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Using natural language processing to explore clinically reported emotion dysregulation in children and adolescents with depression, attention-deficit/hyperactivity disorder (ADHD) and co-occurring depression and ADHD.

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Abstract

Introduction/Objectives: Emotion dysregulation (ED) has been shown to be a common characteristic of several clinical conditions. Moreover, it is highly prevalent among children and adolescents with depression, attention-deficit/hyperactivity disorder (ADHD) and co-occurring depression and ADHD (depression+ADHD group). This study aimed to evaluate the prevalence, predictors (demographic factors, clinical characteristics, and cannabis use), and association of ED in young people with ADHD and depression+ADHD.

Methods: This study adopted a retrospective cohort design; the sample comprised 19961 service users, under 18 years, with a depression or ADHD diagnosis, who underwent assessment within the South London and Maudsley NHS Foundation Trust. Participants were organised into 3 groups: depression, ADHD, and depression+ADHD. A natural language processing model was used to identify clinically reported ED terms in electronic health records.

Results: Clinically reported ED terms were prevalent among 21.9% of the sample; prevalence was greatest among the depression+ADHD group. The likelihood of ED being reported clinically was significantly greater in children and adolescents with depression+ADHD compared to ADHD alone and in depression compared to ADHD. This association was influenced by several predictors, which were also associated with clinically reported ED terms. Clinically reported ED terms were only greater among individuals with depression+ADHD compared to depression alone when exclusively controlling for demographic characteristics.

Conclusion: Clinically reported ED terms are significantly associated with depression and ADHD in young people. These findings show congruencies and contradictions with the existing literature and present numerous clinical and research implications. This study should be viewed in the light of some limitations.

Keywords: Emotion dysregulation, depression, ADHD, youth.

Introduction

ED and its impact

Emotion dysregulation (ED) is characterised as an inability to modulate the intensity of emotional responses and to regulate the interference of emotions with appropriate behaviours (D'Agostino et al., 2017). ED often manifests as irritability, disruptive mood dysregulation disorder (DMDD) or tantrum behaviours (Pablo Vidal-Ribas, 2018; Giesbrecht, Miller and Muller, 2010; Saatchi et al., 2022).

Such symptoms are a common characteristic of several clinical conditions including suicidality, engagement in non-suicidal self-injury (NSSI), numerous psychiatric disorders and alcohol abuse (King et al., 2022; Nordgren et al., 2022; Brausch, Clapham and Littlefield, 2022; Yang et al., 2021). Furthermore, there is a substantial evidence base indicating that difficulties in emotion regulation (ER) are associated with greater levels of suicidal ideation and suicide attempts (Colmenero-Navarrete García-Sancho and Salguero, 2022; Clapham and Brausch, 2022; Brausch, Clapham and Littlefield, 2022). Additionally, Miu et al. (2022) conducted a meta-analysis of 215 studies examining ER and results indicated that ER mediated the relationship between childhood adversity and psychopathology. This existing evidence base highlights the importance of ED research, particularly exploring at risk populations, to improve the understanding of the association between ED and poor outcomes and provide scope for the development of treatment and prevention interventions.

ED in child and adolescent ADHD and depression populations

Children and adolescents are at greater risk of experiencing ED; Evans et al. (2022) examined assessment data of 7–15-year-olds referred for outpatient treatment of mental health concerns and results indicated that in 58% of cases irritability was identified as a top problem. Such findings suggest that ED is a common problem for which families pursue mental health treatment.

There is a substantial evidence base demonstrating the increased risk of experiencing deficiencies in emotion regulation for children and adolescents with attention-deficit/hyperactivity disorder (ADHD) (van Stralen, 2016; Faraone et al., 2019; Neuhaus, Webb and Bernier, 2019). Evidence suggests that ED is prevalent among 24%-50% of child and adolescent ADHD populations (Shaw et al., 2014). More recent research exploring clinical

samples of children and adolescents with ADHD suggest that this prevalence is between 42%-71% (Pylypow et al., 2020). Furthermore, the increased prevalence of ED among ADHD populations results in greater vulnerability to poor outcomes such as an elevated risk of experiencing suicidality and depressive symptoms (Eyre et al., 2019a; Eyre et al., 2019b; Levy et al., 2020).

ED is significantly associated with depressive symptoms among children and adolescents (Masters, Zimmer-Gembeck and Farrel, 2019; Vidal-Ribas and Stringaris, 2021). Furthermore, ER difficulties often precede the onset of depressive symptoms (Paulus et al., 2021). The evidence base demonstrating that early improvement in ED, specifically impulse control, predicts improvement in depression severity among children and adolescents is substantial (Defayette et al., 2021; Mohamed et al., 2023). Additionally, depressive children and adolescents are more likely to experience failure to down regulate negative emotions, increased reactivity toward interpersonal stressors and engage in rumination; therefore aggravating, depressive symptoms (Paulus et al., 2021). This research highlights the presentation of ED among children and adolescents with depression and the adverse impact it has on depressive symptoms. Despite the evident relationship between ED and depression there is little evidence exploring the prevalence of ED in children and adolescents.

Depression and ADHD commonly co-occur (Joseph et al., 2019), the existing literature suggests this association is impacted by ED (Antony et al., 2022; Welkie, Babinski and Neely, 2021). Moreover, research has highlighted ER contributes to the mechanism linking ADHD to depression in children and adolescents (Seymour et al., 2014). According to Eyre et al. (2019b), childhood irritability influences the association between childhood ADHD difficulties and the development of adolescent MDD; results revealed that irritability accounted for 42% of this association. Such evidence emphasizes the demand for early identification of ED among young people with ADHD to prevent the development of comorbid depression.

Despite the significant association between ED and depression and ADHD in young people, NICE guidelines do not offer explicit directives regarding the management of ED in young people with such conditions (NICE, 2019, 2018). Additionally, there are currently no specific pharmacological interventions for ED; although, studies have evidenced the positive effect of multiple medications such as antidepressants, antipsychotics, and stimulants on reducing ED (Salazar de Pablo et al., 2023; Baweja and Waxmonsky, 2022). However, it is evident that

research investigating this association is still required, to improve the pharmacological application of such medications (Baweja and Waxmonsky, 2022).

It is evident that ED is common among children and adolescents with depression, ADHD, and co-occurring depression and ADHD (depression+ADHD). Additionally, there has been an increase in ER research in recent years (Adrian, Zeman and Veits, 2011), yet the research investigating ED in this population is lacking. Similarly, few studies provide data comparing the prevalence, association, and predictors of ED in these diagnostic groups.

Predictors of ED

Previous studies have established several risk factors associated with ED among children and adolescents including environmental and biological factors such as childhood maltreatment, substance abuse, marijuana use (Paulus et al., 2021), heritability of ED and hypothalamic-pituitary-adrenal axis response to stress (Caro-Cañizares et al., 2015). Additionally, research has explored demographic factors such as gender; Gonçalves et al. (2019) indicate that ER difficulties are more strongly associated with depression in girls compared to boys. Furthermore, ED is associated with numerous other mental health disorders including psychosis (Liu et al., 2022), conduct disorder (CD) (Mitchison et al., 2020), obsessive-compulsive disorder (OCD) (Yazici and Yazici, 2019) and several others (Paulus et al., 2021). This evidence base demonstrates the numerous risk factors associated with ED in children and adolescents and stresses the importance of controlling for potential alternative predictors when investigating ED in depression, ADHD, and depression+ADHD populations.

Limitations of conventional approaches to measuring ED

Several measures have been developed to assess components of ER, such as self and parent-report measures and behavioural observations (Núñez et al., 2022); however, these approaches fall subject to several limitations. For instance, self-report questionnaires are not reliable for all clinical populations (McKinnon et al., 2020) and could fail to encapsulate all characteristics of ED (Penner, Steinberg and Sharp, 2022). Similarly, clinical reports of service user's symptomology often prove heterogeneous due to factors such as clinician's attitudes and education (Cillessen et al., 2021). Furthermore, self-report measurements and clinicians' reports are dependent on the service user's capacity to accurately engage in mentalisation, which can be influenced by factors such as social desirability and cognitive biases (Núñez et al., 2022). Moreover, the existing literature presents alternative conceptualizations of ER;

therefore, limiting the comparability of findings across studies (Berking and Wupperman, 2012).

Alternative approaches to enhance measuring ED: utilising EHRs and NLP

Clinical data is now extensively recorded in electronic health records (EHRs) and there is substantial potential to utilise these records to further epidemiological research and clinical care, particularly when combined with approaches such as natural language processing (NLP) (Barak-Corren et al., 2017). EHRs can advance clinical care by establishing alternative methods of patient stratification; EHRs could also improve research methodologies through overcoming cost and time efficiency barriers associated with conventional patient recruitment protocols (Jensen, Jensen and Brunak, 2012).

NLP can prove complementary to conventional measures of ED such as clinician reports and questionnaires and enhance the use of EHRs in clinical and research settings. NLP provides objective insights that are less susceptible to response bias and possess the ability to examine implicit information that may elude explicit articulation within self-report measures (Abram, Mancini and Parker, 2020; Ladas et al., 2023). NLP utilises coding to analyse text and interpret human language (Jurafsky, 2000), recent studies have demonstrated the potential of NLP to enhance epidemiological research (Velupillai et al., 2015). Furthermore, research has shown the capacity of NLP to advanced areas of the clinical setting such as prognosis, by extracting facts expressed in text related to a patient's symptoms (Roberts, 2017). For instance, NLP has been shown to identify, within clinical notes, associations between the use of distancing language in outpatients that later died from suicide (Leonard Westgate et al., 2015). Additionally, Jackson et al. (2017) demonstrate the possibility of utilising NLP to extract a variety of symptoms from the discharge summaries of patients with a severe mental illness diagnosis. This research exemplifies the potential of NLP and suggests the approach could be employed in ADHD and depression populations to identify ED.

Information extraction from clinical texts has substantial potential; however, the application of NLP and EHRs in a clinical and research setting is recent and faces challenges. Currently, the application of information extraction using NLP and EHRs is rarely conducted outside laboratories due to generalizability and scalability issues (Meystre et al., 2008). For instance, clinical narratives are highly variable, including abbreviations and misspellings (Leaman, Khare and Lu, 2015), and NLP models are often confined to the analysis of a specific context;

NLP models trained on one language or cultural context may not perform accurately when applied to an alternative context (Hossain et al., 2023). Additionally, clinical practice evolves continually and NLP models trained on historical data could inaccurately compute more recent language patterns (Wu et al., 2019).

The analysis of electronic medical record data also faces several technical challenges. More specifically, challenges pertaining to accessing restricted data, privacy breaches, incompatible formats, and missing database interoperability (Jensen, Jensen and Brunak, 2012). Furthermore, examining EHRs using NLP requires access to sensitive patient information; therefore, ensuring data privacy and security while scaling up the technology becomes a significant challenge (Bhatti et al., 2021). This demonstrates the demand for further research on information extraction using NLP and EHRs to develop their application to research methodologies and a clinical setting.

Importance of current research project

The present study aims to address multiple gaps in the literature. As outlined above, the existing evidence base demonstrates the increased risk of experiencing adverse clinical outcomes such as suicidality, psychopathology and NSSI due to elevated levels of ED for individuals with depression, ADHD, and depression+ADHD. However, research investigating differences in the prevalence and predictors of ED among these populations is lacking. Such evidence is imperative to inform clinical practice on the appropriate treatment and prevention interventions for reducing ED in these populations. Furthermore, research highlights the potential uses of NLP to examine EHRs which could prove complementary to convectional approaches to measuring ED.

To address these literature gaps, the study will explore employing an NLP application to examine the presence of ED in the EHRs of adolescents with depression, ADHD, and depression+ADHD. Findings will establish differences and similarities in the prevalence and likelihood of clinically reported ED terms which will provide scope for future research to explore treatment and prevention interventions. Furthermore, there is limited evidence regarding the management of ED in depression, ADHD, and depression+ADHD, suggesting the field would benefit from a piece illustrating comparisons of ED across these populations. The findings of this research will inform subsequent studies which will develop and evaluate a digital application for identifying and potentially tailoring treatment to young people with ED.

Moreover, clinicians can employ these methods to aid early identification and subsequent treatment interventions for individuals with ADHD, depression, and depression+ADHD suffering from ED.

This project will fall within an ongoing inter-disciplinary research programme: Regulating Emotions – Strengthening Adolescent Resilience (RE-STAR), which seeks to find ways of reducing adolescent depression risk in young people with ADHD by focusing on ED as both a risk factor and intervention opportunity.

Aims and hypotheses

The study poses the following research question: how does the prevalence and association of clinically reported ED terms differ among adolescents with depression, ADHD and depression+ADHD? Furthermore, to what extent are these differences influenced by demographic factors, clinical characteristics, and cannabis use?

This study has the following aims:

1) To utilise NLP to determine the prevalence of clinically reported ED terms in children and adolescents with depression, ADHD, and depression+ADHD.
2) To examine the predictors of clinically reported ED terms in children and adolescents with depression, ADHD, and depression+ADHD.
3) To compare the association between clinically reported ED terms and depression, ADHD, and depression+ADHD and investigate the influence of demographic factors, clinical characteristics, and cannabis use on these associations.

Considering these aims the study proposes two hypotheses. First, the prevalence of clinically reported ED terms will be significantly greater in the depression+ADHD group compared to the depression group and the ADHD group. Second, the depression+ADHD group will be associated with a significantly greater increase in clinically reported ED terms compared to the depression group and the ADHD group. Furthermore, this association will remain significant after controlling for demographic factors, clinical characteristics, and cannabis use.

Methods

Study setting

This study utilised a retrospective cohort design and was conducted in conjunction with the guidelines for REporting of studies Conducted using Observational Routinely-collected Data (RECORD) (RECORD checklist outlined in appendix A). The cohort comprised patients who underwent assessment within the South London and Maudsley NHS Foundation Trust (SLaM) from 1st January 2008 to 31st December 2022. SLaM serves as the primary provider of mental health services for the child and adolescent population residing in four boroughs of South London, namely Croydon, Lambeth, Lewisham, and Southwark. Child and Adolescent Mental Health Services (CAMHS) receive referrals pertaining to individuals of school age (4-18 years) who present with neurodevelopmental conditions or exhibit emotional or behavioural challenges. Referrals emanate from primary care, educational services and social care services. A comprehensive evaluation is conducted by multidisciplinary teams, employing the International Classification of Diseases, eleventh revision (ICD-11, 2019) to assign diagnoses. All service users undergo a series of fundamental assessments, including overall functional impairment as rated by clinicians; additional assessments specific to the diagnosed condition are conducted as necessary. SLAM CAMHS offers a variety of treatments, encompassing pharmacotherapy and psychological therapies.

Anonymized electronic patient records were accessed, and data were extracted utilizing the Clinical Records Interactive Search (CRIS) system (Stewart et al., 2009). This system consists of a de-identified version of SLAM's EHR system, granting researchers the ability to explore records encompassing a vast cohort of over 250,000 service users, of which over 35,000 are children and adolescents (Downs et al., 2019). These records encompass virtually all individuals who have engaged with SLaM services since 2006. Patient consent was not required for this retrospective study. Following its initial development, the data contained within CRIS has undergone enhancements through external linkages and NLP techniques (Perera et al., 2016).

Ethics approval was covered by an overarching approval for CRIS as a database for secondary analysis issued by the Oxford C Research Ethics Committee. Therefore, a specific ethics approval for this study (CRIS Project ID 22-066) was not required.

Sample

All cases who presented to SLaM CAMHS were screened for ICD-11 diagnoses within clinician-recorded structured or free-text fields. The sample comprised individuals below 18 years of age who presented to the SLaM between 1st January 2008 and 31st December 2022 and had received an ADHD or depression diagnosis (ICD codes are outlined in appendix B). Information was extracted from the diagnosis field within clinical records to establish diagnostic status.

The final sample comprised 19961 children and adolescents who were categorised into 3 diagnostic groups: depression, ADHD, and depression+ADHD. In the case of each individual, the 'index date' was determined as the earliest recorded diagnosis of depression for the depression and depression+ADHD groups, and as the first documented ADHD diagnosis for the ADHD group.

Measures

Socio demographic variables.

Gender and ethnicity were extracted from structured fields. Nine ethnicity groups were combined into 5 to improve statistical sensitivity; this is consistent with prior research utilizing CRIS (Martin et al., 2020; Stewart et al., 2022). Age was calculated by subtracting the date of birth from the index date. Area deprivation was measured using indices of multiple deprivation (IMD). IMD are datasets utilized to assess the relative deprivation of small areas. These indices incorporate various aspects of deprivation, such as income, employment, education, health, crime, barriers to housing and services, and living environment, which are weighted differently and combined to form a comprehensive deprivation score.

Emotion dysregulation

To identify clinically reported ED terms, the NLP software package TextHunter (Jackson et al., 2014) was used to extract documentation of ED terms from unstructured free text fields of clinical assessments in the SLaM EHRs. The ED terms comprise numerous keywords related to mood, affect and emotion (ED terms are outlined in appendix C). Such terms were utilised by a previously used NLP application (Patel et al., 2015) employed to identify construct terms associated with mood instability. Once the application was applied, the output consisted of a

total frequency count of clinically reported ED terms for each participant, defined as any documentation of an ED term.

Clinical characteristics

The Child Global Assessment Scale (CGAS) (Shaffer et al., 1983) is a tool used by clinicians to evaluate the adaptive functioning of children across various domains, including home, school, and peer interactions, within the preceding month. This measure employs a 100-point scale, where a rating of 1 indicates severe impairment for each 10-point interval. A service user can have multiple CGAS assessments; therefore, the assessment score closest to the index date was extracted.

The Strength and Difficulties Questionnaire (SDQ) (Goodman, 2001) is a screening tool used to assess the emotional and behavioural function of children and adolescents. The questionnaire comprises 25 items and covers 5 domains: emotional symptoms, conduct problems, hyperactivity/inattention, peer relationship problems, and prosocial behaviour. A service user can have multiple SDQ assessments; therefore, the assessment score closest to the index date was extracted.

The presence or absence of co-occurring mental health disorders, specifically ICD-11 diagnoses, were retrieved from structured data fields and recorded as binary variables. The included disorders encompassed psychosis, eating disorder, OCD, phobia, anxiety, intellectual disability (ID), CD and emotion disorders (ICD-11 F codes are listed in appendix B).

The presence or absence of pharmacological treatment provision, including antipsychotic, antidepressant, hypnotic and ADHD medication, within 12 months of diagnosis was retrieved from structured data fields into a binary variable.

Service use was calculated by extracting the total number of appointments each service user attended at the SLaM NHS trust post and prior to the index date and the number of days spent in an inpatient unit post and prior to the index date.

Cannabis use

NLP was applied to extract records of cannabis use from unstructured free-text fields in SLaM EHRs; this also utilised the software package TextHunter (Jackson et al., 2014). The

identification of sentences containing a positive reference to current or historical cannabis use was carried out using a Support Vector Machine (SVM) learning approach previously employed to identify the association of cannabis use with hospital admission and antipsychotic treatment failure (Patel et al., 2016). Since the EHRs did not include information on the frequency of cannabis use, a binary variable was defined as any documentation of cannabis use by the patient.

Statistical analysis

The data were analysed using Stata (V.15.0) (StataCorp, 2015).

Descriptive statistics

Descriptive statistics for predictor and outcome variables were obtained as mean and standard deviation (SD) for all continuous variables and as frequencies and percentages for categorical variables. Three sets of group comparison analyses (chi-square tests and *t*-tests) were performed comparing the three diagnostic groups, depression, ADHD, and depression+ADHD. Groups that differed significantly were controlled for in the main analysis.

Association of clinically reported ED terms and diagnostic groups

For the main analysis, the outcome variable, ED terms, was converted into a binary variable (present or absent) because a frequency measure of ED terms could have been affected by numerous patterns that cannot be accounted for, such as number of appointments or clinician interview style (Patel et al., 2015). In the first step of the main analysis, a series of univariate logistic regressions were run to test for any association between ED and diagnostic group, demographic factors, clinical characteristics, and cannabis use. Subsequently, a multivariate logistic regression was conducted to explore the association between clinically reported ED terms and diagnostic groups when controlling for demographic factors, clinical characteristics, and cannabis use. Any factors indicating association at the $p<.05$ level were subsequently retained in a multivariate hierarchical logistic regression with variables entered in 4 blocks: (1) diagnostic group (depression, ADHD, and depression+ADHD); (2) demographic factors (age, gender, and ethnicity); (3) clinical characteristics (SDQ self-report, CGAS score, days spent in an inpatient unit prior and post-index date, psychosis diagnosis, ADHD medication, antipsychotic medication, antidepressant medication and hypnotic medication); (4) cannabis use. For this, the dependent variable was clinically recorded ED terms (binary variable).

Results

Participant demographic and clinical characteristics: between group comparisons

Table 1 presents the sample characteristics of all cases below 18 years of age who presented to SLaM CAMHS with a depression or ADHD diagnosis (t-test and chi^2 statistics are presented in appendix D). The mean age of diagnosis was significantly greater in the depression group (15 years 8 months) than in the depression+ADHD group (14 years 11 months) and the ADHD group (11 years 4 months). The mean age of diagnosis in the depression+ADHD group was significantly greater than in the ADHD group. Area deprivation differed significantly across all three groups; the ADHD group presented the highest mean IMD score. Gender and ethnicity significantly differed across the three groups. The ADHD group had the highest number of males, and the depression group had the highest number of females. The depression+ADHD group had the most participants identifying as white, mixed race, or other ethnicity. The ADHD group contained the most individuals identifying as black, and the depression group had the most identifying as Asian.

Table 1

Sample characteristics

	Depression+ADHD *N*=738	Depression *N*=5159	ADHD *N*=14064	TOTAL *N*=19961
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Age [a*** b*** c***]	14.94 (222)	15.63 (1.88)	11.35 (3.67)	12.59 (3.78)
Area deprivation [a** b*** c**]	24.87 (11.22)	26.08 (11.45)	26.61 (11.28)	26.41 (11.33)
	N (%)	*N* (%)	*N* (%)	*N* (%)
Gender [a*** b*** c***]				
Male	302(40.9)	1462 (28.3)	9607 (68.3)	11371 (57.0)
Female	425(57.6)	3655 (70.9)	4409 (31.4)	8489 (42.5)
Not stated	11 (1.5)	41 (0.8)	46 (.3)	98 (.5)
Ethnicity [a*** b*** c***]				
White	376 (51.0)	2624 (50.9)	6684 (47.6)	9684 (48.6)
Black	136 (18.5)	995 (19.3)	2972 (21.2)	4103 (20.6)
Asian	42 (5.7)	321 (6.2)	493 (3.5)	856 (4.3)
Mixed	93 (12.6)	466 (9.0)	1,702 (12.1)	2261 (11.3)
Other	41 (5.6)	233 (4.5)	596 (4.2)	878 (4.4)
Not stated	49 (6.7)	517 (10.0)	1597 (11.4)	2155 (10.8)

Note. t / chi^2 between group comparison: [a] depression compared to depression+ADHD group [b] ADHD compared to depression+ADHD group [c] ADHD compared to depression group, *p<.05, **p<.01, *** p<.001, no * indicates p>.05.

Functioning differed significantly across all three groups. The ADHD group had the highest mean CGAS score. Self-reported SDQ scores were significantly higher in the depression+ADHD group compared to the depression group and the ADHD group; scores did not differ significantly between the depression group and the ADHD group. Parent-reported SDQ scores differed significantly across all three groups; the highest mean scores were found in the ADHD group. The depression+ADHD group was engaged with services before the index diagnosis for significantly longer than the depression and ADHD group. The mean number of days engaged with inpatient services before the index diagnosis was significantly greater for the ADHD group than the depression+ADHD group and the depression group. The mean number of days engaged with inpatient services post-index diagnosis was significantly greater in the depression+ADHD group than in the depression group and the ADHD group. These results are outlined in Table 2.

Table 2 displays the presence of co-occurring psychiatric diagnoses. The prevalence of psychosis diagnosis, anxiety disorder, and emotional disorder was significantly greater in the depression+ADHD group compared to the depression group and ADHD group. The prevalence of phobia diagnosis, eating disorder and OCD diagnosis was significantly greater in the depression+ADHD group than in the ADHD group; prevalence did not differ significantly from the depression group. The prevalence of any ID was significantly greater in the ADHD group compared to the depression+ADHD group and depression group. The prevalence of CD was significantly greater in the depression+ADHD group and the ADHD group compared to the depression group; the prevalence of CD did not differ significantly between the depression+ADHD group and the ADHD group.

As shown in Table 2, use of hypnotic medication was significantly greater in the depression+ADHD group compared to the depression group and the ADHD group, use of hypnotic medication was also significantly greater in the depression group compared to the ADHD group. Use of antipsychotic medication was significantly greater in the depression+ADHD group compared to the depression group and the ADHD group; antipsychotic medication use did not differ significantly between the depression group and ADHD group. Use of antidepressant medication was significantly greater in the depression+ADHD group and the depression group compared to the ADHD group; antidepressant medication use did not differ between the depression+ADHD group and the depression group. Use of ADHD medication was significantly greater in the ADHD group compared to the depression+ADHD group and the depression group; use of ADHD medication was also significantly greater in the depression+ADHD group compared to the depression group.

Cannabis use (Table 2) was significantly greater in the depression+ADHD group compared to the depression group and the ADHD group. Cannabis use was also significantly greater in the depression group compared to the ADHD group.

Prevalence of clinically reported ED terms

As shown in Table 2, the overall frequency of ED terms recorded clinically was significantly greater in the depression+ADHD group compared to the ADHD group and in the depression group compared to the ADHD group. Frequency of ED terms did not differ significantly between the depression and the depression+ADHD group. The prevalence of ED terms

Table 2

Descriptive data

	Depression+ADHD *N*=738	Depression *N*=5159	ADHD *N*=14064	TOTAL *N*=19961
ED terms, continuous Mean (SD) [range] [a] [b***] [c***]	3.37 (3.86) [1-25]	2.97 (3.90) [1-36]	2.12 (2.70) [1-36]	2.58 (3.39)
ED terms, binary *N* (%) [a**] [b***] [c***]	321 (43.5)	1921 (37.2)	2137 (15.2)	4379 (21.9)
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
CGAS [a***] [b***] [c*]	49.93 (11.02)	52.14 (11.82)	52.60 (12.30)	52.34 (12.11)
SDQ total self-report [a***] [b***] [c]	21.40 (5.69)	19.81 (5.72)	19.80 (6.34)	19.92 (6.05)
SDQ total parent-report [a***] [b*] [c***]	20.82 (6.54)	17.74 (6.34)	22.41 (12.73)	21.42 (11.68)
Service use prior [a***] [b***] [c***]	11.52 (25.11)	6.26 (14.12)	4.75 (13.19)	5.39 (14.12)
Service use post [a***] [b***] [c***]	28.13 (51.43)	16.36 (31.01)	10.80 (20.49)	12.87 (25.62)
Inpatient days prior [a] [b***] [c***]	33.82 (48.34)	24.43 (47.07)	47.07 (39.92)	29.22 (54.76)
Inpatient days post [a] [b***] [c***]	97.84 (126.15)	85.11 (91.39)	91.39 (88.09)	87.22 (97.45)
	N (%)	*N* (%)	*N* (%)	*N* (%)
Psychosis diagnosis [a***] [b***] [c***]	95 (12.9)	387 (7.5)	648 (4.6)	1130 (5.7)
Eating disorder [a] [b***] [c***]	55 (7.5)	329 (6.4)	259 (1.8)	643 (3.2)
OCD diagnosis [a] [b***] [c***]	31 (4.2)	187 (3.6)	292 (2.1)	510 (2.6)
Phobia diagnosis [a] [b***] [c***]	21 (2.9)	157 (3.0)	121 (.9)	299 (1.5)
Anxiety disorder [a***] [b***] [c***]	142 (19.2)	687 (13.3)	878 (6.2)	1707 (8.6)
Any ID [a***] [b***] [c***]	35 (4.7)	65 (1.3)	1030 (7.2)	1130 (5.7)
Conduct disorder [a***] [b] [c***]	52 (7.1)	84 (1.6)	1068 (7.6)	1204 (6.0)
Emotional disorder [a***] [b***] [c**]	113 (15.3)	347 (6.7)	1132 (8.1)	1592 (8.0)
ADHD medication [a***] [b***] [c***]	178 (24.1)	48 (.9)	4753 (33.8)	4979 (24.9)
Antipsychotic medication [a***] [b***] [c]	72 (9.8)	277 (5.4)	710 (5.1)	1059 (5.3)
Antidepressant medication [a] [b***] [c***]	222 (30.1)	1435 (27.8)	672 (4.8)	2329 (11.7)
Hypnotic medication [a**] [b***] [c***]	80 (10.8)	413 (8.0)	845 (6.0)	1338 (6.7)
Cannabis use [a***] [b***] [c***]	318 (43.1)	1600 (31.0)	2993 (21.3)	4911 (24.6)

Note. t / chi^2 between groups comparison: [a] depression compared to depression+ADHD group [b] ADHD compared to depression+ADHD group [c] ADHD compared to depression group,

*p<.05, **p<.01, ***p<.001, no * indicates p>.05.

reported clinically (number of participants presenting with at least one ED term) was significantly greater in the depression+ADHD group compared to the depression and ADHD groups, and in the depression group compared to the ADHD group.

Predictors of clinically reported ED terms

The univariate logistic regression (Table 3) indicated that the depression+ADHD group had a significantly higher likelihood of clinically reported ED terms compared to the ADHD and depression groups. The depression group presented a significantly higher likelihood of clinically reported ED terms compared to ADHD. Clinically reported ED terms were associated with age, gender, ethnicity, functioning, area deprivation, self-reported and parent-reported SDQ, service use prior to and post-index diagnosis, engagement with inpatient services prior to and post-index diagnosis, psychosis diagnosis, eating disorder, OCD diagnosis, phobia diagnosis, anxiety disorder, any ID, emotional disorder, ADHD medication, antipsychotic medication, antidepressant medication, hypnotic medication, and cannabis use. CD was not significantly associated with clinically reported ED terms.

After adjusting for all variables in the multivariate logistic regression analysis (Table 3), the likelihood of ED terms being reported clinically remained higher in the depression+ADHD group compared to the ADHD group and in the depression group compared to the ADHD group. The increased likelihood of clinically reported ED terms did not remain significant in the depression+ADHD group compared to the depression group after adjusting for all variables.

As shown in Table 3, the association between clinically reported ED terms and age, gender, ethnicity, functioning, self-reported SDQ, engagement with inpatient services prior to and post-index diagnosis, psychosis diagnosis, ADHD medication, antipsychotic medication, antidepressant medication, hypnotic medication, and cannabis use, remained significant after adjusting for all variables in the multivariate logistic regression analysis. Although, the association between clinically reported ED terms and area deprivation, parent-reported SDQ, service use prior to and post-index diagnosis, eating disorder, OCD diagnosis, phobia diagnosis, anxiety, any ID, and emotional disorder was no longer significant after adjusting for all variables. The association between CD and clinically reported ED terms remained nonsignificant after adjusting for all variables.

Table 3

Binary logistic regression analysis of factors associated with ED

		Unadjusted (univariate)		Adjusted model (multivariate)	
		OR (95%CI)	p	OR (95%CI)	p
Diagnostic group	Depression Vs depression+ADHD	1.30 (1.11 to 1.52)	.001	1.23 (.92 to 1.64)	.165
	ADHD Vs depression+ADHD	4.30 (3.69 to 5.01)	<.001	1.63 (1.21 to 2.19)	.001
	Depression Vs ADHD	3.31 (3.08 to 3.56)	<.001	1.33 (1.09 to 1.62)	.006
Age		2.00 (1.19 to 1.21)	<.001	1.13 (1.08 to 1.17)	<.001
Gender	Male [a]	.41 (.39 to .44)	<.001	.58 (.48 to .68)	<.001
	Female [b]	2.42 (2.26 to 2.60)	<.001	1.74 (1.47 to 2.07)	<.001
	Not stated [b]	4.88 (3.27 to 7.29)	<.001	3.59 (1.70 to 7.58)	.002
Ethnicity	White [c]	1.63 (1.49 to 1.79)	<.001	1.33 (1.08 to 1.64)	.006
	Black [d]	.81 (.56 to .67)	<.001	.75 (.61 to .92)	.006
	Asian [d]	.90 (.76 to 1.06)	.203	.75 (.50 to 1.10)	.135
	Mixed [d]	.71 (.64 to .80)	<.001	.92 (.72 to 1.16)	.472
	Not stated [d]	.50 (.44 to .57)	<.001	.75 (.49 to 1.16)	.197
	Other [d]	.75 (.63 to .89)	.001	.97 (.65 to 1.43)	.859
CGAS		.97 (.97 to .97)	<.001	.97 (.97 to .98)	<.001
Area deprivation		.99 (.98 to .99)	<.001	98 (.99 to 1.01)	.710
SDQ total, self		1.04 (1.04 to 1.05)	<.001	1.02 (1.01 to 1.04)	.004
SDQ total, parent		.99 (.98 to 1.00)	.008	.99 (.98 to 1.01)	.385
Service use prior		1.02 (1.01 to 1.02)	<.001	1.00 (1.00 to 1.01)	.100
Service use post		1.01 (1.01 to 1.01)	<.001	1.00 (1.00 to 1.00)	.641
Inpatient days prior		1.18 (1.15 to 1.22)	<.001	1.08 (1.03 to 1.13)	.001
Inpatient days post		1.02 (1.02 to 1.03)	<.001	1.01 (1.00 to 1.01)	<.001
Psychosis diagnosis		2.94 (2.60 to 3.33)	<.001	1.38 (1.05 to 1.81)	.020
Eating disorder		3.00 (2.56 to 3.52)	<.001	1.10 (.77 to 1.56)	.602
OCD diagnosis		1.86 (1.54 to 2.24)	<.001	1.27 (.88 to 1.85)	.207
Phobia diagnosis		1.65 (1.29 to 2.11)	<.001	.74 (.49 to 1.13)	.165
Anxiety disorder		2.32 (2.09 to 2.58)	<.001	1.12 (.92 to 1.36)	.251
Any ID		.79 (.68 to .93)	.003	.76 (.48 to 1.21)	.243
Conduct disorder		1.03 (.89 to 1.18)	.726	.86 (.61 to 1.20)	.317
Emotion disorder		1.41 (1.26 to 1.59)	<.001	.98 (.79 to 1.21)	.845
ADHD medication		.80 (.73 to .86)	<.001	.95 (.76 to 1.19)	.676
Antipsychotic medication		5.17 (4.56 to 5.86)	<.001	1.78 (1.19 to 2.63)	.005
Antidepressant medication		5.82 (5.32 to 6.37)	<.001	1.87 (1.51 to 2.31)	<.001
Hypnotic medication		3.84 (3.43 to 4.30)	<.001	1.62 (1.17 to 1.15	.004
Cannabis use		2.50 (2.33 to 2.69)	<.001	1.50 (1.28 to 1.76)	<.001

Note. For categorical variables: [a] Female used as reference group, [b] Male used as reference group, [c] Black used as reference group, [d] White used as reference group.

Differences in clinically reported ED terms across Depression, ADHD, and Depression+ADHD, after controlling for demographic factors, clinical characteristics, and cannabis use.

Table 4 presents the hierarchical logistic regression analysis. The first model was significant; both the depression+ADHD group and the depression group presented an increased likelihood of having ED terms recorded clinically compared to the ADHD group. Although, the likelihood in the depression+ADHD group compared to the depression group was not significant.

The second model, which included demographic variables (age, gender, and ethnicity), showed significant improvement from the first model. This model indicated that when controlling for demographic factors only, the depression+ADHD group showed a significantly greater likelihood of clinically reported ED terms than the depression group and the ADHD group. The depression group showed a significantly greater likelihood of clinically reported ED terms than the ADHD group.

The third model, which included clinical characteristics (functioning, self-reported SDQ, engagement with inpatient services prior to and post-index diagnosis, psychosis diagnosis ADHD medication, antipsychotic medication, antidepressant medication, and hypnotic medication), showed significant improvement from the second model. This model indicated that when controlling for demographic factors and clinical characteristics, the depression+ADHD group showed a significantly greater likelihood of clinically reported ED terms than the ADHD group but not the depression group. The depression group indicated a significantly greater likelihood of clinically reported ED terms than the ADHD group.

The fourth model, which included cannabis use, showed significant improvement from the third model. The significance of the associations between clinically reported ED terms and the diagnostic groups did not change. Overall, the final model, including the diagnostic groups, demographic characteristics, clinical characteristics, and cannabis use, explained 18.9% of the variance.

Table 4

Hierarchical logistic regression analysis examining predictors of ED.

		Block 1		Block 2		Block 3		Block 4	
		OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p	OR (95%CI)	p
Diagnostic group	Depression Vs depression+ADHD	1.21 (.97 to 1.52)	.098	1.38 (1.09 to 1.74)	.007	1.23 (.95 to 1.58)	.113	1.15 (.89 to 1.49)	.224
	ADHD Vs depression+ADHD	3.26 (2.59 to 4.10)	<.001	2.19 (1.72 to 2.79)	<.001	1.61 (1.24 to 2.10)	.001	1.60 (1.23 to 2.07)	.001
	Depression Vs ADHD	2.69 (2.38 to 3.05)	<.001	1.59 (1.38 to 1.84)	<.001	1.30 (1.11 to 1.5)	.001	1.35 (1.17 to 1.62)	<.001
Age				1.78 (1.14 to 1.21)	<.001	1.13 (1.10 to 1.67)	<.001	1.13 (1.10 to 1.16)	<.001
Gender	Male [a]			.58 (.51 to .67)	<.001	.57 (.50 to .66)	<.001	.57 (.49 to .66)	<.001
	Female [b]			1.72 (1.51 to 1.67)	<.001	1.73 (1.49 to 2.00)	<.001	1.75 (1.51 to 2.03)	<.001
	Not stated [b]			3.97 (2.15 to 7.33)	<.001	3.45 (1.78 to 6.69)	<.001	3.38 (1.74 to 6.55)	<.001
Ethnicity	White [c]			1.77 (1.50 to 2.08)	<.001	1.32 (1.11 to 1.58)	.002	1.31 (1.10 to 1.56)	.003
	Black [d]			.57 (.48 to .67)	<.001	.76 (.64 to .90)	.002	.76 (.64 to .91)	.003
	Asian [d]			.60 (.44 to .81)	.001	.75 (.54 to 1.03)	.088	.79 (.57 to 1.09)	.164
	Mixed [d]			.71 (.59 to .87)	.001	.91 (.74 to 1.12)	.394	.88 (.71 to 1.08)	.241
	Not stated [d]			.42 (.31 to .58)	<.001	.69 (.49 to .97)	.021	.71 (.50 to 1.00)	.035
	Other [d]			.55 (.40 to .76)	<.001	.75 (.53 to 1.06)	.094	.76 (.54 to 1.08)	.115
CGAS						.98 (.97 to .98)	<.001	.98 (.97 to .98)	<.001
SDQ total (self)						1.02 (1.01 to 1.03)	.001	1.02 (1.01 to 1.03)	.004
Inpatient days prior						1.04 (1.02 to 1.06)	<.001	1.04 (1.02 to 1.06)	<.001
Inpatient days post						1.01 (1.00 to 1.01)	<.001	1.01 (1.00 to 1.01)	<.001
Psychosis diagnosis						1.47 (1.17 to 1.86)	.036	1.21 (.95 to 1.54)	.103
Antipsychotic medication						2.02 (1.44 to 2.85)	<.001	2.03 (1.45 to 1.85)	<.001
Antidepressant medication						2.27 (1.89 to 2.72)	<.001	2.23 (1.86 to 2.68)	<.001
Hypnotic medication						1.50 (1.13 to 1.98)	.003	1.48 (1.12 to 1.96)	.004
Cannabis use								1.42 (1.23 to 1.62)	<.001
Pseudo R-Squared		.043	<.001	.093	<.001	.186	<.001	.189	<.001

Note. For categorical variables: [a] Female used as reference group, [b] Male used as reference group, [c] Black used as reference group, [d] White used as reference group.

Discussion

This study explored the prevalence and association of clinically reported ED terms in children and adolescents with depression, ADHD, and depression+ADHD and how demographic factors, clinical characteristics, and cannabis use influenced these associations. Findings supported the hypothesis that the prevalence of clinically reported ED terms would be significantly greater in the depression+ADHD group compared to the depression and ADHD groups. Additionally, findings supported the second hypothesis that the depression+ADHD group would be associated with a significantly greater increase in clinically reported ED terms compared to the depression and the ADHD group and that this association would remain after controlling for demographic factors. However, findings contradicted the second hypothesis that this association would remain significant after controlling for clinical characteristics and cannabis use.

Aim 1: Utilise NLP to determine the prevalence of clinically reported ED terms

The data supported the first hypothesis; the depression+ADHD group exhibited the greatest prevalence of clinically reported ED terms, followed by the depression group and the ADHD group. This parallels the existing literature that indicates the presence of ED among children and adolescents with ADHD (van Stralen, 2016) and depression (Masters et al., 2019). However, this study found that the prevalence of clinically reported ED terms in young people with ADHD was 15.2%, whereas current evidence suggests the prevalence of ED in ADHD is higher, 42-71% (Pylypow et al., 2020).

One plausible rationale for this discrepancy stems from the methodology employed in this study, wherein the assessment of ED was conducted through the identification of terms reported in clinical records through NLP. Conversely, ED research has typically relied upon the implementation of standardized rating scales and questionnaires (Lavender et al., 2017). Given that ED rating scales are not commonly applied in routine clinical practice, the reduced prevalence observed in our study could potentially indicate that manifestations of ED are not consistently elicited or documented within EHRs. Furthermore, this suggests that when ED terms are clinically recorded, they are deemed pertinent to the patient's care.

The observed prevalence of ED is likely a consequence of deficits in executive functioning, such as working memory and inhibitory control (Groves et al., 2022; Tajik-Parvinchi et al.,

2021). Neuropsychological evidence suggests the prevalence of ED is due to reductions in functional connectivity of ED in brain regions associated with emotion regulation, the prefrontal cortex, orbitofrontal cortex, amygdala, and ventral striatum (Musella and Weyandt, 2022). Furthermore, previous studies have linked the dysregulation of negative affect among major depressive disorder populations to reduced functional connectivity in the prefrontal-limbic system (He et al., 2019). This evidence base suggests that the presence of ED observed in this study could result from unique neurophysiology.

This study mirrors previous research highlighting the potential of NLP to enhance epidemiological research (Velupillai et al., 2015). This study demonstrates the possibility of identifying the presence of ED in EHRs using automated NLP methods and consequently achieving the successful employment of expedited data extraction pertaining to ED from an extensive sample (19961 participants). The methodology employed in this study shares similarities with the growing evidence base demonstrating the capacity of NLP to enhance clinical practice by developing methods of measuring ED that benefit time and cost efficiency and complement the efficacy of conventional approaches (Leonard Westgate et al., 2015).

Aim 2: Examine the predictors of clinically reported ED terms

Diagnostic group

The data from the univariate analysis partially supported the second hypothesis. Participants with depression+ADHD had a significantly greater likelihood of ED terms being mentioned in their EHRs compared to participants with depression or ADHD. Such findings support the current research suggesting that the co-occurrence of ADHD and depression yields more pronounced ER impairments than the consequences arising from either disorder (Seymour et al., 2014). Previous research has also shown that youth with depression+ADHD experience an increased proclivity to acquire additional maladaptive ER strategies, including self-blame, catastrophizing, and rumination, compared to ADHD alone (Mayer et al., 2022).

The second hypothesis was not entirely supported; the multivariate logistic regression analysis indicated that the likelihood of clinically reported ED terms among participants with depression+ADHD was not significantly greater than participants with depression alone when controlling for demographic factors, clinical characteristics, and cannabis use. This finding contrasts the literature conveying that co-occurring ADHD symptoms in young individuals

with depression lead to increased engagement rumination and inability to downregulate negative emotions (Hinshaw et al., 2012; Paulus et al., 2021).

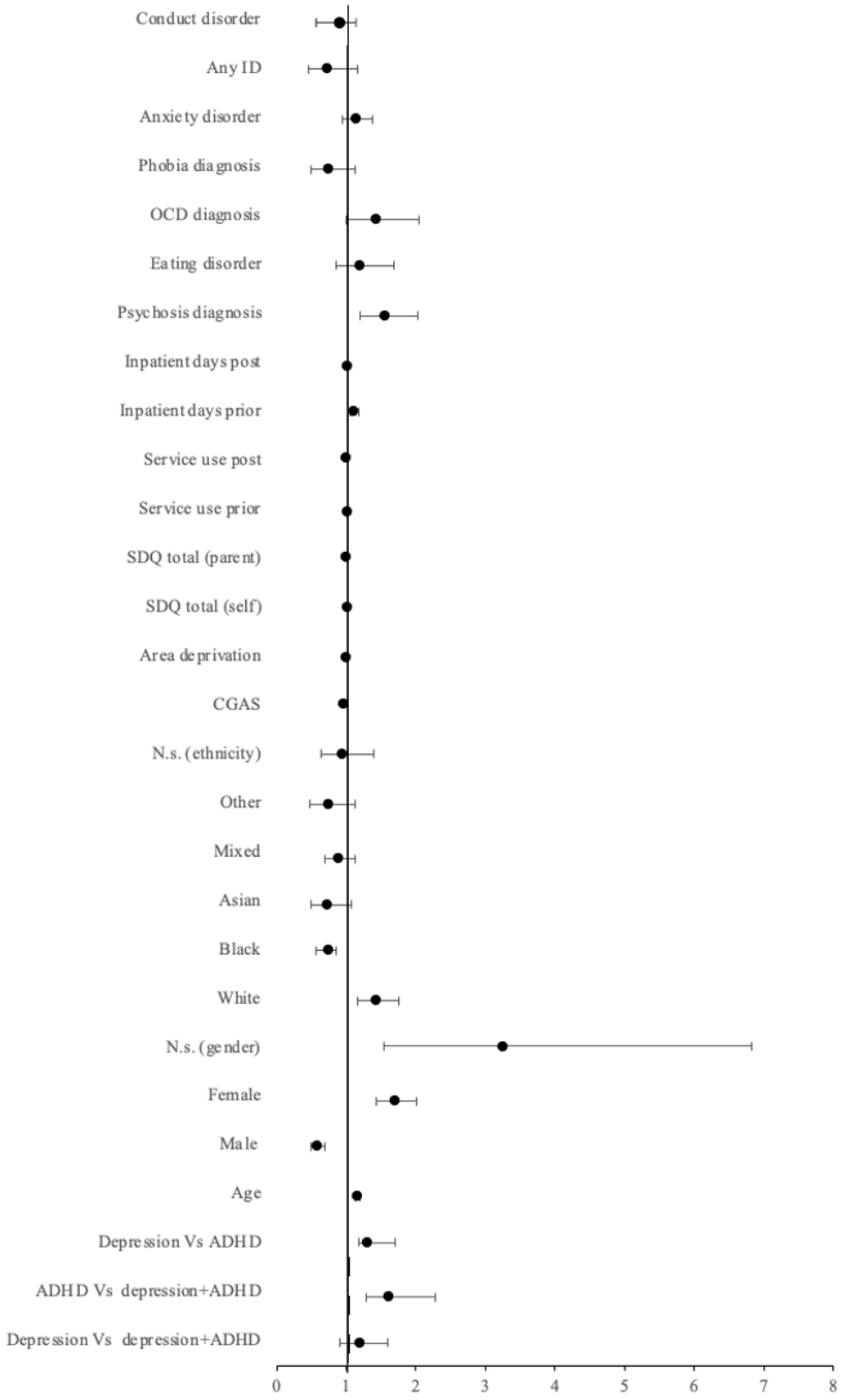
One potential explanation for this observation could be attributed to the resemblance of the symptomology of depression+ADHD compared to depression and ADHD alone. Despite the inherent social and occupational challenges associated with ADHD, more individuals with the disorder manage to maintain mood stability when compared to individuals with a co-occurring mood disorder (McIntosh et al., 2009). Notably, mood instability and ED are not interchangeable terms; mood instability encompasses a broader array of emotional states (Broome et al., 2015), whereas ED specifically refers to an inability to regulate the interference of emotions with appropriate behaviours (D'Agostino et al., 2017). Nevertheless, both concepts share overlapping characteristics; therefore, the notion that depression+ADHD shares greater similarities with depression than ADHD pertaining to regulating emotions is worth considering.

This finding could also have been influenced by the analysis of clinically reported ED terms as a binary variable (present or not present). Group comparison analyses did not reveal a significant difference between frequency scores of clinically reported ED terms in the depression+ADHD group and the depression group, thus indicating the severity of clinically reported ED terms did not differ. This could have influenced the association between these groups and clinically reported ED terms. Nonetheless, it is worth noting that clinically reported ED terms lack construct validity for the assessment of ED severity (Patel et al., 2015), thereby justifying the rationale behind this approach.

The multivariate logistic regression analysis revealed that the increased likelihood of clinically reported ED terms among individuals with depression compared to ADHD remained significant after controlling for demographic factors, clinical characteristics, and cannabis use. Prior research comparing ED among youth with depression and ADHD indicates that maladaptive ER strategies are associated with the severity of depressive symptoms, whereas this association was not linked to ADHD severity (Mayer et al., 2022). Additionally, this finding demonstrates similarities with the research highlighting a disparity in the ability to

Figure 1

Multivariate logistic regression indicating diagnostic groups, demographic factors, clinical characteristics, and cannabis use as predictors of clinically reported ED



Note. Figure presents odds ratios, upper and lower 95% CI; N.s. – not stated.

For categorical variables: female used as reference group for male; male used as reference group for female and N.s.; black used as reference group for white; white used as reference group for black, asian, mixed, other and N.s.

maintain mood stability in ADHD compared to depression+ADHD (McIntosh et al., 2009); although this evidence examines adult populations.

Another alternative explanation for this observation could stem from the significantly greater prescription of ADHD medication in the ADHD group compared to the depression+ADHD group. Consequently, the ADHD group could have encountered more pronounced reductions in clinically reported ED terms due to the positive effects of stimulants on reducing ED (Salazar de Pablo et al., 2023).

Demographic factors

Findings revealed that when controlling for all factors, age, gender, and ethnicity remained a significant predictor of clinically reported ED terms. Odds ratios revealed that females were 1.7 times more likely to have clinically reported ED terms than males. Previous studies have demonstrated a higher prevalence of depression in girls than boys (Merikangas et al., 2010); therefore, this greater likelihood of clinically reported ED terms could be attributed to the increased development of maladaptive ER strategies associated with depression (Mayer et al., 2022).

The research exploring age and ED in depression and ADHD is limited; however, studies examining ED in the general population present heterogeneous results (Isaacowitz et al., 2017). Typically, ADHD is associated with a younger age of onset than depression (Park et al., 2014; Kieling et al., 2010) and the ADHD sample in this study was substantially larger than the depression sample. Therefore, it should be considered that disproportionate group sizes could have skewed results pertaining to the influence of age (Faber and Fonseca, 2014). However, the small p-value observed should mitigate this concern.

Evidence addressing the relationship between ethnicity and ED and depression and ADHD is limited. Therefore, this study furthers the research presenting racial and ethnic differences in emotion regulation strategies among a general population (Weiss et al., 2022) by conveying similar results in a clinical child and adolescent population. Notably, the sample in this study comprised predominantly white individuals. Consequently, it could be argued that the study is overrepresented by participants with white ethnicity and does not accurately reflect the true diversity and variations that exist within the broader population, therefore, causing potential bias (Simundic, 2013).

Clinical characteristics

This study revealed a link between ED and functioning in youth with depression and ADHD, mirroring previous research investigating ED and functioning in adult populations (Fasciano et al., 2021). Furthermore, this study presented self-reported SDQ scores as a significant predictor of clinically reported ED terms; this is consistent with previous studies (Taskiran et al., 2018). The absence of a significant association between parent-reported SDQ scores and clinically reported ED terms could be explained by the influence of parent's internal processes and feelings on ratings of their children's mental difficulties on the SDQ (Shenaar-Golan and Hen, 2022).

Clinically reported ED terms were also associated with days spent engaged with inpatient services and day appointments prior to the patients' index diagnosis. These findings align with previous studies that observed increased admission of children and adolescents with depression (Ebert et al., 2017) and other psychiatric disorders (Raudales et al., 2023) experiencing ED in inpatient settings. This association could result from insecure attachments or a weak therapeutic alliance between the patient and caregiver, reducing overall ER capabilities (Owens et al., 2013). However, the association of ED and engagement with inpatient services could be linked to the broader escalation in psychopathological manifestations associated with the necessity for inpatient admission, including factors such as suicidality and self-harm, rather than being solely attributed to the participants' depression or ADHD diagnosis (Hanssen-Bauer et al., 2011; Stewart, Semovski and Lapshina, 2022). Additionally, it is important to acknowledge that the prevalence of inpatient hospital activity is inherently higher among children than adults, particularly in the context of depression (Degli Esposti et al., 2022).

The univariate logistic regression analysis supports previous research linking psychiatric disorders such as OCD (Yazici and Yazici, 2019), anxiety disorder, eating disorder, phobia diagnoses (Paulus et al., 2021), and ID (Predescu et al., 2020). However, when adjusting for demographic factors, other clinical characteristics, and cannabis use, only psychosis predicted clinically reported ED terms. Furthermore, the results conflict with research presenting CD as a significant predictor of ED (Mitchison et al., 2020). Conversely, it is important to acknowledge that this study pertains exclusively to a cohort of children and adolescents diagnosed with depression and ADHD. Consequently, the associations observed between ED and the aforementioned psychiatric diagnoses are contingent upon their co-occurrence with

depression or ADHD. Therefore, the data does not necessarily conflict with the existing evidence.

Depression and ADHD co-occurring with psychosis predicts clinically reported ED terms. This finding aligns with previous studies which establish a link between psychosis symptoms and ED among adolescents (Bornheimer et al., 2022). Additionally, it has been evidenced that deficiencies in ability to regulate psychotic symptoms among adolescents arise from an increase in sudden fluctuations of affect in response to both positive and negative mood (Gong et al., 2022); this highlights the increased propensity of individuals with a co-occurring psychosis diagnosis to experience ED. Prior investigations have also established connections between ED and insecure attachments between young patients with psychosis and their carers (Liu et al., 2022). This suggests that individuals utilising inpatient services experience elevated occurrences of clinically documented ED terms, potentially influenced by the attachments formed with their carers.

This study indicates that the prescription of antipsychotic, antidepressant and hypnotic medication in children and adolescents with depression, ADHD and depression+ADHD is associated with clinically reported ED terms. Such findings align with the current evidence base highlighting the positive impact of antipsychotic, antidepressant and hypnotic medication on reducing ED (Colizzi et al., 2021; Salazar de Pablo et al., 2023; Baweja and Waxmonsky, 2022). However, due to the design of this study, causality cannot be determined. Consequently, the findings do not elucidate whether ED prompts the demand for antipsychotic, antidepressant, and hypnotic medication or if such medications contribute to ED.

Cannabis use

After controlling for demographic factors and clinical characteristics, cannabis use predicted clinically reported ED terms. This data furthers the substantial evidence base highlighting cannabis use as a risk factor for ED (Paulus et al., 2021; Weidberg et al., 2023). Regular cannabis use leads to increased neuronal activity in brain regions comprising the activation regions required for successful emotion regulation and appraisal of negative emotions (Zimmermann et al., 2017).

Aim 3: Compare the association between clinically reported ED terms and depression and investigate the influence of demographic factors, clinical characteristics, and cannabis use on these associations.

The data from the hierarchical logistic regression analysis (Table 4) did not support the hypothesis that the participants with depression+ADHD would have an increased likelihood of clinically reported ED terms compared to participants with depression after controlling for clinical characteristics and cannabis use. This increased likelihood only remained in depression+ADHD compared to ADHD. However, when controlling for only demographic factors, findings revealed a significant increase in the likelihood of clinically reported ED terms in depression+ADHD compared to depression and ADHD alone. Previous studies have observed greater associations with ED in depression+ADHD populations compared to ADHD and depression alone (Hinshaw et al., 2012; Mayer et al., 2022), whereas this study suggests that when examining clinically reported ED terms this association is similar for individuals with depression+ADHD and depression. Although, this may vary for different demographics.

Age, gender, and ethnicity explained 5% of the variance in the model (Table 4). Previous studies exploring ER across early adolescence, young adulthood, and adulthood found no association between age groups and ER strategies (De France and Hollenstein, 2019). This study continues to stress that the evidence base exploring age and ED is heterogeneous. In addition, it is important to note that ADHD typically exhibits an earlier age of onset compared to depression (Park et al., 2014; Kieling et al., 2010). Consequently, variation in age could be attributed to the participant's diagnosis of depression or ADHD as opposed to demonstrating a direct association with ED.

Gender could have influenced the relationship between ED in depression+ADHD and depression due to exhibiting a greater propensity to experience internalising symptoms and negative emotions among females compared to males (Chaplin, 2015; Deng et al., 2016). Conversely, some evidence suggests that among a young population, this is only exhibited during infancy and middle childhood (Deng et al., 2016); therefore, the influence of gender is uncertain. Another potential rationale for this finding is that the depression group comprised primarily females; therefore, the influence of gender on this association could be more applicably attributed to the emotion regulation deficiencies associated with depression (Mayer et al., 2022) opposed to gender. The odds ratio observed from the not stated group lacks validity; hindered by its restricted sample size (Faber and Fonseca, 2014), it inadequately

reflects the probability of manifesting clinically reported ED terms among individuals who do not identify as either male or female.

After including demographic characteristics in the hierarchical regression, the significant difference in the increased likelihood of clinically reported ED terms in depression+ADHD compared to depression could be due to differences in ethnicity. For instance, previous studies found that Caucasian individuals rated experiencing sadness as more acceptable than African American or Asian American individuals (Matsumoto, 1993). However, it should be considered that most research concerning mental illness is underrepresented by ethnic minorities (Satcher, 2001), and studies exploring the expression of emotions in children have predominantly focused on white middle-class backgrounds (Matsumoto, 1993).

After including clinical characteristics in the model (table 4), there was a significant increase in the likelihood of clinically reported ED terms in depression+ADHD compared to ADHD but not depression. Clinical characteristics including functioning, self-reported SDQ, days spent engaged with inpatient services, co-occurring psychosis diagnosis antipsychotic medication, antidepressant medication and hypnotic medication, explained 9.3% of the variance in the model. This evidence furthers the evidence base illustrating the negative effect of clinical characteristics on ED among child and adolescent populations (Fasciano et al., 2021; Ebert et al., 2017; Taskiran et al., 2018; Raudales et al., 2023; Owens et al., 2013) and provides a novel contribution to research exploring ED in young populations with depression and ADHD.

Of the clinical characteristics included in the hierarchical regression, the largest odds ratio was observed for antipsychotic and antidepressant medication. Such findings could be a result of an increase in the prescription of antipsychotic medication for young individuals with ED (Salazar de Pablo et al., 2023). Furthermore, antidepressant medication has been shown to reduce ED symptoms in adolescent (Capitão et al., 2015) and adult populations (McRae et al., 2014). Therefore, these findings are in line with the current evidence base. Although, considering the prevalence of antidepressant medication was not significantly different in the depression group compared to the depression+ADHD group, it could be argued that the association between antidepressant medication and ED is likely a consequence of the symptomology inherent among individuals requiring antidepressants opposed to the medication itself.

Hypnotic medication and co-occurring psychosis diagnosis also revealed high odds ratios. These results support previous research indicating a link between hypnotic medication and ED symptoms (Colizzi et al., 2021). While the research investigating hypnotic medication and ED is limited, particularly in young populations, the relationship between sleep and ER is evident (Palmer and Alfano, 2017). Inadequate sleep is associated with the generation of negative emotions (Norlander, Johansson and Bood, 2005) and attenuated neurobiological activity in emotional brain regions in response to negative emotion (Ferri et al., 2013). Thus, the association revealed in this study could be a consequence of improved sleep quality due to hypnotic medication. The association between clinically reported ED and a co-occurring psychosis diagnosis shows similarities with previous studies that have indicated ED among young populations with psychosis (Pishdadian et al., 2023; Owens et al., 2013; Paulus et al., 2021). However, it is important to acknowledge that this study examined psychosis comorbid with ADHD and depression.

Cannabis use explained .4% of the variance in the model (Table 4). Adolescents participating in cannabis abuse exhibit difficulties identifying emotions (Dorard et al., 2008). Moreover, emotion regulation techniques, such as mindfulness and self-compassion, are linked to the ability to accept emotional responses, which is consequently associated with reduced marijuana usage (Wisener and Khoury, 2021). Such evidence provides a potential explanation for the contribution of cannabis use in predicting clinically reported ED terms. Recent research has indicated that ED mediates the relationship between mental health and cannabis use, although this was only observed in female samples (Weidberg et al., 2023). This could explain the increased odds ratio for females compared to males when cannabis is included in the model.

After including cannabis use in the model, co-occurring psychosis diagnosis was no longer significantly associated with clinically reported ED terms. Such findings contradict previous studies which found decreased fractional anisotropy in brain regions associated with ER in adolescents when controlling for cannabis use (Romero et al., 2022). Although, arguably this study builds on the evidence base indicating an association between ED and psychosis in young people (Pishdadian et al., 2023; Owens et al., 2013; Paulus et al., 2021) by suggesting this is not the case when psychosis co-occurs with depression or ADHD.

Clinical implications

The findings from this study have several clinical implications. The high prevalence of ED observed in this study highlights that ED should be considered a key aspect of child and adolescent depression and ADHD symptomology, particularly in depression+ADHD. Clinicians should make comprehensive assessments giving adequate consideration to the presence of ED; this will encourage early identification and treatment of ED. Furthermore, this study suggests that clinicians should be mindful of demographic factors when assessing ED in these populations, especially depression+ADHD. Results suggest females could exhibit a greater propensity for ED. The literature examining age and ethnic differences in ED is heterogeneous; therefore, clinicians should employ a dialectic philosophy when considering their influence.

The results indicating demographic factors, clinical characteristics, and cannabis use as predictors of clinically reported ED could guide treatment and prevention interventions. Integrating targeted interventions for co-occurring psychosis and addressing cannabis use into management plans could prove beneficial in reducing the risk of ED development. Moreover, given the role of ED and its association with service use, poor functioning and SDQ scores in this population, interventions targeting improving ER strategies could improve these factors. Providing adequate treatment for ED could also lead to secondary reductions in adverse outcomes such as self-harm, NSSI and suicidal ideation (Brausch et al., 2022; Yang et al., 2021; Clapham and Brausch, 2022)

Currently, NICE guidelines do not offer explicit directives regarding the management of ED in young people with depression and ADHD (NICE, 2019, 2018). Findings from this study suggest that guidelines should highlight the impact of ED in these populations. More specifically, guidelines should stress the increased likelihood of ED in young individuals with depression+ADHD. Furthermore, guidelines could benefit from publicising current interventions that have demonstrated efficacy for reducing ED in young populations, such as emotion regulation and impulse control (ERIC) interventions in depression (Hall et al., 2021) and psychosocial interventions for ADHD (Vacher et al., 2020).

This study also emphasises the potential of NLP to advance clinical practice in areas such as prognosis by extracting information expressed in EHRs related to a patient's ED symptoms.

Using NLP could enhance conventional approaches to measuring ED such as questionnaires and clinician's reports, by overcoming barriers associated with cost and time efficiency.

Limitations

This study should be viewed in the light of some limitations. There was a large disparity between group sizes favouring the ADHD population; this could have led to a bias in the results due to ADHD characteristics being overrepresented in the sample, reducing generalizability (Faber and Fonseca, 2014). However, the depression group was considerably large, which should mitigate this concern.

The sample lacked diversity. Participants were predominantly white, demonstrating parallels with previous literature highlighting a lack of studies on ED exploring culturally diverse backgrounds (Satcher, 2001; Matsumoto, 1993). Consequently, the findings are less generalizable to global populations. This should encourage future research to conduct investigations comprising ethnically diverse samples.

Observations of ED were limited to within 3 months of the index diagnosis. It is possible that most patients' appointments took place outside of this period due to uncontrollable circumstances such as substantial waiting lists. Consequently, some instances of ED could have been missed resulting in an underestimation of clinically reported ED terms in this population. Furthermore, the use of EHRs is subject to limitations due to variations in clinician's reports. Clinical notes are based on observations and parent reports, which are influenced by numerous factors, such as the clinician's attitudes and parent's internal feelings (Cillessen et al., 2021; Shenaar-Golan and Hen, 2022). Such factors could have contributed further to the underestimation or overestimation of clinically reported ED terms.

For the logistic regression analyses, the outcome variable: clinically recorded ED terms, was conceptualised as a binary variable (present or absent). This variable did not examine the severity or frequency of ED, which could be important for predicting the course of ED. Additionally, clinically reported ED terms comprised documentation of keywords related to mood, affect and emotion. This method was chosen due to previous studies illustrating that these terms are used interchangeably (Marwaha et al., 2014a; Marwaha et al., 2014b), and while this approach has been employed in previous studies (Patel et al., 2015), its accuracy as a measure of ED has not been validated, thus prompting uncertainties regarding construct

validity. Nevertheless, despite the potential for heterogeneity, analysis of a large data sample yielded robust and clinically pertinent outcomes. This underscores the NLP models' robust nature as a research instrument, effectively targeting an imperative construct in its own right, despite its potential for variations.

It is important to note that participants might have concurrently been undergoing psychotherapeutic, psychoeducational, or psychosocial interventions for ED in addition to their prescribed medication regimen. This study only provided data on pharmacological interventions received by participants allowing for statistical models to be adjusted controlling for their influence. However, data on nonpharmacological interventions was not included. Nonpharmacological interventions such as DBT provide a strategy for treating a broad spectrum of challenges related to ED (Linehan, 1993); therefore, any reductions in ED due to participants receiving such interventions would not have been accounted for.

While this study controlled for the prescription of numerous psychiatric medications, adherence to participant's medication regimens was not measured. Hence, the associations found between clinically reported ED terms and psychiatric medications ought to be attributed to medication prescriptions rather than direct medication consumption.

Strengths of the present study

A notable strength inherent in this study is the substantial sample size. The participants were drawn from the case registry of a sizable mental healthcare institution and were selected depending on clinical diagnoses of depression and ADHD, as opposed to participants volunteering to participate in the study or being manually chosen by researchers. This methodological approach optimised the generalizability of the findings.

Employing this NLP utilised an automated information extraction method. This allowed for an extensive investigation of patient data that would have been operationally unviable to execute manually. Additionally, establishing the existence of documented ED through this methodology mitigates potential biases arising from manual examination of case records by multiple investigators.

Another strength is that this study included numerous additional predictors in the analysis. Controlling for additional factors enhances the robustness of the findings by minimising the

potential influence of extraneous factors or confounding variables. Additionally, this increased the possibility of the observed effects being attributed to the relevant variables, reducing the risk of drawing incorrect conclusions.

This study addresses several gaps in the literature. ED in child and adolescent populations with depression, ADHD, and depression+ADHD is understudied. This study provides a novel contribution to the field by drawing upon a wide range of clinical data and providing a comprehensive comparison of clinically reported ED in these populations. The findings possess several clinical and research implications that aim to facilitate the development of effective and safe treatment interventions and guidance for ED in child and adolescent depression and ADHD.

Future research directions

Future research should explore the efficacy of treatment interventions for ED in young individuals with depression and ADHD, especially for those with co-occurring ADHD and depression. Experimental studies should aim to further the existing research examining the efficacy of pharmacological and nonpharmacological interventions for reducing ED in young populations with depression (Hall et al., 2021) and ADHD (Vacher et al., 2020).

Future research should also continue to investigate the efficacy of pharmacological interventions for ED. This study indicated significant associations between ED and antipsychotic, antidepressant and hypnotic medication; however, the direction of causality cannot be determined. Randomised controlled trials should investigate the direction of this relationship.

Subsequent investigations comparing ED in young people with depression and depression+ADHD are required. This study suggests that the association between these groups and ED is similar; however, future research should attempt to replicate these findings. Moreover, the results demonstrate a notable impact of demographic variables and underscore the ambiguous nature of prior research. Subsequent investigations should explore the influence of age, gender, and ethnicity on ED, thereby deriving more conclusive insights.

This study indicates several predictors of clinically reported ED. The field would benefit from attempting to replicate these results utilising standardised measures of ED. This would provide

more robust conclusions regarding the mechanisms underlying the association between this population and ED, thus providing scope for the development of treatment and prevention interventions. Furthermore, for demographic variables, causality's direction is evident; however, for clinical characteristics and cannabis use, ambiguity persists regarding whether these factors precipitate ED or are influenced by ED. Subsequent experimental investigations should address this.

The exemplified potential of utilising NLP and EHRs to advance clinical practice through prognosis and early identification of disease should encourage future studies to develop this approach as a clinical tool for identifying ED. Future investigations should aim to refine this methodology into a validated clinical tool for detecting ED. These studies should rigorously assess the construct validity of this approach to evolve it into a reliable method for identifying ED within clinical records.

Conclusion

The likelihood of ED being reported clinically is significantly greater in children and adolescents with depression+ADHD compared to ADHD alone and in depression compared to ADHD. This association remains when controlling for demographic factors, clinical characteristics, and cannabis use. However, when controlling for only demographic variables, individuals with depression+ADHD experience a significantly greater likelihood of clinically reported ED terms than depression alone. Demographic factors, clinical characteristics, and cannabis use are significant predictors of ED in this population. Findings share similarities with previous research exploring ED in depression and ADHD; however, results contradict the evidence base suggesting youth with depression+ADHD exhibit more frequent maladaptive ER strategies than those with depression unless accounting for demographic factors. This study builds on the evidence base exploring predictors of ED and highlights the areas lacking in research.

Policymakers could utilise these findings to construct informed recommendations for managing ED in young individuals with depression, ADHD, and depression+ADHD. Furthermore, this study should encourage clinicians to consider ED as a key characteristic of child and adolescent depression and ADHD symptomology and acknowledge the potential benefits of targeting ED in treating these populations to reduce adverse outcomes such as self-harm. Subsequent studies should explore ED in similar populations utilising standardised

measures of ED to provide more robust conclusions, thus providing scope for the development of treatment and prevention interventions. Additionally, future research should aim to advance clinical practice by continuing to explore the application of NLP to a clinical setting.

References

Abram, M. D., Mancini, K. T. and Parker, R. D. (2020) Methods to Integrate Natural Language Processing Into Qualitative Research. *International journal of qualitative methods*. [Online] 19160940692098460.

Adrian, M., Zeman, J. and Veits, G. (2011) Methodological implications of the affect revolution: A 35-year review of emotion regulation assessment in children. *Journal of experimental child psychology*. [Online] 110 (2), 171–197.

Antony, E. M. et al. (2022) Does emotion dysregulation mediate the association between ADHD symptoms and internalizing problems? A longitudinal within-person analysis in a large population-representative study. *Journal of child psychology and psychiatry*. [Online] 63 (12), 1583–1590.

Barak-Corren, Y. et al. (2017) Predicting Suicidal Behavior From Longitudinal Electronic Health Records. *The American journal of psychiatry*. [Online] 174 (2), 154–162.

Baweja, R. and Waxmonsky, J. G. (2022) Updates in Pharmacologic Strategies for Emotional Dysregulation in Attention Deficit Hyperactivity Disorder. *Child and adolescent psychiatric clinics of North America*. [Online] 31 (3), 479–498.

Berking, M. and Wupperman, P. (2012) Emotion regulation and mental health: recent findings, current challenges, and future directions. *Current opinion in psychiatry*. [Online] 25 (2), 128–134.

Bhatti, B. M. et al. (2021) Information security implications of using NLP in IT outsourcing: a Diffusion of Innovation theory perspective. *Automated software engineering*. [Online] 28 (2), .

Bornheimer, L. A. et al. (2022) Affective Dysregulation Precedes Emergence of Psychosis-Like Experiences in a Community Sample of Young Adults. *Schizophrenia bulletin*. [Online] 48 (3), 664–672.

Brausch, A. M., Clapham, R. B. and Littlefield, A, K. (2022) Identifying Specific Emotion Regulation Deficits that Associate with Nonsuicidal Self-injury and Suicide Ideation in Adolescents. *Journal of youth and adolescence*. [Online] 51 (3), 556–569.

Broome, M. R. et al. (2015) Mood instability: Significance, definition and measurement. *British journal of psychiatry*. [Online] 207 (4), 283–285.

Capitão, L. P. et al. (2015) Acute fluoxetine modulates emotional processing in young adult volunteers. *Psychological medicine*. [Online] 45 (11), 2295–2308.

Caro-Cañizares, I. et al. (2015) Biological and environmental predictors of the dysregulation profile in children and adolescents: the story so far. *International journal of adolescent medicine and health*. [Online] 27 (2), 135–141.

Chaplin, T. M. (2015) Gender and Emotion Expression: A Developmental Contextual Perspective. *Emotion Review*. [Online] 7 (1), 14–21.

Cillessen, F. H. J. M. et al. (2021) Factors affecting the manual linking of clinical progress notes to problems in daily clinical practice: A retrospective quantitative analysis and cross sectional survey. *Health informatics journal*. [Online] 27 (2), 146045822110075.

Clapham, R. and Brausch, A. (2022) Emotion regulation deficits across the spectrum of self-harm. *Death studies*. [Online] 46 (10), 2477–2484.

Colizzi, M. et al. (2021) Further evidence on the interplay between benzodiazepine and Z-drug abuse and emotion dysregulation. *Journal of affective disorders reports*. [Online] 6100234.

Colmenero-Navarrete, L. et al. (2022) Relationship Between Emotion Regulation and Suicide Ideation and Attempt in Adults and Adolescents: A Systematic Review. *Archives of suicide research*. [Online] 26 (4), 1702–1735.

D'Agostino, A. et al. (2017) Reconsidering Emotion Dysregulation. *Psychiatric quarterly*. [Online] 88 (4), 807–825.

Defayette, A. B. et al. (2021) Adolescent depressed mood and difficulties with emotion regulation: Concurrent trajectories of change. *Journal of adolescence (London, England.)*. [Online] 91 (1), 1–14.

Degli Esposti, M. et al. (2022) Trends in inpatient care for psychiatric disorders in NHS hospitals across England, 1998/99–2019/20: an observational time series analysis. *Social Psychiatry and Psychiatric Epidemiology*. [Online] 57 (5), 993–1006.

Deng, Y. et al. (2016) Gender Differences in Emotional Response: Inconsistency between Experience and Expressivity. *PloS one*. [Online] 11 (6), e0158666–e0158666.

Department for Communities and Local Government. (2020) *English indices of deprivation*.

Dorard, G. et al. (2008) Affect dysregulation in cannabis abusers. *European child & adolescent psychiatry*. [Online] 17 (5), 274–282.

Downs, J. M. et al. (2019) An approach to linking education, social care and electronic health records for children and young people in South London: a linkage study of child and adolescent mental health service data. *BMJ open*. [Online] 9 (1), e024355–e024355.

Ebert, D. D. et al. (2017) Emotion Regulation Protects Against Recurrence of Depressive Symptoms Following Inpatient Care for Major Depressive Disorder. *Behavior therapy*. [Online] 48 (6), 739–749.

Evans, S. C. et al. (2022) Is Irritability a Top Problem in Youth Mental Health Care? A Multi-informant, Multi-method Investigation. *Child psychiatry and human development*. [Online]

Eyre, O., Hughes, R. A., et al. (2019a) Childhood neurodevelopmental difficulties and risk of adolescent depression: the role of irritability. *Journal of child psychology and psychiatry*. [Online] 60 (8), 866–874.

Eyre, O., Riglin, L., et al. (2019b) Irritability in ADHD: association with later depression symptoms. *European child & adolescent psychiatry*. [Online] 28 (10), 1375–1384.

Faber, J. and Fonseca, L. M. (2014) How sample size influences research outcomes. *Dental press journal of orthodontics*. [Online] 19 (4), 27–29.

Faraone, S. V et al. (2019) Practitioner Review: Emotional dysregulation in attention-deficit/hyperactivity disorder – implications for clinical recognition and intervention. *Journal of Child Psychology and Psychiatry*. [Online] 60 (2), 133–150. [online]. Available from: https://doi.org/10.1111/jcpp.12899.

Fasciano, L. C. et al. (2021) Relationship of childhood maltreatment, exercise, and emotion regulation to self-esteem, PTSD, and depression symptoms among college students. *Journal of American college health*. [Online] 69 (6), 653–659.

Ferri, J. et al. (2013) Neural correlates of attentional deployment within unpleasant pictures. *NeuroImage (Orlando, Fla.)*. [Online] 70268–277.

De France, K. and Hollenstein, T. (2019) Emotion Regulation and Relations to Well-Being Across the Lifespan. *Developmental psychology*. [Online] 55 (8), 1768–1774.

Giesbrecht, G. F. et al. (2010) The Anger-Distress Model of Temper Tantrums: Associations with Emotional Reactivity and Emotional Competence. *INFANT AND CHILD DEVELOPMENT*. [Online] 19 (5), 478–497.

Gonçalves, S. F. et al. (2019) Difficulties in Emotion Regulation Predict Depressive Symptom Trajectory from Early to Middle Adolescence. *Child psychiatry and human development*. [Online] 50 (4), 618–630.

Gong, J. et al. (2022) Epidemiology of psychotic-like experiences by subtypes and their relationship with emotional regulation and affective lability among Chinese college students. *Schizophrenia research*. [Online] 24439–45.

Goodman, R. (2001) Psychometric Properties of the Strengths and Difficulties Questionnaire. *Journal of the American Academy of Child and Adolescent Psychiatry*. [Online] 40 (11), 1337–1345.

Groves, N. B. et al. (2022) Executive Functioning and Emotion Regulation in Children with and without ADHD. *Journal of abnormal child psychology*. [Online] 50 (6), 721–735.

Hall, K. et al. (2021) An Emotion Regulation and Impulse Control (ERIC) Intervention for Vulnerable Young People: A Multi-Sectoral Pilot Study. *Frontiers in psychology*. [Online] 12554100–554100.

Hanssen-Bauer, K. et al. (2011) Admissions to acute adolescent psychiatric units: a prospective study of clinical severity and outcome. *International journal of mental health systems*. [Online] 5 (1), 1–1.

He, Z. et al. (2019) Functional dysconnectivity within the emotion-regulating system is associated with affective symptoms in major depressive disorder: A resting-state fMRI study. *Australian and New Zealand journal of psychiatry*. [Online] 53 (6), 528–539.

Hinshaw, S. P. et al. (2012) Prospective Follow-Up of Girls With Attention-Deficit/Hyperactivity Disorder Into Early Adulthood: Continuing Impairment Includes Elevated Risk for Suicide Attempts and Self-Injury. *Journal of consulting and clinical psychology*. [Online] 80 (6), 1041–1051.

Hossain, E. et al. (2023) Natural Language Processing in Electronic Health Records in relation to healthcare decision-making: A systematic review. *Computers in biology and medicine*. [Online] 155106649–106649.

Isaacowitz, D. M. et al. (2017) Aging and emotions: experience, regulation, and perception. *Current opinion in psychology*. [Online] 1779–83.

Jackson, R. G. et al. (2014) TextHunter--A User Friendly Tool for Extracting Generic Concepts from Free Text in Clinical Research. *AMIA ... Annual Symposium proceedings*. [Online] 2014729–738.

Jackson, R. G. et al. (2017) Natural language processing to extract symptoms of severe mental illness from clinical text: the Clinical Record Interactive Search Comprehensive Data Extraction (CRIS-CODE) project. *BMJ open*. [Online] 7 (1), e012012–e012012.

Jensen, P. B., Jensen, L. J. and Brunak, S. (2012) Mining electronic health records: towards better research applications and clinical care. *Nature reviews. Genetics*. [Online] 13 (6), 395–405.

Joseph, C. I. et al. (2019) Characterisation of depressive symptoms in young children with and without attention deficit hyperactivity disorder. *European child & adolescent psychiatry*. [Online] 28 (9), 1183–1192.

Jurafsky, D. (2000) *Speech and language processing : an introduction to natural language processing, computational linguistics, and speech recognition*. Prentice Hall series in artificial intelligence. James H. Martin (ed.). Upper Saddle River, N.J: Prentice Hall.

Kieling, C. et al. (2010) The Age at Onset of Attention Deficit Hyperactivity Disorder. *The American journal of psychiatry*. [Online] 167 (1), 14–16.

King, S. A. et al. (2022) A longitudinal examination of alcohol use and emotion dysregulation in adolescence. *Experimental and clinical psychopharmacology*. [Online] 31 (2), 414.

Ladas, N. et al. (2023) Programming techniques for improving rule readability for rule-based information extraction natural language processing pipelines of unstructured and semi-structured medical texts. *Health informatics journal*. [Online] 29 (2), 146045822311646.

Lavender, J. M. et al. (2017) Development and Validation of a State-Based Measure of Emotion Dysregulation. *Assessment (Odessa, Fla.)*. [Online] 24 (2), 197–209.

Leaman, R., Khare, R. and Lu, Z. (2015) Challenges in clinical natural language processing for automated disorder normalization. *Journal of biomedical informatics*. [Online] 5728–37.

Leonard Westgate, C. et al. (2015) Evaluation of Veterans' Suicide Risk With the Use of Linguistic Detection Methods. *Psychiatric services (Washington, D.C.)*. [Online] 66 (10), 1051–1056.

Levy, T. et al. (2020) Attention-deficit/hyperactivity disorder (ADHD) symptoms and suicidality in children: The mediating role of depression, irritability and anxiety symptoms. *Journal of affective disorders*. [Online] 265200–206.

Linehan, M. (1993) *Cognitive-behavioral treatment of borderline personality disorder*. Diagnosis and treatment of mental disorders. New York ; Guilford Press.

Liu, J. et al. (2022) A systematic examination of cognitive emotion regulation strategies, global emotion dysregulation, and cognitive insight in relation to posttraumatic stress disorder symptoms among trauma exposed patients with early nonaffective psychosis. *Psychological trauma*. [Online] 14 (7), 1184–1191.

Martin, A. F. et al. (2020) Co-occurring obsessive–compulsive disorder and autism spectrum disorder in young people: prevalence, clinical characteristics and outcomes. *European child & adolescent psychiatry*. [Online] 29 (11), 1603–1611.

Marwaha, S. et al. (2014a) How is affective instability defined and measured? A systematic review. *Psychological medicine*. [Online] 44 (9), 1793–1808.

Marwaha, Steven et al. (2014b) Mood Instability and Psychosis: Analyses of British National Survey Data. *Schizophrenia bulletin*. [Online] 40 (2), 269–277.

Masters, M. R., Zimmer-Gembeck, M. J. and Farrell , L. J. (2019) Transactional Associations Between Adolescents' Emotion Dysregulation and Symptoms of Social Anxiety and Depression: A Longitudinal Study. *The Journal of early adolescence*. [Online] 39 (8), 1085–1109.

Matsumoto, D. (1993) Ethnic differences in affect intensity, emotion judgments, display rule attitudes, and self-reported emotional expression in an American sample. *Motivation and Emotion*. [Online] 17 (2), 107–123. [online]. Available from: https://doi.org/10.1007/BF00995188.

Mayer, J. S. et al. (2022) Depressive symptoms in youth with ADHD: the role of impairments in cognitive emotion regulation. *European archives of psychiatry and clinical neuroscience*. [Online] 272 (5), 793–806.

McIntosh, D. et al. (2009) Adult ADHD and comorbid depression: A consensus-derived diagnostic algorithm for ADHD. *Neuropsychiatric disease and treatment*. [Online] 5137–150.

McKinnon, A. et al. (2020) The psychometric properties of the cognitive emotion regulation questionnaire (CERQ) in a clinical sample of adults with recurrent depression. *Journal of affective disorders*. [Online] 276212–219.

McRae, K. et al. (2014) Effects of antidepressant medication on emotion regulation in depressed patients: An iSPOT-D report. *Journal of affective disorders*. [Online] 159127–132.

Merikangas, K. R. et al. (2010) Prevalence and Treatment of Mental Disorders Among US Children in the 2001-2004 NHANES. *Pediatrics (Evanston)*. [Online] 125 (1), 75–81.

Meystre, S. M. et al. (2008) Extracting Information from Textual Documents in the Electronic Health Record: A Review of Recent Research. *Yearbook of medical informatics*. [Online] 17 (1), 128–144.

Mitchison, G. et al. (2020) Emotion dysregulation, ODD and Conduct Problems in a sample of five and six-year old children. *Child psychiatry and human development*. [Online] 51 (1), 71–79.

Miu, A. C. et al. (2022) Emotion regulation as mediator between childhood adversity and psychopathology: A meta-analysis. *Clinical psychology review*. [Online] 93102141–102141.

Mohamed, A. K. et al. (2023) Early reduction in irritability is associated with improved outcomes among youth with depression: Findings from the AMOD study. *Journal of affective disorders*. [Online] 32477–81.

Musella, K. E. and Weyandt, L. L. (2022) Attention-deficit hyperactivity disorder and youth's emotion dysregulation: A systematic review of fMRI studies. *Applied neuropsychology. Child*. [Online] ahead-of-print (ahead-of-print), 1–14.

National Institute for Health and Care Excellence (2018) *Attention deficit hyperactivity disorder: diagnosis and management NICE guideline*. [online]. Available from: www.nice.org.uk/guidance/ng87.

National Institute for Health and Care Excellence (2019) *Depression in children and young people: identification and management NICE guideline*. [online]. Available from: www.nice.org.uk/guidance/ng134.

Neuhaus, E. et al. (2019) Linking social motivation with social skill: The role of emotion dysregulation in autism spectrum disorder. *Development and psychopathology*. [Online] 31 (3), 931–943.

Nordgren, L. et al. (2022) Identifying subgroups of patients with eating disorders based on emotion dysregulation profiles: A factor mixture modeling approach to classification. *Psychological assessment*. [Online] 34 (4), 367–378.

Norlander, T., Johansson, A. and Bood, S. A. (2005) The affective personality: its relation to quality of sleep, well-being, and stress. *Social behavior and personality*. [Online] 33 (7), 709–722.

Núñez, D. et al. (2022) Identifying self-report measures of emotion regulation and evaluating their psychometric properties: A protocol for a systematic review. BMJ Open 12 (5).

Owens, K. A. et al. (2013) The Role of the Therapeutic Alliance in the Regulation of Emotion in Psychosis: An Attachment Perspective. *Clinical psychology and psychotherapy*. [Online] 20 (6), 523–530.

Pablo Vidal-Ribas (2018) *Deficits in emotion recognition are associated with depressive symptoms in youth with disruptive mood dysregulation disorder*.

Palmer, C. A. and Alfano, C. A. (2017) Sleep and emotion regulation: An organizing, integrative review. *Sleep medicine reviews*. [Online] 316–16.

Park, S.-C. et al. (2014) Does age at onset of first major depressive episode indicate the subtype of major depressive disorder?: the clinical research center for depression study. *Yonsei medical journal*. [Online] 55 (6), 1712–1720.

Patel, R. et al. (2016) Association of cannabis use with hospital admission and antipsychotic treatment failure in first episode psychosis: an observational study. *BMJ open*. [Online] 6 (3), e009888–e009888.

Patel, R. et al. (2015) Mood instability is a common feature of mental health disorders and is associated with poor clinical outcomes. *BMJ open*. [Online] 5 (5), e007504–e007504.

Paulus, F. W. et al. (2021) Emotional Dysregulation in Children and Adolescents With Psychiatric Disorders. A Narrative Review. *Frontiers in psychiatry*. [Online] 12628252–628252.

Penner, F., Steinberg, L. and Sharp , C. (2022) The Development and Validation of the Difficulties in Emotion Regulation Scale-8: Providing Respondents with a Uniform Context That Elicits Thinking About Situations Requiring Emotion Regulation. *Journal of personality assessment*. [Online] ahead-of-print (ahead-of-print), 1–10.

Perera, G. et al. (2016) Cohort profile of the South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLaM BRC) Case Register: current status and recent enhancement of an Electronic Mental Health Record-derived data resource. *BMJ open*. [Online] 6 (3), e008721–e008721.

Pishdadian, S. et al. (2023) Emotion regulation relates to clinical characteristics and quality of life but not daily functioning in psychosis spectrum outpatients. *Journal of psychiatric research*. [Online] 161289–297.

Predescu, E. et al. (2020) Executive Functions and Emotion Regulation in Attention-Deficit/Hyperactivity Disorder and Borderline Intellectual Disability. *Journal of clinical medicine*. [Online] 9 (4), 986.

Pylypow, J. et al. (2020) A Measure of Emotional Regulation and Irritability in Children and Adolescents: The Clinical Evaluation of Emotional Regulation–9. *Journal of attention disorders*. [Online] 24 (14), 2002–2011.

Raudales, A. M. et al. (2023) Emotion dysregulation as a mechanism linking posttraumatic stress disorder to subsequent suicidal thoughts and behaviors following inpatient psychiatric discharge. *Journal of psychiatric research*. [Online] 16134–39.

Roberts, A. (2017) Language, Structure, and Reuse in the Electronic Health Record. *AMA journal of ethics*. [Online] 19 (3), 281–288.

Romero, S. et al. (2022) Altered White Matter Integrity at Illness Onset in Adolescents With a First Episode of Psychosis. *Frontiers in psychiatry*. [Online] 13876793–876793.

Saatchi, B. et al. (2022) Measuring irritability in young adults: An integrative review of measures and their psychometric properties. *JOURNAL OF PSYCHIATRIC AND MENTAL HEALTH NURSING*. [Online]

Salazar de Pablo, G. et al. (2023) Systematic Review and Meta-analysis: Efficacy of Pharmacological Interventions for Irritability and Emotional Dysregulation in Autism Spectrum Disorder and Predictors of Response. *Journal of the American Academy of Child and Adolescent Psychiatry*. [Online] 62 (2), 151–168.

Satcher, D. (2001) *Mental health : culture, race, and ethnicity, a supplement to mental health - a report of the surgeon general*. Rockville, MD: Substance Abuse and Mental Health Services Administration US.

Seymour, K. E. et al. (2014) Emotion Regulation Mediates the Association Between ADHD and Depressive Symptoms in a Community Sample of Youth. *Journal of abnormal child psychology*. [Online] 42 (4), 611–621.

Shaffer, D. et al. (1983) A Children's Global Assessment Scale (CGAS). *Archives of General Psychiatry*. [Online] 40 (11), 1228–1231. [online]. Available from: https://doi.org/10.1001/archpsyc.1983.01790100074010.

Shaw, P. et al. (2014) Emotional dysregulation and Attention-Deficit/Hyperactivity Disorder. *The American journal of psychiatry*. [Online] 171 (3), 276–293.

Shenaar-Golan, V. and Hen, M. (2022) Do Parents' Internal Processes and Feelings Contribute to the way they Report Their Children's Mental Difficulties on the Strength and Difficulties Questionnaire (SDQ)? *Child psychiatry and human development*. [Online] 1–11.

Simundic, A.-M. (2013) Bias in research. *Biochemia medica*. [Online] 23 (1), 12–15.

StataCorp (2015) *Stata Statistical Software: Release 15*.

Stewart, R., Semovski, V. and Lapshina, N. (2009) The South London and Maudsley NHS Foundation Trust Biomedical Research Centre (SLAM BRC) case register: development and descriptive data. *BMC psychiatry*. [Online] 9 (1), 51–51.

Stewart, S. L. et al. (2022) Adolescent Inpatient Mental Health Admissions: An Exploration of Interpersonal Polyvictimization, Family Dysfunction, Self-Harm and Suicidal Behaviours. *Child psychiatry and human development*. [Online]

van Stralen, J. (2016) Emotional dysregulation in children with attention-deficit/hyperactivity disorder. *Attention deficit and hyperactivity disorders*. [Online] 8 (4), 175–187.

Tajik-Parvinchi, D. et al. (2021) The role of cognitive control and emotion regulation in predicting mental health problems in children with neurodevelopmental disorders. *CHILD CARE HEALTH AND DEVELOPMENT*. [Online] 47 (5), 608–617.

Taskiran, C. et al. (2018) Clinical features and subjective/physiological responses to emotional stimuli in the presence of emotion dysregulation in attention-deficit hyperactivity disorder. *Journal of clinical and experimental neuropsychology*. [Online] 40 (4), 389–404.

Vacher, C. et al. (2020) Efficacy of psychosocial interventions for children with ADHD and emotion dysregulation: a systematic review. *Psychiatry research*. [Online] 291113151–113151.

Velupillai, S. et al. (2015) Recent Advances in Clinical Natural Language Processing in Support of Semantic Analysis. *Yearbook of medical informatics*. [Online] 24 (1), 183–193.

Vidal-Ribas, P. and Stringaris, A. (2021) How and Why Are Irritability and Depression Linked? *Child and adolescent psychiatric clinics of North America*. [Online] 30 (2), 401–414.

Weidberg, S. et al. (2023) Emotion dysregulation in relation to cannabis use and mental health among young adults. *Addictive behaviors*. [Online] 144107757–107757.

Weiss, N. H. et al. (2022) Racial and ethnic differences in emotion regulation: A systematic review. *Journal of clinical psychology*. [Online] 78 (5), 785–808.

Welkie, J. et al. (2021) Sex and Emotion Regulation Difficulties Contribute to Depression in Young Adults With Attention-Deficit/Hyperactivity Disorder. *Psychological reports*. [Online] 124 (2), 596–610.

Wisener, M. and Khoury, B. (2021) Specific emotion-regulation processes explain the relationship between mindfulness and self-compassion with coping-motivated alcohol and marijuana use. *Addictive behaviors*. [Online] 112106590–106590.

World Health Organization (WHO) (2019) *International Classification of Diseases, Eleventh Revision (ICD-11)*

Wu, H. et al. (2019) Efficient Reuse of Natural Language Processing Models for Phenotype-Mention Identification in Free-text Electronic Medical Records: A Phenotype Embedding Approach. *JMIR medical informatics*. [Online] 7 (4), e14782–e14782.

Yang, L. et al. (2021) Emotion reactivity, emotion dysregulation, and suicidality among Chinese undergraduates: A study based on the 'ideation-to-action' framework. *CURRENT PSYCHOLOGY*. [Online]

Yazici, K. U. and Yazici, I. P. (2019) Decreased theory of mind skills, increased emotion dysregulation and insight levels in adolescents diagnosed with obsessive compulsive disorder. *Nordic journal of psychiatry*. [Online] 73 (7), 462–469.

Zimmermann, K. et al. (2017) Emotion regulation deficits in regular marijuana users. *Human brain mapping*. [Online] 38 (8), 4270–4279.

Appendices

Appendix A: The RECORD statement – checklist of items, extended from the STROBE statement, that should be reported in observational studies using routinely collected health data.

	Item No.	STROBE items	Location in manuscript where items are reported	RECORD items	Location in manuscript where items are reported
Title and abstract					
	1	(a) Indicate the study's design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract (Page 6)	RECORD 1.1: The type of data used should be specified in the title or abstract. When possible, the name of the databases used should be included. RECORD 1.2: If applicable, the geographic region and timeframe within which the study took place should be reported in the title or abstract. RECORD 1.3: If linkage between databases was conducted for the study, this should be clearly stated in the title or abstract.	Abstract (page 6) N/A N/A
Introduction					
Background rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction (page 7-12)		

Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction (page 12)		
Methods					
Study Design	4	Present key elements of study design early in the paper	Methods (page 13-16)		
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods (page 13)		
Participants	6	*(a) Cohort study* - Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study* - Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study* - Give the eligibility criteria, and the sources and methods of selection of participants *(b) Cohort study* - For matched studies, give matching criteria and number of exposed and unexposed	Methods (page 13-14) N.a.	RECORD 6.1: The methods of study population selection (such as codes or algorithms used to identify subjects) should be listed in detail. If this is not possible, an explanation should be provided. RECORD 6.2: Any validation studies of the codes or algorithms used to select the population should be referenced. If validation was conducted for this study and not published elsewhere, detailed methods and results should be provided. RECORD 6.3: If the study involved linkage of databases, consider use of a flow diagram or other graphical display to demonstrate the data linkage process, including the number	Methods (page 13-14) Methods (page 13-16) N.a.

		Case-control study - For matched studies, give matching criteria and the number of controls per case		of individuals with linked data at each stage.	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable.	Methods (page 14-16)	RECORD 7.1: A complete list of codes and algorithms used to classify exposures, outcomes, confounders, and effect modifiers should be provided. If these cannot be reported, an explanation should be provided.	Methods (page 14-16)
Data sources/ measurement	8	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods (page 13-16)		
Bias	9	Describe any efforts to address potential sources of bias	Methods (page 14-16)		
Study size	10	Explain how the study size was arrived at	Methods (page 13-14)		
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	Methods (page 16)		
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding (b) Describe any methods used to examine subgroups and interactions	Methods (page 16) Methods (page 16)		

		(c) Explain how missing data were addressed (d) *Cohort study* - If applicable, explain how loss to follow-up was addressed *Case-control study* - If applicable, explain how matching of cases and controls was addressed *Cross-sectional study* - If applicable, describe analytical methods taking account of sampling strategy (e) Describe any sensitivity analyses	N.a. N.a. N.a.		
Data access and cleaning methods		..	Methods (page 13-16)	RECORD 12.1: Authors should describe the extent to which the investigators had access to the database population used to create the study population. RECORD 12.2: Authors should provide information on the data cleaning methods used in the study.	Methods (page 13-16) Methods (page 13-16)
Linkage		..		RECORD 12.3: State whether the study included person-level, institutional-level, or other data linkage across two or more databases. The methods of linkage and methods of linkage quality evaluation should be provided.	Methods (page 13-16)

Results					
Participants	13	(a) Report the numbers of individuals at each stage of the study (*e.g.*, numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed) (b) Give reasons for non-participation at each stage. (c) Consider use of a flow diagram	Results, Table 1 (page 14) N.a. N.a.	RECORD 13.1: Describe in detail the selection of the persons included in the study (*i.e.,* study population selection) including filtering based on data quality, data availability and linkage. The selection of included persons can be described in the text and/or by means of the study flow diagram.	N.a.
Descriptive data	14	(a) Give characteristics of study participants (*e.g.*, demographic, clinical, social) and information on exposures and potential confounders (b) Indicate the number of participants with missing data for each variable of interest (c) *Cohort study* - summarise follow-up time (*e.g.*, average and total amount)	Results, Table 1 (page 18)		
Outcome data	15	*Cohort study* - Report numbers of outcome events or summary measures over time *Case-control study* - Report numbers in each exposure category, or summary measures of exposure	Results, Table 2 (page 20)		

		Cross-sectional study - Report numbers of outcome events or summary measures			
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results, Table 3 (page 22-24) N.a. N.a.		
Other analyses	17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	Results, Tables 1&2 (page 18-24)		
Discussion					
Key results	18	Summarise key results with reference to study objectives	Discussion (page 25-34)		
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion (page 36-37)	RECORD 19.1: Discuss the implications of using data that were not created or collected to answer the specific research question(s). Include discussion of misclassification bias, unmeasured confounding, missing data, and changing eligibility over	Discussion (page 36-37)

				time, as they pertain to the study being reported.	
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion (page 25-34)		
Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion (page 36-38)		
Other Information					
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	N.a.		
Accessibility of protocol, raw data, and programming code				RECORD 22.1: Authors should provide information on how to access any supplemental information such as the study protocol, raw data, or programming code.	N.a.

*Reference: Benchimol EI, Smeeth L, Guttmann A, Harron K, Moher D, Petersen I, Sørensen HT, von Elm E, Langan SM, the RECORD Working Committee. The REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) Statement. *PLoS Medicine* 2015; in press.

Appendix B: Psychiatric diagnoses ICD-11 F codes

Psychiatric Diagnosis	ICD-11 F code
ADHD	F90-F90.8
Depression	F32-F33.9
Psychosis	F15, F20–F29, F31, F32.3, F33.3
Eating disorder	F50
Obsessive compulsive disorder (OCD)	F42
Phobia	F40.0-F40.9
Anxiety	F41.0-F41.9
Intellectual disability (ID)	F70-F73.9; F78-F79.9
Conduct disorder (CD)	F90-F91.9
Emotion disorder	F93-F93.9

Appendix C: ED modifier words entered into NLP application (Patel et al., 2015)

Mood	Affect	Emotion
change	change	changes
changeable	changes	difficulties regulating
changable (misspelling of changeable)	labile	displays of
changes	lability	dysregulation
chaotic	range	extremes
extremes	variable	lability
fluctuate		levels
fluctuated		outbursts of
fluctuates		range
fluctuating		regulation difficulties
fluctuation		unstable
fluctuations		waves of
instability		
labile		
lability		
liability (misspelling of lability)		
liable (misspelling of labile)		
rapid cycling		
swings		
unpredictable		
unsettled		
unstable		
variable		
variation		
variations		
volatile		

Appendix D: Group comparison results (t-test and chi^2 analyses)

	Depression+ADHD Vs depression		Depression+ADHD vs ADHD		Depression Vs ADHD	
	t	p	t	p	t	p
ED terms (continuous)	-1.72	.087	-7.24	<.001	-8.09	<.001
Age	9.11	<.001	-26.37	<.001	-80.13	<.001
CGAS	4.60	<.001	5.52	<.001	2.15	.032
Social deprivation	2.64	.008	4.02	<.001	2.86	.004
SDQ total (self-report)	-4.98	<.001	-4.62	<.001	-.077	.939
SDQ total (parent-report)	-8.97	<.001	2.53	.011	15.95	<.001
Service use prior	-12.79	<.001	-8.41	<.001	-6.90	<.001
Service use post	-19.93	<.001	-8.24	<.001	-14.38	<.001
Inpatient days prior	.12	.900	-5.17	<.001	-9.16	<.001
Inpatient days post	-1.56	.115	-12.72	<.001	-18.31	<.001
	Chi^2	p	Chi^2	p	Chi^2	p
ED terms (binary)	10.74	.001	405.56	<.001	1100.00	<.001
Gender	54.11	<.001	251.01	<.001	2500.00	.001
Ethnicity	28.93	<.001	44.17	<.001	118.96	.001
Psychosis diagnosis	24.82	<.001	100.47	<.001	62.05	<.001
Eating disorder	1.23	.268	106.32	<.001	261.86	<.001
OCD diagnosis	.60	.438	14.83	<.001	37.25	<.001
Phobia diagnosis	.09	.769	29.09	<.001	126.89	<.001
Anxiety diagnosis	18.76	<.001	184.65	<.001	252.54	<.001

Appendix D (continued): Group comparison results (t-test and chi^2 analyses)

	Depression+ADHD Vs depression		Depression+ADHD vs ADHD		Depression Vs ADHD	
	Chi^2	p	Chi^2	p	Chi^2	p
Any ID	46.97	<.001	7.00	<.001	258.35	<.001
Conduct diagnosis	84.11	<.001	.30	.583	238.44	<.001
Emotion diagnosis	66.17	<.001	48.12	<.001	9.30	<.001
ADHD meds	841.98	<.001	29.55	<.001	2200.00	<.001
Antipsychotic meds	22.32	<.001	31.06	<.001	.80	.372
Antidepressant meds	1.64	.200	701.10	<.001	2100.00	<.001
Hypnotic meds	6.77	.009	27.94	<.001	24.62	<.001
Cannabis use	42.90	<.001	192.05	<.001	196.62	<.001