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Supplementary Text

Description of the overlap between police record and self-report data for violent offending.

Of the 106 participants with an official record for violent crime, 46 (43.4%) self-reported two or more violent offenses and 21 (19.8%) self-reported one violent offense. Participants may have endorsed fewer than two violent offenses due to differences in the assessment periods for self-reports and police records. They may have been convicted of violent offenses not assessed in the self-report questionnaire (e.g., sexual assault). Concealment is possible, but unlikely as (a) participants provided consent for their criminal record to be searched, and (b) use of a computer questionnaire increases the validity of teens' reports of illegal behaviors.[1]

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ROC curve analysis of primary childhood risk factors.

We evaluated the accuracy with which our four primary childhood risk factors (low childhood self-control, maltreatment, childhood self-harm, and family psychiatric history) could predict membership in the dual-harm relative to the self-only harm group using a receiver operating characteristic (ROC) curve analysis. An ROC curve plots the sensitivity and specificity of prediction at various thresholds and yields a metric indexing predictive accuracy: the area under the curve (AUC[1]). The AUC reflects the probability of correctly classifying a randomly-selected pair of participants in which one individual is in the dual-harm group and the other is in the self-only harm group. The AUC can take on any value between 0.50 (indicating chance prediction) and 1.00 (indicating perfect prediction). AUC values of 0.56, 0.64, and 0.71 correspond to Cohen's d values of 0.20, 0.50, and 0.80, which reflect small, medium, and large effects, respectively.[2] Together, our four primary childhood risk factors predicted membership in the dual-harm relative to the self-only harm group with high accuracy (AUC=0.75, 95% CI=0.69-0.82). We note the important caveat that within-sample estimation can introduce bias in determining the predictive accuracy of a model. This analysis therefore requires out-of-sample replication.

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Table S1. Violent offenses for which participants had an official police record

Assault
    Common assault or battery
    Assaults occasioning actual bodily harm
    Malicious wounding or grievous bodily harm
    Assaulting a police officer
    Affray

Weapons offenses
    Firing an air weapon beyond premises
    Carrying a loaded firearm in a public place
    Having a bladed or pointed item in a public place
    Possession of a firearm with intent to cause fear or violence

Sexual offenses
    Sexual assault on a minor

Robbery
    Robbery
    Aggravated robbery
    Stealing from the person of another

Threats or intimidations
    Intimidating a juror or witness
    Fear or provocation of violence

Other
    False imprisonment
    Arson
    Racially aggravated incidents (including physical assault and verbal harassment)

Table S2. Violent offenses assessed via self-report at age 18

Item	Males		Females	
	Frequency (%)	N	Frequency (%)	N
Do you sometimes bully or threaten people who you don't like?	55 (5.7)	973	21 (1.9)	1080
Do you sometimes bully or threaten your twin or your brother or sister?	134 (13.8)	971	114 (10.6)	1080
Do you sometimes hit someone when you are having an argument?	199 (20.5)	973	159 (14.7)	1080
Do you sometimes start fights with people?	108 (11.1)	973	52 (4.8)	1080
Do you sometimes hit one of your parents or step-parents?	10 (1.0)	973	10 (0.9)	1080
Have you used a weapon on someone like a knife, piece of wood or baseball bat?	38 (3.9)	971	9 (0.8)	1080
Have you hurt someone just for the fun of it?	54 (5.6)	973	15 (1.4)	1080
Have you hurt someone just to be nasty?	52 (5.3)	973	33 (3.1)	1080
Have you tried to hurt an animal on purpose?	45 (4.6)	973	5 (0.5)	1080
Have you threatened someone to get money or stuff off them?	25 (2.6)	973	3 (0.3)	1080
Have you been in a gang fight?	86 (8.9)	972	12 (1.1)	1080
Have you taken part in happyslapping (either done the slapping or filmed it)?	89 (9.2)	973	24 (2.2)	1080

Note. Violent offenses were classified as those that involved the use of force or threat of force upon a victim.

Table S3. Description of the investigated risk factors for and correlates of dual-harm behavior

Measure	Age assessed	Informant	Description	Reference
Primary Childhood Risk Factors				
Low self-control	5, 7, 10	Mother, teacher, interviewer, participant	Children's self-control during their first decade of life was measured using a multi-occasion/multi-informant strategy. A self-control factor was estimated via nine measures, including observational ratings of children's lack of control (age 5 years), parent and teacher reports of poor impulse control (ages 5, 7, and 10 years), self-reports of inattentive and impulsive behavior (age 7 years), and interviewer judgements of the personality trait of Conscientiousness (age 10 years). 2,232 participants had data for self-control. The factor score was standardized to have a mean of 0 and a standard deviation of 1.	1
Supplemental reports of self-regulation difficulties	12	Mother, teacher	In addition to our summary measure of low childhood self-control, we collected information on caregiver- and teacher-reported self-regulation difficulties at age 12. Mothers responded to questions from a dimensional assessment of borderline personality related characteristics (BPRCs) derived from the Shedler-Westen Assessment Procedure 200-item Q-Sort for Adolescents (SWAP-200-A). They were asked to rate, over the prior six months, how true each item was of their child: (0) = "not true," (1) = "somewhat or sometimes true," and (2) = "very true or often true." We selected seven items that tapped into affective instability/dysregulation and impulsivity/behavioral dysregulation: (1) "angry and hostile"; (2) "irritable, touchy, or quick to 'fly off the handle'"; (3) "emotions spiral out of control, has extremes of rage, despair, excitement"; (4) "lacks stable image of self, changes goals/values"; (5) "expresses emotions in an exaggerated dramatic way"; (6) "unable to soothe or comfort self"; and (7) "cannot think when upset, becomes irrational." We constructed a dimensional scale by summing responses to the seven questions (N = 2,142). Prior to analysis, the individual items and the sum scale were standardized have a mean of 0 and a standard deviation of 1. Using a mailed questionnaire, teachers were asked to rate how frequently they needed to intervene with the child in the classroom. Teachers were asked to use a seven-point scale, ranging from 0 ("much less than typical pupils of the same age") to 6 ("much more than typical pupils of the same age"). The assessment included six items: (1) "How frequently must you act to curb disruptive behavior by this child?" (2) "How frequently must you give this	2-4

			child extra encouragement to get him/her to take part?" (3) "How frequently must you act to keep this child's attention on a task?" (4) "How frequently does this child's behavior make it rewarding to work with him/her?" (5) "How frequently does this child's behavior make it frustrating to work with him/her?" and (6) "How frequently does this child need one-to-one interaction from you?" We constructed a dimensional scale by summing responses to the six items (item 4 was reverse-coded; N = 1,766). Prior to analysis, the individual items and the sum scale were standardized have a mean of 0 and a standard deviation of 1.	
Maltreatment by adult	5, 7, 10, 12	Mother	Mothers reported on their children's exposure to maltreatment during a standardized clinical interview protocol, used when the child was aged 5, 7, 10, and 12 years. Only those children whom the interviewers rated as having definitely experienced physical or sexual harm by an adult before age 12 were considered to have been maltreated. Of the 2,232 participants, 128 (5.7%) were coded as positive for maltreatment.	5-7
Childhood self-harm	10, 12	Mother	At ages 10 and 12, mothers were asked whether each twin had deliberately harmed him/herself or attempted suicide in the previous six months. Participants were coded as positive if self-harm was reported at either assessment. They were coded as negative if self-harm was denied at both assessments. Of the 2,100 participants with childhood self-harm data, 90 (4.3%) were coded as positive.	7
Family history of psychiatric disorder	12	Mother	The mother was asked to report on her own mental health history and the mental health history of her biological mother, biological father, biological sisters, biological brothers, and the twins' biological father. Mothers were asked to report if anyone on the aforementioned list experienced difficulties with substance-use problems, alcohol problems, depression, psychosis, and suicide attempts. The mental health history items comprised four items on substance use derived from the short Michigan Alcoholism Screening Test and the Drug Abuse Screening Test, and one each on problems with drinking and drugs derived from the Family History Screen (FHS); five items on depression derived from the FHS; one item on suicide ideation derived from the FHS; and two items asking about hospitalization and treatment for 'other' mental health disorders. For each of the four domains (substance, depression, suicide, other), family members were considered to have a positive history if any items within that domain were answered positively, and a negative history otherwise. We calculated the proportion of family members with a positive history of any disorder. The average	8-12

			proportion of family members with a history of mental health problems was 0.37 (SD = 0.27, range = 0.0-1.0, N = 2,138).	
Secondary Childhood Risk Factors				
Low IQ	12	Participant	Children's intelligence was measured as IQ using the Weschler Intelligence Scale for Children - Revised (WISC-R; N = 2,131).	13
Depression	12	Participant	Children's depression was assessed using the Children's Depression Inventory (CDI). Of the 2,130 participants with CDI data, 74 (3.5%) met the threshold for clinically-significant depression (CDI score $\geq$ 20).	14
Anxiety	12	Participant	Children's anxiety was assessed using the Multidimensional Anxiety Scale for Children (MASC). Of the 2,130 participants with MASC data, 129 (6.1%) met the threshold for extreme anxiety ($\geq$ 95th percentile).	15
Correlates of Clinical Importance				
Mental Health				
PTSD	18	Participant	Based on DSM-IV criteria for current post-traumatic stress disorder. Of the 2,063 participants with PTSD data, 72 (3.5%) met criteria.	16
Depression	18	Participant	Based on DSM-IV criteria for major depressive episode. Of the 2,063 participants with depression data, 414 (20.1%) met criteria.	16
Psychotic symptoms	18	Participant	Based on DSM-IV criteria for psychotic symptoms. Reporting period covered the prior six years. Of the 2,063 participants with psychosis data, 59 (2.9%) endorsed one or more symptoms.	16
Alcohol dependence	18	Participant	Based on DSM-IV criteria for alcohol dependence. Of the 2,063 participants with alcohol dependence data, 263 (12.8%) met criteria.	16
Cannabis dependence	18	Participant	Based on DSM-IV criteria for cannabis dependence. Of the 2,066 participants with cannabis dependence data, 89 (4.3%) met criteria.	16
Victimization				
Adolescent victimization	18	Participant	At age 18, participants were interviewed about exposure to a range of adverse experiences between 12-18 years using the Juvenile Victimization Questionnaire, 2nd revision (JVQ-R2), adapted as a clinical interview. Each co-twin was interviewed by a different research worker, and each JVQ question was asked for the period "since you were 12." Age 12 is a salient age for our participants because it is the age when British children leave primary school to enter secondary school. The JVQ has good psychometric properties and was used in the U.K. National Society for the Prevention of Cruelty to Children (NSPCC) national survey, thereby providing important benchmark values for comparisons with our cohort. Our adapted JVQ comprised 45 questions covering 7 different forms of victimization: maltreatment, neglect, sexual victimization, family violence, peer/sibling victimization, internet/mobile phone victimization,	17-23

			and crime victimization. Exposure to each type of adolescent victimization was coded on a 3-point scale, in which "0" indicated "no exposure," "1" indicated "probable" or "less severe" exposure, and "2" indicated "definite" or "severe" exposure. In the current study, individuals who reported a "definite" or "severe" level of exposure were coded as positive.	
Poly-victimization	18	Participant	The adolescent poly-victimization variable was derived by summing all victimization experiences that received a code of "2" (severe exposure). Of the 2,062 adolescents with poly-victimization data, 1,332 (64.6%) had zero severe victimization experiences; 396 (19.2%) had one; 195 (9.5%) had two; and 139 (6.7%) had three or more severe victimization experiences.	17-23
Personality Functioning	18	Mother, co-twin, other relative, boy/girlfriend, brother/sister, other	At age 18, participants nominated two people "who knew them well." These informants were provided with questionnaires and asked to describe each participant using a 25-item version of the Big Five Inventory measuring the personality traits of Agreeableness, Conscientiousness, Neuroticism, Extraversion, and Openness to Experience. The majority of informant reports were provided by parents and co-twins. 2,050 participants had personality data, of whom 82.6%-82.7% had data from two co-informants (N's varied slightly across the traits). Where two informants provided data, scores were averaged. Where one informant provided data, the participant's score was taken from that informant. Prior to averaging across co-informants, scores were standardized to have a mean of 0 and a standard deviation of 1. Final composite scores were then re-standardized.	24
Service Use	18	Participant	At age 18, participants were queried regarding their use of treatment for emotional problems in the past year. Participants were asked whether they had used 15 different types of services, including mental health professionals (psychiatrist or psychologist/counsellor/psychotherapist) and other resources (e.g., medical doctor, social services). Participants were also asked whether they had taken any medication in the past year because of emotional problems. 2,065 participants provided data concerning service use, of whom 347 (16.8%) reported using any services, 143 (6.9%) reported using mental health services, and 109 (5.3%) reported taking medication.	25

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Table S4. Comparing dual- and self-only harm groups on personality functioning[a]

Subscale	Self- and Other-Harm Status			t Values[e]		
	Neither (N) n = 1475[b]	Self-Only (S) n = 177[c]	Dual (D) n = 97[d]	S vs. N[f]	D vs. N[f]	D vs. S[g]
	Mean [SD]					
Openness to Experience	0.03 [0.98]	0.24 [0.95]	-0.15 [0.98]	$t = 2.20, p = 0.03$	$t = -1.46, p = 0.14$	***t = -2.57, p = 0.01***
Conscientiousness	0.11 [0.97]	-0.05 [0.95]	-0.65 [0.95]	$t = -2.97, p = 0.003$	$t = -7.15, p < 0.0001$	***t = -3.45, p < 0.001***
Extraversion	-0.01 [1.01]	-0.05 [0.98]	0.09 [0.90]	$t = -1.32, p = 0.19$	$t = 1.44, p = 0.15$	***t = 2.40, p = 0.02***
Agreeableness	0.14 [0.96]	-0.12 [0.99]	-0.58 [1.04]	$t = -3.72, p < 0.001$	$t = -6.09, p < 0.0001$	***t = -2.82, p = 0.005***
Neuroticism	-0.11 [0.97]	0.50 [1.01]	0.38 [1.01]	$t = 6.37, p < 0.0001$	$t = 4.75, p < 0.0001$	$t = -0.49, p = 0.63$

Note. Values are mean *z* scores. Personality functioning was assessed at age 18. All regression models controlled for sex. Bolded estimates indicate a significant difference between the dual-harm and self-only harm groups, which was the test of interest.

[a] Groups were included as predictors in the regression models first as a set of binary dummy codes (with the neither-harm group specified as the reference category), and then as a two-level nominal variable (to compare risk between the dual-harm and the self-only harm groups). We also ran analyses using one set of regression models, with an omnibus test for 'group' (three-level nominal variable) and post-hoc comparisons of means. Omnibus tests were significant for all predictors except Extraversion ($F_{(2,972)} = 2.16, p = 0.12$). Results of all post-hoc comparisons were consistent with the analyses presented in the table.
[b] Number of participants with data = 1463.
[c] Number of participants with data = 176.
[d] Number of participants with data = 91.
[e] Degrees of freedom for t-tests = number of family clusters minus 1.
[f] Degrees of freedom = 972.
[g] Degrees of freedom = 223.

Table S5. Predicting dual- versus other-only harm status from childhood risk factors

Risk Factor	Self- and Other-Harm Status				Odds Ratio [95% CI]
	Neither (N) n = 1475	Self-Only (S) n = 177	Other-Only (O) n = 300	Dual (D) n = 97	D vs. O
Primary risk factors[a]					
Low self-control, Mean [SD][b,c]	-0.19 [SD=0.94]	-0.03 [0.89]	0.58 [1.03]	0.70 [1.08]	1.27 [0.98, 1.63]
Maltreatment, No. (%)	58 (3.9%)	14 (7.9%)	31 (10.3%)	18 (18.6%)	1.98 [0.98, 3.97]
Childhood self-harm, No. (%)	39 / 1419 (2.8%)	17 / 172 (9.9%)	10 / 281 (3.6%)	13 / 93 (14.0%)	**4.70 [1.92, 11.50]**
Family psychiatric history, Mean [SD][d]	0.35 [SD=0.26] (n=1441)	0.45 [0.31] (n=171)	0.41 [0.27] (n=288)	0.45 [0.26] (n=93)	1.78 [0.78, 4.09]
Secondary risk factors[e]					
IQ, Mean [SD]	100.15 [15.08] (n=1442)	98.06 [15.23] (n=171)	95.76 [15.87] (n=287)	91.94 [16.88] (n=93)	0.98 [0.97, 1.00]
Depression, No. (%)	26 / 1441 (1.8%)	14 / 171 (8.2%)	16 / 287 (5.6%)	14 / 93 (15.1%)	**3.16 [1.51, 6.61]**
Anxiety, No. (%)	74 / 1442 (5.1%)	19 / 171 (11.1%)	15 / 287 (5.2%)	10 / 93 (10.8%)	1.99 [0.89, 4.44]

Note. Measures were assessed between ages 5-12. The number of participants with data is reported when lower than the group sample size. All regression models controlled for sex. Bolded estimates indicate a significant difference between the dual-harm and other-only harm groups.

[a] Primary risk factors were prespecified.
[b] The self-control factor score was standardized to have a mean of 0 and a standard deviation of 1.
[c] Higher scores indicate lower levels of self-control (more self-control difficulties).
[d] Indicates the proportion of a participant's relatives with a psychiatric disorder.
[e] Secondary risk factors were added in response to peer review.

Table S6. Comparing dual- and other-only harm groups on correlates of clinical importance

	Self- and Other-Harm Status				Odds Ratio [95% CI]
Mental Health Difficulties	**Neither (N)** n = 1475[a]	**Self-Only (S)** n = 177[b]	**Other-Only (O)** n = 300[c]	**Dual (D)** n = 97[d]	**D vs. O**
	No. (%)				
PTSD	26 (1.8)	24 (13.6)	7 (2.3)	13 (13.5)	**7.27 [2.74, 19.29]**
Depression	182 (12.4)	95 (54.0)	78 (26.0)	58 (59.8)	**3.99 [2.47, 6.46]**
Psychotic symptoms	18 (1.2)	16 (9.0)	8 (2.7)	16 (16.5)	**6.98 [2.81, 17.30]**
Alcohol dependence	144 (9.8)	23 (13.0)	63 (21.0)	33 (34.4)	**2.00 [1.19, 3.34]**
Cannabis dependence	19 (1.3)	11 (6.2)	34 (11.3)	25 (25.8)	**3.16 [1.64, 6.08]**
Victimization Experiences[e]					
Poly-victimization[f]	36 (2.4)	38 (21.5)	31 (10.3)	32 (33.3)	**4.00 [2.27, 7.05]**
Conventional crime	179 (12.1)	59 (33.3)	101 (33.7)	54 (55.7)	**2.63 [1.66, 4.15]**
Maltreatment	15 (1.0)	17 (9.6)	15 (5.0)	20 (20.6)	**4.89 [2.48, 9.62]**
Neglect	12 (0.8)	13 (7.3)	5 (1.7)	14 (14.6)	**10.28 [3.79, 27.85]**
Sexual	7 (0.5)	25 (14.1)	6 (2.0)	15 (15.6)	**7.48 [3.05, 18.39]**
Family	118 (8.0)	41 (23.2)	56 (18.7)	33 (34.4)	**2.21 [1.31, 3.72]**
Internet	69 (4.7)	24 (13.6)	23 (7.7)	15 (15.6)	1.79 [0.89, 3.63]
Peer	152 (10.3)	64 (36.2)	67 (22.3)	36 (37.5)	**2.01 [1.22, 3.30]**

Note. All measures were assessed at age 18. All regression models controlled for sex. Bolded estimates indicate a significant difference between the dual-harm and other-only harm groups. Prevalence estimates are derived using the number of participants with data for the measure; this was occasionally slightly lower than the group sample size.

[a] Number of participants with data ranged from 1473-1475.
[b] Number of participants with data ranged from 176-177.
[c] Number of participants with data = 300.
[d] Number of participants with data ranged from 96-97.
[e] Prevalences for victimization experiences indicate the percentage of individuals who reported a severe level of exposure.
[f] Poly-victimization = 3 or more types of victimization.

Table S7. Comparing dual- and other-only harm groups on personality functioning

Subscale	Neither (N) n = 1475[a]	Self-Only (S) n = 177[b]	Other-Only (O) n = 300[c]	Dual (D) n = 97[d]	D vs. O
			Mean [SD]		
Openness to Experience	0.03 [0.98]	0.24 [0.95]	-0.21 [1.06]	-0.15 [0.98]	$t = -0.09, p = 0.93$
Conscientiousness	0.11 [0.97]	-0.05 [0.95]	-0.25 [1.04]	-0.65 [0.95]	***t = -3.90, p < 0.001***
Extraversion	-0.01 [1.01]	-0.05 [0.98]	0.06 [0.97]	0.09 [0.90]	$t = -0.31, p = 0.75$
Agreeableness	0.14 [0.96]	-0.12 [0.99]	-0.43 [0.95]	-0.58 [1.04]	$t = -1.31, p = 0.19$
Neuroticism	-0.11 [0.97]	0.50 [1.01]	0.06 [0.95]	0.38 [1.01]	***t = 2.42, p = 0.02***

The header spans: **Self- and Other-Harm Status** (columns N, S, O, D) and *t* **Values**[e] (column D vs. O).

Note. Values are mean *z* scores. Personality functioning was assessed at age 18. All regression models controlled for sex. Bolded estimates indicate a significant difference between the dual-harm and other-only harm groups.

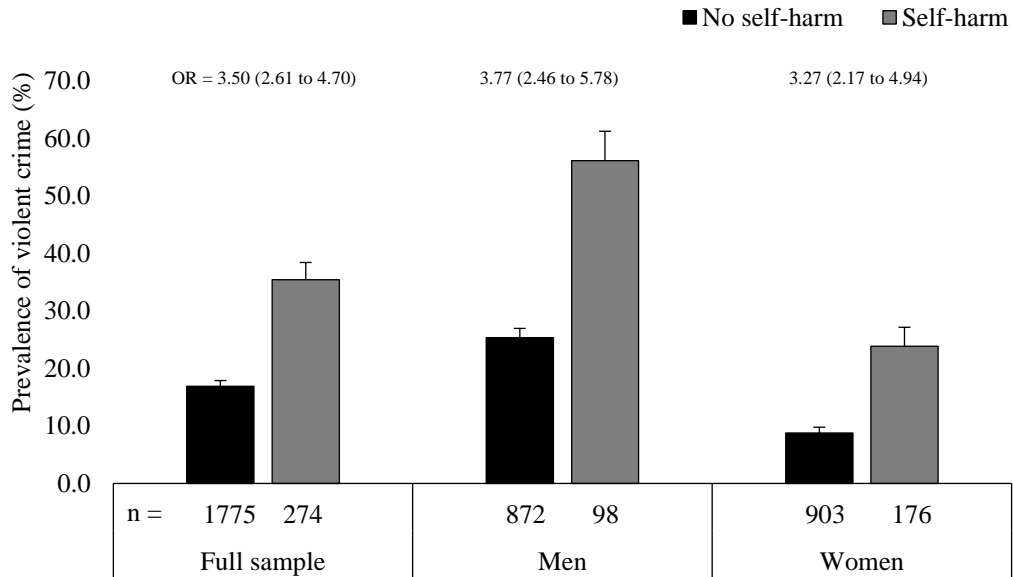[a] Number of participants with data = 1463.
[b] Number of participants with data = 176.
[c] Number of participants with data = 294.
[d] Number of participants with data = 91.
[e] Degrees of freedom for t-tests = 300 (number of family clusters minus 1).
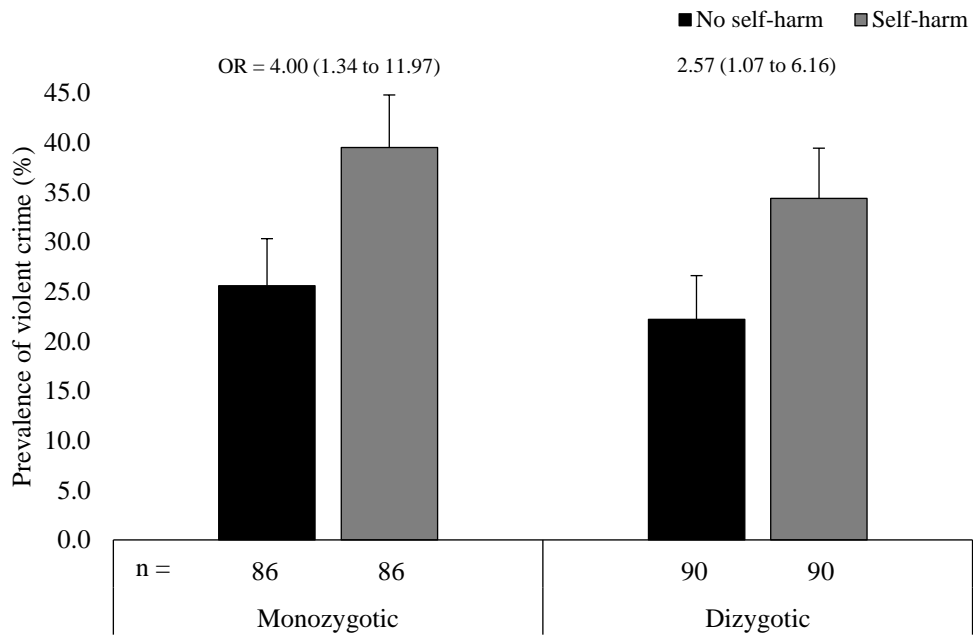
Figure S1. Prevalence of violent crime among adolescents who do and do not self-harm

Note. Associations between self-harm and violent crime are expressed as odds ratios (OR) with 95% confidence intervals. Odds ratio for the full sample estimated controlling for sex. Without adjustment for sex, the odds ratio was 2.69 (2.04 to 3.56). Error bars = robust standard errors.

Figure S2. Prevalence of violent crime in same-sex twin pairs discordant for self-harm

Note. Associations between self-harm and violent crime within discordant pairs are expressed as odds ratios (OR) with 95% confidence intervals. Error bars = standard errors.

Figure S3. Proportion of neither-harm, self-only harm, and dual-harm groups that experienced zero, one, two, or three or more types of severe victimization in adolescence
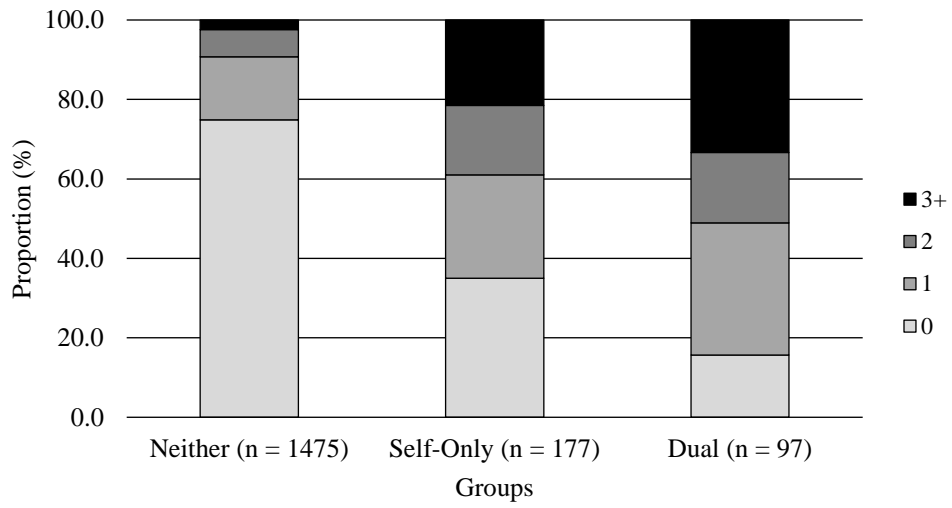
Note. Within the dual-harm group, 96 individuals provided poly-victimization data.