Journal of Affective Disorders 394 (2026) 120527

Contents lists available at ScienceDirect

Journal of Affective Disorders

journal homepage: www.elsevier.com/locate/jad

Research paper

Learning disabilities and adolescent suicidal ideation: Findings from the z-proso cohort study

Marta Codina [a,*], Diego A. Díaz-Faes [b], Noemí Pereda [a], Denis Ribeaud [c], Manuel Eisner [c,d], Ingrid Obsuth [e]

[a] Department of Clinical Psychology and Psychobiology, Institute of Neurosciences, Universitat de Barcelona, Barcelona, Spain
[b] Department of Epidemiology, Mailman School of Public Health, Columbia University, New York, NY, United States
[c] Jacobs Center for Productive Youth Development, University of Zurich, Zurich, Switzerland
[d] Institute of Criminology, University of Cambridge, Cambridge, UK
[e] Health in Social Science, University of Edinburgh, Edinburgh, United Kingdom

ARTICLE INFO

Keywords:
Suicide
Suicidality
Suicidal thoughts
Self-injury
Adolescents
Learning disabilities
Internalizing symptoms

ABSTRACT

Objective: To investigate suicidal ideation among adolescents with learning disabilities and examine whether learning disabilities and a range of risk and protective factors assessed at age 13 are associated with suicidal ideation at age 15.

Methods: Longitudinal data were drawn from a youth population-based cohort (Zurich Project on the Social Development from Childhood to Adulthood [z-proso]; $N = 1675$). Modified Poisson regression was used to estimate the relative risk of suicidal ideation at age 15, with learning disabilities along with the other variables as predictors. An additional model included an interaction term between learning disabilities and anxiety/depression symptoms to test whether the association between anxiety/depression and suicidal ideation varied by learning disability status. Average marginal effects were used to estimate absolute differences in predicted probabilities between groups.

Results: Adolescents with learning disabilities reported significantly higher rates of suicidal ideation (32.5 %) and self-injury (18.4 %) compared to peers without learning disabilities. They showed elevated levels of most risk factors and lower levels of protective factors. Significant predictors of increased relative risk of suicidal ideation included female sex, anxiety/depression symptoms, bullying experiences, and learning disabilities, the latter associated with a 40.2 % higher risk ($RR = 1.402$, 95 % CI = [1.070, 1.387]). Average marginal effects indicated that anxiety/depression significantly increased suicidal ideation risk among adolescents without learning disabilities but not among those with learning disabilities.

Conclusions: Findings suggest that learning disabilities are a significant risk factor for adolescent suicidal ideation, highlighting the need for early identification, tailored assessment, and targeted prevention strategies.

1. Introduction

Suicide is a global public health issue and a leading cause of death, especially among adolescents and young adults (Bertuccio et al., 2024). Suicidality encompasses self-harm (non-fatal acts with or without the motivation to die) and suicide attempts, as well as suicidal ideation (SI), which includes thoughts of suicide, a desire to die, or the expression of suicidal intent (De Leo et al., 2021). SI predicts future planning and attempts, with risk increasing based on the frequency and content of these thoughts, distress levels, and access to means (Franklin et al., 2017; Turecki et al., 2019). Self-injury, even when classified as non-suicidal, is a significant predictor of SI and attempts (Ribeiro et al., 2016). Non-suicidal self-injury is considered a maladaptive emotional regulation strategy, more common among adolescents with poor coping skills and impulse control difficulties (Wolff et al., 2019). Suicidality is a complex, multifactorial phenomenon shaped by individual, social, and environmental factors (Franklin et al., 2017; Turecki et al., 2019). Predicting suicidality remains challenging due to the numerous interacting

* Corresponding author at: Departament de Psicologia Clínica i Psicobiologia, Facultat de Psicologia, Universitat de Barcelona, Passeig Vall d'Hebron, 171, 08035, Barcelona, Spain.
E-mail address: martacodinacobo@ub.edu (M. Codina).

https://doi.org/10.1016/j.jad.2025.120527
Received 7 June 2025; Received in revised form 19 September 2025; Accepted 22 October 2025
Available online 25 October 2025

and dynamic variables involved (Franklin et al., 2017). Moreover, no universal risk formula exists, as it varies across populations.

In adolescent populations, several well-established factors have been consistently associated with SI. Uddin et al., using data from the Global School-based Student Health Survey, estimated the overall 12-month prevalence of SI at 16.9 % (Uddin et al., 2019). Older adolescents (aged 15–17 years) and girls showed a higher prevalence of SI compared to younger adolescents and boys. Gender differences were also reported in previous studies, with gendered risk factors and pathways (Thompson and Light, 2011). The cumulative effect of adverse childhood experiences (ACEs) is a well-documented risk factor for suicidality (Fuller-Thomson et al., 2016; Sahle et al., 2022; Thompson et al., 2019). ACEs negatively affect adolescents' mental health and are frequently linked to internalizing disorders, such as anxiety and depression and to increased substance use. These pathways appear to mediate the relationship between ACEs and suicidality, further compounding the risk (Dube et al., 2001; Fuller-Thomson et al., 2016; Sahle et al., 2022). Bullying is one of the most significant and extensively researched forms of peer victimization in adolescence associated with SI (Espelage and Holt, 2013; Holt et al., 2015). A range of negative effects have been linked to bullying, including distress, feelings of worthlessness and hopelessness, and isolation (Espelage and Holt, 2013). The literature highlights the role of social support and inclusion as protective factors against suicidality (Miller et al., 2015; Miranda-Mendizabal et al., 2019).

Previous research has also shown that adolescents with disabilities are at increased risk of engaging in suicidal behaviors compared to their peers without disabilities (Emerson et al., 2024; Moses, 2018). Within this group, those with learning disabilities (LD) may be one of the subgroups particularly vulnerable.

1.1. Learning disabilities and suicidal ideation

LD are among the most common neurodevelopmental disabilities, affecting approximately 5 to 15 % of children and adolescents (Butterworth and Kovas, 2013; Grigorenko et al., 2020). LD entail difficulties in reading, comprehension, attention, and memory that impact academic achievement, daily living, and social interactions (Grigorenko et al., 2020). Specific LDs, such as dyslexia, dyscalculia, and dysgraphia, often co-occur and are frequently comorbid with other neurodevelopmental disorders, such as ADHD and autism (Butterworth and Kovas, 2013; Grigorenko et al., 2020).

Among the negative consequences of these difficulties are increased negative self-evaluation, lower self-esteem, feelings of inadequacy, difficulties in emotion regulation, and heightened levels of distress, depression, and anxiety (Nelson and Harwood, 2011; Svetaz et al., 2000; Wilson et al., 2009). Adolescent samples report greater academic struggles, school trouble and dropout, social isolation, histories of victimization and bullying, substance use and criminal behavior (Boyes et al., 2020; Daniel et al., 2006; Mishna, 2003; Willcutt et al., 2007). It is not LD itself that confers risk, but rather the challenges and environmental pressures associated with the disability that place adolescents in a comparatively more vulnerable position compared to their peers without disabilities. Assessing the extent of suicidal risk in this group is complex, as it is shaped by interrelated and continually interacting factors, including individual characteristics, personal skills, and broader social determinants of health.

Despite extensive research on suicide risk in general adolescent populations, little is known about those with LD. Svetaz et al. using data from the National Longitudinal Study of Adolescent Health in the United States, found that adolescents with LD were more likely to report emotional distress and suicide attempts compared to their peers without LD (Svetaz et al., 2000). Two other studies based on cross-sectional data from national health surveys in Canada, found similar increased suicide risk among those with LD (Fuller-Thomson et al., 2018; Wilson et al., 2009). Wilson et al. found poor mental health outcomes and three times higher odds of SI in individuals who self-reported having LD, compared to their counterparts without LD (Wilson et al., 2009). Fuller-Thomson et al. (2018), focusing on suicide attempts in adults, also found high odds of suicide attempts among those with LD. Similarly, other studies using small samples of school-aged adolescents with LD have also found increased odds of SI (Boyes et al., 2020; Daniel et al., 2006). Finally, although anxiety and depression are key correlates of SI, their effects may operate differently in adolescents with LD than in their non-LD counterparts, as social, academic, and structural LD-related challenges may moderate the association between mood symptoms and SI. Understanding the association between LD and SI is therefore important to shed light on the mechanisms underlying this relationship.

1.2. Objectives

Using the Zurich Project on the Social Development from Childhood to Adulthood (z-proso), we examine the association between LD and SI, evaluating how a broad range of risk and protective factors measured in early adolescence relate to SI two years later. A prospective longitudinal design allows us to examine how these factors in early adolescence predict later SI, offering insights that cross-sectional studies cannot provide. In this study, a single self-reported measure is used to conceptualize the LD population. While this is the first study to examine LD in the z-proso cohort, prior research using the dataset has explored SI in relation to bullying victimization (Zhu et al., 2022) and in other vulnerable groups, including LGB youth (Garcia Nuñez et al., 2022).

We aim to (1) explore the prevalence of SI and self-injury among a cohort sample of adolescents comparing those with and without LD; (2) determine the independent associations between a set of established risk and protective factors and SI; (3) explore whether the association between anxiety and depression symptoms and SI differs by LD status.

2. Methods

2.1. Participants

This research article utilized the z-proso (Ribeaud et al., 2022). This cohort study began in 2004 with an initial target sample of 1675 children from 56 primary schools. The sample was randomly selected and stratified by size and location from the total population of 2500 first-grade students attending 89 public schools in Zurich. The z-proso investigates risk factors associated with child and human development, mental health, violence, delinquency, and other problem behaviors across the life course. It examines key socio-ecological risk domains, including individual, family, school, and environmental factors. The study incorporates multiple data sources, such as teacher, parent, and child interviews, observational measures, and criminal records. To date, the study consists of nine waves (ages 7 to 24). For details on the study procedure and a complete list of measures for each wave, see (z-proso Project Team, 2024). The present study used data from children who participated in Wave V (age 13) and Wave VI (age 15). Participants who did not take part in either wave were excluded, resulting in a final sample of 1482 youth.

2.2. Measures

2.2.1. Learning disabilities at age 15 (Wave VI)

The participants who self-reported having a disability consisting of "*Learning, memory, or concentration difficulties*" and/or "*Difficulty understanding the others in your usual language or being understood by the others*". Information on disabilities was collected only once, in Wave 6. It was assessed using the item from the z-proso Project Team, adapted from the Washington Group on Disability Statistics (WG) (Washington Group on Disability Statistics, 2009). Although assessed at age 15, it was used as a proxy for longstanding neurodevelopmental difficulties, given that LDs are typically early-onset and lifelong in nature (Thapar et al., 2017). This aligns with the understanding that such conditions often precede

adolescence, even if not formally diagnosed earlier. For the purposes of this study, LD was dichotomized (0 = non-learning disabilities, 1 = learning disabilities).

2.2.2. Sociodemographics at age 13 (Wave V)

Exact *Age* at the time of the interview was treated as a continuous variable. *Sex* was binary (0 = male, 1 = female), and country of birth was dichotomized as *Swiss-born* vs. *foreign-born* (0 = no, 1 = yes), given that 89.5 % of participants were born in Switzerland. Note, however, that 49.6 % of the participants were born to immigrated parents.

2.2.3. Predictors: risk factors at age 13 (Wave V)

2.2.3.1. School difficulties. A four-item portraying academic struggles that adolescents can face at school measured with a 4-point Likert scale developed by the study team, ranging from 'fully untrue' to 'fully true', subsequently summed up to create a composite score with higher scores indicating greater difficulties.

2.2.3.2. Serious victimization. The prevalence of four violent victimizations in the past year, including robbery, assault with/without a weapon resulting in an injury, and sexual assault, was measured using the Serious Victimization Scale, an instrument adapted for the z-proso study. The responses were collapsed into a dichotomous yes/no variable.

2.2.3.3. Bullying victimization. Five types of bullying over the last year were assessed: teasing, stealing/damaging belongings, physical violence, rejection, and sexual harassment, using the ZBBS (Murray et al., 2021), with a 6-point Likert scale ranging from 'never' to '(almost) every day'. Responses were averaged to a composite score, with higher scores indicating a higher frequency of bullying.

2.2.3.4. Life events. A collection of 21 potentially stressful events (Steinhoff et al., 2020), including, for example, parental divorce, illness, death of close family members or friends, romantic breakups, being expelled from the school, or running away. A cumulative sum score was calculated to reflect the total number of experienced events in the last six months.

2.2.3.5. Substance use. It captured the average frequency of substance use, comprising the combined use of alcohol, tobacco, and cannabis over the last year. It was assessed using a checklist of substances along with the frequency of their consumption measured with a 6-point Likert scale ranging from 1 = never to 6 = daily. Higher scores indicate higher frequency.

2.2.3.6. Anxiety and depression symptoms. They were assessed with the internalizing dimensions of the Social Behavior Questionnaire (SBQ) (Murray et al., 2019). This is an eight-item scale measured using four questions for each construct (anxiety and depression) over the last month, on a 5-point Likert scale from 'never' to 'very often'. Responses were averaged to a composite score, with higher values reflecting more anxiety/depression symptomatology.

2.2.3.7. Low self-control. Was measured with a 10-item adaptation of the Grasmick Self-Control Scale (Grasmike et al., 1993), using a 4-point Likert scale ranging from 'fully untrue' to 'fully true'. Includes five subdimensions: impulsivity, self-centeredness, risk-seeking, preference for physical activities, and volatile temper. Higher values on the final composite score reflect lower self-control.

2.2.3.8. Perceived social exclusion. It was assessed with a seven-item scale (Bude and Lantermann, 2006), with items such as 'not feeling a part of society' or 'being segregated'. It was measured with a 4-point Likert scale ranging from 'fully untrue' to 'fully true'. Higher values in the composite score show higher social exclusion.

2.2.3.9. Variety of violent behavior. Reported experiences of delinquency were assessed using a sum score ranging from 0 to 3, reflecting the variety of violent crimes committed in the past year, including carrying a weapon, robbery, and assault.

2.2.3.10. Self-injury. It was assessed with a single item (Steinhoff et al., 2021) measuring self-injurious behavior in the past month, using a 5-point Likert scale ranging from 'never' to 'very often' The item was worded as follows: "I harmed myself on purpose (e.g., cut my arm, tore wounds open, hit my head, tore out my hair)." Responses were dichotomized (0 = no, 1 = yes).

2.2.4. Predictors: protective factors at age 13 (Wave V)

2.2.4.1. Competent conflict-coping. It was measured with a four-item scale, adapted by the study team, on possible abilities to cope with conflictive or negative situations, using a 5-point Likert Scale ranging from 'never' to 'very often'. Lower values on the final composite score show poorer conflict-coping skills.

2.2.4.2. Social support. Was assessed using a seven-item scale, developed by the study team, with two different sources of social support: resilient peers/friends, and resilient adults. Each was measured with a 4-point Likert scale ranging from 'fully untrue' to 'fully true'. Higher scores on each scale show higher social support.

2.2.4.3. Professional support. Measured with a dichotomous item assessing whether adolescents had consulted a school-based provider (e.g., psychologist, social worker, or psychosocial counselor) within the past two years.

2.2.5. Outcome: suicidal ideation at age 15 (Wave VI)

SI was assessed with a one-item question using a 5-point Likert scale, ranging from 'never' to 'very often.' The wording of the question is as follows: "*I thought about killing myself. Please indicate how often you thought about these things in the last month*". For this study, the variable was dichotomized (0 = no, 1 = yes). This item was used in previous research with the current sample, providing evidence of its validity as a single-item measure of SI (Garcia Nuñez et al., 2022; Zhu et al., 2022).

2.3. Statistical analysis

First, descriptive statistics were calculated for all variables, comparing participants with LD to those without. Means and standard deviations were reported for continuous and ordinal variables, while counts and percentages were provided for categorical variables, along with effect sizes where appropriate. We also conducted zero-order correlations among the study variables using Spearman's ρ.

Next, we employed a generalized linear model to examine the relationship between LD and a range of risk and protective factors along with demographic covariates (age, sex, and non-Swiss origin), with SI as the outcome. While odds ratios (OR) can approximate relative risk (RR) under the rare disease assumption (event <10 %), the prevalence of SI in this cohort was considerably higher (19.3 %). To avoid the overestimation that logistic regression can produce under such conditions, we employed a Poisson regression with a Huber–White sandwich estimator and robust standard errors (referred to as the Robust or Modified Poisson model) to estimate RRs and 95 % confidence intervals (CIs) (Zou, 2004). All Variance Inflation Factor (VIF) values were below 1.5, indicating no evidence of multicollinearity. Finally, the Receiver Operating Characteristic (ROC) Area Under the Curve (AUC) was used to evaluate the model's diagnostic performance. To test the conditional effect described in the third aim, we conducted an additional regression

analysis with an interaction term between LD and anxiety/depression to test whether the effect of anxiety/depression on SI differs by LD status. To aid interpretation, we computed the RR for adolescents with LD by combining the main effect of anxiety/depression and its interaction with LD. The significance of the interaction was estimated relying on the absolute difference in predicted probabilities using average marginal effects (AME).

Missing data patterns were inspected and assumed to be missing at random (MAR). We then applied multiple imputation by chained equations (mice) (van Buuren and Groothuis-Oudshoorn, 2011), generating 20 imputed datasets with 10 iterations per dataset. Results were pooled using Rubin's rules (Rubin, 2004). All tests were two-sided and assessed at $p < .05$. Analyses were conducted in R version 4.4.1.

3. Results

This study addresses the scarcity of longitudinal research on the relationship between LD and SI in adolescents. Bivariate analyses comparing participants with and without LD revealed significant differences, with those with LD showing higher levels of various risk factors and lower scores on protective factors. The descriptive analyses showed significantly higher rates of both SI and self-injury among adolescents with LD. SI was reported by 32.5 % of individuals with LD, representing a substantial difference compared to those without LD (18.5 %, $p < .001$, $\Phi = 0.114$) Among those with LD, 18.4 % reported engaging in self-injury, compared to 12.2 % in the non-LD group ($p = .019$, $\Phi = 0.057$). Similarly, they reported significantly more school difficulties, bullying, life events, substance use, anxiety/depression symptoms, lower self-control, greater perceived social exclusion, and a greater variety of violent behavior compared to those without LD ($d = 0.21$–0.66). On protective factors, they showed significantly lower competent conflict coping and reduced peer and adult social support ($d = 0.18$–0.34). They also reported significantly higher prevalence of having received professional support ($\Phi = 0.193$). Full descriptive statistics are presented in Table 1, and correlations between variables are shown in Fig. 1.

The results of the Modified Poisson Regression identified several significant predictors of SI (Fig. 2, Table 2). Sex was a significant predictor, with females 50.6 % more likely to report SI compared to their male peers ($RR = 1.506$, 95 % CI = [1.186, 1.912], $p = .001$). Notably, those with LD had a 40.2 % higher risk of SI compared to those without LD ($RR = 1.402$, 95 % CI = [1.070, 1.837], $p = .018$). Each additional type of bullying victimization experience was linked to a 17.3 % increased risk ($RR = 1.173$, 95 % CI = [1.042, 1.320], $p = .011$), while a one symptom increase in anxiety/depression was associated with a 44.3 % higher risk ($RR = 1.\ 443$, 95 % CI = [1.260, 1.652], $p < .001$), and self-injury increased the risk by 60.3 % ($RR = 1.603$, 95 % CI = [1.268, 2.027], $p < .001$). In contrast, age, foreign-born, school difficulties, adverse life events, substance use, self-control, competent conflict coping, perceived social exclusion, peer and adult social support, receiving professional support, and a variety of violent behavior were not significantly associated with SI in this model. The model demonstrated acceptable discrimination (AUC = 0.744).

The additional regression model, with an interaction term (Table 3, Fig. 3), showed that the same predictors as in the regression without the interaction term remained significant, with very similar RRs, but substance use also emerged as a significant predictor ($\beta = 0.158$, RR = 1.171, 95 % CI = [1.034, 1.327], $p = .017$), reflecting a 17.1 % increase in the risk of suicidal ideation per one-unit increase on the frequency scale. The interaction term indicated that the association between anxiety/depression symptoms and SI significantly differed by LD status ($\beta = -0.398$, $RR = 0.672$, 95 % CI = [0.521, 0.866], $p = .003$). This suggests that the association between anxiety/depression and SI is 32.8 % weaker among adolescents with LD, suggesting that per unit increase in anxiety/depression, the risk of SI increases by only 3.6 % ($RR = 1.036$). As shown in Fig. 4, among adolescents without LD (on the left), the predicted risk of SI goes up as the level of anxiety/depression increases. Among those with LD (on the right), the slope is much flatter, suggesting a weaker association. Notably, the predicted risk is already high even when there is no anxiety/depression, pointing to a higher baseline vulnerability. AMEs showed that for adolescents without LD, a one-unit rise in anxiety/depression was associated with an 8.19 % increase in the predicted probability of SI (AME = 0.0819, 95 % CI = [0.044, 0.115], $p < .001$). In contrast, among adolescents with LD, the effect was near zero and not statistically significant (AME = −0.004, 95 % CI = [−0.084, 0.077], $p = .897$), suggesting no significant association between anxiety/depression symptoms and SI in this group. A likelihood ratio test comparing the interaction model to the non-interaction model showed a significant but modest improvement in fit ($\chi^2[1] = 6.07$, $p = .014$).

Table 1
Descriptives of the study variables by learning disability status.

	Total	Learning disabilities	Non-learning disabilities	Statistics
	$n = 1482$	11.1 %	88.9 %	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	
Age	13.67 (0.37)	13.69 (0.40)	13.67 (0.36)	$t[df] = -0.58$ [176]; $p = .564$
School difficulties	2.01 (0.55)	2.32 (0.51)	1.97 (0.54)	$t[df] = -7.75$ [189]; $p < .001$; $d = 0.663$
Bullying	1.70 (0.77)	1.93 (0.93)	1.67 (0.75)	$t[df] = -3.20$ [169]; $p = .002$; $d = 0.304$
Life events	3.12 (1.75)	3.73 (1.78)	3.06 (1.74)	$t[df] = -4.30$ [182]; $p < .001$; $d = 0.380$
Substance use	1.40 (0.74)	1.69 (0.97)	1.37 (0.70)	$t[df] = -3.81$ [169]; $p < .001$; $d = 0.375$
Anxiety/ depression	2.04 (0.80)	2.19 (0.80)	2.03 (0.80)	$t[df] = -2.37$ [184]; $p = .019$; $d = 0.207$
Low self-control	2.20 (0.47)	2.35 (0.49)	2.18 (0.46)	$t[df] = -3.93$ [181]; $p < .001$; $d = 0.351$
Perceived social exclusion	1.49 (0.52)	1.65 (0.53)	1.47 (0.53)	$t[df] = 3.87$ [183]; $p < .001$; $d = 0.341$
Variety of violent behavior	0.13 (0.40)	0.25 (0.57)	0.12 (0.37)	$t[df] = 2.64$ [160]; $p = .009$; $d = 0.266$
Competent conflict coping	3.23 (0.86)	3.04 (0.92)	3.26 (0.85)	$t[df] = 2.79$ [172]; $p = .006$; $d = 0.251$
Peer social support	3.73 (0.42)	3.66 (0.46)	3.74 (0.42)	$t[df] = 1.99$ [178]; $p = .048$; $d = 0.180$
Adult social support	2.90 (0.70)	2.79 (0.72)	2.91 (0.70)	$t[df] = 2.06$ [182]; $p = .040$; $d = 0.183$
	%	%	%	
Sex, female	48.3	47.8	48.4	$\chi^2[df] = 0.017$ [1], $p = .897$
Foreign-born	10.4	11.9	10.3	$\chi^2[df] = 4.12$ [1], $p = .521$
Serious victimization	20.2	25.2	19.6	χ^2[df] = 2.54 [1], $p < .111$
Self-injury	11.9	18.4	12.2	χ^2[df] = 4.39 [1], $p = .019$, $\Phi = 0.057$
Suicidal ideation	19.3	32.5	18.5	$\chi^2[df] = 18.50$ [1], $p < .001$, $\Phi = 0.114$
Professional support	36.9	63.3	33.6	χ^2[df] = 49.50 [1], $p < .001$, $\Phi = 0.193$

Note. *M* = mean; *SD* = standard deviation; $t[df]$ = Welch's *t*-test [*degrees of freedom*]; *d* = Cohen's d; Φ = Phi-coefficient.

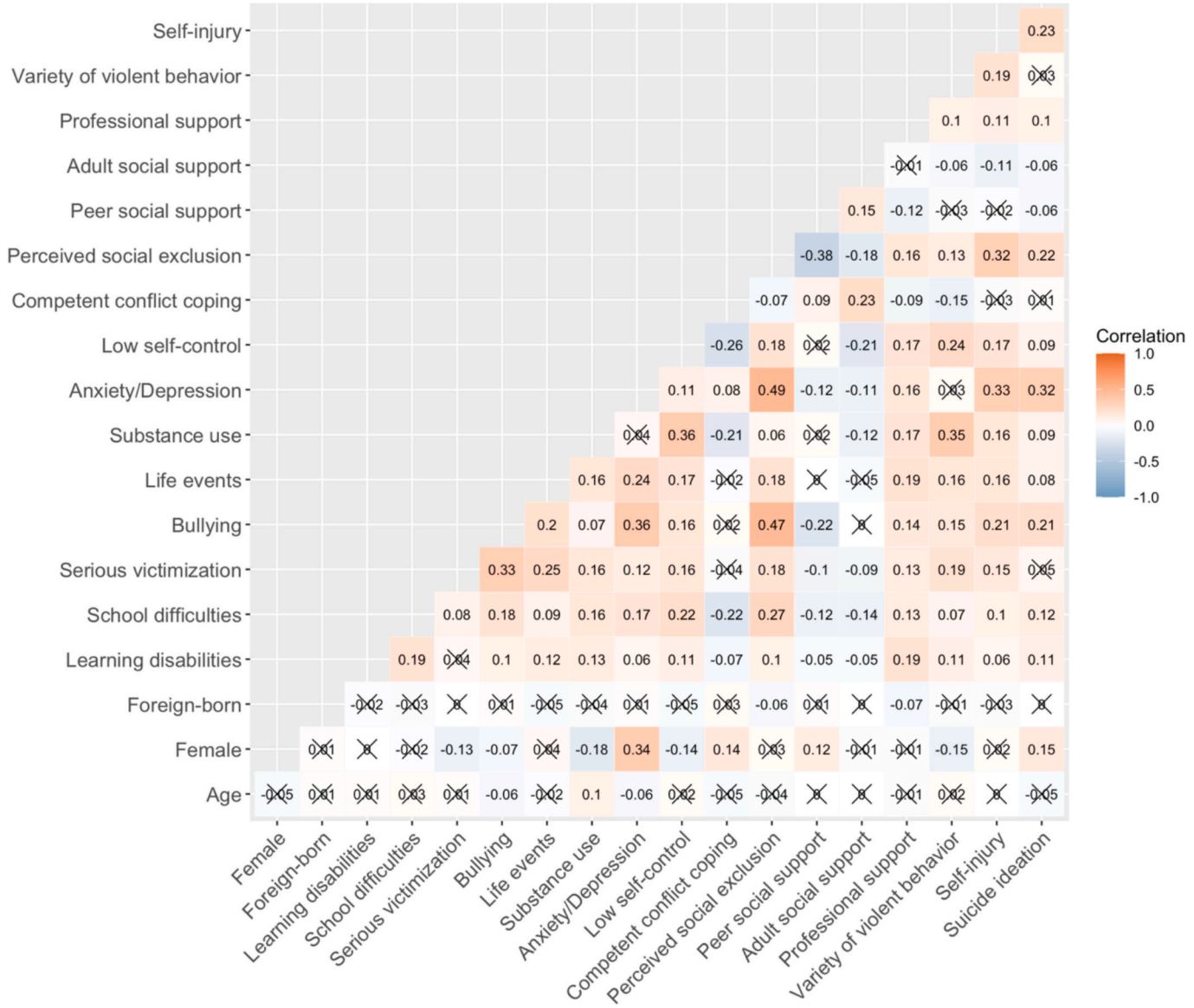

Fig. 1. Correlation plot of the study variables.

4. Discussion

This study reports high rates of SI and self-injury among adolescents with LD compared to their non-LD peers, consistent with previous research (Fuller-Thomson et al., 2018; Svetaz et al., 2000; Wilson et al., 2009). School-related risk factors, such as bullying, perceived social exclusion, and less peer prosocial support, were found. In line with the ACE framework (Sahle et al., 2022; Thompson et al., 2019), adolescents with LD also experience more stressful life events and victimization experiences. The co-occurrence of externalizing behaviors (i.e., substance use and violent behavior) may further undermine their mental health (Sahle et al., 2022). Together, these factors can place adolescents with LD at a heightened disadvantage across multiple domains.

The most relevant predictors of SI include being female, having LD, having experienced bullying victimization, depression/anxiety symptoms, and prior self-injury. Given the clear temporal ordering of variables, this study provides evidence for relatively short-term predictors, developmentally speaking, of early adolescent SI, addressing a gap left by prior cross-sectional research. Among these predictors, the strongest was prior self-injury at age 13, which increased the risk of SI at age 15 by 60.3 %. Self-injury is widely recognized as a maladaptive emotional regulation strategy that increases vulnerability to psychological distress and negative cognitions, which may contribute to suicidal thoughts (Wolff et al., 2019). However, there is ongoing debate about the predictive ability of both suicidal and non-suicidal self-injury as risk factors for SI (Ribeiro et al., 2016). Future research could benefit from using multi-item scales rather than single-item measures to mitigate this and provide a more nuanced assessment of suicidality. As expected, and in line with most of the literature, anxious-depressive symptomatology emerged as a significant predictor. Together with self-injury, this reinforces the well-established association of internalizing symptoms and suicidality (Franklin et al., 2017; Ribeiro et al., 2016).

Sex-based differences were identified. SI tends to increase with age during adolescence, with evidence pointing to a peak in suicidality among mid-adolescent girls, in contrast to the more stable trajectories in boys (Miranda-Mendizabal et al., 2019; Thompson and Light, 2011; Uddin et al., 2019). This peak may help explain the higher rates among girls, potentially reflecting a critical period of heightened risk. Sex differences in suicidal behavior may also be influenced by emotional and behavioral factors. Females experience more internalizing disorders, which are associated with SI and attempts, while males are more prone to externalizing disorders and have higher rates of suicide death

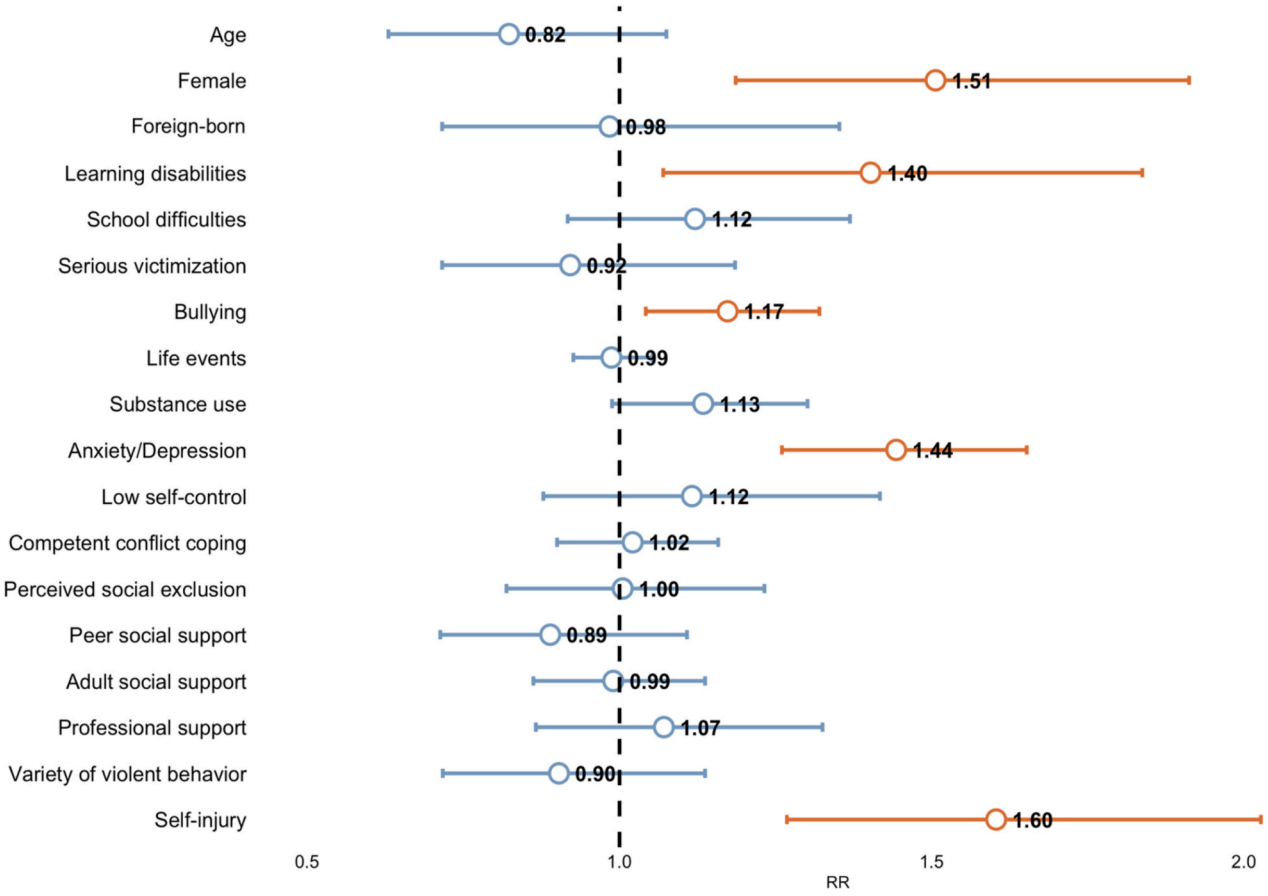

Fig. 2. Forest plot: Modified Poisson regression on suicidal ideation at age 15.

Table 2
Modified Poisson regression on suicidal ideation at age 15.

	β	RR	Lower CI	Upper CI	*p*-Value
Age	−0.196	0.823	0.630	1.075	.162
Female	**0.409**	**1.506**	**1.186**	**1.912**	**.001**
Foreign-born	−0.016	0.984	0.716	1.352	.883
Learning disabilities	**0.337**	**1.402**	**1.070**	**1.837**	**.018**
School difficulties	0.113	1.121	0.917	1.369	.302
Serious victimization	−0.083	0.921	0.716	1.185	.536
Bullying	**0.159**	**1.173**	**1.042**	**1.320**	**.011**
Life events	−0.013	0.987	0.926	1.053	.702
Substance use	0.126	1.134	0.988	1.301	.082
Anxiety/Depression	**0.366**	**1.443**	**1.260**	**1.652**	**<.001**
Low self-control	0.109	1.116	0.878	1.417	.395
Perceived social exclusion	0.004	1.005	0.819	1.232	.796
Variety of violent behavior	−0.103	0.903	0.717	1.137	.416
Self-injury	**0.471**	**1.603**	**1.268**	**2.027**	**<.001**
Competent conflict coping	0.021	1.021	0.900	1.158	.730
Peer social support	−0.119	0.889	0.713	1.108	.316
Adult social support	−0.010	0.990	0.862	1.137	.758
Professional support	0.068	1.071	0.866	1.325	.543

Note: Results are presented as risk ratios (RR) with 95 % confidence intervals (CIs). Bolded values indicate statistically significant results.

Table 3
Modified Poisson regression on suicidal ideation at age 15 with an interaction term between learning disabilities and anxiety/depression.

	β	RR	Lower CI	Upper CI	*p*-Value
Age	−0.206	0.814	0.625	1.061	0.137
Female	**0.407**	**1.503**	**1.186**	**1.904**	**0.001**
Foreign-born	0.006	1.006	0.734	1.379	0.920
Learning disabilities	**1.346**	**3.855**	**1.936**	**7.676**	**0.000**
School difficulties	0.123	1.132	0.930	1.378	0.255
Serious victimization	−0.120	0.888	0.692	1.138	0.366
Bullying	**0.189**	**1.208**	**1.082**	**1.348**	**0.001**
Life events	−0.019	0.981	0.921	1.044	0.568
Substance use	**0.158**	**1.171**	**1.034**	**1.327**	**0.017**
Anxiety/Depression	**0.433**	**1.542**	**1.341**	**1.774**	**0.000**
Low self-control	0.070	1.073	0.850	1.354	0.554
Perceived social exclusion	0.016	1.017	0.836	1.236	0.770
Variety of violent behavior	−0.135	0.875	0.688	1.112	0.303
Self-injury	**0.464**	**1.592**	**1.264**	**2.005**	**0.000**
Competent conflict coping	0.014	1.015	0.897	1.148	0.759
Peer social support	−0.097	0.908	0.733	1.125	0.400
Adult social support	−0.012	0.988	0.862	1.133	0.763
Professional support	0.045	1.046	0.846	1.295	0.684
LD * Anxiety/ Depression	**−0.398**	**0.672**	**0.521**	**0.866**	**0.003**

Note: Results are presented as risk ratios (RR) with 95 % confidence intervals (CIs). Bolded values indicate statistically significant results.

(Miranda-Mendizabal et al., 2019) Such patterns stress the need for a particular focus on suicide prevention efforts for girls, using gender-sensitive approaches.

Among the various ACE-related predictors examined in our model, such as serious victimization and stressful life events, only bullying emerged as a significant predictor of SI. This is consistent with previous studies using the same cohort sample (Zhu et al., 2022). Bullying

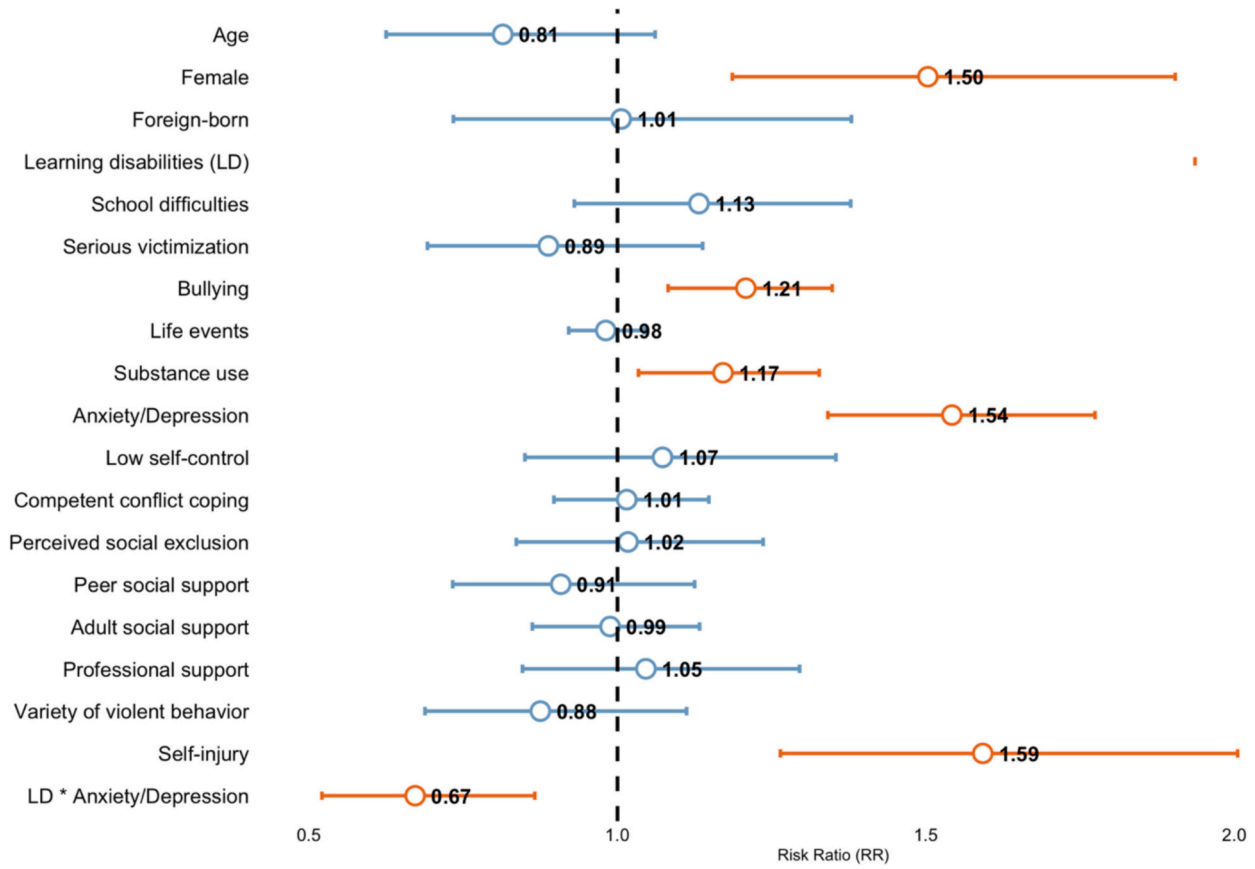

Fig. 3. Forest plot: modified Poisson regression on suicidal ideation at age 15 with learning disabilities × anxiety/depression interaction.

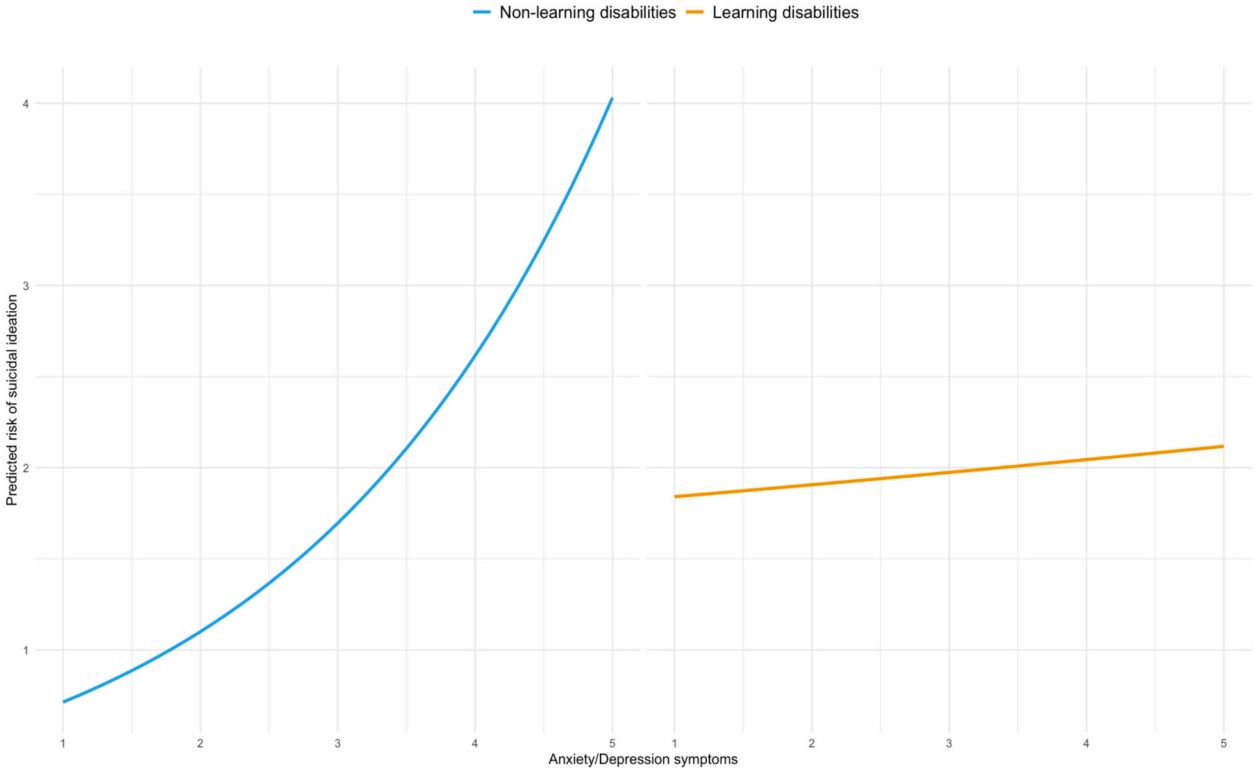

Fig. 4. Interaction: conditional effect of learning disabilities on the relationship between anxiety/depression and suicidal ideation.

victimization may be especially harmful in adolescence, as it disrupts core developmental needs like belonging, self-esteem, and peer acceptance (Espelage and Holt, 2013). School is one of the environments where adolescents spend most of their time, so problems that arise within this setting are likely to be particularly relevant. However, neither school difficulties nor perceived social exclusion were found to be significant predictors for this model. Surprisingly, protective factors included in the model (i.e., the different forms of social support and coping skills) did not show a significant effect. Notably, one unexpected finding was that despite 63.3 % of adolescents with LD receiving professional support, their rates of SI remained higher than those of peers without LD. This support showed no protective effect, suggesting that that current support services may not fully capture or mitigate SI risk in this high-risk group. This lack of significant effects of protective factors may indicate that general measures are not specific enough to address the challenges faced by adolescents with LD. Future research should examine tailored forms of support, as protective factors for adolescents with LD may differ from those of their peers without LD.

Finally, having LD was associated with a 40.2 % increased risk of SI compared to peers without LD. To our knowledge, this is one of the few longitudinal studies examining this relationship. The findings underscore the need for targeted suicide prevention in this often-overlooked population. The interaction term indicated that the impact of anxiety/depression symptoms on SI varies by LD status, suggesting a distinct risk pathway. As previous research has shown, traditional SI risk factors may operate differently across subpopulations (Franklin et al., 2017), particularly among those with LD, who may follow substantially different risk trajectories (Fuller-Thomson et al., 2018). One possible explanation is a ceiling effect: adolescents with LD may already be at elevated risk, making the additional impact of anxiety/depression appear smaller. However, the wide CIs around this estimate warrant cautious interpretation. Further replication in similar cohort samples is needed to confirm this exploratory finding. These results reinforce the need for further research to clarify how risk factors interact within this group and to guide more tailored prevention strategies, including comprehensive screening for suicidality and self-injury.

5. Limitations

Despite its strengths, this study has several limitations. First, there is variation in the timeframes used to assess different variables across waves (e.g., last month, last year). Some predictors were temporally closer to the outcome than others, which may influence their relationship with SI. Second, SI may be influenced by variables not captured in this study. For example, consistent with minority stress theory (Meyer, 2003), hostile and stressful social environments tied to sexual and gender minority status contribute to mental health disparities and, alongside broader adversity, may place these youth at higher risk for suicide (Clements-Nolle et al., 2018; Díaz-Faes et al., 2024). Sexual orientation and gender identity were not assessed until later waves, as these identities typically consolidate in mid-to-late adolescence (Bishop et al., 2024). Thus, it was not possible to examine in this same study both school-related and sexuality-related predictors within the same timeframe. Third, reliance on a single self-reported item as a proxy for LD is a relevant limitation. This measure provides limited information on the specific type of LD, may not capture all individuals with a diagnosed LD, and could include others with non-specific academic difficulties. Finally, because this study is based on a single-city sample (Zurich), the findings may be specific to this context, and further research in different populations is needed to replicate them. Because of the above limitations, the generalizability of the findings should be interpreted with caution. Despite all, this study offers new longitudinal evidence on the increased SI risk in adolescents with LD.

Acknowledge and funding information

We are grateful to the participants and research assistants of z-proso. The z-proso study is currently supported by funding from the Swiss National Science Foundation (SNSF; grant no. 10FI15_229647), the Jacobs Center (JC), and the Jacobs Foundation (JF). Substantial funding in previous project phases was provided by the SNSF (specifically grant no. 100014_132124 as regards the data used in this paper), the JC, the JF, the Swiss Federal Office of Public Health, the Swiss State Secretariat for Migration and its predecessors, the Department of Education of the Canton of Zurich, the Bank Baer Foundation, and the Visana Foundation, which is gratefully acknowledged.

CRediT authorship contribution statement

Marta Codina: Writing – review & editing, Writing – original draft, Visualization, Methodology, Conceptualization. **Diego A. Díaz-Faes:** Writing – review & editing, Writing – original draft, Visualization, Methodology, Formal analysis, Conceptualization. **Noemí Pereda:** Writing – review & editing, Supervision. **Denis Ribeaud:** Project administration, Funding acquisition. **Manuel Eisner:** Writing – review & editing, Project administration, Funding acquisition. **Ingrid Obsuth:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors hereby declare that there are no financial, personal, or professional conflicts of interest (real or perceived) that could have influenced the design, conduct, or reporting of this research. No funding sources, affiliations, or relationships exist that might be construed as affecting the objectivity, integrity, or validity of the findings presented in this manuscript. All authors have disclosed any potential competing interests, and none have been identified.

References

Bertuccio, P., Amerio, A., Grande, E., La Vecchia, C., Costanza, A., Aguglia, A., Berardelli, I., Serafini, G., Amore, M., Pompili, M., Odone, A., 2024. Global trends in youth suicide from 1990 to 2020: an analysis of data from the WHO mortality database. EClinicalMedicine 70, 102506. https://doi.org/10.1016/j.eclinm.2024.102506.

Bishop, M.D., Fish, J.N., Russell, S.T., 2024. The timing of sexual identity development milestones: disentangling age from cohort influences. Psychol. Sex. Orientat. Gend. Divers. https://doi.org/10.1037/sgd0000745.

Boyes, M.E., Leitão, S., Claessen, M., Badcock, N.A., Nayton, M., 2020. Correlates of externalising and internalising problems in children with dyslexia: an analysis of data from clinical casefiles. Aust. Psychol. 55, 62–72. https://doi.org/10.1111/ap.12409.

Bude, H., Lantermann, E.-D., 2006. Soziale exklusion und exklusionsempfinden. KZfSS Kölner Zeitschrift für Soziologie und Sozialpsychologie 58, 233–252. https://doi.org/10.1007/s11575-006-0054-1.

Butterworth, B., Kovas, Y., 2013. Understanding neurocognitive developmental disorders can improve education for all. Science 1979 (340), 300–305. https://doi.org/10.1126/science.1231022.

Clements-Nolle, K., Lensch, T., Baxa, A., Gay, C., Larson, S., Yang, W., 2018. Sexual identity, adverse childhood experiences, and suicidal behaviors. J. Adolesc. Health 62, 198–204. https://doi.org/10.1016/j.jadohealth.2017.09.022.

Daniel, S.S., Walsh, A.K., Goldston, D.B., Arnold, E.M., Reboussin, B.A., Wood, F.B., 2006. Suicidality, school dropout, and reading problems among adolescents. J. Learn. Disabil. 39, 507–514. https://doi.org/10.1177/00222194060390060301.

De Leo, D., Goodfellow, B., Silverman, M., Berman, A., Mann, J., Arensman, E., Hawton, K., Phillips, M.R., Vijayakumar, L., Andriessen, K., Chavez-Hernandez, A.-M., Heisel, M., Kolves, K., 2021. International study of definitions of English-language terms for suicidal behaviours: a survey exploring preferred terminology. BMJ Open 11, e043409. https://doi.org/10.1136/bmjopen-2020-043409.

Díaz-Faes, D.A., Pereda, N., Gámez-Guadix, M., 2024. The role of adverse childhood experiences in suicide among sexual minority undergraduate students. Death Stud. 48, 219–227. https://doi.org/10.1080/07481187.2023.2214892.

Dube, S.R., Anda, R.F., Felitti, V.J., Chapman, D.P., Williamson, D.F., Giles, W.H., 2001. Childhood abuse, household dysfunction, and the risk of attempted suicide throughout the life span. JAMA 286, 3089. https://doi.org/10.1001/jama.286.24.3089.

Emerson, E., Aitken, Z., Arciuli, J., King, T., Llewellyn, G., Kavanagh, A., 2024. Self-harm among 17-year-old adolescents with/without disabilities in the United Kingdom. Crisis 45, 376–379. https://doi.org/10.1027/0227-5910/a000951.

Espelage, D.L., Holt, M.K., 2013. Suicidal ideation and school bullying experiences after controlling for depression and delinquency. J. Adolesc. Health 53, S27–S31. https://doi.org/10.1016/j.jadohealth.2012.09.017.

Franklin, J.C., Ribeiro, J.D., Fox, K.R., Bentley, K.H., Kleiman, E.M., Huang, X., Musacchio, K.M., Jaroszewski, A.C., Chang, B.P., Nock, M.K., 2017. Risk factors for suicidal thoughts and behaviors: a meta-analysis of 50 years of research. Psychol. Bull. 143, 187–232. https://doi.org/10.1037/bul0000084.

Fuller-Thomson, E., Baird, S.L., Dhrodia, R., Brennenstuhl, S., 2016. The association between adverse childhood experiences (ACEs) and suicide attempts in a population-based study. Child Care Health Dev. 42, 725–734. https://doi.org/10.1111/cch.12351.

Fuller-Thomson, E., Carroll, S.Z., Yang, W., 2018. Suicide attempts among individuals with specific learning disorders: an underrecognized issue. J. Learn. Disabil. 51, 283–292. https://doi.org/10.1177/0022219417714776.

Garcia Nuñez, D., Raible-Destan, N., Hepp, U., Kupferschmid, S., Ribeaud, D., Steinhoff, A., Shanahan, L., Eisner, M., Stulz, N., 2022. Suicidal ideation and self-injury in LGB youth: a longitudinal study from urban Switzerland. Child Adolesc. Psychiatry Ment. Health 16, 21. https://doi.org/10.1186/s13034-022-00450-5.

Grasmike, H.G., Tittle, C.R., Bursik, R.J., Arneklev, B.J., 1993. Testing the core empirical implications of Gottfredson and Hirschi's general theory of crime. J. Res. Crime Delinq. 30, 5–29. https://doi.org/10.1177/0022427893030001002.

Grigorenko, E.L., Compton, D.L., Fuchs, L.S., Wagner, R.K., Willcutt, E.G., Fletcher, J.M., 2020. Understanding, educating, and supporting children with specific learning disabilities: 50 years of science and practice. Am. Psychol. 75, 37–51. https://doi.org/10.1037/amp0000452.

Holt, M.K., Vivolo-Kantor, A.M., Polanin, J.R., Holland, K.M., DeGue, S., Matjasko, J.L., Wolfe, M., Reid, G., 2015. Bullying and suicidal ideation and behaviors: a meta-analysis. Pediatrics 135, e496–e509. https://doi.org/10.1542/peds.2014-1864.

Meyer, I.H., 2003. Prejudice, social stress, and mental health in lesbian, gay, and bisexual populations: conceptual issues and research evidence. Psychol. Bull. 129, 674–697. https://doi.org/10.1037/0033-2909.129.5.674.

Miller, A.B., Esposito-Smythers, C., Leichtweis, R.N., 2015. Role of social support in adolescent suicidal ideation and suicide attempts. J. Adolesc. Health 56, 286–292. https://doi.org/10.1016/j.jadohealth.2014.10.265.

Miranda-Mendizabal, A., Castellví, P., Parés-Badell, O., Alayo, I., Almenara, J., Alonso, I., Blasco, M.J., Cebrià, A., Gabilondo, A., Gili, M., Lagares, C., Piqueras, J.A., Rodríguez-Jiménez, T., Rodríguez-Marín, J., Roca, M., Soto-Sanz, V., Vilagut, G., Alonso, J., 2019. Gender differences in suicidal behavior in adolescents and young adults: systematic review and meta-analysis of longitudinal studies. Int. J. Public Health 64, 265–283. https://doi.org/10.1007/s00038-018-1196-1.

Mishna, F., 2003. Learning disabilities and bullying. J. Learn. Disabil. 36, 336–347. https://doi.org/10.1177/00222194030360040501.

Moses, T., 2018. Suicide attempts among adolescents with self-reported disabilities. Child Psychiatry Hum. Dev. 49, 420–433. https://doi.org/10.1007/s10578-017-0761-9.

Murray, A.L., Obsuth, I., Eisner, M., Ribeaud, D., 2019. Evaluating longitudinal invariance in dimensions of mental health across adolescence: an analysis of the social behavior questionnaire. Assessment 26, 1234–1245. https://doi.org/10.1177/1073191117721741.

Murray, A.L., Eisner, M., Ribeaud, D., Kaiser, D., McKenzie, K., Murray, G., 2021. Validation of a brief self-report measure of adolescent bullying perpetration and victimization. Assessment 28, 128–140. https://doi.org/10.1177/1073191119858406.

Nelson, J.M., Harwood, H., 2011. Learning disabilities and anxiety: a meta-analysis. J. Learn. Disabil. 44, 3–17. https://doi.org/10.1177/0022219409359939.

Ribeaud, D., Murray, A., Shanahan, L., Shanahan, M.J., Eisner, M., 2022. Cohort profile: the Zurich project on the social development from childhood to adulthood (z-proso). J Dev Life Course Criminol 8, 151–171. https://doi.org/10.1007/s40865-022-00195-x.

Ribeiro, J.D., Franklin, J.C., Fox, K.R., Bentley, K.H., Kleiman, E.M., Chang, B.P., Nock, M.K., 2016. Self-injurious thoughts and behaviors as risk factors for future suicide ideation, attempts, and death: a meta-analysis of longitudinal studies. Psychol. Med. 46, 225–236. https://doi.org/10.1017/S0033291715001804.

Rubin, D.B., 2004. Multiple Imputation for Nonresponse in Surveys. Wiley. https://doi.org/10.1002/9780470316696.

Sahle, B.W., Reavley, N.J., Li, W., Morgan, A.J., Yap, M.B.H., Reupert, A., Jorm, A.F., 2022. The association between adverse childhood experiences and common mental disorders and suicidality: an umbrella review of systematic reviews and meta-analyses. Eur. Child Adolesc. Psychiatry 31, 1489–1499. https://doi.org/10.1007/s00787-021-01745-2.

Steinhoff, A., Bechtiger, L., Ribeaud, D., Eisner, M., Shanahan, L., 2020. Stressful life events in different social contexts are associated with self-injury from early adolescence to early adulthood. Front. Psych. 11. https://doi.org/10.3389/fpsyt.2020.487200.

Steinhoff, A., Ribeaud, D., Kupferschmid, S., Raible-Destan, N., Quednow, B.B., Hepp, U., Eisner, M., Shanahan, L., 2021. Self-injury from early adolescence to early adulthood: age-related course, recurrence, and services use in males and females from the community. Eur. Child Adolesc. Psychiatry 30, 937–951. https://doi.org/10.1007/s00787-020-01573-w.

Svetaz, M.V., Ireland, M., Blum, R., 2000. Adolescents with learning disabilities: risk and protective factors associated with emotional well-being: findings from the National Longitudinal Study of Adolescent Health. J. Adolesc. Health 27, 340–348. https://doi.org/10.1016/S1054-139X(00)00170-1.

Thapar, A., Cooper, M., Rutter, M., 2017. Neurodevelopmental disorders. Lancet Psychiat. 4, 339–346. https://doi.org/10.1016/S2215-0366(16)30376-5.

Thompson, M.P., Light, L.S., 2011. Examining gender differences in risk factors for suicide attempts made 1 and 7 years later in a nationally representative sample. J. Adolesc. Health 48, 391–397. https://doi.org/10.1016/j.jadohealth.2010.07.018.

Thompson, M.P., Kingree, J.B., Lamis, D., 2019. Associations of adverse childhood experiences and suicidal behaviors in adulthood in a U.S. nationally representative sample. Child Care Health Dev. 45, 121–128. https://doi.org/10.1111/cch.12617.

Turecki, G., Brent, D.A., Gunnell, D., O'Connor, R.C., Oquendo, M.A., Pirkis, J., Stanley, B.H., 2019. Suicide and suicide risk. Nat. Rev. Dis. Primers. 5, 74. https://doi.org/10.1038/s41572-019-0121-0.

Uddin, R., Burton, N.W., Maple, M., Khan, S.R., Khan, A., 2019. Suicidal ideation, suicide planning, and suicide attempts among adolescents in 59 low-income and middle-income countries: a population-based study. Lancet Child Adolesc Health 3, 223–233. https://doi.org/10.1016/S2352-4642(18)30403-6.

van Buuren, S., Groothuis-Oudshoorn, K., 2011. mice: multivariate imputation by chained equations in R. J. Stat. Softw. 45. https://doi.org/10.18637/jss.v045.i03.

Washington Group on Disability Statistics, 2009. The Washington Group short set on functioning (WG-SS) [WWW Document].

Willcutt, E.G., Betjemann, R.S., Pennington, B.F., Olson, R.K., DeFries, J.C., Wadsworth, S.J., 2007. Longitudinal study of reading disability and attention-deficit/hyperactivity disorder: implications for education. Mind Brain Educ. 1, 181–192. https://doi.org/10.1111/j.1751-228X.2007.00019.x.

Wilson, A.M., Deri Armstrong, C., Furrie, A., Walcot, E., 2009. The mental health of Canadians with self-reported learning disabilities. J. Learn. Disabil. 42, 24–40. https://doi.org/10.1177/0022219408326216.

Wolff, J.C., Thompson, E., Thomas, S.A., Nesi, J., Bettis, A.H., Ransford, B., Scopelliti, K., Frazier, E.A., Liu, R.T., 2019. Emotion dysregulation and non-suicidal self-injury: a systematic review and meta-analysis. Eur. Psychiatry 59, 25–36. https://doi.org/10.1016/j.eurpsy.2019.03.004.

Zhu, X., Griffiths, H., Eisner, M., Hepp, U., Ribeaud, D., Murray, A.L., 2022. Developmental associations between bullying victimization and suicidal ideation and direct self-injurious behavior in adolescence and emerging adulthood. J. Child Psychol. Psychiatry 63, 820–828. https://doi.org/10.1111/jcpp.13529.

Zou, G., 2004. A modified Poisson regression approach to prospective studies with binary data. Am. J. Epidemiol. 159, 702–706. https://doi.org/10.1093/aje/kwh090.

z-proso Project Team, 2024. z-Proso Handbook: Instruments and Procedures in the Adolescent and Young Adult Surveys (Age 11 to 20; Waves K4-K8). Short Version. Zurich.