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# Childhood emotional dysregulation paths for suicide-related behaviour engagement in adolescence

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**Abstract**

**Objectives.** To identify the heterogeneous trajectories of emotional dysregulation across childhood, and to study the relationship between specific trajectories and adolescent suicide-related behaviour (SRB). **Methods.** Data from the Millennium Cohort Study (N=13,853 children; 49.07% female, *M* = 3.13 years at baseline, *SD* = 0.2) were used to identify the emotional dysregulation trajectories from 3-8 years old, using growth mixture modelling. Moreover, 1,992 participants (52.86% female) from the initial sample were used to study the relationship between childhood emotional dysregulation trajectory and engagement in both self-harm and suicide attempt at age 17, using logistic regression. Some other time-invariant and proximal (adolescent) risk factors were incorporated into this analysis. **Results.** Six emotional dysregulation trajectories were identified. Self-harm at age 17 was significantly associated with the history of self-harm and other proximal factors, but not with emotional dysregulation trajectory membership. Childhood trajectories featured by earlier emotional dysregulation were associated with higher risk of lifetime suicide attempt, as well as other proximal factors (concurrent self-harm). **Conclusion.** This study found differential risk profiles involved in both SRB forms. A relationship between early emotional dysregulation and suicide attempt engagement in adolescence was identified. Early interventions should be developed to deal with SRB risk factors from childhood.

**Key words:** Childhood emotional regulation; Suicide-related behaviour; Self-harm; Suicide Attempt; Adolescence.

## Childhood emotional dysregulation paths for suicide-related behaviour engagement in adolescence

Suicide-related behaviour (SRB) constitutes a major health concern among adolescent people. SRB comprises a variety of self-inflicted, potentially injurious acts by which an individual intends at some (either undetermined or known) degree to kill oneself [1–4]. When SRB results in nonfatal outcome, intent to die features the two major SRB forms: self-harm (i.e., self-inflicted, potentially injurious behaviour without explicit nor implicit intent to die) and suicide attempt (i.e., self-inflicted behaviour with evidence of explicit intent to die). Both self-harm and suicide attempt range among the most prominent public health concerns in children and adolescents [5]. Mounting evidence supports that these two SRB forms may have distinctive functions, and specific underpinnings [6–9]. For instance, blunted striatal activation and decreased frontolimbic connectivity (particularly between structures involved in the default mode network and salience network circuit) was found in suicide attempters, directly associated with self-regulation problems; by contrast, patients with active self-harm showed altered frontotemporal connections, mainly related to hyperarousal and reduced impulse control [10]. Moreover, different main motives are found in the current literature: for self-harm, triggers such as dealing with negative emotions or stress coping are named by those affected, whereas suicide attempts are more likely to be motivated by, for example, entrapment fe [9, 11, 12]. Finally, self-harm constitutes a key risk factor of suicide attempt [6].

Adolescent SRB prevalence has significantly increased in recent years [13, 14], with one in five adolescents reporting self-harm behaviour on a community basis [15]. Self-harm repetition may show a peak of higher incidence in late adolescence [16–18].

In addition, an increasing trend in adolescent suicide attempt has been observed over the last decades [19]. An adolescent suicide attempt may be associated with elevated risk of premature death, and poorer mental health outcome later in life [20–22].

From a lifelong standpoint, a particular interest exists in disentangling developmental pathways leading to SRB [23, 24]. In this regard, adolescent SRB engagement may result from the interaction between biological vulnerabilities, distal factors, such as childhood risk factors (e.g., child maltreatment, insecure family environments, economic hassles); and more proximal (adolescent) ones (e.g., depressive disorders, recent SRB, bullying exposure). Previous studies have suggested that the impact of distal risk factors on adolescent SRB may be mediated by changes in emotional regulation systems at neurobiological and behavioural levels (e.g., hypothalamus-pituitary-adrenals axis response, coping strategy selection) [25, 26]. Unfortunately, most studies rely on static snapshots (i.e., cross-sectional approach) on emotional regulation in childhood and its impact on adolescent SRB [27–30].

Emotional regulation skills (i.e., those involved in processes of monitoring, evaluation, and modification on emotional reaction [31]) are developed throughout childhood, observing a wide repertoire of behavioural and cognitive strategies to manage their positive and negative emotions in preschool ages, and becoming more sophisticated thereafter [32–34]. Mounting studies have shown a link between SRB and dysfunctional emotion regulation [35–37]. Certain maladaptive coping strategies, such as rumination or dysregulated anger responses are not only associated with SRB, but also with increased depression or other mental disorders, and lower academic performance and SRB [29, 30, 38–40] . According to Dvir et al.,[41] the development and learning of different emotion regulation strategies in early childhood (a life period mainly featured by high rates of synaptic regrowth and remodeling in the brain) may

play an essential role for mental health in later life. To the best of our knowledge, there is a lack of research in this field. Accordingly, the aim of this exploratory study was to analyse the relationship between the heterogeneous trajectories of emotional dysregulation throughout childhood and SRB in adolescence. Moreover, it intended to identify potential emotional dysregulation trajectories associated with the specific nonfatal SRB forms (self-harm and suicide attempt).

## Method

### Sample and study variables

Longitudinal data from the Millennium Cohort Study (MCS) [42] were used in this study. More concretely, data from 13853 children were used (51.24% boys; mean age at baseline = 3.13 years, *SD* = 0.20). The Millennium Cohort Study is a UK nationally-representative birth cohort study aimed at depicting the developmental course of physical and mental health outcomes of people born between 2000-2002 (millennials), and focused specifically on the identification of potential socioeconomic and health-related protective and risk factors. Data from people living in the four United Kingdom countries were collected in the MCS. Sampling was based on a stratified clustering strategy to ensure adequate representation of ethnic minorities. All the protocols conducted in the MCS was approved by an ethical committee for human research [43].

We used data from parents' reports from three MCS survey sweeps: MCS 2004 sweep (*n* = 12907; cohort member age, *m* = 3.13, *sd* = 0.20), considered the baseline wave in this study; 2006 sweep (*n* = 13853; cohort member age, *m* = 5.22, *sd* = 0.25) and 2008 sweep (*n* = 12462; cohort member age, *m* = 7.23, *sd* = 0.25). More concretely, sociodemographic data (child's sex at birth, ethnic group, household income) at baseline were used from the MCS 2004 survey. Moreover, responses to the 5-item emotional

dysregulation scale of the Child Social Behaviour Questionnaire (CSBQ)[44, 45] were used from the three aforementioned sweeps. The CSBQ is usually was selected for its face validation. Even so, the CSBQ emotional dysregulation scale can also be used to assess child's emotional dysregulation in the general population due to its items (e.g., reactivity and recovery from negative emotions, frequency of mood swings, over excitation, frustration and impulsiveness). Higher scale score indicates higher emotional dysregulation. In an sample of children with autism, the subscales of the CBSQ showed good internal consistency (Cronbach's alpha ranging from .73-.91) [44].

Proximal (adolescent) variables included self-reported data collected when the cohort member was an adolescent. More concretely, data from the MCS 2015 sweep survey ($n$ = 9791; 50.50% female; cohort member age, $m$ = 13.77, $sd$ = 0.45) and MCS 2018 sweep survey ($n$ = 8586; 50.93% female; cohort member age, $m$ = 17.17, $sd$ = 0.33) were used. Bearing in mind the study aims, two single items were taken from the MCS 2015 sweep survey that included history of bullying (item: 'How often other children hurt or pick on cohort member?') and self-harm in mid adolescence (whether the cohort member had self-hurt in the last year at least in one of these self-harm modalities: bruising or pinching; burning, cutting or stabbing, taking an overdose of tablets, pulled out hair). Other adolescent factors were measured at the MCS 2018 sweep: current mental health difficulties, derived from the Strength and Difficulties Questionnaire (SDQ)[46] total score. The SDQ showed acceptable reliability levels in British adolescents (Cronbach's $\alpha$ = .71) [47]. Moreover, a cognition score, derived from the 10-item version of the Cognitive Abilities Test 3, Level H, Number Analogies test [48, 49] was used. The higher the score, the better the cognitive performance inferred. Psychometric properties of the Number Analogies test were satisfactory in our

study sample (Cronbach's $\alpha = .81$). Finally, data from single items on alcohol drinking, cannabis smoking and other drug use were used from the 2018 sweep.

The adolescent outcomes were also measured at MCS 2018 Sweep, using single items: 12-month self-harm (item: whether the cohort member had self-hurt in the last year at least in one of these ways: bruising or pinching; burning, cutting or stabbing, taking an overdose of tablets, pulled out hair) and adolescent suicide attempt (item: 'Have you ever hurt yourself on purpose in an attempt to end your life?'). The Table 1 presents an overview of the variables of interest for this study.

(Insert Table 1 here)

**Data analysis**

Attrition analysis was conducted by comparing the sample used for emotional regulation trajectory enumeration ($N = 13853$) and the adolescent sample with complete data ($n = 1992$), by means of the Pearson's $\chi^2$ test for independent samples (for binary or categorical factors) and the *t* test (continuous factors). To prevent from type I error inflation, meaningful differences (i.e., those with at least medium effect size: Cramer's $V \geq .30$ or Cohen's $d \geq .50$) were indicative of sample differences due to the large sample size in analysis [50].

Growth mixture modelling (GMM) [51, 52] was used to identify heterogeneous trajectories of emotional dysregulation (CSBQ score) throughout the childhood (from 3 to 8 years old) using the data from three MCS sweeps (MCS 2004 sweep, 2006 sweep, and 2008 sweep). GMM constitutes a flexible person-centred approach that allows for latent trajectory identification, as the assumption of a unitary course of development is relaxed. Subject-specific variability may be well captured by clustering individuals with

similar developmental course into a same group (class). Model estimation relies on robust maximum likelihood and full information methods (this enables the depiction of individual-specific trajectories even when intermittent missing data are present). To model the longitudinal course of emotional dysregulation, age was used as a time factor (considering both a linear and quadratic effect on trajectory) and no covariate was included into models to prevent from increased probability of class overestimation [53, 54].

Following a model comparison rationale, GMM solutions with increasing trajectory classes were compared. Criteria to select the model with the optimal class enumeration were [55, 56]: low sample-adjusted Bayesian information criterion (SABIC) and consistent Akaike information criterion (CAIC), mean of posterior probabilities to belong to each identified class higher than .70; and meaningful proportion of participants within each class (5%).

Binary logistic regression was used to study the risk of showing self-harm and suicide attempt at age 17 separately, by means of time-invariant (sex and ethnic group), distal (childhood emotional dysregulation class membership), and proximal factors: both mid-adolescence (bullying exposure at age 14) and late-adolescent risk factors (household income, mental health difficulties, cognition score, alcohol, cannabis and other drug use at age 17). covariates in the present study were selected according to literature [6, 17, 57–59] and availability within the MCS, retrospectively. The history of self-harm (i.e., self-harm at age 14) was used as a risk factor to explain the self-harm outcome at age 17. The 12-month self-harm at age 17 was used as a covariate for adolescent suicide attempt. The UK country was used as a weighting factor to control for unequal number of participants across countries within the sample and country-specific policies in terms of health and welfare [60, 61]. The Akaike information

criterion (AIC) was estimated to assess whether the model with all the aforementioned covariates fitted better than an unconstrained model (i.e., model without covariates) and a model with sociodemographic covariates. Moreover, the Hosmer-Lemeshow test was performed to examine how data fitted the logistic model. The Nagelkerke pseudo-$R^2$ was used as an effect size estimate. The odds ratio (*OR*) was used as a covariate loading estimate. The TRIPOD checklist has been included in the Supplementary material for transparent reporting on predictive model studies [62].

All the analyses were conducted by means of R x64 3.0.1 (lcmm and psych packages).

## Results

The Table 2 displays the descriptive statistics of sample used to identify the emotional dysregulation trajectories (initial sample) and the sample for outcome prediction (adolescent sample), as well as the attrition analysis. Although significant differences were found between the samples, none of them reached the level of meaningfulness (i.e., at least medium effect size). Of note was the finding that more than 27% of adolescents (considering the complete-case sample) had engaged in self-harm in the last year, when they were 17 years old. Furthermore, 7.93% of the adolescents had attempted suicide.

(Insert Table 2 here)

Analysis on emotional dysregulation trajectory identification pointed to a better fit of the 6-class model depicting a quadratic effect of time (SABIC = 24721.33, CAIC = 24612.40; mean of posterior probabilities for each class = .87 - .97). Fit indexes

derived from all the estimated GMM solutions are displayed in Table 3. The course of emotional dysregulation across the identified classes is displayed in Figure 1.

(insert Table 3 here)

The first class (U-shaped class; 15.25% of participants) was featured by decreasing emotional dysregulation in early ages, leveling off at age 6 (linear effect of age with slope, $B = -0.67$, $p < .01$; quadratic slope, $B = 0.23$, $p < .01$), and showed an increase thereafter. The second class (decreasing dysregulation class) comprised 22.51% of participants and was characterised by a decreasing trajectory of emotional dysregulation over time (linear effect of age with slope, $B = -5.14$, $p < .01$; quadratic slope, $B = 0.93$, $p < .01$). The third class (increasing dysregulation class) was featured by a rise of emotional dysregulation over time (linear effect of age with slope, $B = 0.41$, $p < .01$; quadratic slope, $B = -0.15$, $p < .01$); this class comprised 10.94% of the participants. The fourth class (heightened dysregulation class; 10.58% of participants) showed heightened emotional dysregulation over time with a slight increase from age 6 onwards (linear effect of age, $B = -1.59$, $p < .01$; quadratic slope, $B = 0.55$, $p < .01$). The fifth class (modal class; 32.34% of participants) showed minimal levels of emotional dysregulation up to age 6, with a slightly increasing pattern onwards (linear effect of age, $B = -0.50$, $p < .01$; quadratic slope, $B = 0.17$, $p < .01$). The final class (inverted U-shaped class; 8.39% of participants) was featured by increasing levels of emotional dysregulation up to age 6, then showed a decreasing pattern of emotional dysregulation thereafter (linear effect of age with slope, $B = 4.21$, $p < .01$; quadratic slope, $B = -0.60$, $p < .01$). The Table S1 (see Supplementary material) displays the profile factors related to each identified classes in comparison to the modal class.

(Insert Figure 1 here)

Regarding adolescent outcome prediction, logistic regression revealed that the covariates studied were relevant to explain both outcomes at age 17, as model with all the covariates showed lower AIC (for the 12-month self-harm outcome, AIC = 5593.18; for the suicide attempt outcome, AIC = 2325.41) than both the unconstrained one (for the 12-month self-harm outcome, AIC = 15185.81; for the suicide attempt outcome, AIC = 7545.38) and the model with sociodemographic covariates (for the 12-month self-harm outcome, AIC = 12803.45; for the suicide attempt outcome, AIC = 4417.41). The data fitted better the model with all the covariates for both the self-harm outcome, Hosmer-Lemeshow $\chi^2$ (8) = 13370.47, $p < .01$; and the suicide attempt outcome, Hosmer-Lemeshow $\chi^2$ (8) = 3843.45, $p < .01$. The model with all the covariates explained a significant proportion of outcome variance, for both the 12-month self-harm outcome (pseudo-$R^2_{adj}$ = .40) and suicide attempt outcome (pseudo-$R^2_{adj}$ = .37). The Table 4 displays the covariate coefficients according to outcome. Multicollinearity between covariates was low in the full model (i.e., model with all the covariates) for both outcomes, self-harm (generalised Variance Inflation Factor [VIF] between 1.02-1.33, across covariates) and suicide attempt (VIF between 1.02-1.38, across covariates).

Childhood emotional dysregulation class membership (in comparison to the modal class) was associated with an increased risk of having engaged in suicide attempt but not with self-harm engagement in the last year. More concretely, adolescents who were at higher risk of having attempted suicide were more likely to show either a decreasing emotional dysregulation trajectory in childhood ($OR$ = 1.93, $p < .01$),

heightened dysregulation trajectory (*OR* = 2.06, $p < .01$) or a U-shaped trajectory (*OR* = 1.48, $p < .01$).

The risk of showing self-harm in the last year was associated with being female, middle household income quartiles, mental health difficulties, higher cognitive score, cannabis use, and mid-adolescence self-harm and bullying. Adolescent suicide attempt risk (regardless of their emotional dysregulation trajectory membership) was related to being female, from Asian ethnic groups, lower household income, lower cognitive score and lower levels of alcohol drinking. Finally, suicide attempt was associated with higher levels of mental health difficulties, marijuana use, concurrent self-harm and bullying in mid adolescence.

(Insert Table 4 here)

## Discussion

This study aimed to gain insight into the specific paths of childhood emotional dysregulation that may lead to SRB engagement in adolescence. The two non-lethal SRB forms examined were self-harm and suicide attempt. Our study revealed the presence of six trajectories of emotional dysregulation with different courses across childhood. Three of these trajectories (decreasing emotional dysregulation trajectory, heightened dysregulation trajectory, and U-shaped trajectory) were significantly associated with an increased risk of adolescent suicide attempt. Being a girl and some proximal late-adolescence (lower socioeconomic status, mental health difficulties, cannabis use, lower cognitive performance and concurrent self-harm) and mid-adolescence risk factors (bullying exposure) were also associated with suicide attempt.

Conversely, none of the emotional dysregulation trajectories was significantly associated with self-harm in late adolescence, except for sex and proximal risk factors. In this regard, previous self-harm in adolescence (i.e., self-harm in mid adolescence) was proven to be highly influential for subsequent self-harm engagement, in line with existing evidence on increased self-harm repetition risk in late adolescence [16, 17].

Our results support the theory of differential mechanisms and motivational components for the two SRB forms studies. Klonsky et al. [9, 63] developed a 2-factor model to explain motivation for SRB. In this sense, intrapersonal (i.e., internal, self-oriented) and interpersonal (i.e., other-oriented) functions may dynamically interact to put individuals at higher risk of self-harm engagement. The intrapersonal functions include affect regulation, anti-suicide reasons (i.e., coping strategy for resisting urges to attempt suicide) and self-punishment. Intrapersonal function has been associated with self-harm repetition [64]. As reported by numerous research, the most common functions to perform self-harm are intrapersonal: psychological pain and coping strategy [64, 65].

Our result indicates that approximately one in four adolescents from our sample (27.8%) had engaged in self-harm in the last 12 months. Bearing in mind the Klonky's framework, it is not surprising to see that the proximal factors were more strongly associated with self-harm engagement than the distal ones. In this sense, adolescents with higher mental health difficulties were at higher risk of self-harm; speculatively, self-harm was used to cope with the negative emotions associated with these mental health difficulties. Moreover, the high use of cannabis may be considered as another maladaptive coping strategy involved in symptom management (i.e., self-medication) [66, 67]. In line with previous studies [17, 68], being a girl and part of a family from low-to-middle socioeconomic backgrounds, as well as a history of bullying have

significantly been associated with self-harm, too. Finally, we found a higher risk of self-harm engagement with higher cognition score. Note that the cognition score used in this study is related to fluid intelligence skills and most of participants showed modal performance on the cognition test used in comparison to norm groups [48, 49]. We speculate that the positive relationship between self-harm and cognition score may be mediated by other cognitive moderators not included in this study, such as perfectionism, which is highly related to high intellectual quotient and elevated cognitive performance [69–71].

Adolescent suicide attempt was associated with three proximal risk factors (mental health difficulties, cannabis use and bullying history). In line with previous studies [9, 72], suicide attempt may be also driven by coping-specific motivations to deal with negative emotions (mental health conditions and being bullied often result in difficult and hard emotions, as well as cannabis use for regular users), as self-harm may. However, other intrapersonal (e.g., escape, hopelessness) and interpersonal motivations (e.g., suicide as a method of communication, help seeking) have also been consistently associated with suicide attempt in adolescence [73, 74]. Suicide attempt may be driven by the desire to escape from feelings of entrapment (due to highly intense emotions), in conjunction with cognitive (e.g., thwarted belongingness, perceived burdensomeness and psychological pain) and volitional moderators (e.g., having access to the means of suicide, acquired capability to attempt suicide, impulsivity) [6, 59]. In line with this argument, we found concurrent self-harm to be the covariate with a stronger relationship with suicide attempt (*OR* = 7.84). Self-harm engagement could be related to increased capability to attempt suicide, due to repeated exposure to pain.

Regarding emotional dysregulation trajectories, we found that trajectories sharing higher dysregulation scores at earlier age (decreasing emotional dysregulation

trajectory, heightened dysregulation trajectory, and U-shaped trajectory) to have placed the individuals at higher risk of suicide attempt in adolescence. Moreover, adolescents showing these trajectories were characterised by some distinctive features at an earlier age (see Table S1 in the Supplementary material): coming from lower-income backgrounds, showing higher levels of psychological symptoms and having parents with higher levels of psychopathology. Emotional regulation skills tend to become more stable across preschool age. Unfortunately, emotional insecurity due to ambivalent bonding, poverty, interparental conflict and parental psychopathology may significantly contribute to increased emotional regulation deficits across early childhood [75, 76].

Early childhood constitutes a critical period for brain development, due to increased neural plasticity [77]. In addition, the parasympathic branch of the autonomous nervous system, which is involved in self-regulation, stress coping and the development of multiple mental health conditions as well as SRB [78–80]. Dysregulation in emotional regulation may contribute to abnormal maturation on systems involved in emotion processing (e.g., default mode network circuit) during early childhood, leading to long-lasting effects on self-regulation [10, 41, 81]. In this regard, increasing difficulties when dealing with intense emotions can be found across childhood, contributing to maladaptive emotional cascade development (i.e., escalation in negative emotion intensity due to vicious cycles of interactions between maladaptive coping strategies, such as rumination, and negative affect). Maladaptive emotional cascades constitute critical precursors of emotional instability and personality disorder development in adolescence [82, 83]. Suicide may therefore be seen as an effective way to escape from negative thoughts about one’s self and emotional pain, derived from negative emotional cascades.

On the other hand, our results go in line with existing studies pointing to increased risk of suicide attempt in adolescent females, lower-income backgrounds and poorer cognitive performance (i.e., associated with poorer problem-solving skills and impulsivity) [13, 18, 84]. The negative relationship between alcohol drinking and risk of suicide attempt may be of particular interest in light of our results. Even though, it should be considered that alcohol use may be a mean to satisfactorily achieve social motives to build social camaraderie in adolescence [85].

Although the exploratory analytical strategy followed for emotional dysregulation trajectory enumeration (i.e., the use of GMM), this study provides some interesting evidence on the involvement of emotional dysregulation course for adolescent SRB engagement. First, we found that more than one in four adolescents from our sample had engaged in self-harm in the last year when they were 17 years old. This may link with the coping function of self-harm to deal with negative emotions on a daily basis. For that reason, proximal factors (e.g., adolescent's psychopathology) may be more relevant to explain self-harm behaviour. Regarding adolescent suicide attempt, almost 8% of adolescents had committed at least one suicide attempt in their entire life in our sample. As seen in our research, distal factors (i.e., the course of emotional dysregulation in preschool age) may constitute risk factors for key mediators of suicide attempt, particularly for those involved in affective processes, such as maladaptive emotional cascades, impulsivity and emotional instability.

As a main strength of our study, our findings come from a robust analytical strategy using longitudinal data from a large cohort of adolescents followed from early life. Moreover, some relevant proximal and distal factors were included in the analysis. Some limitations deserve being mentioned. First, the SRB forms were measured at different time scales (12-month self-harm and lifetime suicide attempt). This issue is

related to the MCS design considering two obvious reasons: first, the lower prevalence of suicide attempt in comparison to self-harm in community samples; and second, the critical relationship between an episode of suicide attempt in adolescence and the poorer mental health outcome later in life [11, 12, 86]. On the other hand, the sample for adolescent SRB analysis was much smaller than baseline sample. In other words, attrition rate was substantially large between samples. Despite a long follow-up period (14 years), adolescent sample in analysis did not show meaningful differences comparing to baseline sample, in terms of sociodemographic and clinical factors (see Table 2). It is also worth noting that covariates used to explain the SRB outcomes in adolescence were retrospectively selected. In this regard, the MCS constitutes a wider study covering multiple aspects of physical and mental health of millennials. Therefore, the MCS was not specifically designed for SRB study and a limited number of protective/risk factors for SRB was collected though. For that reason, covariates in the present study were selected according to literature [6, 17, 57–59] and availability within the MCS, retrospectively. Likewise, multi-informant data and data on other relevant risk factors and SRB contributors (e.g., mental disorder diagnosis, psychological or psychiatric treatment, maladaptive emotional cascade, distress intolerance) are missing from this study. Finally, the outcomes were measured using stand-alone questions and CSBQ was validated in another population different from the population in study. These issues may lead their related psychometric limitation. For all these reasons, our results provide an overall, community-based picture on the relationship between emotional dysregulation trajectory in childhood and adolescent SRB. Further research should contribute to disentangle specific paths of adolescent development using a more fine-grained approach, purposely designed to study SRB precursors, at a clinical level and with a multi-informant data collection procedure.

Some clinical implications may be derived from this study. First, a lifelong perspective should be followed to identify individuals at risk of suicide-related behaviour in adolescence. Some studies have identified a substantial proportion of individuals engaging in SRB without any apparent risk factor [29]. A lifelong perspective may contribute to accurately detect at-risk profiles from earlier in life. Second, preventive action becomes mandatory. Selective intervention should be provided for children with poorer emotional regulation skills. Finally, this study aims at promoting awareness of children's mental health issues. The promotion of children's emotional and behavioural wellbeing should be prioritised towards an overall healthy development, by improving screening protocols for children and optimising of health care provision.

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The MCS data are available upon request on the UK Data Service website.

## References

1. Butler AM, Malone K (2013) Attempted suicide v. non-suicidal self-injury: Behaviour syndrome or diagnosis? Br J Psychiatry 202:324–325. https://doi.org/10.1192/bjp.bp.112.113506
2. Silverman MM, Berman AL, Sanddal ND, et al (2007) Rebuilding the Tower of Babel: A Revised Nomenclature for the Study of Suicide and Suicidal Behaviors

Part 2: Suicide-Related Ideations, Communications, and Behaviors. Suicide Life-Threatening Behav 37:264–277. https://doi.org/10.1521/suli.2007.37.3.264

3. Silverman MM, Berman AL, Sanddal ND, et al (2007) Rebuilding the Tower of Babel : A Revised Nomenclature for the Study of Suicide and Suicidal Behaviors. Part 2 : Suicide-Related Ideations , Communications , and Behaviors. Suicide Life-Threatening Behav 37:264–277
4. De Leo D, Goodfellow B, Silverman M, et al (2021) International study of definitions of English-language terms for suicidal behaviours: A survey exploring preferred terminology. BMJ Open 11:1–10. https://doi.org/10.1136/bmjopen-2020-043409
5. Reichl C, Kaess M (2021) Self-harm in the context of borderline personality disorder. Curr Opin Psychol 37:139–144. https://doi.org/10.1016/j.copsyc.2020.12.007
6. O'Connor RC (2011) Towards An Integrated Motivational–Volitional Model of Suicidal Behaviour Rory. In: O'Connor RC, Platt S, Gordon J (eds) International Handbook of suicide prevention: Research, policy and practice. John Wiley & Sons, Ltd., London, pp 181–198
7. Kapur N, Cooper J, O'Connor RC, Hawton K (2013) Non-suicidal self-injury v. attempted suicide: New diagnosis or false dichotomy? Br J Psychiatry 202:326–328. https://doi.org/10.1192/bjp.bp.112.116111
8. Andover MS, Morris BW, Wren A, Bruzzese ME (2012) The co-occurrence of non-suicidal self-injury and attempted suicide among adolescents: distinguishing risk factors and psychosocial correlates. Child Adolesc Psychiatry Ment Health 6:1–7. https://doi.org/10.1186/1753-2000-6-11
9. May AM, Klonsky ED (2013) Assessing motivations for suicide attempts:

Development and psychometric properties of the inventory of motivations for suicide attempts. Suicide Life-Threatening Behav 43:532–546. https://doi.org/10.1111/sltb.12037

10. Auerbach RP, Pagliaccio D, Allison GO, et al (2021) Neural Correlates Associated With Suicide and Nonsuicidal Self-injury in Youth. Biol Psychiatry 89:119–133. https://doi.org/10.1016/j.biopsych.2020.06.002
11. Parra-Uribe I, Blasco-Fontecilla H, Garcia-Parés G, et al (2017) Risk of re-attempts and suicide death after a suicide attempt: A survival analysis. BMC Psychiatry 17:1–11. https://doi.org/10.1186/s12888-017-1317-z
12. Brière FN, Rohde P, Seeley JR, et al (2015) Adolescent suicide attempts and adult adjustment. Depress Anxiety 32:270–276. https://doi.org/10.1002/da.22296
13. McManus S, Gunnell D (2020) Trends in mental health, non-suicidal self-harm and suicide attempts in 16–24-year old students and non-students in England, 2000–2014. Soc Psychiatry Psychiatr Epidemiol 55:125–128. https://doi.org/10.1007/s00127-019-01797-5
14. Miron O, Yu K-H, Wilf-Miron R, Kohane IS (2019) Suicide Rates among Adolescents and Young Adults in the United States, 2000-2017. JAMA 321:2362–2364. https://doi.org/10.15585/mmwr.mm6722a1
15. Lim KS, Wong CH, McIntyre RS, et al (2019) Global lifetime and 12-month prevalence of suicidal behavior, deliberate self-harm and non-suicidal self-injury in children and adolescents between 1989 and 2018: A meta-analysis. Int J Environ Res Public Health 16:. https://doi.org/10.3390/ijerph16224581
16. Andrews T, Martin G, Hasking P, Page A (2013) Predictors of continuation and cessation of nonsuicidal self-injury. J Adolesc Heal 53:40–46. https://doi.org/10.1016/j.jadohealth.2013.01.009

17. Rahman F, Webb RT, Wittkowski A (2021) Risk factors for self-harm repetition in adolescents: A systematic review. Clin Psychol Rev 88:. https://doi.org/10.1016/j.cpr.2021.102048

18. Lawrence HR, Burke TA, Sheehan AE, et al (2021) Prevalence and correlates of suicidal ideation and suicide attempts in preadolescent children: A US population-based study. Transl Psychiatry 11:1–10. https://doi.org/10.1038/s41398-021-01593-3

19. Xiao Y, Cerel J, Mann JJ (2021) Temporal Trends in Suicidal Ideation and Attempts among US Adolescents by Sex and Race/Ethnicity, 1991-2019. JAMA Netw Open 4:1–14. https://doi.org/10.1001/jamanetworkopen.2021.13513

20. Parra-Uribe I, Blasco-Fontecilla H, Garcia-Parés G, et al (2017) Risk of re-attempts and suicide death after a suicide attempt: A survival analysis. BMC Psychiatry 17:. https://doi.org/10.1186/s12888-017-1317-z

21. Briere J, Kwon O, Semple RJ, Godbout N (2019) Recent suicidal ideation and behavior in the general population: The role of depression, posttraumatic stress, and reactive avoidance. J Nerv Ment Dis 207:320–325. https://doi.org/http://dx.doi.org/10.1097/NMD.0000000000000976

22. de la Torre-Luque A, Borges G, Benjet C, et al (2022) Diagnostic profiles in adolescence and emerging adulthood: Transition patterns and risk factors. Rev Psiquiatr Salud Ment. https://doi.org/10.1016/j.rpsm.2022.01.002

23. Gunnell D, Lewis G (2005) Studying suicide from the life course perspective : implications for prevention. Br J Psychiatry 187:206–209

24. Seguin M, Beauchamp G, Robert M, et al (2014) Developmental model of suicide trajectories. Br J Psychiatry 205:120–126. https://doi.org/10.1192/bjp.bp.113.139949

25. Braquehais MD, Picouto MD, Casas M, Sher L (2012) Hypothalamic-pituitary-adrenal axis dysfunction as a neurobiological correlate of emotion dysregulation in adolescent suicide. World J Pediatr 8:197–206. https://doi.org/10.1007/s12519-012-0358-0

26. Vargas-Medrano J, Diaz-Pacheco V, Castaneda C, et al (2020) Psychological and neurobiological aspects of suicide in adolescents: Current outlooks. Brain, Behav Immun - Heal 7:100124. https://doi.org/10.1016/j.bbih.2020.100124

27. Peh CX, Shahwan S, Fauziana R, et al (2017) Emotion dysregulation as a mechanism linking child maltreatment exposure and self-harm behaviors in adolescents. Child Abus Negl 67:383–390. https://doi.org/10.1016/j.chiabu.2017.03.013

28. Xavier A, Cunha M, Pinto-Gouveia J (2016) The Indirect Effect of Early Experiences on Deliberate Self-Harm in Adolescence: Mediation by Negative Emotional States and Moderation by Daily Peer Hassles. J Child Fam Stud 25:1451–1460. https://doi.org/10.1007/s10826-015-0345-x

29. Uh S, Dalmaijer ES, Siugzdaite R, et al (2021) Two Pathways to Self-Harm in Adolescence. J Am Acad Child Adolesc Psychiatry 00:1–10. https://doi.org/10.1016/j.jaac.2021.03.010

30. Ghaderi M, Ahi Q, Vaziri S, et al (2020) The mediating role of emotion regulation and intolerance of uncertainty in the relationship between childhood maltreatment and nonsuicidal self-injury in adolescents. Int Arch Heal Sci 7:96–103. https://doi.org/10.4103/iahs.iahs

31. Gross JJ, Thompson RA (2007) Handbook of emotion regulation. Guilford Publications, New York, NY, pp 3–24

32. Gullone E, Hughes EK, King NJ, Tonge B (2010) The normative development of

emotion regulation strategy use in children and adolescents: A 2-year follow-up study. J Child Psychol Psychiatry Allied Discip 51:567–574. https://doi.org/10.1111/j.1469-7610.2009.02183.x

33. Cracco E, Goossens L, Braet C (2017) Emotion regulation across childhood and adolescence: evidence for a maladaptive shift in adolescence. Eur Child Adolesc Psychiatry 26:909–921. https://doi.org/10.1007/s00787-017-0952-8

34. Zeman J, Cassano M, Perry-Parrish C, Stegall S (2006) Emotion regulation in children and adolescents. Dev Behav Pediatr 27:155–168. https://doi.org/10.1017/S0954579406060536

35. Kuehn KS, King KM, Linehan MM, Harned MS (2020) Modeling the suicidal behavior cycle: understanding repeated suicide attempts among individuals with borderline personality disorder and a history of attempting suicide. J Consult Clin Psychol 88:570-581. https://doi.org/10.1037/ccp0000496

36. Gratz KL, Spitzen TL, Tull MT (2020) Expanding our understanding of the relationship between nonsuicidal self-injury and suicide attempts: The roles of emotion regulation self-efficacy and the acquired capability for suicide. J Clin Psychol 76:1653–1667. https://doi.org/http://dx.doi.org/10.1002/jclp.22950

37. Rajappa K, Gallagher M, Miranda R (2012) Emotion dysregulation and vulnerability to suicidal ideation and attempts. Cognit Ther Res. https://doi.org/10.1007/s10608-011-9419-2

38. Edossa AK, Schroeders U, Weinert S, Artelt C (2018) The development of emotional and behavioral self-regulation and their effects on academic achievement in childhood. Int J Behav Dev 42:192–202. https://doi.org/10.1177/0165025416687412

39. Storr CL, Schaeffer CM, Petras H, et al (2009) Early childhood behavior

trajectories and the likelihood of experiencing a traumatic event and PTSD by young adulthood. Soc Psychiatry Psychiatr Epidemiol 44:398–406. https://doi.org/10.1007/s00127-008-0446-6

40. Moffitt TE, Arseneault L, Belsky D, et al (2011) A gradient of childhood self-control predicts health, wealth, and public safety. Proc Natl Acad Sci U S A 108:2693–2698. https://doi.org/10.1073/pnas.1010076108
41. Dvir Y, Ford JD, Hill M, Frazier JA (2014) Childhood maltreatment, emotional dysregulation, and psychiatric comorbidities. Harv Rev Psychiatry 22:149–161. https://doi.org/10.1097/HRP.0000000000000014
42. Connelly R, Platt L (2014) Cohort profile: UK Millennium Cohort Study (mcs). Int J Epidemiol 43:1719–1725. https://doi.org/10.1093/ije/dyu001
43. Shepherd P, Gilbert E (2019) Millennium Cohort Study. Ethical review and consent. London
44. Luteijn E, Jackson S, Volkmar FR, Minderaa RB (1998) Brief report: The development of the children's social behavior questionnaire: Preliminary data. J Autism Dev Disord. https://doi.org/10.1023/A:1026060330122
45. Johnson J, Atkinson M, Rosenberg R, et al (2015) Millennium Cohort Study. Psychological,Psychological , Developmental and Health Inventories. London
46. Goodman R, Meltzer H, Bailey V (1998) The strengths and difficulties questionnaire: A pilot study on the validity of the self-report version. Eur Child Adolesc Psychiatry. https://doi.org/10.1007/s007870050057
47. Essau CA, Olaya B, Anastassiou-Hadjicharalambous X, et al (2012) Psychometric properties of the Strength and Difficulties Questionnaire from five European countries. Int J Methods Psychiatr Res 21:232–245. https://doi.org/10.1002/mpr.1364

48. Ipsos MORI (2019) Millennium Cohort Study Seventh Sweep (MCS7) Technical Report

49. Lohman DF, Thorndike RL, Hagen EP (2005) Cognitive Abilities Test: 3rd Edition, 3rd ed. GL Assessment, London

50. Lin M, Jr HCL, Shmueli G, Lin M (2013) Too Big to Fail : Large Samples and the p -Value Problem. Inf Syst Res 7047:1–12. https://doi.org/http://dx.doi.org/10.1287/isre.2013.0480

51. Ram N, Grimm KJ (2009) Growth Mixture Modeling: A Method for Identifying Differences in Longitudinal Change Among Unobserved Groups. Int J Behav Dev 33:565–576. https://doi.org/10.1177/0165025409343765.Growth

52. Proust-lima C, Liquet B (2017) Estimation of Extended Mixed Models Using Latent Classes and Latent Processes : The R Package lcmm

53. Vermunt JK (2010) Latent class modeling with covariates: Two improved three-step approaches. Polit Anal 18:450–469. https://doi.org/10.1093/pan/mpq025

54. Hu J, Leite WL, Gao M (2017) An evaluation of the use of covariates to assist in class enumeration in linear growth mixture modeling. Behav Res Methods 49:1179–1190. https://doi.org/10.3758/s13428-016-0778-1

55. Chen Q, Luo W, Palardy GJ, et al (2017) The Efficacy of Common Fit Indices for Enumerating Classes in Growth Mixture Models When Nested Data Structure Is Ignored: A Monte Carlo Study. SAGE Open 7:1–19. https://doi.org/10.1177/2158244017700459

56. van der Nest G, Lima Passos V, Candel MJJM, van Breukelen GJP (2020) An overview of mixture modelling for latent evolutions in longitudinal data: Modelling approaches, fit statistics and software. Adv Life Course Res 43:100323. https://doi.org/10.1016/j.alcr.2019.100323

57. Bilsen J (2018) Suicide and Youth: Risk Factors. Front Psychiatry 9:1–5. https://doi.org/10.3389/fpsyt.2018.00540

58. Glenn CR, Kleiman EM, Kellerman J, et al (2020) Annual Research Review: A meta-analytic review of worldwide suicide rates in adolescents. J Child Psychol Psychiatry Allied Discip 61:294–308. https://doi.org/10.1111/jcpp.13106

59. Van Orden KA, Witte TK, Cukrowicz KC, et al (2010) The Interpersonal Theory of Suicide. Psychol Rev 117:575–600. https://doi.org/10.1037/a0018697

60. Bywaters P, Scourfield J, Jones C, et al (2018) Child welfare inequalities in the four nations of the UK. J Soc Work 20:193–215. https://doi.org/10.1177/1468017318793479

61. Harrington BE, Smith KE, Hunter DJ, et al (2009) Health inequalities in England, Scotland and Wales: Stakeholders' accounts and policy compared. Public Health 123:e24–e28. https://doi.org/https://doi.org/10.1016/j.puhe.2008.10.010

62. Moons KGM, Altman DG, Reitsma JB, et al (2015) Transparent reporting of a multivariable prediction model for individual prognosis or diagnosis (TRIPOD): Explanation and elaboration. Ann Intern Med 162:W1–W73. https://doi.org/10.7326/M14-0698

63. Klonsky ED, May AM, Saffer BY (2016) Suicide, Suicide Attempts, and Suicidal Ideation. Annu Rev Clin Psychol 12:307–330. https://doi.org/10.1146/annurev-clinpsy-021815-093204

64. Glenn CR, Klonsky ED (2011) Prospective Prediction of Nonsuicidal Self-Injury: A 1-Year Longitudinal Study in Young Adults. Behav Ther 42:751–762. https://doi.org/10.1016/j.beth.2011.04.005

65. Wilcox HC, Arria AM, Caldeira KM, et al (2012) Longitudinal predictors of past-year non-suicidal self-injury and motives among college students. Psychol Med

42:717–726. https://doi.org/10.1017/S0033291711001814

66. Pedersen W, Mastekaasa A, Wichstrøm L (2001) Conduct problems and early cannabis initiation: A longitudinal study of gender differences. Addiction 96:415–431. https://doi.org/10.1046/j.1360-0443.2001.9634156.x

67. Fox CL, Towe SL, Stephens RS, et al (2011) Motives for cannabis use in high-risk adolescent users. Psychol Addict Behav 25:492–500. https://doi.org/10.1037/a0024331

68. Liu ZZ, Chen H, Bo QG, et al (2018) Psychological and behavioral characteristics of suicide attempts and non-suicidal self-injury in Chinese adolescents. J Affect Disord 226:287–293. https://doi.org/10.1016/j.jad.2017.10.010

69. Chang EC, Schaffer MR, Novak CJ, et al (2019) Sexual assault history and self-destructive behaviors in women college students: Testing the perniciousness of perfectionism in predicting non-suicidal self-injury and suicidal behaviors. Pers Individ Dif 149:186–191. https://doi.org/10.1016/j.paid.2019.05.021

70. Guignard JH, Jacquet AY, Lubart TI (2012) Perfectionism and anxiety: A paradox in intellectual giftedness? PLoS One 7:3–8. https://doi.org/10.1371/journal.pone.0041043

71. Pemau A, Diaz-Carracedo P, Lopez-Soto T, et al (2022) The Price of Perfection: The Link between Perfectionism and Suicidal Behavior. In: Looking for a Perfect World. Empirical and Applied Lines. Nova Science Publishers, Inc., New York, NY, pp 95–124

72. Gardner KJ, Paul E, Selby EA, et al (2021) Intrapersonal and Interpersonal Functions as Pathways to Future Self-Harm Repetition and Suicide Attempts. Front Psychol 12:. https://doi.org/10.3389/fpsyg.2021.688472

73. May AM, O'Brien KHMM, Liu RT, Klonsky ED (2016) Descriptive and

psychometric properties of the inventory of motivations for suicide attempts (IMSA) in an inpatient adolescent sample. Arch Suicide Res 20:476–482. https://doi.org/10.1080/13811118.2015.1095688

74. Shiratori Y, Tachikawa H, Nemoto K, et al (2014) Network analysis for motives in suicide cases: A cross-sectional study. Psychiatry Clin Neurosci 68:299–307. https://doi.org/http://dx.doi.org/10.1111/pcn.12132

75. Blandon AY, Calkins SD, Grimm KJ, et al (2010) Testing a developmental cascade model of emotional and social competence and early peer acceptance. Dev Psychopathol 22:737–748. https://doi.org/10.1017/S0954579410000428

76. Lyons-Ruth K, Brumariu LE (2021) Emerging child competencies and personality pathology: toward a Developmental Cascade model of BPD. Curr Opin Psychol 37:32–38. https://doi.org/10.1016/j.copsyc.2020.07.004

77. Power JD, Schlaggar BL (2017) Neural plasticity across the lifespan. Wiley Interdiscip Rev Dev Biol 6:. https://doi.org/10.1002/wdev.216

78. James KM, Woody ML, Feurer C, et al (2017) Disrupted physiological reactivity among children with a history of suicidal ideation: Moderation by parental expressed emotion-criticism. Biol Psychol 130:22–29. https://doi.org/http://dx.doi.org/10.1016/j.biopsycho.2017.10.003

79. Zeytinoglu S, Calkins SD, Leerkes EM (2020) Autonomic nervous system functioning in early childhood: Responses to cognitive and negatively valenced emotional challenges. Dev Psychobiol 62:657–673. https://doi.org/10.1002/dev.21926

80. Friedman BH (2007) An autonomic flexibility-neurovisceral integration model of anxiety and cardiac vagal tone. Biol Psychol 74:185–199. https://doi.org/10.1016/j.biopsycho.2005.08.009

81. Elsayed NM, Vogel AC, Luby JL, Barch DM (2021) Labeling Emotional Stimuli in Early Childhood Predicts Neural and Behavioral Indicators of Emotion Regulation in Late Adolescence. Biol Psychiatry Cogn Neurosci Neuroimaging 6:89–98. https://doi.org/https://doi.org/10.1016/j.bpsc.2020.08.018

82. Sharp C, Tackett JL (2014) Handbook of borderline personality disorder in children and adolescents. Springer Berlin Heidelberg, London

83. Selby EA, Joiner Jr. TE (2009) Cascades of Emotion: The Emergence of Borderline Personality Disorder from Emotional and Behavioral Dysregulation. Rev Gen Psychol 13:219. https://doi.org/10.1037/a0015687

84. Allen KJD, Bozzay ML, Edenbaum ER (2019) Neurocognition and Suicide Risk in Adults. Curr Behav Neurosci Reports 6:151–165. https://doi.org/10.1007/s40473-019-00189-y

85. Corbin WR, Iwamoto DK, Fromme K (2011) Broad social motives, alcohol use, and related problems: Mechanisms of risk from high school through college. Addict Behav 36:222–230. https://doi.org/10.1016/j.addbeh.2010.11.004

86. de la Torre-Luque A, Essau CA (2019) Symptom network connectivity in adolescents with comorbid major depressive disorder and social phobia. J Affect Disord 255:60–68. https://doi.org/10.1016/j.jad.2019.05.015

**Table 1.** Variables in analysis.

| Time-invariant variables | Distal variables | Proximal variables |
|---|---|---|
| Sex at birth | Child emotional regulation (from age 3 to 8)[1] | Household income at age 17 (ref. 1st quartile) |
| Age | Self-harm at age 14 | Mental health difficulties[2] |
| Ethnic group | Bullying history | Cognition score[3] |
| | | Alcohol drinking |
| | | Cannabis smoking |
| | | Other drug us |
| | | Self-harm at age 17 |
| | | Suicide attempt |

*Note.* Variables included were used for the main analyses of this study. Distal factors were collected across the three first MCS sweeps (i.e., MCS 2004 sweep, 2006 sweep, or 2008 sweep) in this study (child emotional regulation) and the 2015 sweep (self-harm and the history of bullying experiences). Proximal factors were collected from the 2018 sweep.

[1] Derived from the Child Social Behaviour Questionnaire. [2] Derived from the Strength and Difficulties Questionnaire total score; [3] Total score from the Cognitive Abilities Test 3, Level H, Number Analogies test.

**Table 2.** Descriptive statistics and attrition analysis.

| | Initial sample ($N$ = 13,853)† | Final sample ($n$ = 1,992)†† | Attrition analysis | |
|---|---|---|---|---|
| | | | Contrast test | ES |
| Sex (% female) | 49.07 | 52.86 | 14.12 | 0.03 |
| Ethnic group (%) | | | 192.44 | 0.07 |
| White | 87.9 | 97.14 | | |
| Asian | 7.23 | 1.26 | | |
| Black | 2.65 | 0.6 | | |
| Other/Mixed | 2.22 | 1 | | |
| Country (%) | | | 19.27 | 0.02 |
| England | 62.31 | 59.09 | | |
| Wales | 15.31 | 17.62 | | |
| Scotland | 12.3 | 13.96 | | |
| North Ireland | 10.08 | 9.34 | | |
| Baseline variables | | | | |
| Age (years) | 3.13 (0.2) | 3.11 (0.17) | 4.69 | 0.1 |
| Household income (%)[1] | | | 363.3 | 0.1 |
| 1st quintile | 20.27 | 9.36 | | |
| 2nd quintile | 20.31 | 14.39 | | |
| 3rd quintile | 19.96 | 19.87 | | |
| 4th quintile | 19.81 | 25.91 | | |
| 5th quintile | 19.65 | 30.48 | | |
| Adolescent (proximal) variables | | | | |
| Mental health difficulties[2] | 11.25 (5.56) | 11.17 (5.46) | 0.72[ns] | 0.02 |
| Cognition score[3] | 5.28 (2.69) | 5.75 (2.61) | -8.94 | -0.23 |
| Alcohol drinking in the last year (% >40 times a year) | 11.11 | 12.1 | 2.61[ns] | 0.01 |
| Cannabis smoking in the last year (%) | | | 218.97 | 0.08 |
| No use | 74.13 | 63.81 | | |
| Sporadic | 17.91 | 29.02 | | |
| Regular | 7.97 | 7.18 | | |
| Other drug use in the last year (%yes) | 3.88 | 6.48 | 45.09 | 0.04 |
| History of bullying (%yes)[4] | 15.35 | 17.06 | 5.2 | 0.01 |
| History of self-harm behaviour (%yes)[5] | 14.98 | 17.84 | 15.08 | 0.02 |
| 12-month self-harm behaviour (%yes) | 23.25 | 27.81 | 30.05 | 0.03 |
| Lifetime suicide attempt (%yes) | 7.45 | 7.93 | 0.77 [ns] | 0 |

*Note.* Percentage of cases are displayed for dichotomous and categorical variables. Mean and standard deviation (between brackets) are displayed for continuous variables. Attrition analysis involves comparing the variables of interest between the sample used to enumerate emotional regulation trajectories and the adolescent sample. The $t$ -based tests (continuous variables) and $\chi^2$ tests (dichotomous/categorical variables) were used as contrast test statistics. Effect size (ES) estimates were the Cohen's $d$ for continuous variables and Cramer's $V$ for non-continuous ones.

† Total sample included and showing data at least in one of the three first MCS sweeps (i.e., MCS 2004 sweep, 2006 sweep, or 2008 sweep). Data from this sample were used for emotional dysregulation trajectory class identification.

†† Sample that showed data across all the variables across the analyses (i.e., trajectory class analysis and adolescent outcome prediction).

[1] Quintiles were calculated from the Organisation for Economic Co-operation and Development data, using the whole Millennium Cohort Study sample ($N$ = 18,552) at the study baseline; [2] Derived from the Strength and Difficulties Questionnaire total score; [3] Total score from the Cognitive Abilities Test 3, Level H, Number Analogies test. [4] Self-reported items on being bullied at age 14 (2015). [5] Self-harm at age 14 (2015). All contrast tests were significant ($p < .05$), except those with superscript [ns].

**Table 3. Growth mixture modelling solutions for emotion dysregulation course.**

| Class | Model specification | Emotional dysregulation | | | |
|---|---|---|---|---|---|
| | | LL | CAIC | SABIC | %n in class |
| 1 | intercept | -27292.54 | 54591.08 | 54604.15 | 100 |
| 1 | linear | -26428.09 | 52864.18 | 52881.61 | 100 |
| 1 | quadratic | -24665.38 | 49340.77 | 49362.56 | 100 |
| 2 | intercept | -26246.26 | 52502.53 | 52524.32 | 35.75-64.25 |
| 2 | linear | -25334.94 | 50683.88 | 50714.38 | 35.22-64.78 |
| 2 | quadratic | -24237.05 | 48492.11 | 48531.33 | 21.32-78.68 |
| 3 | intercept | -26246.26 | 52506.52 | 52537.03 | 0-63.60 |
| 3 | linear | -24738.62 | 49497.24 | 49540.82 | 21.09-48.36 |
| 3 | quadratic | -19769.61 | 39565.24 | 39621.89 | 22.72-44.87 |
| 4 | intercept | No convergence | | | |
| 4 | linear | -24738.62 | 49503.24 | 49559.89 | 4.58-82.13 |
| 4 | quadratic | -18992.33 | 38018.67 | 38092.75 | 7.76-44.55 |
| 5 | intercept | No convergence | | | |
| 5 | linear | -24309.20 | 48650.42 | 48720.14 | 0-43.25 |
| 5 | quadratic | -14673.32 | 29388.66 | 29480.16 | 8.94-33.62 |
| 6 | intercept | No convergence | | | |
| 6 | linear | -24309.20 | 48656.42 | 48739.21 | 0-59.11 |
| 6 | quadratic | -12281.18 | 24612.40 | 24721.33 | 8.39-32.34 |

*Note.* All solutions were modelled using age (centred on the minimum) as a time factor, with no effect (intercept model) linear or quadratic effects (see Model specification).

'Class' refers to number of classes considered in each model. '%n in class' refers to percentage of participants in each class.

LL = Maximum log-likelihood estimator for model convergence; CAIC = Consistent Akaike information criterion; SABIC = Sample-adjusted Bayesian information criterion.

**Table 4. Predictors of 12-month self-harm and lifetime suicide.**

| | Self-harm | | Suicide attempt | |
|---|---|---|---|---|
| | *OR* ($CI_{95}$) | *z* | *OR* ($CI_{95}$) | *z* |
| (Intercept) | 0.11 (0.09, 0.13) | -21.98** | 0.01 (0.01, 0.01) | -24.1** |
| Sex (ref. Male) | | | | |
| Female | 1.89 (1.64, 2.19) | 8.58** | 1.79 (1.4, 2.31) | 4.53** |
| Age | 0.92 (0.86, 0.99) | -2.15* | 0.96 (0.86, 1.08) | -0.67 |
| Ethnic group (ref. White) | | | | |
| Asian | 1.06 (0.55, 1.97) | 0.19 | 2.57 (1.04, 5.68) | 2.2* |
| Black | 0.76 (0.33, 1.57) | -0.69 | 0.38 (0.02, 1.93) | -0.92 |
| Other/mixed | 0.7 (0.35, 1.34) | -1.04 | 0.71 (0.16, 2.18) | -0.54 |
| Adolescent (proximal) covariate | | | | |
| Household income at age 17 (ref. 1st quartile) | | | | |
| 2nd quartile | 1.22 (1.03, 1.43) | 2.34* | 0.85 (0.66, 1.1) | -1.2 |
| 3rd quartile | 1.96 (1.31, 2.9) | 3.33** | 0.43 (0.18, 0.92) | -2.03* |
| 4th quartile | 1.18 (0.98, 1.41) | 1.79 | 0.61 (0.45, 0.83) | -3.17** |
| Mental health difficulties[1] | 2.6 (2.41, 2.81) | 24.33** | 1.62 (1.44, 1.83) | 7.83** |
| Cognition score[2] | 1.17 (1.09, 1.26) | 4.38** | 0.78 (0.69, 0.88) | -3.97** |
| Alcohol drinking (ref. Less than 40 times a year) | 1.22 (0.98, 1.51) | 1.77 | 0.66 (0.44, 0.95) | -2.16* |
| Cannabis smoking (ref. No use) | | | | |
| Sporadic use | 1.4 (1.19, 1.65) | 4.03** | 1.67 (1.29, 2.17) | 3.87** |
| Regular use | 1.52 (1.12, 2.04) | 2.74** | 2.54 (1.68, 3.82) | 4.45** |
| Other drug use (ref. No) | 1.28 (0.94, 1.73) | 1.6 | 1.37 (0.88, 2.09) | 1.43 |
| Self-harm at age 14 (ref. No)[3] | 3.54 (3, 4.19) | 14.8** | | |
| Self-harm at age 17 (ref. No)[4] | | | 7.84 (6.07, 10.21) | 15.53** |
| Bullying history[5] | 1.22 (1.03, 1.45) | 2.3* | 1.9 (1.49, 2.42) | 5.21** |
| Distal covariate | | | | |
| Emotional dysregulation class (ref. modal) | | | | |
| Decreasing | 1.03 (0.86, 1.23) | 0.32 | 1.93 (1.43, 2.6) | 4.28** |
| Increasing | 0.96 (0.75, 1.22) | -0.35 | 1.25 (0.82, 1.88) | 1.04 |
| Heightened | 0.82 (0.65, 1.02) | -1.79 | 2.06 (1.44, 2.94) | 3.99** |
| U-shaped | 0.95 (0.74, 1.21) | -0.43 | 1.48 (1.01, 2.17) | 2.02* |
| Inverted U-shaped | 0.91 (0.7, 1.19) | -0.67 | 1.07 (0.67, 1.66) | 0.29 |

*Note.* Logistic binary regression was used for both the self-harm behaviour and suicide outcomes (reference category: absence). UK country was used as a weighting factor in the regression.
*OR* = Odds ratio. $CI_{95}$ = 95% confidence interval of the *OR*. *z* = Wald's *z*-based statistic to test whether loading is significantly different from one.

[1] Total score of the Strengths and Difficulties Questionnaire.

[2] Total score from the Cognitive Abilities Test 3, Level H, Number Analogies test.

[3] Self-harm behaviour at age 14 was also used as a covariate in the 12-month self-harm at age 17 prediction model.

[4] Self-harm behaviour at age 17 was also used as a covariate in the suicide prediction model.

[5] Taken from the self-reported question on being bullied at age 14.

* $p < .05$; ** $p < .01$.

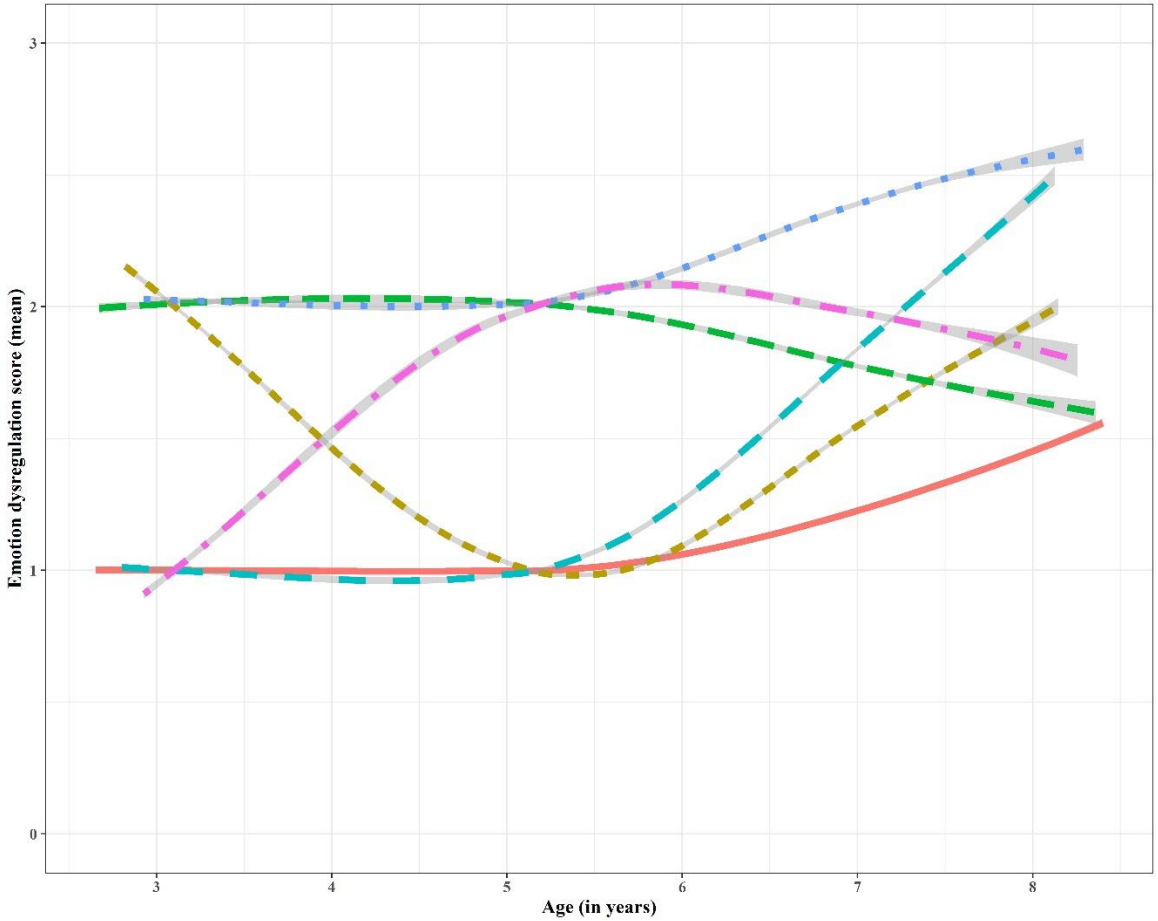


**Figure 1. Heterogeneous trajectories of emotion dysregulation in childhood.**
*Note.* Emotion dysregulation was measured by parent' response to the Child Social Behaviour Questionnaire (CSBQ).
Shaded area displays the 95% confidence interval of the mean.
Trajectory classes: Modal class = Orange solid line. U-shaped class = Olive green line.
Decreasing dysregulation class = Green dashed line. Increasing dysregulation class = Turquoise dashed line.
Heightened dysregulation class = Blue dotted line. Inverted U-shaped class = Violet dashdot line.

## Supplementary material

### Results

The Table S1 displays the profile factors related to each identified classes in comparison to the modal class; profile factors were measured at the baseline (i.e., MCS 2004 sweep). Findings were based on multinomial logistic regression analysis, considering the modal emotion dysregulation trajectory class membership as an outcome reference class. The UK country was used as a weighting factor in this analysis. As a result, the regression model showed a McFadden's pseudo-$R^2$ = .10, and AIC = 57975.26 (AIC for the unconstrained model = 72861.32). Children showing the U-shaped trajectory were more likely to be male, living in a rural area, with lower levels of household income and parents less educated. Finally, they were featured by poorer physical and mental health, and poorer sleep routines and child-parent relationships. Although members of the decreasing trajectory class showed a relatively similar profile than the U-shaped trajectory children, they were also featured by a higher risk of living without any of their natural parents. The heightened emotion dysregulation trajectory children were also featured by the same risk factors, but coefficients pointed to stronger relationships with class membership. The increasing emotion dysregulation trajectory was less characteristic of children from Asian ethnic groups in comparison to modal trajectory children. Finally, the inverted U-shaped trajectory members could live either in rural or urban areas. Even though the same risk factors that featured the other non-modal classes were significantly linked with the inverted U-shaped trajectory membership.

Table S1. **Regression coefficients to explain emotion dysregulation class membership.**

| | U-shaped | | Decreasing | | Increasing | | Heightened | | Inverted U-shaped | |
|---|---|---|---|---|---|---|---|---|---|---|
| | *RRR* (*CI*$_{95}$) | *Z* | *RRR* (*CI*$_{95}$) | *Z* | *RRR* (*CI*$_{95}$) | *Z* | *RRR* (*CI*$_{95}$) | *Z* | *RRR* (*CI*$_{95}$) | *Z* |
| Sex (ref. Boy) | | | | | | | | | | |
| Girl | 0.84 (0.78, 0.91) | -4.18** | 0.93 (0.83, 1.04) | -1.31 | 0.88 (0.79, 0.97) | -2.54* | 0.58 (0.52, 0.64) | -10.19** | 0.71 (0.64, 0.80) | -5.90** |
| Urbanicity (ref. Urban) | | | | | | | | | | |
| Rural | 0.87 (0.80, 0.95) | -3.20** | 0.78 (0.70, 0.87) | -4.35** | 0.95 (0.85, 1.05) | -1.01 | 0.75 (0.67, 0.83) | -5.25** | 0.92 (0.82, 1.03) | -1.46 |
| Ethnic group (ref. White) | | | | | | | | | | |
| Asian | 1.18 (0.91, 1.53) | 1.28 | 1.32 (0.97, 1.80) | 1.74 | 0.57 (0.38, 0.86) | -2.70** | 0.89 (0.64, 1.22) | -0.74 | 1.33 (0.97, 1.83) | 1.74 |
| Black | 0.78 (0.55, 1.11) | -1.39 | 0.63 (0.39, 1.04) | -1.81 | 0.62 (0.38, 1.01) | -1.91 | 0.72 (0.46, 1.13) | -1.41 | 0.81 (0.51, 1.30) | -0.87 |
| Other/mixed | 0.82 (0.56, 1.21) | -0.99 | 0.97 (0.60, 1.56) | -0.14 | 0.62 (0.36, 1.07) | -1.71 | 0.72 (0.44, 1.18) | -1.29 | 1.12 (0.70, 1.80) | 0.47 |
| Household income (ref. 1st quintile)[1] | | | | | | | | | | |
| 2nd quintile | 0.90 (0.78, 1.04) | -1.44 | 0.77 (0.65, 0.92) | -2.84** | 0.85 (0.70, 1.02) | -1.73 | 0.76 (0.65, 0.90) | -3.20** | 0.74 (0.62, 0.89) | -3.26** |
| 3rd quintile | 0.77 (0.66, 0.89) | -3.51** | 0.67 (0.56, 0.81) | -4.13** | 0.86 (0.71, 1.03) | -1.61 | 0.50 (0.42, 0.60) | -7.59** | 0.52 (0.43, 0.63) | -6.56** |
| 4th quintile | 0.67 (0.57, 0.78) | -5.18** | 0.63 (0.51, 0.76) | -4.68** | 0.72 (0.60, 0.88) | -3.22** | 0.37 (0.30, 0.45) | -10.11** | 0.43 (0.35, 0.53) | -8.1** |
| 5th quintile | 0.59 (0.50, 0.69) | -6.38** | 0.46 (0.37, 0.58) | -7.02** | 0.63 (0.52, 0.78) | -4.37** | 0.31 (0.25, 0.39) | -10.91** | 0.35 (0.28, 0.43) | -9.54** |
| Living with both natural parents (ref. yes) | | | | | | | | | | |
| No | 1.12 (0.98, 1.27) | 1.71 | 1.34 (1.15, 1.57) | 3.68** | 1.01 (0.86, 1.19) | 0.14 | 1.19 (1.03, 1.39) | 2.32* | 1.14 (0.96, 1.34) | 1.51 |
| Parents' education (years)[2] | 0.92 (0.91, 0.94) | -8.71** | 0.90 (0.87, 0.92) | -8.94** | 0.97 (0.95, 0.99) | -2.68** | 0.87 (0.85, 0.89) | -11.29** | 0.97 (0.95, 0.99) | -2.44* |
| Parental psychopathology[2,3] | 1.03 (1.01, 1.04) | 3.82** | 1.04 (1.02, 1.06) | 4.86** | 1.01 (0.99, 1.03) | 1.12 | 1.05 (1.03, 1.07) | 6.24** | 1.02 (1.00, 1.04) | 2.27* |
| Toddler's health status (ref. good) | | | | | | | | | | |
| Poor | 1.17 (1.04, 1.32) | 2.53* | 1.24 (1.07, 1.44) | 2.85** | 1.05 (0.90, 1.23) | 0.66 | 1.38 (1.19, 1.58) | 4.42** | 1.59 (1.37, 1.86) | 6.04** |
| Toddler's development[4] | 0.99 (0.97, 1.00) | -1.37 | 1.00 (0.98, 1.02) | 0.23 | 1.01 (0.99, 1.03) | 0.64 | 1.02 (1.00, 1.04) | 1.98* | 1.01 (0.99, 1.04) | 1.37 |
| Eating routines (ref. usually not followed) | | | | | | | | | | |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sometimes | 1.07 | (0.73, 1.58) | 0.36 | 1.08 | (0.67, 1.74) | 0.30 | 1.17 | (0.68, 2.00) | 0.56 | 0.70 | (0.47, 1.06) | -1.7 | 1.08 | (0.66, 1.76) | 0.29 |
| Always | 1.02 | (0.69, 1.51) | 0.12 | 1.09 | (0.67, 1.77) | 0.36 | 1.15 | (0.67, 1.97) | 0.5 | 0.60 | (0.39, 0.90) | -2.44* | 0.91 | (0.55, 1.50) | -0.38 |
| Sleep routines (ref. usually not followed) | | | | | | | | | | | | | | | |
| Sometimes | 0.57 | (0.48, 0.69) | -6.12** | 0.70 | (0.56, 0.88) | -3.07** | 0.84 | (0.66, 1.07) | -1.4 | 0.62 | (0.50, 0.77) | -4.46** | 0.54 | (0.43, 0.68) | -5.30** |
| Always | 0.55 | (0.46, 0.66) | -6.34** | 0.61 | (0.48, 0.77) | -4.17** | 0.77 | (0.60, 0.99) | -2.05** | 0.58 | (0.47, 0.73) | -4.84** | 0.58 | (0.46, 0.73) | -4.62** |
| Child-parent relationship[5] | 0.86 | (0.85, 0.86) | -38.61** | 0.82 | (0.81, 0.83) | -40.58** | 0.91 | (0.91, 0.92) | -17.84** | 0.78 | (0.77, 0.79) | -52.25** | 0.90 | (0.89, 0.90) | -20.91** |

*Note*. Multinomial logistic regression was conducted to explain emotional dysregulation class membership. Reference category for the outcome was the modal trajectory class membership. UK country was used as a weighting factor in the regression.

*RRR* ($CI_{95}$) = Relative risk ratio with 95% confidence interval (between brackets). *Z* = *Z*-based statistic for Wald's test.

[1] Taken from the Organisation for Economic Co-operation and Development.

[2] Data collected from the respondent parent.

[3] Measured using the Kessler Screening Scale for Psychological Distress (K6).

[4] The Development index was calculated by summing up the ratings of the Denver Developmental Screening test and the MacArthur Communicative Development Inventories.

[5] Measured using the Child-Parent Relationship Pianta Scale (Short Form).

* $p < .05$; ** $p < .01$.

# TRIPOD CHECKLIST FOR PREDICTION MODEL STUDIES

| Section/Topic | ı | Checklist Item | Page |
|---|---|---|---|
| **Title and abstract** | | | |
| Title | 1 | Identify the study as developing and/or validating a multivariable prediction model, the target population, and the outcome to be predicted. | 1 |
| Abstract | 2 | Provide a summary of objectives, study design, setting, participants, sample size, predictors, outcome, statistical analysis, results, and conclusions. | Not all (no predictors) due to limited space |
| **Introduction** | | | |
| Background and objectives | 3a | Explain the medical context (including whether diagnostic or prognostic) and rationale for developing or validating the multivariable prediction model, including references to existing models. | 3 |
| | 3b | Specify the objectives, including whether the study describes the development or validation of the model or both. | 4 |
| **Methods** | | | |
| Source of data | 4a | Describe the study design or source of data (e.g., randomized trial, cohort, or registry data), separately for the development and validation data sets, if applicable. | 5 |
| | 4b | Specify the key study dates, including start of accrual; end of accrual; and, if applicable, end of follow-up. | 5 |
| Participants | 5a | Specify key elements of the study setting (e.g., primary care, secondary care, general population) including number and location of centres. | 5 |
| | 5b | Describe eligibility criteria for participants. | 5 |
| | 5c | Give details of treatments received, if relevant. | NA |
| Outcome | 6a | Clearly define the outcome that is predicted by the prediction model, including how and when assessed. | 6 |
| | 6b | Report any actions to blind assessment of the outcome to be predicted. | NA |
| Predictors | 7a | Clearly define all predictors used in developing or validating the multivariable prediction model, including how and when they were measured. | 5-6 |
| | 7b | Report any actions to blind assessment of predictors for the outcome and other predictors. | NA |
| Sample size | 8 | Explain how the study size was arrived at. | 6-8, Table 1 |
| Missing data | 9 | Describe how missing data were handled (e.g., complete-case analysis, single imputation, multiple imputation) with details of any imputation method. | 7 |
| Statistical analysis methods | 10a | Describe how predictors were handled in the analyses. | 7 |
| | 10b | Specify type of model, all model-building procedures (including any predictor selection), and method for internal validation. | 7 |
| | 10d | Specify all measures used to assess model performance and, if relevant, to compare multiple models. | 7 |
| Risk groups | 11 | Provide details on how risk groups were created, if done. | 7 |
| **Results** | | | |
| Participants | 13a | Describe the flow of participants through the study, including the number of participants with and without the outcome and, if applicable, a summary of the follow-up time. A diagram may be helpful. | 6-8, Table 1 |
| | 13b | Describe the characteristics of the participants (basic demographics, clinical features, available predictors), including the number of participants with missing data for predictors and outcome. | Table 1 and supplementary file |
| Model development | 14a | Specify the number of participants and outcome events in each analysis. | 6-8, Tables 1-3 |
| | 14b | If done, report the unadjusted association between each candidate predictor and outcome. | NA |
| Model specification | 15a | Present the full prediction model to allow predictions for individuals (i.e., all regression coefficients, and model intercept or baseline survival at a given time point). | 9, Table 3 |
| | 15b | Explain how to the use the prediction model. | 7, 9 |
| Model performance | 16 | Report performance measures (with CIs) for the prediction model. | 9, Table 3 |
| **Discussion** | | | |
| Limitations | 18 | Discuss any limitations of the study (such as nonrepresentative sample, few events per predictor, missing data). | 15-16 |

| | | | |
|---|---|---|---|
| Interpretation | 19b | Give an overall interpretation of the results, considering objectives, limitations, and results from similar studies, and other relevant evidence. | 13-15 |
| Implications | 20 | Discuss the potential clinical use of the model and implications for future research. | 17 |
| **Other information** | | | |
| Supplementary information | 21 | Provide information about the availability of supplementary resources, such as study protocol, Web calculator, and data sets. | 17 |
| Funding | 22 | Give the source of funding and the role of the funders for the present study. | 17 |