically on both adversity-impacted youth and their caregivers.

Conceptual Framework: Shift and Persist Model

GRIT is guided by the Shift and Persist Model (Chen, McClain, & Miller, 2015). The Shift and Persist Model posits that chronic, unpredictable stress shapes youth perception of and responses to stress and offers specific strategies to mitigate these exposures. These strategies are facilitated through positive

role models who teach youth how to self-regulate their emotions through cognitive reappraisals, trusting others, and becoming future-oriented (Chen, McClain, & Miller, 2015; Chen & Miller, 2012). Since ACEs can lead to substance use and other mental health problems and can be transmitted intergenerationally, we propose that coaching focused on facilitating both self and co-regulation with youth and families most at risk will be efficacious in preventing substance use.

By improving adolescent self-regulation through co-regulation, the Shift and Persist Model suggests we can mitigate cardiometabolic risk (e.g., improve HRV) in youth experiencing chronic, unpredictable stress (Chen, McClain, & Miller, 2015). HRV refers to the fluctuations in time between consecutive heartbeat cycles (Malik, et al, 1996; Tiwari, et al, 2021). HRV assessment is regarded as a valid and practical tool for assessing psychological stress (Farhan, et al., 2023; Immanuel, et al, 2023), where lower HRV is consistently associated with higher psychological stress (Immanuel, et al, 2023). HRV-BF is a behavioral intervention that uses electronic feedback and paced breathing to increase HRV (Lehrer, et al, 2020). To our knowledge, existing evidence-based family interventions aimed at preventing toxic stress have yet to use psychoeducation in combination with HRV-BF (Goodrum & Prinz, 2022). While HRV-BF has been found to be an effective intervention for managing stress in adults (Goessl, Curtiss, & Hofmann, 2017; Lehrer, et al, 2020), it has yet to be rigorously studied in youth (Dormal, Vermeulen, & Mejias, 2021). Therefore, the feasibility of implementing GRIT is the focus of this pilot study.

Intergenerational Transmission of Stress, Adversity, and Trauma

Clearly defining key concepts is essential for contextualizing this present study. In this paper, trauma is defined as an event, series of events, or set of circumstances that an individual experiences as physically or emotionally harmful, and which may result in lasting adverse effects on the individual's functioning and mental, physical, emotional, or spiritual well-being (SAMHSA, 2014). We define ACEs as potentially traumatic events or circumstances that occur before the age of 18, which may negatively impact long-term health. Examples of potentially traumatic events range from childhood neglect and maltreatment to household dysfunction (e.g., domestic violence, parental separation/divorce, mental illness, substance use, and incarceration) as well as community-level exposures (e.g., community violence, discrimination, housing instability, and food insecurity) (Felitti et al., 1988; CDC, 2021). Exposure to ACEs and/or trauma (herein referred to as exposure to adversity) may lead to toxic stress (Thakur et al., 2020). Toxic stress is characterized by the presence of stressors that lead to repeated and/or prolonged activation of stress response systems in the absence of buffering safe, stable, nurturing relationships. Toxic stress during childhood has been associated with disruptions in brain circuitry and other biological systems (Shonkoff, Slopen, & Williams, 2021), underscoring the critical role of caregivers in moderating youth's stress experiences and supporting healthy development.

Trauma, stress, and adversity (TSA) can be transmitted intergenerationally within families (Burkhart et al., 2022; Isobel et al., 2021; Buchheim, 2022). The intergenerational transfer of TSA is often rooted in the experiences and behaviors of caregivers who, in their own childhoods, were exposed to adversity, without the presence of buffering protective factors (Burkhart et al., 2022). As the primary source of

emotional learning and attachment, caregivers play a central role in molding a child's capacity for self-regulation through both direct teaching and behavioral modeling (Paley & Hajal, 2022); current literature visualizes the transfer of TSA following a similar mechanism. Caregivers may perpetuate the intergenerational cycle of TSA through both intentional behaviors, such as maltreatment and negative parenting practices, (Shonkoff, Slopen, & Williams, 2021; Isobel et al., 2021) or as unintentional modeling during uncontrollable circumstances (Tottenham et al., 2019), including collective trauma, poverty, and discrimination (Isobel et al., 2021; McEwen & McEwen, 2017). When not effectively addressed, adversity and the resulting toxic stress-can accumulate into adulthood, contributing to impairments in psychological functioning including dysregulated mood, maladaptive thought patterns, and disordered behaviors (Isobel et al., 2021; Shonkoff, Slopen, Williams, 2021). Within the intergenerational cycle of TSA, a caregiver's emotion dysregulation can influence youth through multiple pathways, including the replication of learned abusive behaviors (Isobel, 2021), the absence of a consistent model for self-regulation during critical developmental periods (Paley & Hajal, 2022), and the lack of co-regulatory support in response to stressors (Tottenham et al., 2019). Therefore, a caregiver's capacity for self-regulation plays a critical role in either sustaining or disrupting the intergenerational transmission of TSA.

Methods

Study Design and Sample

We recruited a convenience sample of adolescents ages 12 to 17 years and their caregivers. To be eligible, adolescents had to be referred by a health care provider or school counselor and/or had to score into the High-Risk category through self-report using the ACEs and Toxic Stress Risk Assessment Algorithm (ACEs Aware, 2019; i.e., report 4 or more ACEs or any number of ACEs with an ACE-related condition such as depression, anxiety, or school difficulties). Eligibility for adolescents and their caregivers also included having access to a smartphone and the internet, the ability to speak and understand English, and willingness to download applicable apps and participate in the intervention, including practicing with the Inner Balance Trainer. Dyads were excluded from participation if they were currently enrolled in another family-based intervention (i.e., family therapy); were in acute distress requiring immediate need of a higher level of care (e.g., imminent risk of harm to self or others, active psychosis); or reported the identified caregiver's home environment was deemed unsafe or required supervised visits by child welfare.

Study Procedures

Institutional Review Board (IRB) approval was obtained from the Blinded for Review (IRB# 20216806). At baseline assessment, data collection took place in person at a community location that was convenient for the dyad. These sites included campus and community partner sites, as well as public meeting places. The assessment took approximately two hours to complete and included the informed consent

process, orientation to the study and technology, completion of self-report measures on a tablet in REDCap, measuring participant height, weight, and blood pressure, and conducting adolescent and caregiver HRV assessments.

Intervention: Garnering Resilience in Traumatized youth and families (GRIT)

In the GRIT pilot study, health sciences students at a minority-serving institution in Southern California were trained as near peer CHWs to deliver the GRIT intervention. The GRIT intervention systematically teaches comprehensive self-regulation skills (i.e. HeartMath Techniques; Elbers, & McCraty, 2020) using a health coaching model (van Zyl et al., 2020) and incorporates cognitive behavioral therapy (CBT) principles in combination with HRV-BF using the Inner Balance Trainer™. The GRIT intervention fosters adolescent-caregiver co-regulation by providing and modeling warm, responsive relationships, helping adolescents find and create supportive environments, especially with their caregiver, and coaching and modeling self-regulation skills (Alamillo et al, 2023). Adolescent-caregiver dyads received 8 sessions together via weekly 60–90-minute sessions delivered over 12 weeks via Zoom. GRIT included supportive health coaching to garner resilience via psychoeducation, co-regulation, and the promotion of buffering protective factors among adolescents and caregivers allowing opportunities for learning and practicing self-regulation using HRV-BF.

Variables & Measures

Demographics were collected using an investigator-developed survey and included: adolescent age (continuous), gender, sexual orientation, race/ethnicity, school enrollment, and grade; caregiver age (age bands of 10 years), gender, sexual orientation, highest degree, employment status, and youth-caregiver relationship.

Feasibility. Feasibility (i.e., whether GRIT was supported by community partners and attractive to intended participants) (Bowen et al., 2009), was evaluated by tracking community partners who agreed to share the study recruitment flyer, the number of interest and eligibility screenings completed, the number of participants enrolled, and number of sessions attended. Initially, interest and eligibility was assessed separately. However, due to losing potential participants between expressing interest and completing the eligibility survey, both interest and eligibility for the study was assessed at the same time through a combined online survey accessible through a QR code.

Mental Health. Adolescent and caregiver mental health symptoms were measured using the Patient Health Questionnaire (PHQ-9) for depressive symptoms, the Generalized Anxiety Disorder 7-item scale (GAD-7) for anxiety symptoms, the Primary Care PTSD Screen for DSM-5 (PC-PTSD-5) for symptoms of post-traumatic stress disorder (PTSD), and the Perceived Stress Scale (PSS-10) for self-reported stress.

Depression Symptoms were measured using the 9-item PHQ-9 depression scale (Kroenke, Spitzer, & Williams, 2001). The PHQ-9 measures the presence and severity of depression symptoms over the past 2 weeks. Each item is answered using a 4-point Likert scale, ranging from 0 ("*not at all*") to 3 ("*nearly every day*"). Scores range from 0 to 27, with higher scores indicating higher depression symptoms. The generally accepted cut-off of 10 is used as an indicator of possible depression (Kroenke, Spitzer, & Williams, 2001). Validity and reliability (McDonald's Omega = 0.87) of the PHQ-9 have also been established among school-based adolescents (Fonseca-Pedrero et al., 2023).

Anxiety Symptoms were measured using the GAD-7 (Spitzer, Kroenke, Williams, & Löwe, 2006). The GAD-7 measures the presence and severity of anxiety symptoms over the past two weeks using a 4-point Likert scale, ranging from 0 ("*not at all*") to 3 ("*nearly every day*"). Scores range from 0 to 21, with higher scores indicating higher anxiety symptoms. The generally accepted cut-off for possible anxiety is 10 (Spitzer et al., 2006). Adequate psychometric properties of the GAD-7 scores have been established among a general population of Spanish adolescents, with good internal consistency (McDonald's Omega = 0.90) (Casares et al., 2024).

PTSD Symptoms were assessed using the 5-item PC-PTSD-5 (Prins et al., 2016). The PC-PTSD-5 screens for PTSD symptoms experienced over the past month reflecting the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) criteria for PTSD. The PC-PTSD-5 begins with an item designed to assess lifetime exposure to traumatic events. If a respondent indicates any lifetime exposure to trauma, they are instructed to respond to 5 additional "*yes*" / "*no*" questions about how that trauma exposure has affected them over the past month. Higher scores on the PC-PTSD-5 indicate a greater severity of PTSD symptoms. Data were originally collected from a sample of veterans aged 24 to 89 years in the US (Prins et al., 2016); however, reliability and validity of the PC-PTSD-5 for screening for probable PTSD has since been established among community adult and child (ages 8–16) samples (Lathan et al., 2023; Li et al., 2019).

Perceived Stress Symptoms were assessed using the 10-item PSS-10, a widely used measure of perceived stress in adolescents and adults (Cohen, Kamarck, & Mermelstein, 1983). The PSS-10 measures the degree to which an individual perceives their life to be unpredictable, uncontrollable, and overloaded over the past month. Items are rated on a 5-point Likert-type scale, ranging from 0 ("*never*") to 4 ("*very often*"). Scores range from 0 to 40, with reverse-coding of positively worded items so that higher scores indicate higher levels of perceived stress.

Substance Use. Adolescent and caregiver substance use were measured using the Alcohol Use Disorders Identification Test–Consumption (AUDIT-C) for alcohol use, the Cannabis Use Disorder Identification Test–Revised (CUDIT-R) for cannabis use, and the Patient-Reported Outcomes Measurement Information System–Severity of Substance Use (PROMIS SSU) for other substance use.

Alcohol Use was assessed using the 3-item AUDIT-C (Bush et al., 1998). The AUDIT-C is a brief screening tool used to identify problematic alcohol use, with items assessing drinking frequency, quantity, and binge drinking behavior over the past year. Each question is scored from 0 to 4 points, resulting in a total

score ranging from 0 to 12; higher scores indicate greater risk for problematic alcohol use. The AUDIT-C has demonstrated good validity and reliability in both adult and adolescent populations (Liskola et al., 2018).

Cannabis Use was assessed using the 8-item CUDIT-R (Adamson et al., 2010). The CUDIT-R is a screening tool used to identify problematic cannabis use. Questions assess frequency, intensity, and negative consequences of cannabis use over the past 6 months. Questions 1 through 7 are scored from 0 to 4 points, and the eighth question is scored as 0, 2, or 4. Higher scores indicate greater risk for problematic cannabis use. The CUDIT-R has demonstrated good validity and reliability among college student samples (Mezquita et al., 2022) and has been used in studies to assess the severity of cannabis use among adolescents (e.g., Lees et al., 2024).

Other Substance Use was assessed using the 7-item PPRMIS SSU (Pilkonis et al., 2015). The PROMIS SSU measures the severity of substance use either over the past 30 days or over the past 3 months; the current study used the version assessing the r the past 3 months. Each item is rated on a five-point Likert scale, from 0 (*never*) to 5 (*almost always*), with higher scores indicating more severe substance use. The PROMIS SSU has demonstrated good validity and reliability in both clinical and community settings (Pilkonis et al., 2015).

Youth Risk and Protective Factors. Risk and protective factors were conceptualized as risky behavior and healthy habits measured using the Youth Risk Behavior Survey (YRBS), sleep quality using the Pittsburgh Sleep Quality Index (PSQI), and family functioning using the McMaster Family Assessment Device (FAD).

Youth Risk Behaviors and Healthy Habits were assessed using the 87-item YRBS (2021 Standard High School version; CDC, 2021). In the current study, 6 items already collected under demographics or the physical assessment portions were removed (age, sex, race, ethnicity, height, and weight). The YRBS measures a broad range of health-related behaviors, experiences and conditions that can lead to poor health among adolescents. Response choices are dichotomized for lifetime involvement questions (e.g., “During the past 12 months, have you ever been bullied on school property?”) with ordinal response options (e.g., frequency of an event) used for other questions (e.g., “How often do you wear a seat belt when riding in a car driven by someone else?”). The YRBS has demonstrated acceptable or greater test-retest reliability (i.e., kappa mean scores = 58.1% or higher) among community middle school (Zullig et al., 2006) and high school (Raghupathy & Hahn-Smith, 2012) samples when assessed at 2-week intervals (Charles et al., 2024).

Sleep Quality was assessed using the 19-item PSQI (Buysse et al., 1989), which measures sleep quality and disturbance over the past month. Items are grouped into 7 components, including: (1) sleep duration; (2) sleep disturbance, (3) sleep latency, (4) daytime dysfunction due to sleepiness, (5) sleep efficiency, (6) overall sleep quality, and (7) sleep medication use. Each component is scored from 0 to 3, with higher scores indicating greater dysfunction. Component scores are summed to yield a global score ranging from 0 to 21; higher scores indicate poorer overall sleep quality (Zhong et al., 2015). A global score of greater than 5 yields a sensitivity of 89.6% and a specificity of 86.5% in distinguishing between

good and poor sleepers (Buysse et al., 1989). Reliability and validity of the PSQI have been established in both adult and adolescent samples (Grandner et al., 2006; Raniti, et al. 2018).

Family Functioning was assessed using the 53-item FAD (Epstein, Baldwin, & Bishop, 1983). The FAD consists of six subscales that correspond to the following dimensions: Problem-Solving, Communication, Roles, Affective Responsiveness, Affective Involvement, Behavior Control, and General Functioning (Epstein, Baldwin, & Bishop, 1983). Items consist of statements about a family, and respondents are asked to rate how well each statement describes their own family using a 4-point Likert scale, from 1 (*strongly agree*) to 4 (*strongly disagree*). The FAD is scored by summing responses within each scale and dividing by the number of items, with higher scores indicating poorer family functioning. The FAD is designed to be completed by family members ages 12 years and up and has demonstrated good validity and reliability (Miller et al., 1985).

Data Analysis

R version 4.1.2 (R Core Team, 2021) was used for statistical analyses. All statistical tests were two-sided with an alpha of 0.05. Descriptive statistics (means and standard deviations for continuous variables and frequencies and percentages for categorical variables) were used to describe the distribution of demographic, adversity, and risk variables. Following descriptive analyses, categories of demographic variables were collapsed according to cell size. Complete case analysis was used in instances of missing data, resulting in only complete observations being included. Relationships between variables were examined using Pearson's correlation coefficients. Statistical significance was determined using the $P < 0.05$ criterion.

Results

Feasibility

We engaged several community partners across Southern California who agreed to share flyers with their clients/patients/students. Organizations ranged from medical providers who work with adolescents to youth-serving organizations such as schools and non-profit community organizations who offer in-school case management and after-school programming. The majority of referrals came from schools. Both passive and active modes of partnership were implemented. Passive sharing included posting our flyer in waiting rooms at health care clinics. More active approaches included school counselors and/or case managers referring adolescents directly to the study.

Seventy-one potential participants (adolescents [26, 38.8%], parent/caregiver [39, 58.2%], other [2, 3.0%], and missing [4, 5.6%]) completed an interest and/or eligibility form. Twenty-three dyads (23 adolescents and 21 caregivers) representing 20 families (one family had 3 adolescents with 2 caregivers [one caregiver participated twice] and another family had 2 adolescents with one caregiver who participated twice) completed the informed consent process, and a total of 44 participants enrolled in the study. A

total of 16 dyads completed all 8 sessions (69.5%), with 19 dyads (82.6%) completing four or more sessions. Two families completed a single session.

Participant Characteristics

At baseline data collection, adolescents were on average 13.5 years old (SD = 1.56, range: 12–17 years), mostly female (73.9%), heterosexual (52.2%), and from diverse ethnic/racial backgrounds with 26.1% identifying as “other” and 13% identifying as Black. Caregivers (85.7% parents) were on average between 41 and 50 years old, female (85.7%), heterosexual (90.5%), Asian (23.8%), employed (85.7%), and college-educated (61.8%).

Descriptive Statistics for Main Variables

Descriptive statistics and Cronbach’ alphas for adolescent and caregiver mental health, substance use, and risk and protective factors are presented in Table 1. Mean adolescent mental health scores were higher than mean caregivers’ scores for depression, anxiety, and stress symptoms. Minimal alcohol, cannabis, and other substance use was reported by adolescents and caregivers within the last 6 months: only one adolescent and three caregivers reported cannabis use, and one caregiver reported other substance use in the past 3 months. Adolescent and caregiver global family functioning scores were similar, with adolescent scores being slightly higher (worse) than caregiver scores. Sleep scores indicated poor sleep quality with adolescents scoring worse than their caregivers.

Table 1
Main Variables

Variable	YOUTH n = 23		CAREGIVERS n = 21	
	Mean (SD) Median [Range]	Cronbach's alpha ¹	Mean (SD) Median [Range]	Cronbach's alpha ¹
Depression Symptoms (PHQ-9 Score)	7.91 (7.41) 5.00 [0, 27.0]	0.93	3.67 (3.53) 3.00 [0, 14.0]	0.86
Anxiety Symptoms (GAD-7 Score)	8.43 (6.49) 7.00 [1.00, 21.0]	0.92	4.38 (4.81) 3.00 [0, 21.0]	0.91
PTSD Symptoms (PC-PTSD-5 Score)	0.87 (1.66) 0 [0–5.0]	0.81	1.00 (1.48) 0 [0, 5.00]	0.72
Stress Symptoms (PSS-10 Score)	19.6 (8.89) 17.0 [5.0, 36.0]	0.92	15.0 (8.67) 15.0 [0, 33.0]	0.95
Problematic Alcohol Use (AUDIT-C Score)	0.52 (1.50) 0 [0–7.0]	0.80	2.24 (2.19) 2.00 [0, 8.00]	0.68
Problematic Cannabis Use (CUDIT-R Score)	0.43 (2.09) 0 [0, 10.0]	NA	0.48 (1.40) 0 [0, 6.00]	NA
Problematic Other Drug Use (PROMIS Score)	NA	NA	0.33 (1.53) 0 [0, 7.00]	NA
Family Functioning Score (FAD–General Functioning Subscale)	2.05 (0.53) 2.08 [1.33, 3.00]	0.88	1.90 (0.66) 1.92 [1.00, 3.58]	0.95
Sleep Quality (PSQI Global Score)	6.26 (2.49) 7.0 [2.0– 10.0]	0.73	5.48 (2.69) 5.00 [1.00, 12.0]	0.72

¹ Cronbach's alpha was not calculated for CUDIT-R and PROMIS because most records have not reported use of the corresponding substances.

Correlations

Pearson's correlation analyses revealed minimal to no significant associations between adolescent and caregiver scores on most mental health and well-being instruments. Specifically, correlations between adolescent and caregiver scores were weak and non-significant for reported depressive symptoms (PHQ-9), anxiety symptoms (GAD-7), PTSD symptoms (PC-PTSD-5), perceived stress (PSS-10), and sleep quality (PSQI). In contrast, moderate to strong positive correlations were observed for alcohol use (AUDIT-C: $r = 0.59$, $p = 0.003$) and overall family functioning (FAD-GF: $r = 0.57$, $p = 0.0042$), indicating that caregiver and adolescent responses in these domains were more closely aligned.

Among adolescents, several instruments showed strong and statistically significant correlations. Depression symptoms were highly correlated with anxiety symptoms ($r = 0.83$, $p < 0.001$), PTSD symptoms ($r = 0.61$, $p < 0.01$), and perceived stress ($r = 0.87$, $p < 0.001$), indicating substantial overlap in the mental health domains (Fig. 1). Anxiety symptoms also showed strong associations with PTSD symptoms ($r = 0.5$, $p < 0.05$) and perceived stress ($r = 0.86$, $p < 0.001$), while PTSD symptoms showed correlation with perceived stress ($r = 0.5$, $p < 0.05$). Notably, sleep quality was significantly associated with perceived stress ($r = 0.72$, $p < 0.001$), anxiety ($r = 0.74$, $p < 0.001$), and depression ($r = 0.64$, $p < 0.001$), suggesting a strong link between emotional distress and poor sleep among adolescents. The correlation between cannabis use and risky alcohol use was high (0.94); however, only one adolescent reported cannabis use within the past six months (Fig. 1).

Among caregivers, a consistent pattern of co-occurring emotional distress was observed, with strong correlations among depression, anxiety, PTSD, and perceived stress (Fig. 1). Similar to adolescents, these domains of emotional distress were also associated with poorer sleep quality. Anxiety, PTSD, and perceived stress, were correlated with alcohol use. As with the adolescent cohort, correlations involving cannabis or other substance use should be interpreted with caution due to limited sample size of past 6-month use among caregivers (Fig. 1). Moreover, a moderate to strong positive correlation between adolescent risky alcohol use and caregiver alcohol use ($r = 0.59$, $p < 0.01$), caregiver PTSD symptoms ($r = 0.48$, $p < 0.05$), and caregiver anxiety symptoms ($r = 0.67$, $p < 0.001$) was found. No other correlations were statistically significant.

National Comparisons of Risk Behaviors and Healthy Habits

Adolescents in our sample reported less rates of suicidal ideation, alcohol, and substance use than their peers nationally (Table 2). With nearly 74% of our adolescents reporting spending more than 3 hours of screen time per day, this rate was the same as the national rate. Rates of physical activity were also similar with nearly 48% of adolescents reporting at least 60 minutes of physical activity a day for at least 5 days compared to 45.3% nationally. Our adolescents reported better sleep than their national peers with 39% reporting getting at least 8 hours of sleep per night. Finally, our adolescents reported higher rates of describing themselves as overweight (47.8%), than the rate of their national peers (28.1%).

Table 2
Selected YRBS questions* (CDC, n.d.)

Mental health	GRIT Study, 2022–2024 (N = 23)	US 9th Graders, 2023, (95% CI)
Considered suicide	4.3%	21.3% (18.7–19.7)
Planned suicide	4.3%	16.8% (14.3–19.0)
Attempted suicide	0	10.4% (9.0–11.9)
Substance use		
Had first drink of alcohol before age 13	13.0%	17.1% (15.4–18.9)
Drank alcohol in the past month	4.3%	14.8% (13.1–16.6)
Ever tried cigarette smoking	8.7%	10.1% (8.5–11.9)
Ever used electronic vapor products	8.7%	25.4% (22.5–28.5)
Ever used marijuana	8.7%	18.6% (16.2–21.3)
Healthy habits		
Described self as slightly or very overweight	47.8%	28.1% (25.6–30.7)
Spent 3 + hours per day on screen time	73.9%	74.3% (69.8–78.4)
Physically active at least 60 min per day on 5 or more days	47.8%	45.3% (43.3–47.3)
Got ≥ 8 hours of sleep on an average school night	39.1%	31.0% (27.8–34.4)

*Statistical significance indicators represent comparison between GRIT and US 9th Grade National Samples.

Discussion

Feasibility

The GRIT pilot study demonstrated promising feasibility results. However, there were adjustments made to address several challenges. First enrollment was slow. While many expressed interest, much less actually enrolled in the study. We addressed this challenge in a few ways. First, we became mobile by changing the location of our assessments from our university to a location convenient for the family (e.g., classrooms at the school the youth attended). We also increased our incentives. Initially, we incrementally increased our incentive over time at each assessment. We changed the incentive to a flat

rate of \$50 per assessment to incentivize each data collection assessment equally. Finally, we noticed that we were losing potential participants between interest and screening for eligibility. To decrease losing touch with potential participants who expressed interest, we added the eligibility screening to the interest form.

In total, 69.5% of dyads completed all 8 health coaching sessions, and 82.6% completed at least half of the sessions. This completion rate compares favorably with other psychosocial substance use prevention interventions for adolescents. A recent systematic review and meta-analysis found an estimated overall completion rate of 59% (95% CI 57–61%) across 88 studies of psychosocial substance use prevention interventions among adolescents and young adults (Wells et al., 2024). Notably, those that were family-based interventions were associated with improved completion rates compared to other therapeutic approaches. Specifically, all five randomized controlled trials included reported significantly higher rates of treatment completion among those receiving family-based interventions (Wells et al., 2024). Our retention rate is also comparable to the 76% completion rate reported for Culturally Informed and Flexible Family-Based Treatment for Adolescents (CIFTA) implemented in community settings (Mena et al., 2023). These results suggest that the GRIT intervention's novel approach, which combines health coaching, co-regulation strategies, and HRV-BF within a family-based framework, was acceptable to both adolescents and caregivers and aligns with the enhanced retention rates found with family-based approaches.

Mental Health Patterns

Adolescent participants reported more elevated mental health symptoms compared to their caregivers, including higher depression, anxiety, and stress symptoms. This finding aligns with current research indicating increasing rates of mental health challenges among adolescents (Racine et al., 2021; Viner et al., 2022). Data from the National Institute of Mental Health show that in 2021, approximately 20.1% of U.S. adolescents aged 12–17 experienced at least one major depressive episode, with a higher prevalence among females (29.2%) compared to males (11.5%; NIMH, 2023; as cited in Substance Abuse and Mental Health Services Administration, 2022). Additionally, the Centers for Disease Control and Prevention (CDC, 2025) reported that in 2021–2023, 20% of U.S. adolescents aged 12–17 experienced symptoms of anxiety in the past two weeks, and 18% reported symptoms of depression during the same period. Together, these findings underscore the growing prevalence of mental health symptoms among US adolescents. The mean PHQ-9 score of 7.91 among adolescents in our study is below the clinical cutoff of 10; however, given that mental health symptoms may compound over time without appropriate support (McLaughlin et al., 2020), this finding of mild depressive symptoms among the study sample supports the importance of early intervention for adversity-impacted adolescents.

The correlation analyses revealed patterns of relationships within adolescent and caregiver variables, as well as some unexpected patterns between adolescent and caregiver measures that warrant deeper examination. While some correlations aligned with established literature, others provided unexpected insights that may inform future intervention development and research directions. The correlation patterns observed in Figs. 2a-c serve as both a validation check for our instruments and a hypothesis-

generating exercise for future research. Several statistically significant correlations aligned with well-established relationships in the literature, providing confidence that our measures are capturing valid data. The strong correlations between depression, anxiety, PTSD symptoms, and perceived stress among adolescents ($r = 0.50\text{--}0.87$, all $p < 0.05$) align with extensive literature documenting high comorbidity rates among internalizing disorders in adolescents, providing confidence that our mental health instruments are effectively measuring their intended constructs. Similarly, the significant correlations between sleep quality and emotional distress measures ($r = 0.64\text{--}0.74$ for depression, anxiety, and stress) are consistent with robust literature demonstrating bidirectional relationships between sleep disturbances and mental health symptoms in adolescents. The moderate correlation between adolescent and caregiver alcohol use ($r = 0.59$, $p < 0.01$) validates established research on familial transmission of substance use behaviors, reinforcing the critical role of family relationships in shaping adolescent substance use patterns and suggesting that targeting both youth and caregivers in prevention efforts may be particularly important (Eiden et al., 2020).

The absence of expected correlations in some domains also provided valuable insights. Correlation analyses in the current study did not show strong direct relationships between adolescent and caregiver mental health measures. This finding is counter to the literature, indicating that caregiver well-being significantly impacts adolescent outcomes (Bøe et al., 2018; Cuijpers et al., 2015). Our contrary findings may reflect the relatively small sample size or the specific characteristics of our pilot population. The relationship between adolescent and caregiver mental health is complex. The intergenerational transmission of trauma, stress, and adversity (TSA) further complicates these relationships. According to Crnic (2024), parenting stress and problematic youth behavior are consistently interconnected, and contemporary developmental psychopathology frameworks have shifted from examining simple direct relationships to exploring the complex, multifaceted pathways through which parenting stress contributes to emerging difficulties within child and family systems. Direction of effect in these relationships may be reciprocal and bidirectional rather than unidirectional (Neece et al., 2012), with accumulation over time escalating risk of adaptive problems for adolescents and parents. Future studies examining the mechanisms through which these relationships emerge, the directions of effect involved, and the complex pathways of influence will be key to better understanding the impact on risk for psychopathology.

Risk Behaviors and Healthy Habits

Examination of 2021 YRBS data (Table 4) reveals several important patterns when comparing our sample to national data. Notably, our sample reported lower rates of suicidal ideation, planning, and attempts compared to national averages. In the study sample, 4.3% of our participants reported considering or planning suicide; these rates are substantially higher nationally (22.2% and 17.6%, respectively). This difference may be due to the younger age of our study sample (predominantly middle schoolers), compared with 9th graders in national YRBS data, highlighting a window of opportunity for prevention.

The prevalence of substance use in the study sample was also lower compared to national YRBS data. This may also be due to the younger age in the study sample, with 13% reporting alcohol use before age 13 compared to 15% nationally, and only 8.7% reporting ever trying cigarettes, electronic vapor products, or marijuana (compared to higher rates in the reference populations). These findings highlight the importance of middle school as an intervention target, before substance initiation typically begins for most adolescents (Gallimberti et al., 2015; Kingston et al., 2017). Research has demonstrated that adolescents who initiate cannabis use develop use disorders at substantially higher rates within the first year (10.7%) than young adults who begin using cannabis (6.4%), indicating that earlier age of first use may accelerate the development of problematic cannabis use (Volkow et al., 2021). This suggests that younger age at initiation may be associated with more rapid progression to problematic use patterns. Similarly, research using the ABCD Study identified that by age 12, 14.4% of previously substance-naïve adolescents had initiated substance use, with alcohol being the most common (Green et al., 2023). Together, these findings support earlier intervention efforts during middle school years, before substance use patterns become entrenched, may be more effective than waiting until high school. School-based prevention programs have been recognized as effective strategies for reducing substance use among young people (Alarcó-Rosales et al., 2021). Our data support the growing consensus that prevention efforts should begin earlier, particularly for adversity-impacted youth who are at heightened risk for early substance initiation. Childhood adversity has been established as a robust predictor of future substance misuse, with exposure to ACEs increasing vulnerability to both early experimentation with substances and the progression to substance use disorders (Grummitt et al., 2021; Meadows et al., 2024). Implementing preventive interventions during middle school can address these risks proactively, potentially mitigating the impact of ACEs on substance use trajectories.

Regarding healthy habits, our participants reported higher rates of adequate sleep (≥ 8 hours) at 39.1% compared to both California (25.2%) and national (22.7%) averages. These findings may represent a protective factor in the study sample. However, 73.9% of the study sample reported spending 3 or more hours daily on screens, similar to the national average (75.9%). These health behavior patterns provide important baseline information for the GRIT intervention, which specifically targets the development of healthy habits to regulate stress responses.

Family Functioning and Co-regulation

The mean family functioning scores reported by both adolescents (2.05) and caregivers (1.90) suggest moderate functioning, indicating room for improvement. These scores are particularly meaningful in the context of adversity-impacted families, as positive childhood experiences including higher family functioning has been consistently found to be protective against the negative impacts of ACEs on physical and mental health (Daines, et al., 2021). Furthermore, supportive family relationships can significantly reduce the likelihood of mental illness among those with multiple ACEs. Specifically, adolescents with interpersonal support consistently reported lower rates of mental health issues. These findings underscore the critical role of family support in mitigating the adverse effects of early life stressors (Suh, Gallaway, & Celaya, 2024).

Our approach aligns with the growing recognition that youth social environments, particularly their home environment and caregivers' well-being, are critical factors in developing interventions to support at-risk youth. Positive, supportive adults constitute a primary protective factor for youth, and secure attachments to caregivers enhance youth's ability to regulate their stress response. To protect youth and future generations from the sequelae of ACEs, it is essential to identify and support ACE-related responses among their caregivers. Research indicates that positive family functioning serves as a buffer against the negative impacts of ACEs on physical and mental health (Morris & Hays-Grudo, 2023). Promoting positive family functioning can be achieved through various strategies, including enhancing co-regulation between caregivers and youth, improving parenting skills such as communication and problem-solving, and offering social support. Co-regulation involves caregivers providing supportive environments that help youth learn to manage their emotions and behaviors effectively. Additionally, teaching problem-solving skills and fostering effective communication within the family unit contribute to better family dynamics and youth outcomes (Cui et al., 2025). Social support for caregivers has also been shown to mitigate the effects of stress and improve overall family functioning.

The importance of family-based interventions is further highlighted in recent research. Mena et al. (2023) found that family-based interventions that address unique stressors experienced by Latino and Black youth may be particularly attractive to these families. Their study of Culturally Informed and Flexible Family-Based Treatment for Adolescents showed significant improvements in youth outcomes and family functioning when implemented in community settings. Similarly, Wells et al. (2024) found that family-based treatments were associated with improved completion rates compared to other therapeutic approaches. They specifically noted that all five randomized controlled trials comparing family-based interventions to other approaches found significantly higher rates of treatment completion among those receiving family-based treatments.

Implications for Practice and Policy

The findings from this feasibility pilot have several implications for clinical practice and policy. First, they support the value of intervening at the middle school level, before the typical escalation of risk behaviors seen in high school. In a comprehensive systematic review and meta-regression analysis of school-based substance use prevention programs across different developmental stages, different developmental periods offered distinct possibilities for prevention, with early adolescence (middle schoolers) showing particular responsiveness to certain prevention approaches (e.g., those targeting social norms; Onrust et al., 2015). Early adolescence represents a critical intervention window because this developmental period involves significant shifts in young people's social environments as they transition to middle or secondary school, where they encounter expanded peer networks and increased peer interaction opportunities (Onrust et al., 2015). Our sample's lower rates of substance use, mental health issues, suicidality, and ideation compared to high school samples in California and national data further support middle school as an ideal time for intervention, particularly for adversity-impacted youth.

Second, our findings highlight the importance of family-centered approaches in addressing adversity. The high completion rate observed in this pilot (82.6% completing at least half of the health coaching

sessions) aligns with previous research suggesting that family-based interventions have better retention than individual-focused interventions (Wells et al., 2024). This suggests that public health initiatives and clinical interventions targeting adolescent mental health and substance use prevention should consider incorporating family participation to enhance engagement and effectiveness. Caregivers remain influential figures in adolescents' lives despite the growing significance of peer relationships during this developmental stage (Onrust et al., 2015); our data support the value of interventions that harness this continuing caregiver influence.

Third, the integration of technology-based tools like HRV-BF into family-based psychoeducational interventions represents an innovative approach that can increase engagement and effectiveness. Policy makers should consider supporting the development and dissemination of evidence-based digital health tools that can augment traditional interventions, particularly those that provide concrete, measurable feedback to participants. As digital health technologies become more accessible, incorporating them into prevention programs may create scalable, cost-effective solutions for reaching adversity-impacted youth (Grist, Porter, & Stallard, 2017). This may be particularly relevant for middle school students who, according to YRBS data, already report high rates of screen time usage, suggesting comfort with technology that could be leveraged for prevention efforts.

Fourth, our study underscores the potential value of community health worker (CHW) models for delivering complex interventions. CHWs offer a promising workforce solution that can extend the reach of mental health services, particularly in underserved communities (Barnett et al., 2018). Policy initiatives should consider expanding training programs and career pathways for CHWs, especially those focused on youth mental health and family support. Sustainable funding mechanisms for CHW-delivered interventions, such as Medicaid reimbursement or dedicated public health funding streams, would enhance implementation and sustainability (Mehra et al., 2020; Worku, 2021). CHWs delivering GRIT successfully suggests that community-based health coaching models may be particularly effective for engaging diverse populations.

Limitations

Several limitations should be considered when interpreting these findings. First, this is a pilot study with a small sample size, limiting statistical power and generalizability. Second, the reliance on self-report measures may introduce reporting biases, particularly for sensitive topics like substance use and mental health symptoms. Third, the cross-sectional nature of the baseline data prevents assessing causality among the relationships observed. Fourth, our convenience sampling approach may have resulted in selection bias, potentially enrolling families more motivated to participate in an intervention. Fifth, our comparison to national samples was limited to 9th graders. Finally, while our sample was diverse, the results may not generalize to all populations or settings.

Future Directions

Building on this feasibility pilot, future research targeting middle-school age youth should examine the effectiveness of the GRIT intervention through a larger randomized controlled trial with longer follow-up periods. Specific attention should be paid to whether improvements in self-regulation and co-regulation skills mediate changes in youth outcomes, particularly regarding substance use prevention and mental health. Additionally, exploring the biological mechanisms underlying the intervention's effects, particularly through HRV measures, could provide valuable insights into how GRIT impacts stress regulation at a physiological level.

The promising completion rates and engagement observed in this pilot suggest that the GRIT intervention warrants further development and testing. Its integration of health coaching, self- and co-regulation strategies, and HRV-BF technology represents an innovative approach to supporting adversity-impacted youth and their families that addresses both the neurobiological and relational impacts of toxic stress. As reported by recent research (Wells et al., 2024; Mena et al., 2023), family-based interventions show particular promise for improving retention and outcomes among diverse youth populations.

Conclusion

The GRIT pilot demonstrated that a family-based, CHW-delivered intervention combining health coaching, self- and co-regulation strategies with HRV-BF is feasible and acceptable to adversity-impacted adolescents and their caregivers. The baseline characteristics of participants revealed important patterns in mental health, substance use, and family functioning that support the need for early, family-centered interventions. Findings support middle school as a critical window for such interventions, before the typical escalation of risk behaviors seen in high school occurs. By addressing both youth and caregiver self-regulation within the context of their relationship, GRIT offers a promising approach to mitigating the intergenerational transmission of TSA. While further research is needed to establish its effectiveness and explore mechanisms of change, this pilot provides a solid foundation for such work.

Declarations

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data availability statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Figures

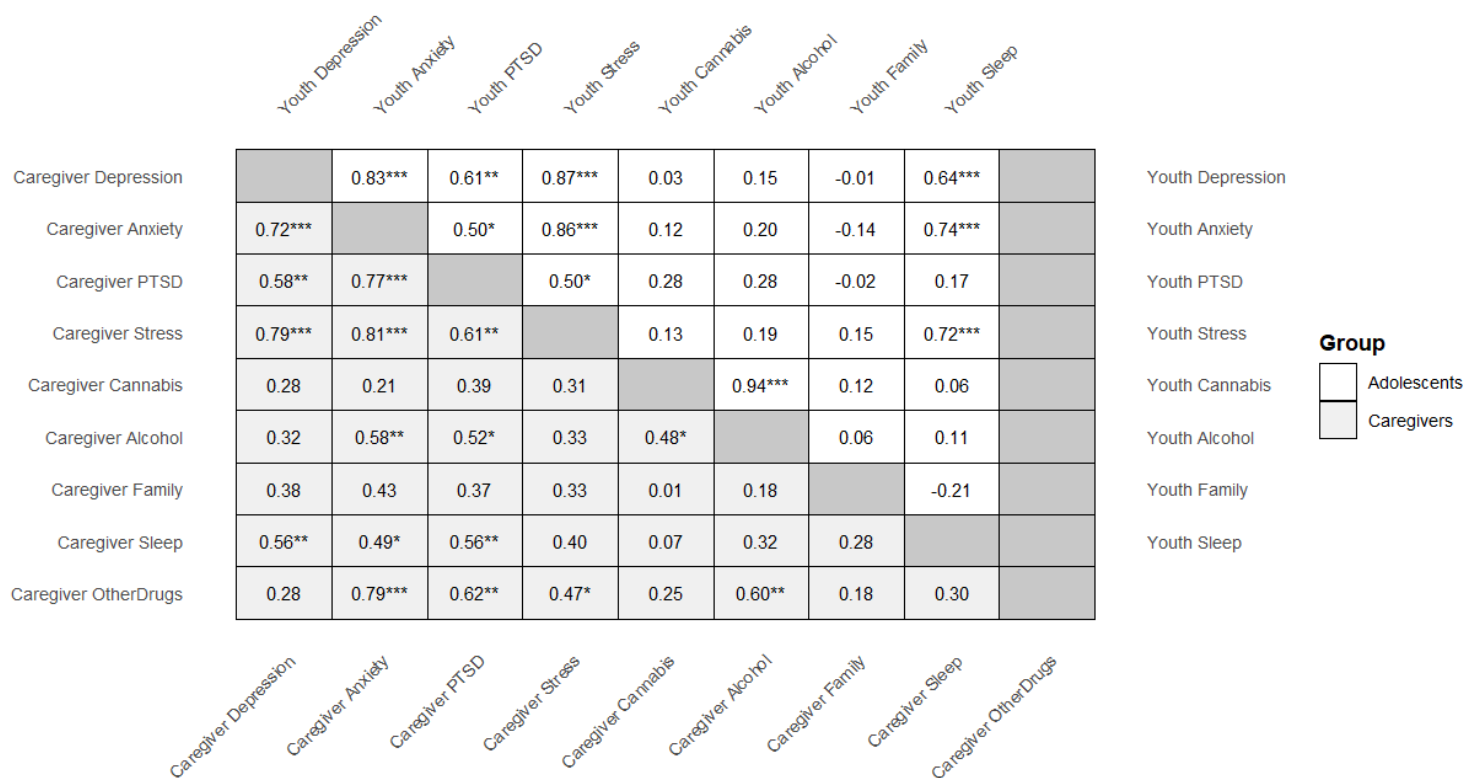


Figure 1

Pearson's correlation coefficients (r) for adolescent and caregiver-reported variables