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The Stress and Adversity Inventory for Adolescents (Adolescent STRAIN): associations with mental and physical health, risky behaviors, and psychiatric diagnoses in youth seeking treatment

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Background: Numerous theories have posited that stressors occurring over the lifespan may exert a cumulative effect on psychological and biological processes that increase individuals' risk for a variety of mental and physical health problems. Given the difficulty associated with assessing lifetime stress exposure, however, few empirical studies have directly tested these cumulative risk models of psychopathology and human health. **Method:** To address this issue, we examined the usability, acceptability, concurrent validity, and predictive validity of the recently developed Stress and Adversity Inventory for Adolescents (Adolescent STRAIN) in 338 youth (M_{age} = 15.64; 229 females) seeking mental health treatment. **Results:** The Adolescent STRAIN achieved high acceptability and was completed in approximately 25 min (interquartile range: 20–32 min). Concurrent associations with other measures of early adversity (Childhood Trauma Questionnaire-Short Form) and interpersonal stress (Revised Peer Experiences Questionnaire) were very good (*r*s = .50–.59). In analyses that adjusted for participants' age, sex, and race, the STRAIN was significantly associated with depression, anxiety, and anhedonia severity; general mental and physical health complaints; risky behavior engagement; and number of interviewer-based psychiatric diagnoses (βs = .16–.52; risk ratios = 1.006–1.014). Contrary to classic theories of stress which assume that different stressors exert similar effects on health, substantial differences were observed across the two stressor types, twelve life domains, and five core social-psychological characteristics assessed by the Adolescent STRAIN. **Conclusions:** These data confirm the relevance of lifetime stress exposure for multiple health outcomes in adolescence, which can in turn inform existing theories of lifespan health. Because stress is a common presenting problem in hospitals and clinics, these data also suggest the possibility of using the Adolescent STRAIN to generate stress exposure profiles for case conceptualization and treatment planning purposes. **Keywords:** Life stress; assessment; adolescence; psychopathology; health.

Introduction

Few topics have garnered more interest in psychiatry and clinical psychology than the role that life stress plays in shaping mental and physical health. Indeed, numerous theories have described how social-environmental adversity may initiate psychological, biological, and behavioral risk processes that can emerge in childhood and adolescence, and, in turn, affect lifespan health (e.g. Boyce & Ellis, 2005; Cicchetti & Toth, 1995; Danese & McEwen, 2012; Gunnar & Quevedo, 2007; Miller, Chen, & Parker, 2011). Consistent with these cumulative risk models, early life stress exposure has been associated with aberrations in health-relevant processes at multiple levels of analysis, including altered brain structure and function (Lupien, McEwen, Gunnar, & Heim, 2009), greater basal inflammatory activity and reactivity (Slavich & Irwin, 2014), more DNA methylation (Essex et al., 2013) and inflammatory gene expression (Miller et al., 2009), and poorer metabolic and mental health (Danese et al., 2009). Greater stress exposure in early life also is a strong predictor of chronic disease risk (Felitti et al., 1998) and accelerated biological aging in both adolescence (Humphreys et al., 2016) and adulthood (Tyrka et al., 2010), thus highlighting the particularly pernicious nature of these effects across the lifespan.

Although this large body of research on stress and health is notable for measuring stress *biology* in a relatively nuanced fashion, the measurement of stress *exposure* has remained crude (Slavich, 2019). The main methodological issues have been described elsewhere (e.g. Dohrenwend, 2006; Monroe, 2008; Shields & Slavich, 2017; Slavich, 2016), but three points warrant highlighting. First, most studies on stress and health assess stress exposure as if life stress is a singular, unitary construct, even though stressors emerge in different forms (e.g. acute vs. chronic), occur in a variety of life domains

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(e.g. housing, work, intimate relationships), and possess different social-psychological characteristics (e.g. interpersonal loss, physical danger, humiliation) that can have varying effects on health (Cohen, Murphy, & Prather, 2019; Epel et al., 2018). Second, although many theories have hypothesized that the specific *timing* of stressor exposure can influence the types of effects observed (e.g. Andersen & Teicher, 2008), stress exposure is presently measured using a wide variety of instruments, some of which assess exposure timing in a very general fashion (e.g. childhood vs. adulthood) and others of which do not assess exposure timing at all. Finally, although existing theories generally posit that stressors occurring across the *entire lifespan* can have cumulative effects on human health and development, very few studies have actually assessed all of the acute life events and chronic difficulties that individuals have experienced, largely because of the difficulty associated with obtaining such data in an efficient and reliable manner. As a result, our current understanding of stress is overly simplistic and has generally paid little attention to how associations between stress and health may differ based on the specific types of stressors experienced over the lifespan (for some exceptions, see Humphreys & Zeanah, 2015; McLaughlin, Sheridan, & Lambert, 2014; Slavich & Cole, 2013; Slavich, O'Donovan, Epel, & Kemeny, 2010; Slavich & Shields, 2018; Teicher & Samson, 2016; Zeanah & Sonuga-Barke, 2016).

To address these methodological issues to the best extent possible, G.M. Slavich developed an online, interview-based system for assessing lifetime stress exposure in adults, called the Stress and Adversity Inventory for Adults (Adult STRAIN), which measures individuals' exposure to 55 different major stressors occurring across the life course (Slavich & Shields, 2018). For each stressor that is endorsed, respondents are asked a series of tailored follow-up questions that ascertain the stressor's severity, frequency, timing, and duration. Based on the data collected, the STRAIN can, in turn, produce 115 stress exposure summary scores that provide a panoramic snapshot of individuals' lifetime stress exposure. In a recent validation study, the system demonstrated very good concurrent, discriminate, and predictive validity, and excellent test-retest reliability over 2–4 weeks (*r*s = .904–.919; Slavich & Shields, 2018). The system and its derivative, the Daily STRAIN, have also predicted a variety of outcomes across several independent studies and levels of analysis, including diurnal cortisol and reactivity levels (Cuneo et al., 2017; Lam, Shields, Trainor, Slavich, & Yonelinas, 2019), metabolic function (Kurtzman et al., 2012), executive function (Slavich & Shields, 2018), memory (Goldfarb, Shields, Daw, Slavich, & Phelps, 2017; Shields, Ramey, Slavich, & Yonelinas, In press; Shields, Doty et al., 2017), birth timing (Gillespie, Christian, Alston, & Salsberry, 2017), sleep problems (Slavich & Shields, 2018), depression and fatigue (Bower, Crosswell, & Slavich, 2014; Dooley, Slavich, Moreno, & Bower, 2017), and mental and physical health (Shields, Moons, & Slavich, 2017; Slavich & Shields, 2018; Toussaint, Shields, Dorn, & Slavich, 2016).

As educational, parental, and school-based peer difficulties are more prevalent during adolescence, with other stressors being less likely to occur (e.g. marriage problems), G.M. Slavich subsequently developed the Stress and Adversity Inventory for Adolescents (Adolescent STRAIN) with the assistance of G.S. Shields. Compared to the Adult STRAIN, which is used with adults aged 18 years and older, the Adolescent STRAIN is appropriate for youth aged 10–18 years old and is designed to achieve maximal coverage of 75 major stressors that are most relevant for this age group. Although stress exposure in adolescence could well be measured with cruder instruments (as described above), early adversity has particularly long-lasting effects on lifespan health that we believe require high-quality stress assessment to fully understand. In the present study, therefore, we examined for the first time the usability, acceptability, concurrent validity, and predictive validity of the Adolescent STRAIN, and used the system to investigate how lifetime stress exposure is associated with a broad array of mental and health outcomes in adolescence. To accomplish this, youth entering a psychiatric residential treatment program were administered the Adolescent STRAIN, as well as other measures of stress exposure, psychiatric symptom severity (i.e. depression, anxiety, and anhedonia), general mental and physical health complaints, and risky behavior engagement. In addition, psychiatric diagnoses were independently obtained by an expert diagnostic interviewer.

Based on prior research using the Adult STRAIN (reviewed above) and one existing study using the Adolescent STRAIN (Stewart et al., in press), we hypothesized that the Adolescent STRAIN would exhibit good usability and acceptability and would be significantly associated with other concurrently administered measures of life stress. In addition, we hypothesized that cumulative lifetime stress exposure as measured by the Adolescent STRAIN would be strongly associated with the seven outcomes assessed but that these associations would differ by stressor type, as has been shown previously with both the Adult STRAIN (Slavich & Shields, 2018) and other interview based measures of life stress (e.g. Brown, Harris, & Hepworth, 1995).

Method

Participants and procedure

Participants were 338 adolescents, aged 13–19 years old (M = 15.64, SD = 1.47), who were admitted to a psychiatric residential treatment program over two years (April 2015-April

2017). All demographic and clinical characteristics are presented in Table S1. The initial sample included 359 adolescents. However, 21 participants (5.85%) did not have complete clinical outcome data and were thus excluded from the STRAIN portion of the study. Compared to included participants, those with missing data had significantly more early life stressors, as assessed by the Childhood Trauma Questionnaire-Short Form (CTQ-SF; Bernstein et al., 2003), $t(355) = 2.26$, $p = .025$, $d = 0.49$. Otherwise, included and excluded participants did not differ on demographic or clinical factors (all ps $> .20$).[1]

Prior to participating, legal guardians and adolescents aged 18–19 years old provided written, informed consent, and adolescents 13–17 years old provided assent. Within approximately 48 hr of their admission to the treatment program, participants completed all of the measures described below in a single visit. All procedures were approved by the Institutional Review Board.

Stress assessment measures

Adolescent STRAIN. Participants' lifetime stress exposure was assessed using the Adolescent STRAIN (see http://www.strainsetup.com). Consistent with the development of the Adult STRAIN, stressors were identified for possible inclusion using a seven-step process. First, existing interview-based measures of life stress were reviewed to catalogue stressors that are frequently assessed. Second, an exhaustive review of existing studies on adolescent stress and health was conducted to identify stressors that consistently predict poor lifespan health. Third, expert life stress raters reviewed the initial list of possible stressors and made consensus judgments to: (a) eliminate stressors that were redundant or not moderate-to-severe in nature, (b) categorize stressors into primary life domains, and (c) identify the core social-psychological characteristic of each stressor. Fourth, consultation sessions were convened with external experts who specialize in the conceptualization and assessment of life stress exposure. These experts provided high-level input regarding the instrument and reviewed and suggested revisions for the reduced question set. Fifth, the wording of each stressor item was refined to ensure maximum clarity and readability. Sixth, the question order was adjusted to improve the interview flow and user experience. Finally, the interview was pilot tested with adolescents and, based on user feedback, the question set, item order, and specific wording of the interview was finalized.

The version of the Adolescent STRAIN employed here (version 1.1) assesses the severity, frequency, timing, and duration of 75 different stressors, including 33 acute life events and 42 chronic difficulties spanning 12 primary life domains (i.e. Housing, Education, Work, Treatment/Health, Marital/Partner, Reproduction, Financial, Legal/Crime, Other Relationships, Parent/Guardian, Death, Life-Threatening Situations) and five social-psychological characteristics (i.e. Interpersonal Loss, Physical Danger, Humiliation, Entrapment, Role Change/Disruption; see Table S2). After an individual endorses a stressor, the STRAIN system generates several tailored follow-up questions to ascertain the stressor's severity, frequency, timing, and duration. Based on these answers, the system can produce stress exposure summary scores and life charts that summarize individuals' total lifetime stressor count and severity for all of the acute life events and chronic difficulties experienced, both in aggregate and separately by timing of exposure and across the different life domains and social-psychological characteristics described above. Higher scores always indicate greater stress exposure.

Childhood adversity. Physical, sexual, and emotional abuse was assessed using the CTQ-SF (Bernstein et al., 2003). The CTQ-SF includes 25 items rated on a 5-point scale from 1 (*never true*) to 5 (*very often true*), which measure physical, emotional, and sexual abuse, and emotional and physical neglect. Total CTQ-SF scores can thus range from 25 to 125, with higher scores reflecting more severe childhood adversity. The internal consistency of the CTQ-SF was very good, $\alpha = .88$.

Peer stress and bullying. Experiences of peer stress, victimization, and bullying over the past year were assessed using the Revised Peer Experiences Questionnaire (RPEQ; Prinstein, Boergers, & Vernberg, 2001). The RPEQ includes nine items measuring how frequently respondents experienced various forms of peer stress. Individuals indicate the frequency of experiencing these circumstances on a scale from 1 (*never*) to 5 (*always*), and total RPEQ scores can thus range from 9 to 45, with higher scores indicating more life stress. The internal consistency of the RPEQ was excellent, $\alpha = .90$.

Psychiatric symptoms

Depression. Depressive symptoms were assessed with the widely used 20-item Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977). Each item is rated on a 4-point scale, ranging from 0 to 3, and total scores can thus range from 0 to 60. The internal consistency of the CES-D was excellent, $\alpha = .94$.

Anxiety. Anxiety symptoms were assessed using the Multidimensional Anxiety Scale for Children (MASC; March, Parker, Sullivan, Stallings, & Conners, 1997). The questionnaire includes 39 items that are rated on a 4-point scale, ranging from 0 to 3. Total scores can thus range from 0 to 117, with higher scores indicating more severe anxiety. The internal consistency of the MASC was excellent, $\alpha = .91$.

Anhedonia. Anhedonia symptoms were assessed using the Snaith-Hamilton Pleasure Scale (SHAPS; Snaith et al., 1995). Each of the 14 items is rated on a 4-point scale. Total scores can thus range from 14 to 56, with higher scores reflecting greater inability to experience pleasure. The SHAPS has demonstrated strong psychometric properties in samples of adolescent inpatients (Auerbach, Millner, Stewart, & Esposito, 2015), and the internal consistency of the SHAPS was very good, $\alpha = .89$.

General mental health complaints

Participants' general mental health complaints over the past month were assessed using the Kessler-6 item psychological distress inventory (K-6; Kessler et al., 2002). The K-6 differs from the above-mentioned scales in that it assesses non-specific psychological distress (e.g. feeling sad, nervous, restless, worthless) rather than symptoms of a specific disorder. Responses are given on a 1 (*never*) to 5 (*very often*) scale, and total scores can thus range from 6 to 30, with higher scores representing more mental health complaints. The K-6 possesses excellent psychometric properties and shows good convergence with DSM-IV based measures of mental health symptoms (Kessler et al., 2002). The internal consistency of the K-6 was very good, $\alpha = .88$.

General physical health complaints

Participants' general physical health complaints over the past month were assessed using the 14-item Physical Health Questionnaire (PHQ), which measures the frequency of experiencing a variety of different somatic symptoms including headaches, upset stomach, constipation, and cold symptoms (Spence, Helmreich, & Pred, 1987). Eleven items are rated from 1 (*not at all*) to 7 (*all the time*), 2 are rated from *0 times* to *7+ times*, and 1 item is rated from *1 day* to *7+ days*. Total scores can thus range from 14 to 98, with higher scores reflecting

more physical and somatic health problems. The internal consistency of the PHQ was good, α = .84.

Risky behaviors

Participants' engagement in risky behaviors over the past month was assessed using the Risky Behaviors Questionnaire for Adolescents (RBQ-A; Auerbach & Gardiner, 2012). This scale includes 20 items indicating the presence and frequency of several different risky behaviors, including sexual precociousness, aggression, and rule-breaking. Items are rated from 0 (*Never*) to 4 (*≥4 times/week*), and total scores can thus range from 0 to 80, with higher scores indicating more risky behaviors. The internal consistency of the RBQ-A was satisfactory, α = .77.

Interviewer-based psychiatric diagnoses

We assessed adolescents' current and lifetime psychiatric diagnoses using the MINI-KID (Sheehan et al., 2010), which was administered by interviewers who received at least 25 hr of closely supervised training. The MINI-KID has shown excellent reliability in both inpatient (Auerbach et al., 2014) and outpatient (Sheehan et al., 2010) adolescent samples. For analyses, we summed each participant's total number of psychiatric diagnoses to represent his or her overall psychiatric status. On average, participants met criteria for two current psychiatric diagnoses (M = 1.90, Mdn = 2.00, SD = 1.19; range: 0–7).

Data analysis

Preliminary analyses included descriptive statistics for the sample, and means and standard deviations for lifetime stressor count and severity. We used Pearson product-moment correlations and multiple linear regression models to analyze continuous dependent variables (e.g. psychiatric symptom severity), and Poisson regression models with robust standard errors for count outcomes (i.e. number of psychiatric diagnoses) to address overdispersion. McFadden's pseudo-R^2 is presented for Poisson regression models.

Results

Usability and acceptability of the STRAIN

Out of all youth who began the STRAIN, only 2.02% discontinued participation during the interview and no complaints were reported during debriefing. The median time to complete the STRAIN was 25 min (interquartile range = 20–32 min; min: 11 min, max: 95 min). The usability and acceptability of the Adolescent STRAIN was thus very good.

Descriptive statistics

Given the distinct absence of systematic lifetime stress exposure data on adolescents, we next characterized youths' lifetime experience of acute and chronic stressors. Participants experienced an average of 31 stressors over the lifespan (M = 31.17, SD = 14.99, range: 3–77; possible range: 0–214), including 17 acute life events (M = 17.14, SD = 9.88, range: 0–51; possible range: 0–168) and 14 chronic difficulties (M = 14.03, SD = 6.35, range: 1–37; possible range: 0–46). The total lifetime severity of all stressors, acute life events, and chronic difficulties was 75.94 (SD = 37.38), 26.33 (SD = 15.13), and 49.62 (SD = 24.79), respectively. Additional descriptive statistics by gender are available in Appendix S1.

Validity

We next examined how the Adolescent STRAIN performed in relation to the other stress assessment instruments administered, and the mental and physical health outcomes assessed.

Concurrent validity. We expected participants' lifetime stressor data to correlate with their childhood adversity severity levels (CTQ-SF) and their experiences of peer-related stress and bullying (RPEQ). As expected, total lifetime stressor count and total lifetime severity were strongly associated with participants' scores on both the CTQ-SF, $r(334) = .59$, $p < .001$ and $r(336) = .57$, $p < .001$, respectively, and the RPEQ, $r(333) = .54$, $p < .001$ and $r(336) = .50$, $p < .001$, respectively, thus providing evidence of the Adolescent STRAIN's concurrent validity.

Predictive validity. Next, we assessed the STRAIN's predictive validity in relation to several different psychiatric, health, and behavioral outcomes—namely, psychiatric symptoms, general mental and physical health complaints, risky behavior engagement, and interviewer-based psychiatric diagnoses. As predicted, total lifetime stressor count and severity were significantly associated with these seven outcomes: depression (count: $r[335] = .34$, $p < .001$; severity: $r[337] = .40$, $p < .001$), anxiety (count: $r[335] = .31$, $p < .001$; severity: $r[337] = .41$, $p < .001$), anhedonia (count: $r[335] = .18$, $p < .001$; severity: $r[337] = .19$, $p < .001$), general mental health complaints (count: $r[336] = .42$, $p < .001$; severity: $r[338] = .49$, $p < .001$), general physical health complaints (count: $r[336] = .47$, $p < .001$; severity: $r[338] = .52$, $p < .001$), risky behavior engagement (count: $r[334] = .44$, $p < .001$; severity: $r[336] = .40$, $p < .001$), and number of interviewer-based psychiatric diagnoses (count: $b = 0.013$, $SE = 0.002$, $Z = 5.94$, $p < .001$, risk ratio [RR] = 1.013, 95% confidence interval [CI] [1.009, 1.018]; severity: $b = 0.006$, $SE = 0.001$, $Z = 7.07$, $p < .001$, RR = 1.006, 95% CI [1.005, 1.008]). Consequently, for every additional stressor experienced, youths' likelihood of being diagnosed with an additional psychiatric disorder increased by 1.3%.

To examine the robustness of these associations, we reran these analyses while adjusting for participants' age, sex, and race. Adding these covariates to the models did not alter the results. Total lifetime stressor count remained significantly associated with all of the continuous outcomes assessed (βs = .16–.48, all ps < .006) and with having more interviewer-based psychiatric diagnoses, $b = 0.014$, $SE = 0.03$, $Z = 5.62$, $p < .001$, RR = 1.014, 95% CI

[1.009, 1.018]. Similarly, lifetime stressor severity remained significantly associated with all of the continuous outcomes assessed (βs = .16–.52, all ps < .004) and with having more interviewer-based psychiatric diagnoses, $b = 0.006$, $SE = 0.001$, $Z = 6.49, p < .001, \text{RR} = 1.006, 95\%\text{CI}[1.004, 1.008]$.

Comparative predictive validity. To examine the comparative predictive validity of the STRAIN, CTQ-SF, and RPEQ, we conducted analyses that simultaneously adjusted for these stress assessment instruments in addition to participants' age, sex, and race. As shown in Table 1, lifetime stressor count as measured by the STRAIN was significantly associated with all of the outcomes assessed except anhedonia ($p = .757$). Moreover, the STRAIN was generally more strongly related to these outcomes than the CTQ-SF or RPEQ. Additionally, only the STRAIN significantly predicted youths' psychiatric status, which was the most methodologically independent outcome assessed. Results for stressor severity were nearly identical to those observed for lifetime stressor count (see Table 1).

To more directly compare the STRAIN with the CTQ-SF and RPEQ, we next examined the percent of variance in each health outcome that was explained by the STRAIN out of the total variance explained by the complete model (i.e. STRAIN, CTQ-SF, RPEQ, age, sex, and race). As show in Table 2, lifetime stressor count explained substantial amounts of variance in these outcomes, including a full 30.08% of the total variance explained in number of interviewer-based psychiatric diagnoses. These results were replicated for lifetime stressor severity, although in almost all cases, lifetime stressor severity explained more variance than lifetime stressor count. For example, 42.81% of the variance in youths' number of interviewer-based psychiatric diagnoses was explained by the STRAIN's index of lifetime stressor severity (see Table 2).

Table 1 Comparative predictive validity of the STRAIN, CTQ-SF, and RPEQ

	STRAIN	CTQ-SF	RPEQ
STRAIN Lifetime Stressor Count			
		β	
Depression symptoms (CES-D)	**.18**	.08	**.19**
Anxiety symptoms (MASC)	**.16**	.05	**.22**
Anhedonia symptoms (SHAPS)	−.02	**.15**	**.16**
General mental health complaints (K-6)	**.35**	.04	.08
General physical health complaints (PHQ)	**.30**	**.14**	**.15**
Risky behaviors (RBQ-A)	**.22**	**.17**	**.24**
		Risk ratio	
Number of interviewer-based psychiatric diagnoses (MINI-KID)	**1.012**	1.002	1.002
STRAIN Lifetime Stressor Severity			
		β	
Depression symptoms (CES-D)	**.28**	.04	**.17**
Anxiety symptoms (MASC)	**.31**	−.02	**.17**
Anhedonia symptoms (SHAPS)	.01	.14	**.14**
General mental health complaints (K-6)	**.42**	.00	.08
General physical health complaints (PHQ)	**.38**	**.13**	**.15**
Risky behaviors (RBQ-A)	**.17**	**.19**	**.26**
		Risk ratio	
Number of interviewer-based psychiatric diagnoses (MINI-KID)	**1.006**	1.000	1.002

Significant p values ($p < .05$) are in bold. All associations are adjusted for relevant covariates—specifically, participants' age, sex, and race. Lifetime Stressor Count and Lifetime Stressor Severity refer to the Adolescent STRAIN variables used as predictors in these models. The CTQ-SF and RPEQ do not yield separate count and severity scores.

Effects by stressor type, life domain, and core-social psychological characteristic

Finally, we examined associations between different types of life stress exposure and adolescents' mental and physical health, based on the hypothesis that such effects are not constant across stressor types. Count of acute life events and chronic difficulties across the life course were both significantly associated with all outcomes, but these effects were generally stronger for chronic difficulties. Associations with psychiatric symptoms (i.e. depression, anxiety, and anhedonia severity), for example, were marginally stronger for total count of chronic difficulties (rs = .20–.37, ps < .001) than acute life events (rs = .15–.28, ps < .007). Total count of acute life events and chronic difficulties were both moderately strongly associated with general mental health (rs = .37 and .42, respectively; ps < .001) and physical health complaints (rs = .40 and .50, respectively; ps < .001), and both were also significantly associated with more interviewer-based psychiatric diagnoses (RRs = 1.018 and 1.033, respectively; ps < .001). Risky behavior engagement was the only outcome more strongly associated with acute life events ($r = .42$, $p < .001$) than chronic difficulties ($r = .38$, $p < .001$). Similar results were observed for lifetime stressor severity: as compared to acute life events, total severity of chronic difficulties was generally more strongly associated with psychiatric symptoms (events: rs = .15–.32, ps < .007; difficulties: rs = .19–.43, ps < .001), and with general mental and physical health complaints (events: rs = .40–.41, ps < .001; difficulties: rs = .48–.53, ps < .001). However, relative to chronic difficulties, acute life event severity was numerically more strongly associated with risky behaviors ($r = .41$ and $r = .36$, respectively; ps < .001) and interviewer based psychiatric diagnoses ($RR = 1.013$ and $RR = 1.009$, respectively; ps < .001).

Turning to the primary life domains, as shown in Figure 1, both lifetime stressor count and severity were each significantly associated with the seven outcomes assessed across all twelve life domains,

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Table 2 Variance explained in each outcome in each hierarchical regression model

Model	Depression symptoms (CES-D)		Anxiety symptoms (MASC)		Anhedonia symptoms (SHAPS)		General mental health complaints (K-6)		General physical health complaints (PHQ)		Risky behaviors (RBQ-A)		Number of interviewer-based psychiatric diagnoses (MINI-KID)[a]	
	Total R^2	Δ R^2	Total R^2	Δ R^2	Total R^2	Δ R^2	Total R^2	Δ R^2	Total R^2	Δ R^2	Total R^2	Δ R^2	Total R^2	Δ R^2
STRAIN Lifetime Stressor Count														
Covariates	.019	–	.051	–	.014	–	.040	–	.037	–	.001	–	.029	–
Covariates + CTQ-SF & RPEQ	.153	**.135*****	.170	**.119*****	.075	**.061*****	.161	**.122*****	.256	**.219*****	.243	**.242*****	.094	**.065*****
Covariates + CTQ-SF & RPEQ + STRAIN	.169	**.015***	.184	**.013***	.075	<.001	.221	**.060*****	.296	**.040*****	.269	**.026****	.134	**.040*****
% of total explained variance accounted for by the STRAIN	8.88%		7.07%		0.09%		27.15%		13.51%		9.67%		30.08%	
STRAIN Lifetime Stressor Severity														–
Covariates	— Identical to above —													
Covariates + CTQ-SF & RPEQ	— Identical to above —													
Covariates + CTQ-SF & RPEQ + STRAIN	.198	**.044*****	.225	**.054*****	.075	<.001	.260	**.098*****	.324	**.068*****	.258	**.015***	.164	**.070*****
% of total explained variance accounted for by the STRAIN	22.22%		24.00%		0.09%		37.69%		20.99%		5.81%		42.81%	

Significant p values are in bold. Number of psychiatric disorders, as assessed by the Mini International Neuropsychiatric Interview for children and adolescents (MINI-KID). Standard regression analyses were used for the CES-D, MASC, SHAPS, K-6, PHQ, and RBQ-A. Poisson regression analyses were used for interviewer-based psychiatric diagnosis analyses. CES-D, Center for Epidemiologic Studies Depression Scale; K-6, Kessler-6 item psychological distress inventory; MASC, Multidimensional Anxiety Scale for Children; PHQ, Physical Health Questionnaire; RBQ-A, Risky Behavior Questionnaire for Adolescents; SHAPS, Snaith-Hamilton Pleasure Scale.

[a]McFadden's pseudo R^2 is presented for number of interviewer-based psychiatric diagnoses.

*p < .05; **p < .01; ***p < .001.

*p*s < .001. However, there was also significant variability by life domains for all outcomes, *p*s < .001. Whereas stressors involving other relationships most strongly predicted nearly all of the outcomes assessed, reproduction-related stressors were unrelated to all outcomes, presumably due to the low base rate of reproduction-related stressors in this sample.

Finally, we examined associations between the different social-psychological characteristics assessed by the Adolescent STRAIN and the seven outcomes assessed. As shown in Figure 2, both lifetime stressor count and severity were each significantly associated with the outcome assessed across all of the social-psychological characteristics, *p*s < .001. Again, however, there was substantial variability in the magnitude of these associations. In fact, most of the outcomes showed significant differential associations by these stressor characteristics, *p*s < .015, with two exceptions: anhedonia was not differentially associated with the social-psychological characteristics for both lifetime stressor count and severity, *p*s > .163, and risky behavior engagement was not differentially associated with the social-psychological characteristics for lifetime stressor severity, $p = .128$. No systematic patterns emerged in the relative strength of associations for the different core social-psychological characteristics, indicating that rather than one characteristic being a better predictor of all outcomes, different characteristics were stronger predictors of certain outcomes than others.

Discussion

Numerous theories have posited that life stress exerts a cumulative impact on risk for psychopathology and poor physical health that unfolds over time. Given the inherently developmental nature of many of these theories, empirical studies testing such models should arguably assess stressful experiences occurring over the entire lifespan. However, interview-based measures that are generally regarded as gold-standard instruments for assessing life stress typically cover only the most recent 1–2 years of a person's life, and self-report checklist measures that assess stress over longer periods of time have well-known limitations caused, for example, by brief or vague items (leading to 'intracategory variability'); limited follow-up questions for assessing stressor severity, frequency, timing, and duration; and a restricted focus on particular stressors (e.g. childhood abuse, neglect) while ignoring other types of adversity that also affect health (Dohrenwend, 2006; Monroe, 2008; Slavich, 2019). As a result of these methodological limitations, while the theoretical literature on lifetime stress exposure and health is quite rich, the empirical literature remains scant.

We sought to address these issues by developing the Adolescent STRAIN. The system assesses a wide variety of acute life events and chronic difficulties that can impact adolescent health and development. Moreover, each stressor question includes substantial contextual information to help reduce intracategory variability, and tailored follow-up probes are used to ascertain additional details that are needed to determine exactly when a stressor occurred, how long it lasted, how many times it happened, and how much it impacted the individual. The resulting data provide a high-resolution, panoramic picture of adolescents' exposure to 75 major life stressors spanning two main stressor types, 12 primary life domains, and five social-psychological characteristics. These data can thus be used to study the effects of lifetime stress exposure on adolescent health in a highly granular and comparative manner.

In the present study, which represents the most in-depth examination of the Adolescent STRAIN to date, we found that the interview was completed relatively quickly (*Median* = 25 min), with a very high completion rate and no reported complaints. The STRAIN demonstrated very good concurrent validity and was associated with each of the health outcomes assessed. Additionally, when compared to the CTQ-SF and RPEQ in models that included each stress measures simultaneously and all of the demographic covariates assessed, the Adolescent STRAIN emerged as the strongest predictor of the seven outcomes examined and as the only instrument that predicted adolescents' independently evaluated psychiatric status. This predictive validity is best summarized in Table 2, which shows that the Adolescent STRAIN accounted for 30.08%–42.81% of the total variance explained in youths' psychiatric status in the fully adjusted models.

The fact that stress was associated with these outcomes is not itself surprising, given that similar results have been reported in prior studies using both self-report scales of early adversity (e.g. Childhood Trauma Questionnaire, Adverse Childhood Experiences Questionnaire) and interview-based measures (e.g. Childhood Experience of Care and Abuse, UCLA Life Stress Interview, Life Events and Difficulties Schedule). As described by Harkness and Monroe (2016), though, self-report scales suffer from several methodological limitations and interview-based systems require substantial training and time to implement (e.g. up to 6 hr/participant). The STRAIN, therefore, is not designed to replace more resource-intensive approaches, but rather to provide a reasonable alternative that is reliable, well-validated, and more feasible to implement, especially in research or clinical settings where time or resources are limited or where a more scalable approach is required.

Finally, consistent with research showing that different stressors can have unique physiologic and health consequences (Kemeny, 2003; Weiner, 1992), we found that the effects of different stressors were not uniform across different types of life stress

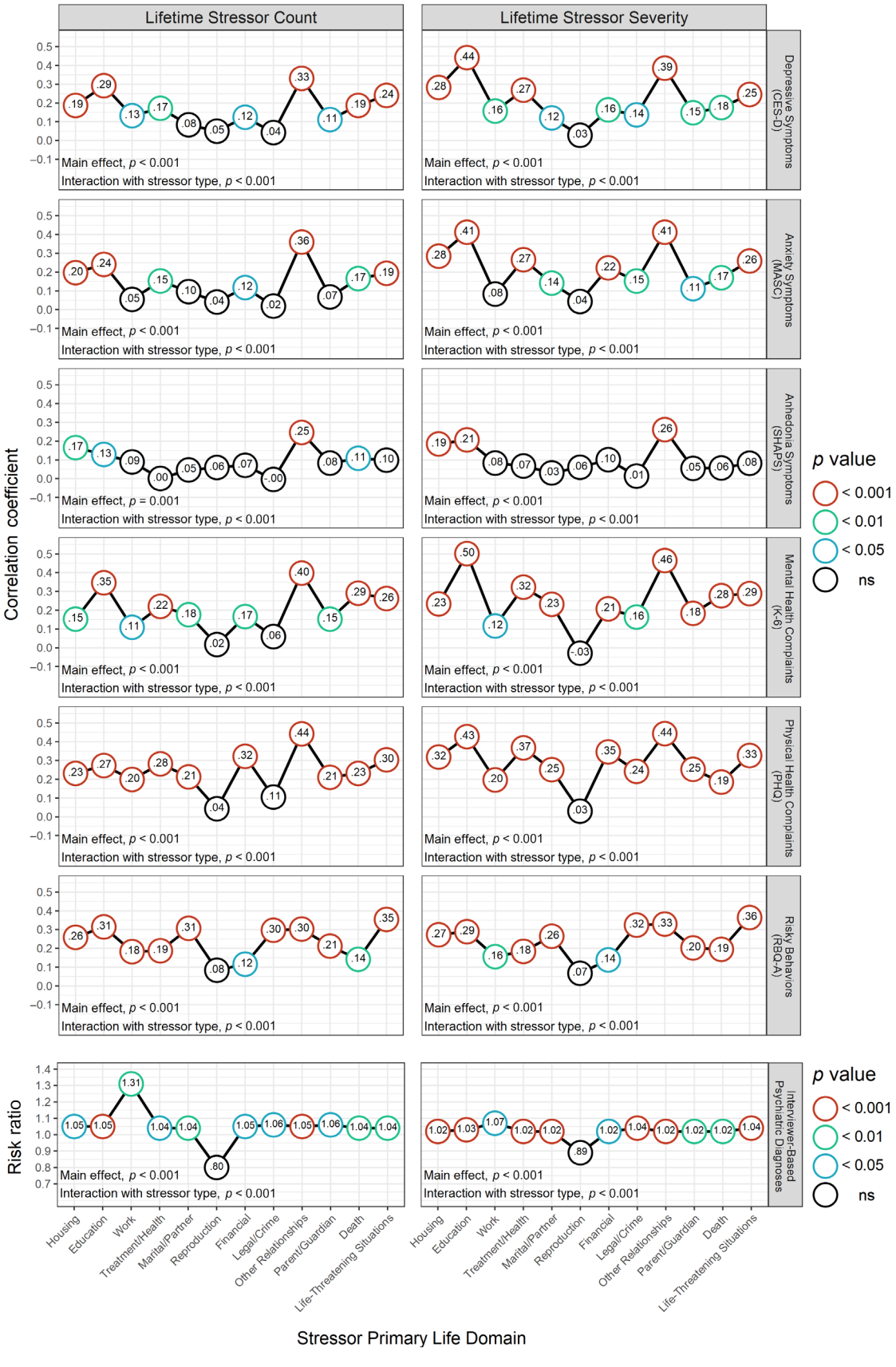

Figure 1 Associations between the twelve primary life domains assessed by the Adolescent STRAIN and the seven outcomes measured, shown separately for lifetime stressor count and lifetime stressor severity. Consistent with a *stressor characteristics perspective* on stress and health, stressors occurring in different life domains had substantially different associations with the health outcomes assessed. A significant 'Main effect' indicates that Lifetime Stressor Count or Lifetime Stressor Severity was significantly associated with the outcome indicated, without taking the specific type of stress exposure into account. In contrast, a significant 'Interaction with stressor type' indicates that there were significantly different effects for that particular outcome across the twelve primary life domains assessed by the Adolescent STRAIN. (N = 336–338, depending on outcome)

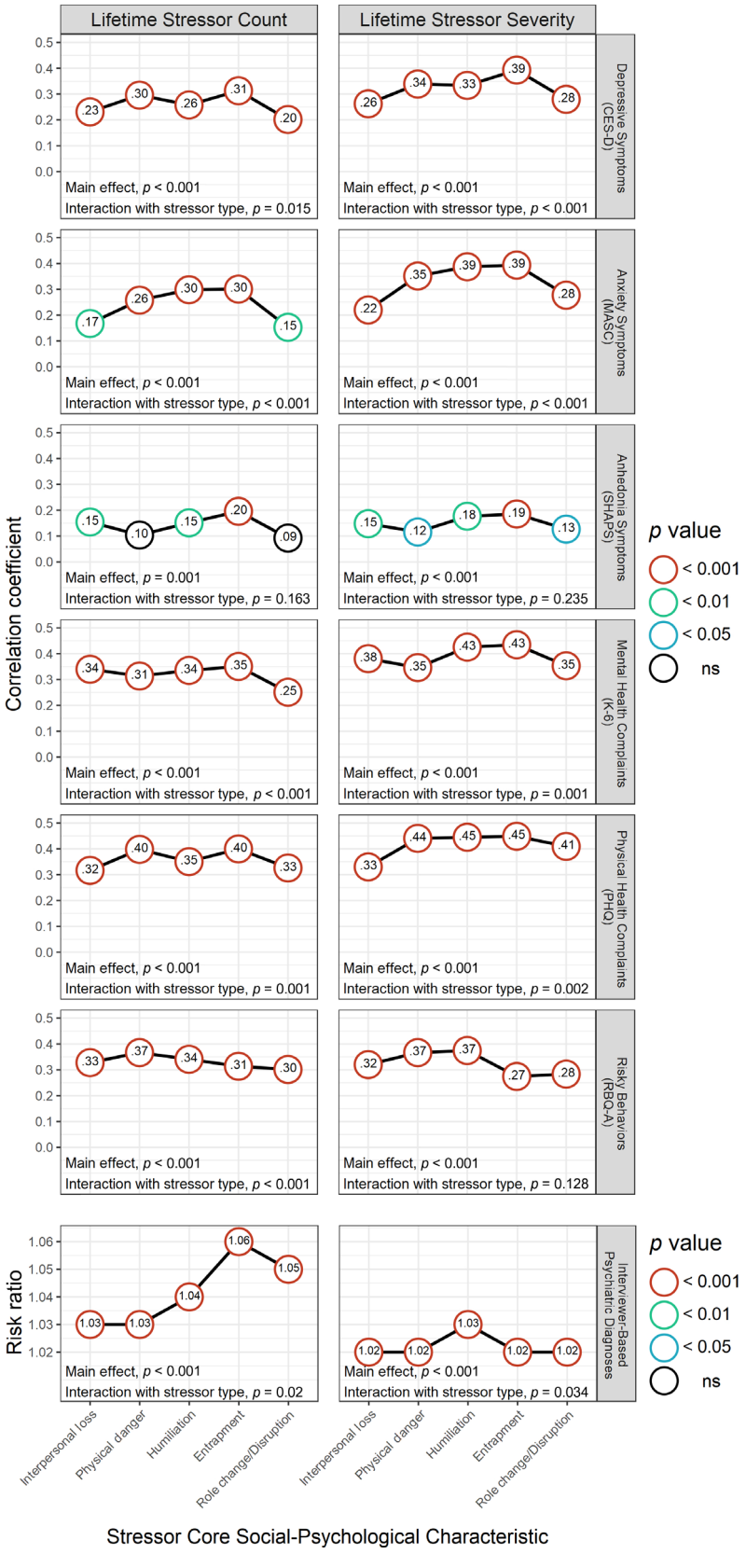

Figure 2 Associations between the five core social-psychological characteristics assessed by the Adolescent STRAIN and the seven outcomes measured, shown separately for lifetime stressor count and lifetime stressor severity. Consistent with a *stressor characteristics perspective* on stress and health, stressors possessing different social-psychological characteristics had substantially different associations with most of the health outcomes assessed. A significant 'Main effect' indicates that Lifetime Stressor Count or Lifetime Stressor Severity was significantly associated with the outcome indicated, without taking the specific type of stress exposure into account. In contrast, a significant 'Interaction with stressor type' indicates that there were significantly different effects for that particular outcome across the five different core social-psychological characteristics assessed by the Adolescent STRAIN. (N = 336–338, depending on outcome)

assessed by the Adolescent STRAIN but rather differed substantially as a function of the specific types of stress experienced. These data are consistent with our prior results from the Adult STRAIN (Slavich & Shields, 2018) and highlight the importance of using sophisticated instruments for assessing life stress. More broadly, these findings are consistent with existing research implicating stress in structuring risk for poor mental and physical health but extend this work by providing clear evidence that such associations differ across the specific types of stressors that youth experience.

Several limitations of this study should be noted. First, we sampled a clinical population, so lifetime stressor count and severity could be elevated relative to the general population, and future research with non-clinical populations is warranted to examine issues of generalizability. Second, scores on the STRAIN are based on participants' self-report. We have previously shown that the STRAIN is not influenced by personality or social desirability characteristics (Slavich & Shields, 2018), but such processes could still have played a role. Third, out of the seven outcomes assessed, only psychiatric diagnoses were based on a methodologically independent assessment. Therefore, additional research using outcomes that cannot be influenced by self-report is needed. Fourth, we compared the STRAIN to two self-report life stress measures to highlight the availability of a low-cost, psychometrically sound alternative to the types of scales presently used in almost all stress studies. Moving forward, though, the STRAIN should also be compared to interview-based systems. Finally, given the cross-sectional nature of this study, all of the associations reported here are correlational and causation cannot be assumed.

In conclusion, the present data show that the Adolescent STRAIN has excellent usability, very good concurrent validity, and outstanding predictive validity across a variety of mental and physical health outcomes. These data thus confirm the usability and validity of the Adolescent STRAIN and provide some of the first empirical evidence demonstrating the systematic relevance of lifetime stress exposure for multiple outcomes in adolescence. Most important, these data provide a highly nuanced picture of adolescents' lifetime stress burden that may be useful for case conceptualization and treatment planning purposes, as well as for informing next-generation theories of stress exposure and lifespan health. Looking forward, it will be important to compare the Adolescent STRAIN to other interview-based systems for assessing life stress, validate the instrument against other clinical and biological outcomes, and examine the generalizability of the present results to other populations and clinical groups.

Supporting information

Additional supporting information may be found online in the Supporting Information section at the end of the article:

Appendix S1. Additional descriptive statistics.

Table S1. Demographic and clinical characteristics of the sample, stratified by sex.

Table S2. Examples of stressors across the different stressor types, primary life domains, and social-psychological characteristics assessed by the adolescent STRAIN.

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Key points

- Numerous theories have proposed that lifetime stress exposure exerts a cumulative impact on adolescent health and development.
- However, few studies have actually tested these theories given the difficulty associated with systematically assessing lifetime stress exposure.
- By employing the Stress and Adversity Inventory for Adolescents (Adolescent STRAIN), we demonstrate that greater lifetime stress exposure is associated with a variety of adverse mental and physical health outcomes.
- Moreover, these stress-health links differ substantially by the specific types of stress experienced.
- Given the ability for the STRAIN to produce comprehensive lifetime stress exposure profiles, the system may be useful in both research and clinical settings.

Note

[1]Seventeen adolescents (5.03%) did not report their sex or answered 'prefer not to say' and were thus excluded from analyses testing sex differences.

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