Childhood correlates and young adult outcomes of trajectories of emotional problems from childhood to adolescence

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Abstract

Background. Emotional problems, especially anxiety, have become increasingly common in recent generations. Few population-based studies have examined trajectories of emotional problems from early childhood to late adolescence or investigated differences in psychiatric and functional outcomes.

Methods. Using the Avon Longitudinal Study of Parents and Children (ALSPAC, $n = 8286$, 50.4% male), we modeled latent class growth trajectories of emotional problems, using the parent-reported Strength and Difficulties Questionnaire emotional scale (SDQ-E) on seven occasions (4–17 years). Psychiatric outcomes in young adulthood (21–25 years) were major depressive disorder (MDD), generalized anxiety disorder (GAD), and self-harm. Functional outcomes were exam attainment, educational/occupational status, and social relationship quality.

Results. We identified four classes of emotional problems: low (67.0%), decreasing (18.4%), increasing (8.9%), and persistent (5.7%) problems. Compared to those in the low class, individuals with decreasing emotional problems were not at elevated risk of any poor adult outcome. Individuals in the increasing and persistent classes had a greater risk of adult MDD (RR: 1.59 95% CI 1.13–2.26 and RR: 2.25 95% CI 1.49–3.41) and self-harm (RR: 2.37 95% CI 1.91–2.94 and RR: 1.87 95% CI 1.41–2.48), and of impairment in functional domains. Childhood sleep difficulties, irritability, conduct and neurodevelopmental problems, and family adversity were associated with a persistent course of emotional problems.

Conclusions. Childhood emotional problems were common, but those whose symptoms improved over time were not at increased risk for adverse adult outcomes. In contrast, individuals with persistent or adolescent-increasing emotional problems had a higher risk of mental ill-health and social impairment in young adulthood which was especially pronounced for those with persistent emotional problems.

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Introduction

Emotional problems, especially anxiety, have become increasingly common in recent generations (Patalay & Gage, 2019). Anxiety (characterized by worry and fears) frequently begins in childhood (Watson, 2009), whereas depression (marked by low mood and loss of pleasure) is relatively uncommon in childhood but increases sharply during adolescence and early adulthood (Thapar, Eyre, Patel, & Brent, 2022).

Understanding the developmental course of emotional problems can help identify children who are at increased risk of poor long-term outcomes. Though childhood fears and temperamental traits of clinginess or nervousness are common for many, they often improve with time (Giesbrecht, Letourneau, & Dewey, 2022). However, for other children, emotional problems persist over time and are associated with later anxiety disorder and emergence of depression (Copeland, Angold, Shanahan, & Costello, 2014). Follow-up studies of clinical samples of children with anxiety suggest that developmental continuities in emotional problems across childhood and adolescence are associated with poorer adult outcomes (Hovenkamp-Hermelink, Jeronimus, Myroniuk, Riese, & Schoevers, 2021). However, population-based studies following the course and consequences of emotional problems from early childhood into adult life are lacking.

Trajectory-based analyses can distinguish developmental patterns of symptoms based on the severity, age at onset, and degree of persistence or desistance of difficulties over time (Thapar & Riglin, 2020). Population-based longitudinal studies of adolescent depression

have demonstrated the utility of trajectory-based methods for distinguishing developmental patterns that predict varying liability toward adult mental health problems, self-harm, and impairment (Copeland et al., 2014; Glied & Pine, 2002; Kertz, Sylvester, Tillman, & Luby, 2019; López-López et al., 2019; Pickles et al., 2010). Currently, little is known about developmental trajectories of emotional problems more broadly – particularly anxiety – from childhood through adolescence, and how these relate to adult outcomes.

Emotional problems, including anxiety and depression, have a complex multifactorial etiology involving childhood characteristics (childhood temperamental and behavioral traits), inherited influences, and family and social factors (Penninx, Pine, Holmes, & Reif, 2021). Previous research has shown that female gender (Gutman & Codiroli McMaster, 2020), behavioral inhibition (Beesdo-Baum et al., 2012; Fox, Henderson, Marshall, Nichols, & Ghera, 2005), neurodevelopmental problems (Addicoat, Thapar, Riglin, Thapar, & Collishaw, 2020), sleep problems (Orchard, Gregory, Gradisar, & Reynolds, 2020), irritability (Eyre et al., 2019), behavior, and conduct problems (Kosterman et al., 2009) are important predictors of depression and/or anxiety, alongside family risk and contextual factors such as social adversity and social support (Cadman et al., 2021; Joinson, Kounali, & Lewis, 2017; Pickard, Happe, & Mandy, 2018). Research also shows that inherited factors including genetic risk for depression and anxiety are associated with emotional problems throughout adolescence and into young adulthood (Kwong et al., 2019a; Kwong et al., 2021). However, more research is needed to understand associations of these factors with differences in developmental course of emotional problems.

To the best of our knowledge, trajectory-based analyses have largely focused on depression (Kwong et al., 2019b; Weavers et al., 2021). Where trajectory-based analyses of anxiety specifically or emotional problems more generally have been undertaken, these have often used a limited number of timepoints that do not span childhood and adolescence (Galambos, Barker, & Almeida, 2003) or have not examined implications for mental health and functional outcomes in adulthood (de Lijster et al., 2019).

Aims

Using a UK population cohort, we aimed to (a) characterize heterogeneity in trajectories of emotional problems from early childhood to late adolescence (4–17 years old), (b) examine childhood correlates of those trajectories, and (c) test the association of emotional problem trajectories with psychiatric and functional outcomes in young adulthood (up to 25 years old). We also examined whether results replicated when constraining trajectories to include anxiety symptoms only and when modeling trajectories by sex.

Methods

Study design and participants

We used data from the Avon Longitudinal Study of Parents and Children (ALSPAC), an ongoing longitudinal population-based UK cohort (Boyd et al., 2013). ALSPAC enrolled a sample of 14 541 women residing in the Avon area of England, who were pregnant and had an expected delivery date between 1 April 1991 and 31 December 1992 (Fraser et al., 2013). In total, there were 14 062 live births, and 13 988 of these children were alive

at 1 year of age. When the oldest children were approximately 7 years of age, an attempt was made to bolster the initial sample with eligible cases who had failed to join the study originally. An additional 913 children were enrolled, resulting in 14 901 children who were alive at age 1 (Northstone et al., 2019). Please note that the study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool (http://www.bristol.ac.uk/alspac/researchers/our-data/). Sex was assessed via a maternal report at birth. For data gathered from participants aged 22 onwards, study data were collected and managed using REDCap electronic data capture tools hosted at the University of Bristol. REDCap (Research Electronic Data Capture) is a secure, web-based software platform designed to support data capture for research studies (Harris et al., 2009, 2019). Our sample comprised 8286 individuals who completed at least one Strengths and Difficulties Questionnaire assessment between the ages of 4 and 9 and once between 12 and 17 years, to account for the well-established differences in the prevalence of emotional problems in childhood and adolescence (McLaughlin & King, 2015). For twins, the second-born twin was excluded to avoid non-independent observations.

Ethical approval for the study was obtained from the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. Informed consent for the use of data collected via questionnaires and clinics was obtained from participants following the recommendations of the ALSPAC Ethics and Law Committee at the time.

Emotional problems

Parents completed the emotional problems subscale of the Strength and Difficulties Questionnaire (SDQ), a brief validated screening tool for common mental health problems in children and young people (Armitage et al., 2023; Goodman, 1999). The emotional symptoms scale (SDQ-E) contains five items, including questions about fears and anxiety ('many worries, often seems worried', 'nervous or clingy in new situations, easily loses confidence', 'many fears, easily scared'), depressed mood ('often unhappy, down-hearted or tearful'), and somatic complaints ('often complains of headaches, /stomach-aches or sickness'). Items are rated on a 3-point scale (2: certainly true; 1: sometimes true; 0: not true; range 0–10).

The SDQ-E has been validated as a measure of emotional disorders for individuals aged up to 18 years (Armitage et al., 2023). The SDQ-E was completed by the child's main carer (usually the child's mother) when children were ~4, 7, 8, 9, 12, 13, and 17 years old.

The general worry item (score ranging from 0 to 2) was explored separately to examine developmental trajectories specific to generalized anxiety. The SDQ-E has previously shown high accuracy for discriminating cases of generalized anxiety (AUC = 0.80–0.93) (Armitage et al., 2023).

Validation

Trajectories of emotional problems were validated using the Development and Wellbeing Assessment (DAWBA) (Goodman, Heiervang, Collishaw, & Goodman, 2011), a structured diagnostic assessment collected via parent-report at 7, 10, and 13, and self-report at 15 years, which was used to assign probability of psychiatric diagnoses following Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) criteria for depressive

disorder, anxiety disorder, and any emotional disorder (i.e. depression or anxiety). The interview questions were administered online (face-to-face at age 15 only), and the probability of diagnosis was generated using a validated six-band computer prediction (Goodman et al., 2011).

Childhood correlates

Child factors
These included child sex reported by the parent. Temperamental intensity was assessed by the Carey Infant Scale intensity subscale (CITS) at 6 months (Carey & McDevitt, 1978), with a higher score indicating higher intensity (range ⩽49). Behavioral inhibition was measured at 3 years via the shyness sub-scale of the Emotionality Activity Sociability (EAS) Temperament Survey (Kostyrka-Allchorne, Wass, & Sonuga-Barke, 2020), with a higher score indicating higher inhibition (range ⩽25). Irritability was assessed at 4 years using the SDQ ('child is irritable. is quick to fly off the handle') (Goodman, 1999). The presence of child ADHD traits at age 7 was assessed using the parent-reported DAWBA (Goodman et al., 2011). Autism spectrum disorder (ASD)-related symptoms were assessed using the parent-reported Social and Communication Disorders Checklist (SCDC) at age 7 (cut-point ⩾9) (Skuse et al., 2009). One binary variable assessing either high ADHD or ASD traits were used in analyses. Low IQ (defined as ⩽85) was assessed at 8 years old using Wechsler Intelligence Scale for Children (Wechsler, 2003). Conduct problems were measured using the five-item SDQ conduct scale at age 7 years (with a cut-off at >3; high/very high) (Goodman & Goodman, 2009). Presence of sleep problems was assessed via parent-report at 6 years (Morales-Muñoz, Broome, & Marwaha, 2020).

Wider family
Maternal depression and anxiety symptoms during the child's early life were derived using the Edinburgh postnatal depression scale (EPDS) (Cox, Holden, & Sagovsky, 1987) and the Crown–Crisp index (Birtchnell, Evans, & Kennard, 1988), respectively at child age 1 year 9 months.

Family poverty was assessed when the child was aged 11 using a household income of <60% of the median for the sample (<£240 per week) (Weavers et al., 2021).

Adverse childhood events were assessed at 7 years using a questionnaire completed by mothers, recording whether the child had experienced upsetting events (see online Supplementary Table S1) since the child was 5 years old.

Polygenic scores
Polygenic scores (PGS) are a continuous measure that captures a person's common genetic liability to a particular disorder or trait. The genetic variants a person carries are weighted on the basis of their effect size in a Genome-Wide Association Study (GWAS) to create an overall score with a higher score indicating greater genetic susceptibility to the trait. We generated three polygenic scores using the auto option of PRS-CS (Ge, Chen, Ni, Feng, & Smoller, 2019), using discovery data from the largest available GWAS for anxiety disorder (Purves et al., 2020), major depressive disorder (MDD) (Wray et al., 2018), and ADHD (Demontis et al., 2019). PGS were standardized as Z scores to allow for meaningful interpretation of results and comparisons across scores. We used Plink v1.9 to perform a principal components analysis, and we included the first ten principle components as covariates in all PGS analyses to adjust for population stratification. Only individuals of

European ancestry were genotyped by ALSPAC, and thus PGS analyses are limited to this population.

Outcomes in young adulthood

Mental health outcomes
MDD and Generalized Anxiety Disorder (GAD) were each assessed using self-reports on two occasions in young adulthood. The Clinical Interview Schedule-Revised (CIS-R) (Lewis, Pelosi, Araya, & Dunn, 1992) was used to assign DSM-IV diagnoses of depression and GAD at 24 years. Lifetime suicidal self-harm was assessed by self-report at age 24.

Functional outcomes

At 22 years, individuals answered 11 self-reported questions about employment and education. Those not in either full-time, part-time, or irregular work, doing an apprenticeship, self-employed, or in full-time education were defined as being not in education, employment, or training (NEET). Educational attainment was assessed via the highest qualification achieved and grouped as having achieved a General Certificate of Secondary Education (GCSEs A*-C) or higher, or no GCSEs A*-C. Finally, social functioning was assessed by the self-report SDQ impact supplement questions on difficulties in relationships and social interactions with others at age 25 (Goodman, 1999).

Statistical analyses

Emotional problem trajectory classes (4–17 years)
We used the SDQ emotional scale score, treating it as a continuous measure,(Kwong et al., 2019b) ranging from 0 to 10, to calculate trajectories of emotional problems. Latent class growth models (Muthen & Muthen, 2000), which allow for the probabilistic assignment of individuals into classes based on patterns of scores over repeated assessments, were fit using MPlus (version 8) (Muthen, Muthen, & Muthén, 2017).

We considered different class solutions from 1 to 5 classes and selected the best fitting model based on model fit indices, sample size per class (no less than 100 individuals), and ease of interpretation as recommended (Asparouhov & Muthén, 2014). Model fit indexes included loglikelihood (LL), sample size adjusted Bayesian information criterion (BIC), entropy, Lo-Mendell-Rubin test, and Bootstrapped likelihood ratio test. We evaluated model fit for 1–5-class solutions for different functions of time: linear, quadratic, and cubic (see online Supplementary Table S2a).

Missing data
For deriving trajectories, we used Full Information Maximum Likelihood, which makes a missing at random assumption to allow for the inclusion of partially incomplete data. Individuals with SDQ-E data at least once in childhood (ages 4, 7, 8, and 9) and at least once in adolescence (12, 13, and 17) were included ($N = 8286$).

To investigate associations with childhood correlates and outcomes in young adulthood we imputed the covariates and outcomes to account for further missingness in these variables. Multiple imputation using fully conditional specification was used in IBM SPSS Statistics Version 27. In total, 40 imputations (10 iterations in each instance) were implemented, with logistic regression models being used for the categorical variables and

predictive mean matching for the continuous variables (see online Supplement Multiple imputation section).

Associations of trajectory class members with childhood correlates and adult outcomes

Descriptive statistics were used to explore childhood correlates across different (predicted) classes of emotional problems in the imputed dataset in STATA. We ran univariable multinomial logistic regression models in MPlus, controlling for sex. These allowed us to investigate the associations between class membership and childhood correlates and adult outcomes. This was done using a manual implementation of the bias-adjusted three-step approach in the imputed dataset, deriving pooled estimates using Rubin's rules (Rubin, 1987). Sensitivity analyses using complete-case data for descriptive statistics and bivariate associations are presented in the online Supplementary Appendix.

Secondary analyses

Additional analyses examined (i) trajectories with more stringent criteria by running LCGA models that included all individuals with SDQ-E data on three occasions with at least one in childhood and one in adolescence ($N = 8220$), (ii) trajectories of emotional problems run separately for male and female participants, and (iii) trajectories focused on anxiety only indexed by the SDQ item about general worry (coded certainly true v. sometimes true or not true).

Role of the funding source

The funders of the study had no role in the study design, data collection, data analysis, data interpretation, or writing of the report.

Results

Sample characteristics

The sample consisted of 8286 participants who had completed the SDQ-E at least once across childhood and at least once in adolescence ($n = 4178$ males, $n = 4108$ females); 3.7% were from non-White ethnic backgrounds. Response patterns across the longitudinal data for childhood correlates, measures of emotional problems, and outcome variables are shown in online Supplementary Table S5.

Symptoms of emotional problems assessed by the individual SDQ-E items showed variation across development (see online Supplementary Fig. S1a). The most common problems in early childhood were nervousness/clinginess and fears, whereas in late adolescence the most common problems were general worry and somatic complaints. The prevalence of low mood, somatic complaints, and general worry increased with age, fearfulness showed a stable pattern developmentally, and nervousness/clinginess decreased with age. When looking at SDQ-E items separately for males and females (online Supplementary Figs S1b and S1c), some differences were observed with greater developmental increases in somatic complaints and low mood for females than for males.

Longitudinal trajectories of emotional problems

The cubic 4-class solution was selected based on model fit statistics, parsimony, and theoretical expectations (see online Supplementary Table S2a for model fit statistics). As shown in Fig. 1, the selected model included four classes: persistently low emotional problems ($n = 5550$, 67.0%), decreasing levels of emotional problems ($n = 1524$, 18.4%), increasing levels of emotional problems ($n = 743$, 8.9%), and persistent high levels of emotional problems throughout childhood and adolescence ($n = 469$, 5.7%).

Validation of emotional problem trajectories against diagnostic measures of emotional disorders

Table 1 displays the proportion with a probable DAWBA-derived diagnosis of a depressive disorder, anxiety disorder, or any emotional disorder (including depression and anxiety) at ages 7, 10, 13, and 15 years for each trajectory.

The low emotional problems class had low rates of a probable emotional disorder at all time points (0.5–1.6%). The decreasing problems class had low but elevated rates (relative to the low class) at ages 7, 10, and 13 years but not at 15 years. The increasing trajectory had elevated rates of emotional disorders at all time points relative to the low emotional problems class, and also relative to the decreasing problems class at ages 10, 13, and 15. The
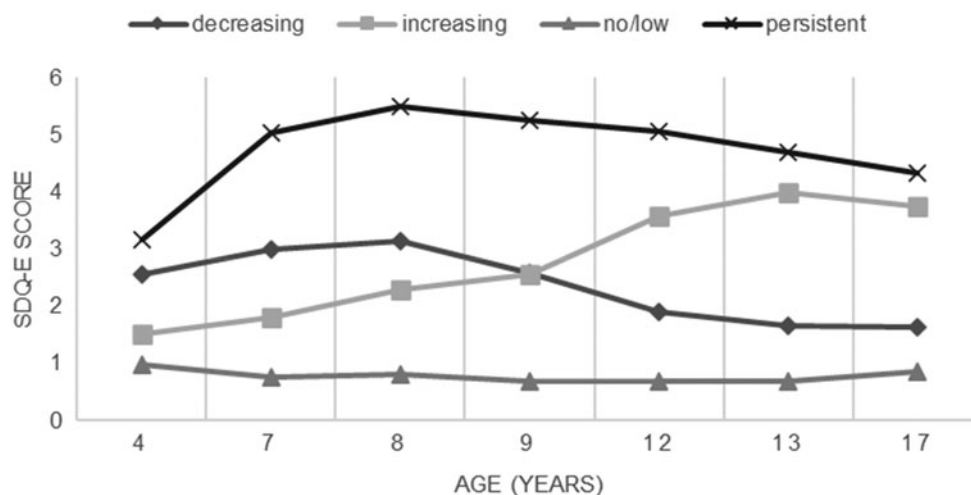

Figure 1. Cubic 4-class trajectory of emotional problems from 4 to 17 years.
aSDQ-E clinical cut-off point ⩾5.

Table 1. Validation of the 4-class solution

	Depressive disorder			
	DAWBA 7 (DEP)	DAWBA 10 (DEP)	DAWBA 13 (DEP)	DAWBA 15 (DEP)
Low	0.1 (0–0.1)	0.2 (0.1–0.3)	0.2 (0.1–0.4)	1.5 (1.1–2.0)
Decreasing	0.9 (0.5–1.6)	1.4 (0.8–2.1)	0.4 (0.1–1.0)	1.3 (0.6–2.3)
Increasing	1.0 (0.3–2.1)	2.9 (1.7–4.6)	3.6 (2.3–5.5)	2.2 (1.0–4.1)
Persistent	4.1 (2.3–6.5)	4.8 (2.9–7.4)	4.5 (2.6–7.4)	2.8 (1.1–5.7)
Anxiety disorder				
	DAWBA 7 (ANX)	DAWBA 10 (ANX)	DAWBA 13 (ANX)	DAWBA 15 (ANX)
Low	0.4 (0.2–0.7)	0.6 (0.4–0.9)	0.3 (0.2–0.5)	1.5 (1.1–2.0)
Decreasing	2.5 (1.7–3.5)	2.1 (1.4–3.1)	1.5 (0.9–2.3)	1.5 (0.8–2.6)
Increasing	2.0 (1.1–3.4)	5.0 (3.4–7.1)	5.1 (3.4–7.1)	3.4 (1.8–5.6)
Persistent	12.8 (9.6–16.4)	14.3 (11.0–18.2)	9.0 (6.2–12.6)	4.4 (2.2–7.7)
Emotional disorder				
	DAWBA 7 (EMO)	DAWBA 10 (EMO)	DAWBA 13 (EMO)	DAWBA 15 (EMO)
Low	0.5 (0.1–0.7)	0.6 (0.5–1.1)	0.5 (0.3–0.8)	1.6 (1.2–2.0)
Decreasing	2.8 (1.8–3.7)	3.0 (2.1–4.1)	1.8 (1.1–2.8)	1.7 (1.0–2.6)
Increasing	3.5 (1.9–5.7)	6.9 (5.1–9.2)	7.1 (5.1–9.4)	4.5 (2.8–6.7)
Persistent	14.8 (10.2–17.5)	18.0 (14.3–22.2)	12.0 (8.7–16.0)	5.9 (3.7–7.6)

Data represent proportions (95% CI).

persistent class had the highest rate of emotional disorders at all time points except that rates at 15 were similar to the increasing class (5.9–18.0%).

Childhood correlates of emotional problem trajectories
We then examined differences in childhood correlates of the four classes (Tables 2 and 3). There was an excess of females in the decreasing, increasing, and persistent classes relative to the low class.

Children in the decreasing emotional problems and persistent emotional problems (but not increasing emotional problems) trajectories showed elevated behavioral inhibition in early childhood. All three elevated emotional problem classes showed higher rates of childhood psychopathology relative to the low emotional problems class including irritability, sleep problems, neurodevelopmental difficulties (high ADHD or ASD traits), and conduct problems, and further tests showed that the persistent class also had somewhat higher ADHD or ASD traits than the decreasing class (RR 5.56 95% CI 3.04–10.17 *v.* RR 2.48 95% CI 1.58–3.90). Childhood psychopathology was most strongly associated with membership of the persistent emotional problems class (risk ratios ranging 3.71 [3.02–4.57] to 6.40 [4.49–9.98]). Persistent emotional problems were also associated with low IQ.

Polygenic scores for MDD and anxiety, but not ADHD, were elevated in the persistent emotional problems class, compared to the low emotional problems class. There was also a modest association between MDD PGS and the increasing and decreasing emotional problem classes, and between anxiety PGS and the decreasing class, compared to the low emotional problems class (Table 3).

Finally, children with persistent emotional problems experienced high rates of maternal depression (RR 2.95 95% CI 2.41–

3.61) and maternal anxiety (RR 2.89 95% CI 2.32–3.60), adverse childhood life events (RR 2.18 95% CI 1.65–2.88), and family poverty (RR 1.52 95% CI 1.08–2.13) relative to the low class, with intermediate rates of family adversity for children with increasing and decreasing emotional problems (Tables 2 and 3).

Sensitivity analyses using complete-case data for bivariate associations indicated a similar pattern of associations (see online Supplementary Tables S4, S5a & S5b).

A post-hoc analysis was implemented comparing the decreasing and the persistent groups, to investigate early life factors that may distinguish remitting from persistent emotional symptoms. It indicated that the two classes differed on the childhood factors including irritability, sleep, and conduct problems as well as also on maternal mental health (online Supplementary Table S5c).

Outcomes of trajectories of emotional problems
Our third aim was to test associations of emotional problem trajectories with psychiatric and functional outcomes in young adulthood (online Supplementary Tables 4 & S6). As shown in Table 4, we did not find strong evidence of increased risk of any adverse adult outcome for children in the decreasing emotional problems class. For psychiatric outcomes, the increasing trajectory class showed an elevated risk of MDD (RR 1.59 95% CI 1.13–2.26) and self-harm (RR 2.37 95% CI 1.91–2.94). The persistent emotional problems trajectory class had increased risk of MDD (RR 2.25 95% CI 1.49–3.41) as well as lifetime self-harm by age 24 years (RR 1.87 95% CI 1.41–2.48), with weaker evidence for GAD (RR 1.54 94% CI 0.93–2.54).

When focusing on functional outcomes, attainment (no GCSEs) was associated with the increasing and persistent classes (RR 1.76 95% CI 1.38–2.23 and RR 1.95 95% CI 1.35–2.79,

Table 2. Child and family characteristics stratified by emotional problems trajectory class in the imputed sample

	Low emotional problems	Decreasing emotional problems	Increasing emotional problems	Persistent emotional problems
	67.0%	18.4%	8.9%	5.7%
Child factors				
Female, % [a]	46.6	52.5	62.2	55.4
Temperament intensity (6 m), mean (s.d.)[b]	−0.01 (1.01)	0.03 (0.99)	0.03 (1.01)	0.02 (1.02)
Behavioral inhibition (3y), mean (s.d)[b]	−0.12 (0.95)	0.34 (1.02)	0.01 (0.98)	0.44 (1.11)
Irritability (4y), % [a]	35.6	52.4	49.1	67.2
Sleep problems (6y), % [a]	3.0	8.0	7.1	18.5
High ADHD or ASD traits (7y), % [a]	7.8	16.0	16.0	29.0
Conduct problems (7y), % [a]	17.6	34.1	36.3	51.1
Low IQ (8y), % [a]	19.0	20.9	24.7	28.3
Genetic risk				
PGS (MDD), mean (s.d.)[b]	−0.07 (0.99)	0.03 (1.00)	0.08 (0.99)	0.03 (1.04)
PGS (anxiety), mean (s.d.)[b]	−0.05 (1.00)	0.02 (1.02)	0.03 (1.01)	0.06 (1.00)
PGS (ADHD), mean (s.d.)[b]	−0.06 (0.99)	−0.05 (1.01)	0.02 (1.03)	0.02 (1.07)
Wider family factors				
Maternal depression (8 m), % [a]	19.3	28.9	30.4	41.2
Maternal anxiety (8 m), % [a]	14.4	24.1	27.7	32.6
Adverse experiences (7y), % [a]	9.6	13.8	14.5	18.9
Family poverty (11y), % [a]	20.5	22.0	22.3	28.0

[a]Binary variable.
[b]Standardized variable.

respectively) and NEET status at age 22 years with the persistent class (RR 2.92 95% CI 1.75–5.13). We did not find strong evidence for an association between emotional problems trajectory class and social relationship functioning.

Secondary analyses

Upon using more stringent missing data inclusion criteria (having at least three data points available), a cubic 4-class model was derived which was very similar to the model in the full cohort (online Supplementary Table S7 and Fig. S2).

LCGA models run separately for males and females again identified cubic 4-class models as the best fitting solution (see online Supplementary Table S8), and trajectory classes of emotional problems that were closely similar to the model for males and females combined (see online Supplementary Figs S3a and 3b).

Finally, LCGA models were repeated using the single general worry item to assess developmental trajectories of worry only. This indicated the presence of four classes: low (59.9%), decreasing (20.4%), adolescence increasing (9.2%), and persistent high (10.6%) (see online Supplementary Table S9 and Fig. S4). Univariable multinomial logistic regression models indicated that, in contrast to findings using trajectories of emotional problems, temperament intensity was associated with all worry trajectories, especially the persistent class (RR 1.14 95% CI 1.06–1.23). Otherwise, the pattern of associations of worry trajectory classes with early correlates was closely similar to that observed

in our main analyses (see online Supplementary Table S10a). In terms of outcomes in young adulthood (online Supplementary Table S10b), findings again found strong evidence of elevated risk of young adult mental health problems (MDD, GAD, and self-harm) for those with increasing or persistent worry but not for those with decreasing worry. Persistent worry was also linked with poor social functioning (RR 1.93 95% CI 1.33–2.80) but there was no strong evidence of association with NEET status and attainment.

Discussion

Children's trajectories of parent-reported emotional problems across childhood to adolescence showed considerable heterogeneity. Four trajectory classes were identified that differed in severity, age at onset, and persistence of symptoms over time. The majority experienced low emotional problems across childhood and adolescence (67.0%), the next most common class comprised individuals with elevated emotional problems in childhood that improved over time (18.4%), followed by a class with increasing emotional problems in adolescence (8.9%), and a class with persistently high emotional problems across childhood and adolescence (5.7%). Trajectories of emotional problems were validated against structured diagnostic assessments of emotional disorders on four occasions spanning childhood and adolescence.

This study demonstrates that while some emotional problems are common in childhood, these often decrease during

Table 3. Univariable multinomial logistic regressions of the association of early life factors with trajectory classes of emotional problems

	Low emotional problems	Decreasing emotional problems	Increasing emotional problems	Persistent emotional problems
	67.0%	18.4%	8.9%	5.7%
Child factors				
Female[1] [a]	1 (ref)	1.27 (1.13–1.42)	1.88 (1.61–2.21)	1.43 (1.18–1.72)
Temperament intensity (6 m)[2] [b]	1 (ref)	1.05 (0.98–1.11)	1.05 (0.96–1.13)	1.03 (0.94–1.14)
Behavioral inhibition (3y) [2] [b]	1 (ref)	1.58 (1.49–1.69)	1.13 (0.98–1.23)	1.74 (1.58–1.92)
Irritability (4y)[2] [a]	1 (ref)	1.99 (1.77–2.25)	1.75 (1.50–2.05)	3.71 (3.02–4.57)
Sleep problems (6y)[2] [a]	1 (ref)	2.82 (2.18–3.64)	2.51 (1.77–3.56)	6.40 (4.49–9.98)
High ADHD or ASD traits (7y)[2] [a]	1 (ref)	2.48 (1.58–3.90)	2.63 (1.58–4.38)	5.56 (3.04–10.17)
Conduct problems (7y)[2] [a]	1 (ref)	2.47 (2.16–2.82)	2.78 (2.34–3.31)	5.03 (4.09–6.19)
Low IQ (8y)[2] [a]	1 (ref)	1.14 (0.82–1.58)	1.43 (0.95–2.17)	1.71 (1.04–2.79)
Genetic risk				
PGS (MDD)[2] [b]	1 (ref)	1.11 (1.04–1.18)	1.17 (1.06–1.27)	1.10 (1.02–1.24)
PGS (anxiety)[2] [b]	1 (ref)	1.08 (1.01–1.15)	1.08 (0.99–1.18)	1.12 (1.00–1.25)
PGS (ADHD)[2] [b]	1 (ref)	1.00 (0.94–1.07)	1.07 (0.98–1.18)	1.08 (0.96–1.22)
Wider family factors				
Maternal depression (8 m)[2] [a]	1 (ref)	1.71 (1.49–1.96)	1.84 (1.55–2.21)	2.95 (2.41–3.61)
Maternal anxiety (8 m)[2] [a]	1 (ref)	1.90 (1.64–2.19)	2.31 (1.91–2.77)	2.89 (2.32–3.60)
Adverse experiences (7y)[2] [a]	1 (ref)	1.51 (1.25–1.81)	1.59 (1.24–2.03)	2.18 (1.65–2.88)
Family poverty (11y)[2] [a]	1 (ref)	1.10 (0.85–1.42)	1.11 (0.78–1.59)	1.52 (1.08–2.13)

Data show relative risk ratios and 95% confidence intervals.
[1]: unadjusted, [2]: adjusted for sex, a: binary variable, b: standardized variable.
Relative risk ratio: for categorical variables, being in the non-reference category of the correlate increases the risk of being in the non-reference category of the outcome by risk ratio times.
For continuous variables, an increase of 1 in the correlate, increases the risk of being in the non-reference category of the outcome by risk ratio times.

Table 4. Univariable multinomial logistic regressions of adult functional and mental health outcomes across trajectory classes of emotional problems

	Low emotional problems	Decreasing emotional problems	Increasing emotional problems	Persistent emotional problems
	67.0%	18.4%	8.9%	5.7%
Mental health outcomes				
MDD (CISR;24y)[1] [a]	1 (ref)	1.04 (0.77–1.41)	1.59 (1.13–2.26)	2.25 (1.49–3.41)
GAD (CISR;24y)[1] [a]	1 (ref)	1.12 (0.85–1.47)	1.31 (0.93–1.86)	1.54 (0.93–2.54)
Self-harm (24y)[1] [a]	1 (ref)	1.26 (0.99–1.54)	2.37 (1.91–2.94)	1.87 (1.41–2.48)
Functional outcomes				
Attainment (no GCSEs)[1]	1 (ref)	1.01 (0.82–1.23)	1.76 (1.38–2.23)	1.95 (1.35–2.79)
NEET (22y)[1] [a]	1 (ref)	0.99 (0.87–1.12)	0.97 (0.82–1.15)	2.92 (1.75–5.13)
Social functioning (25)[1] [a]	1 (ref)	1.03 (0.74–1.45)	1.55 (0.96–2.27)	1.58 (0.98–2.46)

Data show relative risk ratios and 95% confidence intervals.
[1]: adjusted for sex, a binary variable.
Relative risk ratio: for categorical variables, being in the non-reference category of the correlate increases the risk of being in the non-reference category of the outcome by risk ratio. For continuous variables, an increase of 1 in the correlate increases the risk of being in the non-reference category of the outcome by risk ratio.

adolescence. The relatively low risk of poor outcomes in early adult life for these children highlights that childhood emotional problems often resolve without harmful developmental consequences. In contrast, children with persistent emotional problems experienced high rates of anxiety and depressive disorders in childhood and adolescence, as well as poor outcomes in young adulthood including depression, self-harm, and educational/occupational impairment.

One important question is whether it is possible to differentiate in childhood those children with time-limited emotional difficulties from those who go on to experience prolonged problems with adverse life course consequences. Comparison of children with early emotional problems that decreased *v.* persisted over time suggested that persistence of emotional problems was associated with greater early irritability, sleep difficulties, ADHD or ASD traits, and conduct problems, as well as with poorer maternal mental health, and higher rates of adverse childhood life events.

A further important group involved children who showed an increasing trajectory of emotional problems. This group had relatively low rates of emotional problems in childhood but then experienced increasing emotional problems during adolescence. Despite a later onset of emotional problems and lower rates of emotional disorders up to 15 years relative to the persistent group, the increasing group also experienced an elevated risk of MDD and self-harm behaviors in adulthood and poorer educational attainment during secondary school. Interestingly, however, the profile of early childhood correlates of the increasing emotional problems group was more similar to that of the decreasing trajectory group than the persistent trajectory group. This raises the important question of how to identify children at risk of later increasing emotional problems.

One unexpected finding was that we did not see strong evidence of increased risk of generalized anxiety disorder in young adulthood for any of the emotional problem trajectory groups. The validation analyses confirmed elevated risks of anxiety (and depressive) disorders concurrent with the assessment of emotional problems in childhood and adolescence, particularly for the persistent trajectory class. By adulthood, however, poor mental outcomes were primarily evident in relation to depression and self-harm, but not generalized anxiety. These findings highlight that there may be developmental change in the expression of mental health risk associated with emotional problems across childhood, adolescence, and adulthood (Copeland et al., 2014; Pickles et al., 2010).

There are some noteworthy differences between the findings of this study and previous research examining (adolescent) trajectories of depression (Kwong et al., 2019b; Weavers et al., 2021). First, middle childhood (~8–12 years) was an important period in this study, with symptoms reducing for those with a decreasing trajectory and rising sharply for those with an increasing trajectory. In contrast, studies of depression trajectories have pointed to adolescence and early adulthood as particularly important periods of change (Kwong et al., 2019b; Weavers et al., 2021). Second, there was only a modest excess of females in the elevated emotional problem trajectories in contrast to epidemiological studies of depression highlighting 2–4 fold elevated rates in females (Weavers et al., 2021), and longitudinal studies which highlight a particularly marked female excess for those with persistent trajectories of depression (Weavers et al., 2021). Third, we did not find strong evidence of a link between emotional problems and impaired adult social relationships, whereas this has been consistently observed for depression. At the same time, it is clear from the findings that emotional problems that persist or increase with age may be important precursors of later depression.

The current study extends previous findings on early correlates of emotional problems by showing that these can differentiate children with elevated emotional problem trajectories from those with low emotional problems, and some also distinguished those with time-limited or persistent emotional problems.

Behavioral inhibition is a robust predictor of anxiety (Fox et al., 2005), and in this study was associated with persistent high emotional symptoms. Co-occurring childhood problems including conduct problems, irritability, and sleep problems were also associated with persistent emotional problems. One possibility is that these difficulties have cumulative effects contributing to the continuity of emotional problems across development as well as the increased risks of depression and self-harm seen in adulthood (Eyre et al., 2019; Stringaris, Lewis, & Maughan, 2014).

The study observed modest associations between depression and anxiety polygenic risk scores and emotional problems, but there was no strong evidence that genetic risk varied between children with decreasing, increasing, and persistent emotional problems. Previous studies have highlighted that very early-onset depression is associated with neurodevelopmental problems and elevated ADHD genetic risk (Rice et al., 2019). There was no evidence from the current study that ADHD genetic risk contributes to developmental differences in patterns of emotional problems more generally.

As expected, maternal depression and anxiety and the experience of childhood stressful life events were associated with all three elevated emotional problem trajectories. As noted, these factors also predicted persistence of emotional problems when comparing those with persistent and decreasing difficulties. Past research suggests that poverty is an important risk factor for mental health problems in children and young people (Yoshikawa, Aber, & Beardslee, 2012), and that mental health inequalities have increased in generations (Collishaw, Furzer, Thapar, & Sellers, 2019). The current study suggests that a developmental perspective is important here and that family poverty may be particularly associated with emotional problems that persist over development.

Strengths and limitations

This study has a number of strengths, including the use of prospectively assessed repeated measures of emotional problems across childhood and adolescence, rich coverage of hypothesized childhood correlates, as well as measures of relevant psychiatric and social outcomes in young adulthood. Although trajectories of emotional problems have been previously examined over relatively short periods of time, or of depression specifically in adolescence, we were able to provide information on emotional problems spanning childhood and adolescence with mental health and functional outcomes in adulthood.

There are some caveats that should be considered. Parents may not always be good reporters on emotional problems. However, validation against structured diagnostic assessments in childhood and adolescence and the utility of the trajectories in predicting MDD and self-harm in young adulthood, suggests that parent reports of emotional problems can be useful indicators of mental health risk. Nevertheless, caution is required when interpreting the clinical meaning of class membership for individual children in the study. We used a brief dimensional symptom screen not a diagnostic assessment, and only a minority of children on each occasion in the elevated problem trajectories also met diagnostic criteria for an emotional disorder.

Another key limitation is the fact that cohort studies that involve repeated assessments over long periods of time often have substantial missing data. To address this, we used multiple imputation that incorporated covariates related to our measures of interest to make a missing at random assumption more

plausible. Nevertheless, it remains possible that our results are affected by non-random loss to follow-up. This could limit the representativeness of the ALSPAC cohort (Rice et al., 2019), and if children from more vulnerable backgrounds are under-represented this could mean that the findings provide a conservative estimate of the prevalence of emotional problems and adverse adult outcomes. It was not possible to distinguish trajectories of specific emotional disorder phenotypes due to the measures available in this cohort. Finally, analyses were not corrected for multiple testing, and results should be interpreted with some caution, and in terms of both effect size estimates and associated confidence intervals.

Implications

Previous studies have considered developmental trajectories of depression to inform understanding of long-term mental health outcomes (Weavers et al., 2021). When examining emotional problems more broadly – and anxiety in particular – our findings suggest that for individuals with emotional problems in childhood, these often improve over time. Children with decreasing emotional problems were not found to be at greater risk of poor psychiatric or functional outcomes in young adulthood as those with low emotional problems of. In contrast, those who showed persistent emotional difficulties often experienced poor long-term outcomes. This has important implications for early interventions aimed at improving young people's mental health. In particular, it suggests that preventative interventions should target children who show signs of being at greatest risk of a persistent course of emotional problems – for example those with co-occurring psychopathology, early sleep problems, those with a family history of mental health problems, or those who experience greater wider family adversity. The study also demonstrates that young people with emerging (later-onset, in adolescence) emotional problems also require support given evidence of problematic adult outcomes, including a high risk of suicidal self-harm.

In conclusion, this novel population-based prospective study distinguished developmental trajectories of emotional problems across childhood and adolescence. The majority of children with some early emotional problems showed improvement in symptoms over time, but those with persistent high emotional problems often experienced poor mental health outcomes in young adulthood. Patterns of early childhood correlates may help distinguish those with relatively benign childhood-limited difficulties and children who are more likely to experience persistent emotional problems that are associated with a higher risk of poor long-term outcomes. Early identification and intervention for emotional problems are likely important for preventing a persistent course of emotional difficulties and associated negative outcomes in young adulthood. The findings further demonstrate the importance of supporting young people with emerging emotional difficulties in adolescence.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0033291724000631

Data availability. Scripts used for the analyses conducted in this study are available on request from the corresponding author, FT. The data are available upon request and subject to cohort-specific executive data access procedures. ALSPAC data access is regulated through a system of managed open access. Please note that the ALSPAC study website contains details of all the data that is available through a fully searchable data dictionary and variable search tool (http://www.bristol.ac.uk/alspac/researchers/our-data/). Informed consent

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