Associations between COVID-19 pandemic impact, dimensions of behavior and eating disorders: A longitudinal UK-based study

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ARTICLE INFO

ABSTRACT

Background: There is growing concern about how people with eating disorders are impacted by the widespread societal restructuring during the COVID-19 crisis.

Aims: We aimed to examine how factors relating to the impact of the pandemic associate with eating disorders and quantify this relationship while adjusting for concurrent and longitudinal parameters of risk.

Methods: We gathered demographic, behavioral and clinical data pre- and mid-pandemic as well as childhood trauma history from a longitudinal online survey of 489 adults (mean age 23.4 years) recruited from the Neuroscience in Psychiatry Network (NSPN). Using pre-pandemic (T1) and concurrent (T2) data we aimed to predict eating disorders at mid-pandemic (T2). We deployed hierarchical generalized logistic regression to ascertain the strength of longitudinal and concurrent associations.

Results: Pre-pandemic eating disorder scores strongly associated with concurrent eating disorder ($z = 5.93$). More conflict at home mid-pandemic ($z = 2.03$), pre- (lower sensation seeking $z = -2.58$) and mid-pandemic (higher lack of perseverance $z = 2.33$) impulsivity traits also associated with mid-pandemic eating disorder.

Conclusion: Conflict at home mid-pandemic and specific aspects of impulsiveness significantly associated with concurrent eating disorder symptoms, baseline demographics, behavioral traits, history of traumatic experiences and concurrent psychopathology. These results provide insight into the struggles of those suffering with eating disorders during the COVID-19 pandemic and highlight the importance of impulsiveness traits and the immediate family environment in their experience of illness during the pandemic.

1. Introduction

Eating disorders (EDs) are widespread problems with public health implications and still remain an important health burden for societies worldwide [1,2]. They have the highest morbidity and mortality of all mental illnesses [3] and a significant lifetime prevalence: ~1.2–2.4% for anorexia nervosa (AN) and ~1.2–2.3% for bulimia nervosa (BN), depending on diagnostic criteria and population under study [4].

Incidence of EDs is higher in community studies as opposed to studies focusing on treatment seeking individuals (using primary or secondary care registers) [5].

1.1. Pandemic impact on mental health

The COVID-19 pandemic has brought about unprecedented societal restructuring triggering significant public health concerns over the

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direct effects of the infection as well as the indirect effects on mental health due to societal changes and restrictions [6]. Mounting evidence suggests that the COVID-19 pandemic has insidiously fueled an upcoming mental health crisis [7]. Anxiety symptoms did increase from pre-pandemic to mid-pandemic in a large longitudinal UK cohort [6]; moreover, people reporting pre-existing diagnoses of psychiatric conditions including anxiety and depression experienced a differential degree of pandemic impact when compared to the general population [6]. In relation to eating disorders, lockdown orders have undoubtedly posed new problems to individuals with EDs [8,9], who were expected to struggle with isolation and loneliness, feel conflicted about how to prioritize self-care over helping others, and experience challenges from altered family dynamics and loss of support [10]. In the UK, Children and Young People (CYP) eating disorder services' urgent caseload almost doubled (>90%) in the second and third quarter of 2020 as compared to the respective 2019 quarters [11]. Similarly the need for CYP anorexia nervosa inpatient treatment doubled (+104%) as compared to the previous three years in Western Australia [12].

1.2. Behavioral predictors of EDs

In this context, it is important to consider what antecedent variables may predict new onset or exacerbation of eating disorder symptoms under stressful circumstances, such as the pandemic. Two concepts likely to be important are impulsivity and obsessionality/compulsivity [13]. Obsessional ideas and compulsive behavior are prevalent in eating disorder populations [5]; obsessive-compulsive disorder (OCD) is one of the most common comorbidities of AN. Obsessions are repeated, persistent, intrusive, and unwanted thoughts, mental images, or urges that cause distress or worries. Body-image related obsessions are among the core symptoms of AN [14]. Obsessions during this time might confer risk towards ED, as repetitive concerns over the pandemic might trigger 'safety behaviors' and impact on the individual's level of functioning. Obsessions are linked to compulsions which are defined as persistently repeated acts despite adverse consequences. In ED, compulsions can manifest in the form of extreme dietary restriction and over-exercise [5]. Compulsions might exacerbate ED risk during the pandemic as lockdown and other socio-economic changes might trigger ritualistic or safety behavior, loss of established routine and impact on functioning. OCD symptoms have indeed increased between pre- to mid-pandemic levels [6] in the general population and they may contribute to the struggles of ED vulnerable populations. On the other hand, impulsivity is a multi-faceted construct referring to acting without forethought or reflection or consideration of the consequences. In EDs, impulsivity may influence symptom severity and the presence of psychiatric comorbidities, thus the maintenance of ED symptoms and treatment response [15]. It has been shown to be linked with bingeing and purging [14]. Sensation seeking impulsivity has been significantly correlated with bulimic behaviors [16]. Lockdown measures which trigger lack of access to safe food options, re-direction of food purchasing and exercise routines and may exacerbate impulsivity related ED symptoms. Furthermore, there is increasing recognition that stress and traumatic life events are important vulnerability factors for the development of obsessional ideas and compulsions, but also childhood maltreatment experiences are common in sufferers of eating disorders [17].

1.3. The use of technology during the pandemic

Moreover, the environmental and online context (i.e. use of the internet) are also likely to play a role in determining the impact of the pandemic on eating disorders [18]. In recent work, it was found that the way people use technology has large effect sizes in statistically accounting for the self-perceived impact of the pandemic [6]. Typically, the way people use technology - despite being of large effect size importance in determining pandemic impact - is unmeasured in pandemic-related mental health research. However, validated measures exist, in order to quantify problematic usage of the internet (PUI), which is an umbrella term used to describe maladaptive behaviors manifesting on the online milieu [19]. There are concerns regarding maladaptive use of the internet and potential negative impact on those suffering and those vulnerable to disordered eating [20]. Previous work from our group suggested a mediational role for PUI in the interaction between obsessions, impulsivity and eating disorders, as well as excessive exercise in ED [21].

1.4. Aims and hypotheses

This current study had two aims: first to examine how factors relating to the impact of the pandemic correlated with EDs. Our second aim was to statistically quantify the relationship between the pandemic impact variables and eating disorders, while adjusting for background demographics and maltreatment history as well as pre- and mid-pandemic levels of behavior, and eating disorder psychopathology. To date there is no such study quantifying the associations of those pandemic measures with eating disorders.

Our hypotheses were (1) that self-reported pandemic impact would correlate with concurrent ED status; and that (2) historical and concurrent parameters of impulsivity and compulsivity, problematic usage of the internet, excessive exercise and history of maltreatment would positively associate with ED status. These hypotheses were based on prior literature relating to disordered eating [5,8,18,20], as well as extant findings in terms of pandemic impact on other areas of mental health [6].

2. Material and methods

2.1. Study criteria and recruitment

Participants were recruited in two waves from the Neuroscience in Psychiatry Network (NSPN), which is a longitudinal cohort in the UK, exploring brain development trajectories and mental health outcomes [22]. The sample was originally recruited on an age-sex stratified basis to maximize representativeness of the general population in the catchment areas covered (Cambridge and London). In the first (pre-pandemic) wave of data collection (T1 = 22nd Sept 2017 – 4th Sept 2018) all individuals who were still enrolled in this cohort at the time were contacted via email and invited to take part in an online study conducted via Redcap. For T1, survey invitations were sent to 2017 participants of which 764 responded and 639 completed the survey. All participants received £15 compensation in form of a gift voucher. The second recruitment wave (T2) happened during the first lockdown phase of the UK COVID-19 pandemic response (T2 = 26th May 2020–04 July 2020); survey invitations were sent to 2036 individuals, 1005 participants responded, however, five were excluded due to uncertainty of responder identity. Participants received a £25 gift voucher as compensation for their time. The unexpected (against usual attrition rates) increase of responders from T1 to T2 was attributed to a spike of public interest in COVID-19 related research and the higher monetary compensation in taking part. As a result of both recruitment waves, 489 individuals completed both T1 and T2 surveys and this sub-cohort was the focus of this study.

2.2. Ethical considerations

The procedures of this study were carried out in accordance with the Declaration of Helsinki and the study was approved by the Cambridge East Research Ethics Committee (Study approval number 16/EE/0260, IRAS 207190). All subjects gave informed consent online.

2.3. Assessments

The instruments used in this study are summarized briefly below.

Further methodological details about the recruitment and instruments are presented in the online supplement (supplement S1-S6).

2.4. Pandemic impact

The **Pandemic General Impact Scale (PD-GIS)** [6] was designed to quantify self-perceived current and longer-term impact of the COVID-19 pandemic on multiple levels of psycho-socio-ecological ascertainment by measuring levels of agreement with 45 statements. The PD-GIS has been validated in a separate cross-sectional study during the time of the first UK lockdown ($n = 379,875$). Horn's parallel analysis ($n = 79,736$) in this extensively large sample indicated an optimal seven factor model for the PD-GIS: factor A = "More time less stressed/tired"; B = "Disrupted lifestyle"; C = "Increased health concerns"; D = "Positive outlook", E = "More conflict at home"; F = "Improved environment"; G = "More time for people at home". More details about the PD-GIS scale and how it was used in the current study are presented in the supplement (see supplement paragraph S1). Due to the need for a relatively brief survey, the current study omitted Factor D questions.

2.5. Clinical assessments

Eating disorder (ED) assessment: for the assessment of EDs we used the SCOFF Eating Disorder Questionnaire [23], which is a 5-item validated screening tool for the detection of eating disorders, covering anorexia nervosa or bulimia nervosa. For SCOFF, a score of 2 and above indicates high probability of having AN or BN. The scale ascertains the presence of different aspects of eating disorder symptoms, such as purging, weight loss, distorted body image, loss of control over eating and food preoccupation.

Generalized Anxiety Disorder (GAD); the GAD-7 is a brief self-report scale to identify probable cases of GAD [24].

Depression severity assessment (PHQ-9): The PHQ-9 (Patient Health Questionnaire-9) objectifies and assesses degree of depression severity via questionnaire [25].

2.6. Behavioral assessments

Problematic usage of the internet was quantified using the 12-item short version of the **Internet Addiction Test** (IAT-12) [26]. We further assessed compulsivity using the **Cambridge–Chicago Compulsivity Trait Scale** (CHI-T) [27]; a scale designed to capture the comprehensive aspects of compulsivity, viewed trans-diagnostically. The **PADUA inventory** (PI), a self-report measure of obsessive and compulsive symptoms [28]. The **short Urgency, Premeditation (lack of), Perseverance (lack of), Sensation Seeking, Positive Urgency, Impulsive Behavior Scale** (S-UPPS) was used to measure impulsivity as a multi-faceted and multi-dimensional construct, comprising five impulsive personality traits [29,30]. For the assessment of excessive exercise, we used the **Exercise Addiction Inventory** (EAI) [31]. Adverse childhood experiences were assessed using the **Childhood Trauma Questionnaire** (CTQ) [32]. More information about the instruments used can be found in the online supplement (see online supplement S2-S6).

2.7. Statistical analysis

Participants were grouped into those likely to have an eating disorder at mid-pandemic (T2; SCOFF ≥ 2), designated as cases, and controls. Data processing and statistical analyses were conducted in R version 3.4.2 using packages "dplyr" [33] and "caret" [34].

2.7.1. Representativeness of the cohort under study

The sub-cohort that entered the analysis was tested for its representativeness against the NSPN baseline, which was a stratified and representative cohort of adolescence and young adults in the UK. The current cohort under study, was slightly over-represented by older age at study entry ($p = 0.012$, Cohen's d = 0.12, small) and over-represented by female participants ($p < 0.001$, Phi $\varphi = 0.10$, small). There were no statistical differences between ethnicity, maternal education and relationship status (at time T2) between the studied sub-cohort and baseline. No significant attrition biases were identified. A full representativeness analysis report is presented in the online supplement (supplement S7).

2.7.2. Hierarchical logistic regression

Hierarchical regression is a form of multiple regression which allows exploring relationships among, and testing hypotheses about, a dependent variable and several independent variables. More specifically, using hierarchical regression analysis the independent variables are not entered into the regression simultaneously, but in steps. We considered this approach would allow us to achieve our second aim, which was to statistically quantify the relationship between the pandemic impact variables and EDs at T2, while adjusting for concurrent and background variables. To assess EDs at T2, we used a set of predictors to perform hierarchical logistic regression (HLR) in 8 different steps; [M0] baseline history step = includes age (numeric), gender (two-level factor), relationship status (four-level factor) as baseline predictors; [M1] = M0 plus history of maltreatment (five Childhood Trauma Questionnaire subscales) as predictors; [M2] = M1 plus behavioral predictors at time T1 (Internet Addiction Test, short version (IAT-12, total score); Cambridge–Chicago Compulsivity Trait Scale (CHI-T) (two subscales/factors); Short Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency Scale (SUPPS) (five subscales/factors); exercise Addiction Inventory (EAI)(total score); Padua Inventory (PI) (total score)); [M3] = M2 plus behavioral predictors at time T2; [M4] = M3 plus Pandemic General Impact scale (PD-GIS six subscales/factors); [M5] = M4 plus GAD-7 (total score); [M6] = M5 plus PHQ-9 (total score); [M7] = M6 plus SCOFF score at T1. While SCOFF at T1 was antecedent to other independent variables, it was entered alone as the last modelling step, because it was expected to be strongly and causally related to the dependent variable (past ED symptoms predicting current ED), to allow for an exploration of how intermediate step associations change when adjusted for prior ED status.

2.7.3. Out-of-sample cross validation

When regression is performed in-sample, having too many predictor variables typically leads to over-fitting, and can be fundamentally flawed in making predictions on new data [35]. Therefore, we used out-of-sample cross validation [36] to quantify the predictive strength of the modelling steps and to add confidence in our model selection process (for details see supplement S8). Our cross-validation would ascertain that the addition of the specific predictors in the M1-M7 steps does not negatively affect the out-of-sample predictive capacity of the steps towards correctly classifying eating disorder psychopathology at T2, which would suggest model over-fitting.

3. Results

Our final sample comprised 93 cases (i.e. individuals meeting criteria for probable eating disorder at T2), and 396 controls. We performed direct case-control comparisons using Welch *t*-test under the assumption of normal distribution of behavioral characteristics in our cohort. We used chi-square to compare non-parametric values e.g. gender. The descriptive statistics of the cohort and stratified by group are presented in Table 1. Group comparisons on descriptive statistics are presented here for completeness and to contextualize the subsequent analyses, rather than to infer associations or structural relationships between variables.

3.1. Correlations between PD-GIS and clinical and behavioral variables

The PD-GIS instrument comprised six factors; three positive and

Table 1
Descriptive statistics with group comparisons of study cohort.

	TOTAL $N = 489$	No case $N = 396$	Case $N = 93$	p-value	p-corrected ($\times 38$)	Signif.	Cohen's d
	Mean (sd)	Mean (sd)	Mean (sd)				es (95%CI)
Age	23.46 (3.3)	23.48 (3.3)	23.35 (3.0)	–	–	–	–
Gender [count]	Male = 159	Male = 138	Male = 21/	<0.0	–	–	–
	Female = 330	Female = 258	Female = 72	5			
Relationship status							
1 = single (never married)	1 = 212	1 = 164	1 = 48	<0.05	–	–	–
2 = single (divorced/ widowed)	2 = 1	2 = 0	2 = 1				
3 = in relationship/married but living apart	3 = 72	3 = 64	3 = 8				
4 = in relationship and cohabiting	4 = 204	4 = 168	4 = 36				
CTQ† emotional abuse	3.01 (3.6)	2.68(3.3)	4.43 (4.3)	***	<0.05	*	0.13–0.58
CTQ physical abuse	0.82 (2.1)	0.80(2.1)	0.90 (2.0)	–	–	–	–
CTQ sexual abuse	0.46 (2.0)	0.43(1.8)	0.63 (2.5)	–	–	–	–
CTQ emotional neglect	4.13 (4.0)	3.91(4.0)	5.07 (4.0)	*	–	–	–
CTQ physical neglect	1.22 (2.3)	1.14(2.2)	1.59 (2.6)	–	–	–	–
T1 assessment ‡							
PADUA	39.36 (17.8)	37.81(16.1)	45.9 (22.5)	**	<0.05	*	0.43–0.92
Reward-seeking/ perfection compulsivity (CHI-T)	19.73 (3.1)	19.65 (3.1)	20.1 (2.9)	–	–	–	–
Anxiolytic/soothing compulsivity (CHI-T)	19.45 (3.8)	19.17 (3.9)	20.61 (3.7)	***	<0.05	*	0.37–0.86
Negative urgency (SUPPS)	4.59 (2.6)	4.361 (2.5)	5.60 (2.6)	***	<0.01	**	0.54–1.04
Lack of perseverance (SUPPS)	4.40 (1.9)	4.389 (1.9)	4.49 (1.8)	–	–	–	–
Lack of premedition (SUPPS)	3.85 (1.8)	3.785 (1.7)	4.16 (1.8)	–	–	–	–
Sensation seeking (SUPPS)	5.89 (2.6)	6.04 (2.6)	5.21 (2.6)	*	–	–	–
Positive urgency (SUPPS)	3.02 (2.1)	2.89 (2.1)	3.58 (2.1)	**	–	–	–
Internet use (IAT-12)	12.85 (7.8)	12.26 (7.2)	15.37 (9.4)	**	–	–	–
Exercise addiction (EAI)	13.34 (5.3)	13.26 (5.1)	13.71(5.9)	–	–	–	–
T2 assessment ‡							
PADUA	42.37 (19.0)	40.35 (17.2)	50.9 (23.2)	***	<0.01	**	0.58–1.09
Reward-seeking/ perfection compulsivity (CHI-T)	19.98 (3.2)	19.98 (3.3)	19.99 (3.0)	–	–	–	–
Anxiolytic/soothing compulsivity (CHI-T)	19.44 (3.8)	19.03 (3.6)	21.19 (3.8)	***	<0.001	***	0.68–1.21
Negative urgency (SUPPS)	8.317 (2.7)	7.982 (2.6)	9.742 (2.8)	***	<0.001	***	0.79–1.33
Lack of perseverance (SUPPS)	8.27 (1.8)	8.21 (1.8)	8.538 (2.0)	–	–	–	–
Lack of premedition (SUPPS)	7.76 (1.7)	7.662 (1.6)	8.194 (2.0)	*	–	–	–
Sensation seeking (SUPPS)	9.46 (2.6)	9.563 (2.7)	9.032 (2.6)	–	–	–	–
Positive urgency (SUPPS)	6.79 (2.1)	6.616 (2.0)	7.548 (2.5)	***	<0.05	*	0.42–0.91
Internet use (IAT-12)	12.65 (8.0)	11.87 (7.3)	15.98 (9.9)	***	<0.01	**	0.52–1.02
Exercise addiction (EAI)	14.84 (5.0)	14.72 (4.8)	15.34 (5.5)	–	–	–	–
Clinical §¶							
GAD-7	12.27 (4.9)	11.67 (4.5)	14.83 (5.5)	***	<0.001	***	0.75–1.29
PHQ-9	6.828 (5.6)	5.89 (4.9)	10.83 (6.7)	***	<0.001	***	1.07–1.67
SCOFF – T1	0.78 (1.1)	0.54 (0.9)	1.81 (1.4)	***	<0.001	***	1.41–2.09
SCOFF – T2	0.72 (1.0)	0.28 (0.5)	2.59 (0.8)	***	<0.001	***	4.77–6.46
Pandemic related							
PD-GIS-A [positive]	25.79 (7.4)	26.08 (7.4)	24.6 (7.5)	–	–	–	–
PD-GIS-B [negative]	14.65 (6.0)	13.97 (5.7)	17.6 (6.0)	***	<0.001	***	0.74–1.28
PD-GIS-C [negative]	13.85 (3.8)	13.51 (3.6)	15.3 (3.9)	***	<0.01	**	0.52–1.03
PD-GIS-E [negative]	3.035 (1.5)	2.89 (1.4)	3.61 (2.0)	**	<0.05	*	0.43–0.92
PD-GIS-F [positive]	10.6 (2.7)	10.57 (2.7)	10.7 (2.6)	–	–	–	–
PD-GIS-G [positive]	4.55 (1.6)	4.54 (1.6)	4.62 (1.8)	–	–	–	–

Welch two sample t-test p-values for continuous variables and chi-square for categorical variables; Significance: '*' <0.05; '**' <0.01; '***' <0.001.

† **CTQ** – Childhood trauma questionnaire subscales.

‡ **T1/T2 Behavioral** = Internet Addiction Test, short version (**IAT-12**); Cambridge–Chicago Compulsivity Trait Scale (**CHI-T**); Short Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency Scale (**SUPPS**); Exercise Addiction Inventory (**EAI**); Padua Inventory (**PI**).

§ **GAD-7** = Generalized Anxiety Disorder; **PHQ-9** = Depression severity questionnaire; **SCOFF** – eating disorder questionnaire.

¶ **PD-GIS factors** – Pandemic General Impact Scale A – More time less stressed/tired; B – Disrupted lifestyle; C – Increased health concerns; E – More conflict at home; F – Improved environment; G – More time for personal relationships.

three negative. We hypothesized that all PD-GIS factors would correlate with ED at T2 and indeed all negative PD-GIS factors correlated positively with ED at T2 (e.g. Factor B "disrupted lifestyle" ~ ED at T2, $r = 0.27$), however none or the positive PD-GIS factors correlated with ED at T2 (see Fig. 1 for full results). All the negative factors correlated positively with anxiety and depression at T2 and eating disorders at T1 (e.g. Factor B "disrupted lifestyle" ~ ED at T1, $r = 0.22$). However, PD-GIS factor E "more conflict at home" only correlated with eating disorders at T2 ($r = 0.21$) but not at T1 ($r = 0.05$) (see Fig. 1). All basic correlations between historical and concurrent parameters of impulsivity and compulsivity, problematic usage of the internet, excessive exercise and history of maltreatment were positively associated with ED at T2 in line with our hypotheses, apart from lack of perseverance and sensation seeking, both at T1 and T2. Detailed correlations between historical and concurrent variables are presented in the supplement (supplemental Fig. S3).
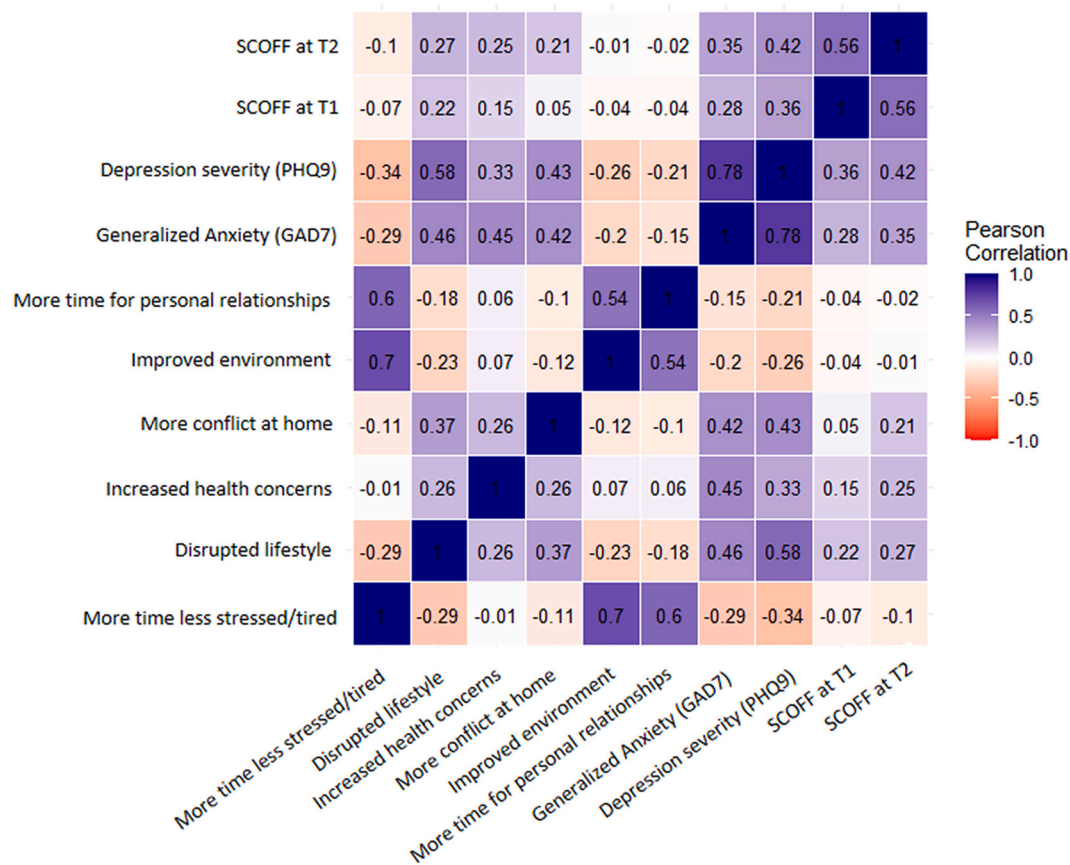
Fig. 1. Pearson's Correlations of clinical and pandemic related parameters.
PD-GIS factors = Pandemic General Impact Scale A – More time less stressed/tired; B – Disrupted lifestyle; C – Increased health concerns; E – More conflict at home; F – Improved environment; G – More time for personal relationships; **GAD7** – Generalized Anxiety Disorder-7 Questionnaire; **PHQ-9** = Depression severity questionnaire; **SCOFF** – Eating disorder questionnaire at T1 and T2.

3.2. Hierarchical logistic regression

The results from the final HLR step (M7, 37 predictors) are presented in Table 2. In this final step, ED at T1 was strongly associated with the ED T2 outcome (ED outcome = SCOFF $\geq$2 at T2; z = 5.93 p < 0.001). More conflict at home (PD-GIS Factor E) was also associated with the ED outcome (z = 2.03 p < 0.05). Lower sensation seeking at T1 (z = −2.58 p < 0.01) and higher lack of perseverance at time T2 (z = 2.33 p < 0.05) were also significantly associated with the ED outcome. For purposes of completeness, all results from the intermediate regression steps are presented in the supplement (supplement S8 and Table S4).

4. Discussion

This is the first study to examine the associations of pandemic-related impact with eating disorders via a longitudinal cohort in the UK. Our results are novel and clinically relevant as they identify the importance of impulsivity traits and the immediate environment (more conflict at home, PD-GIS Factor E) as having a significant association with ED psychopathology mid-pandemic, while accounting for established longitudinal (antecedent) and concurrent predictors of risk in ED. While global health services are faced with an unprecedented health crisis and clinicians as well as wider stakeholders need insights into how to prioritize resources, such results are of significant clinical and public health relevance.

4.1. Impulsivity and compulsivity and their associations with ED mid-pandemic

The fact that baseline and concurrent impulsivity traits independently contributed to the prediction of ED symptoms is in line with previous research suggesting the importance of impulsivity traits in eating disorders, but also highlights that ED sufferers with specific impulsiveness characteristics may be more vulnerable towards pandemic-related impact. Research has shown that purging but not bingeing is associated with higher scores of impulsivity, including novelty seeking [37]. Furthermore, impulsivity can help differentiating between ED diagnostic subtypes [13,15]. It is important to note that on a basic correlational level, neither sensation seeking nor lack of perseverance were strongly positively correlated with ED at T2, which was against our hypothesis, however they present as important predictors when other variables were taken into account. This highlights how regression analyses adjusted for important confounders may be an important complement to correlational analyses. Putting those results into context, the fact that a history of lower scores of sensation seeking impulsivity and higher scores of concurrent lack of perseverance predicted concurrent ED status suggests that complex relationships do exist between different facets of impulsivity and ED status cross-sectionally and longitudinally. In regression analyses, it is also important to consider collinearity effects in the interpretation of associations involving highly correlated variables. Here, sensation seeking at T1 had low correlations with all T1 and T2 behavioral variables (except with sensation seeking at T2 which correlated strongly, r = 0.73), and was negatively correlated with concurrent ED symptoms, whereas all other facets of impulsivity correlated positively with ED. Therefore, the

Table 2
Hierarchical generalized logistic model predicting eating disorder status.

	Final model (M7)	
	Regression coef.	p-value
Predictors		
Age	–	–
Gender (2-level factor)	–	–
Relationship status at T2 (4-level factor)	–	–
CTQ (5 sub-scales)†	–	–
T1 behavioral ‡	–	–
SUPPS-Sensation seeking	z = −2.58	p < 0.01
All other T1 behavioral	–	–
T2 behavioral ‡	–	–
SUPPS-Lack of perseverance	z = 2.33	p < 0.05
All other T2 behavioral	–	–
PD-GIS-A More time less stressed/tired §	–	–
PD-GIS-B Disrupted lifestyle	–	–
PD-GIS-C Increased health concerns	–	–
PD-GIS-E More conflict at home	z = 2.03	p < 0.05
PD-GIS-F Improved environment	–	–
PD-GIS-G More time for people at home	–	–
T2 GAD-7	–	–
T2 PHQ-9	–	–
T1 SCOFF	z = 5.93	p < 0.001

Final hierarchical regression model including 37 predictors at T2 in 489 individuals (final model) with AIC = 396.7 and out-of-sample (cross-validated) averaged metrics of ROC-AUC mean = 0.77, sd = 0.05; and PR-AUC mean = 0.38, sd = 0.07. Full results from intermediate models are presented in the online supplement (supplement S8, Table S4).

Relationship status, L1 = single (never married), L2 = Single (divorced/ widowed), L3 = in relationship/married but living apart, L4 = in relationship and cohabiting.

† **CTQ** – Childhood trauma questionnaire subscales.

‡ **T1/T2 Behavioral** = Internet Addiction Test, short version (**IAT-12**); Cambridge–Chicago Compulsivity Trait Scale (**CHI-T**); **CHIT_arss** = "anxiety reduction and self-soothing" subscale; Short Urgency-Premeditation-Perseverance-Sensation Seeking-Positive Urgency Scale (**SUPPS**); **SUPPS-LP** = SUPPS Lack of perseverance; Exercise Addiction Inventory (**EAI**); Padua Inventory (**PI**).

§ **PD-GIS factors** – Pandemic General Impact Scale.

distinct and negative association between sensation seeking impulsivity and ED was identified separately in regression analyses and on a correlational level. Future work could focus on examining those different facets of impulsivity longitudinally and in reference to different aspects of ED psychopathology. Chamberlain et al. demonstrated that impulsivity and compulsivity have distinct antecedents in young people, in support of the clinical dissection of impulsivity and compulsivity [38] and a recent systematic review was supportive of a trans-diagnostic approach to eating disorders, given the mixed findings of both impulsivity and compulsivity across AN and BN [13]. Here, we did not find significant transdiagnostic compulsivity predictors in the final model, which was adjusted for history of eating disorders. However, "anxiety reduction/self-soothing" compulsivity was statistically significantly associated with ED at T2 in all intermediate steps M3-M6, and moderately on a correlational level (r = 0.29). This may suggest that this transdiagnostic compulsivity subscale has particular relevance for the understanding of ED symptoms. Additionally, it should be considered that impulsive and compulsive tendencies may have differential roles in psychiatric symptoms at different points. Newly developing ED symptoms may have been of relatively short duration. Conceptually, impulsive traits may predispose to onset, whereas compulsivity may be more relevant to chronicity; as such compulsivity may be captured within the remits of chronic ED psychopathology, when assessed longitudinally.

4.2. Conflict at home and its associations with ED mid-pandemic

The importance of family dynamics is pervasively dominant in many aspects of clinical understanding of eating disorders and their treatment.

Family dynamics play a role in resilience towards ED and qualitative exploratory themes suggest that, when available, family support has been beneficial during the COVID-19 pandemic [9]. Prospective studies have linked high family conflict with later onset of EDs [39]. We demonstrated herein that conflict at home was independently associated with ED symptoms concurrently, even after adjusting for baseline demographic and trauma experiences and concurrent and longitudinal parameters of risk. While the relationship between ED and family conflict in general might be complex (e.g. ED at T1 may have contributed to family conflict at T2) and bidirectional (e.g. ED at T2 may have contributed to family conflict at T2 and vice versa), conflict at home might represent an important parameter in the context of the pandemic, sensitive to pandemic-related vulnerability towards an ED outcome. In a simple path analysis including only ED at T1, T2 and PD-GIS-E (TLI > 0.95, RMSEA <0.05), more conflict at home did not seem to mediate or moderate the relationship between ED T1 and ED T2 (total effect coef. = 0.44, p < 0.001, indirect effect coef. = 0.01, p = 0.25), but rather independently associate with ED at T2 (standardized coef. = 0.16, p < 0.001) (Fig. 2). During a time in which lockdown measures, school and university closures and working from home imperatives have drastically altered many family/home structures and dynamics, the identification of such parameter of risk is very relevant for clinicians and stakeholders of eating disorder services. Things to consider are the young people's struggle to achieve separation from the family unit, the challenge of perfectionism while vocational and educational striving have been put on hold and the diminished capacity for flexible adaptation in a lockdown-family-life, characterized by an enforced sedentary lifestyle and limited options around private space and meals structure.

4.3. The use of technology during the pandemic

There is mounting evidence supporting the role of problematic use of internet/technology influencing eating disorder outcomes [20,40], which supports its inclusion as a potential determinant of ED in the mid-pandemic era [18]. In a recent meta-analysis of 32,295 participants with
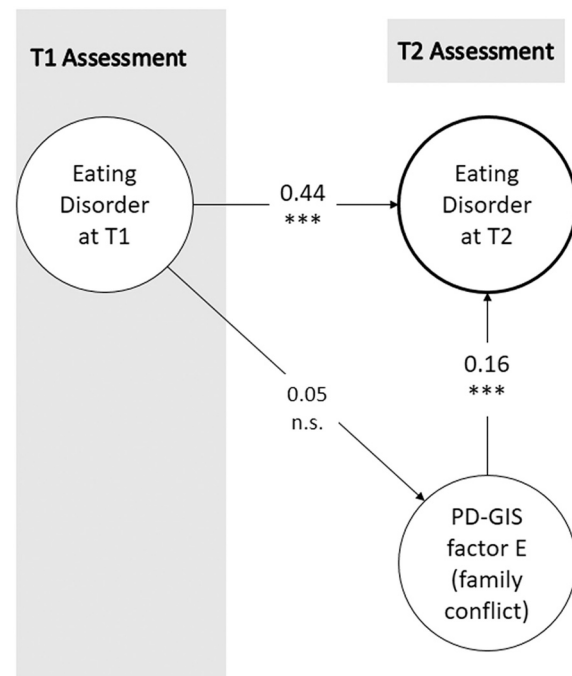
Fig. 2. Path analysis.
Simple path analysis. Regression standardized coefficients displayed on paths. PD-GIS factor E = Pandemic General Impact Scale, factor E, more conflict at home.

eating disorder general psychopathology and PUI, a significant correlation was identified (Pearson $r = 0.22$; s.e. $= 0.04$, $p < 0.001$) [20]. In the current analysis, ED had similar correlations with PUI (Pearson's $r = 0.24$ at T1 and $r = 0.26$ at T2). However, PUI was not a statistically significantly associated (concurrently or longitudinally) when other parameters were considered together. Previous work suggested a partially mediational relationship of PUI in the association between sensation seeking impulsivity and EDs [21]. The results of the current study support the notion that PUI could be contributing to (via a more complex relationship including potentially influencing the effects of behavioral traits), but not definitively critical to (directly affecting), the development of EDs during the pandemic.

4.4. Limitations

While we believe this to be the first longitudinal examination of disordered eating symptoms from pre-pandemic to within the pandemic, there are limitations to consider in this study. Online survey methods offer advantages in terms of scalability and low risk of transmission of infection during pandemics; however, they are likely to be less accurate for measuring psychopathology constructs as compared to face-to-face clinical assessments. There is also the possibility of sampling bias towards more technologically adept NSPN returning participants (though types of bias are of course always present, even in face-to-face studies using representative sampling). However, during the COVID-19 pandemic online-led research is the predominant source of data collection. Furthermore, while the NSPN was designed as a stratified population sample, representative of the general population, our current subsample has been subject to attrition, which is of course expected in any longitudinal study. As presented in our online supplement (supplement S7) our attrition rates were higher in males and relatively younger participants. This may temper the extent to which the findings can be generalized to the population at large. Both AN and BN affect predominately females and males with ED are often understudied. Those contributing to attrition are often younger and have more mental health problems. As such we would expect that our attrition may lead to an underestimation of ED in males in our sample. However, even if this were the case, we were able to identify a substantial number of male participants with putative ED ($n = 21$, 15.2% out of all male participants) suggesting that our non-response bias did not significantly influence our capacity to capture ED outcomes for males at T2. In respect to the instruments used, the SCOFF questionnaire is regarded as an excellent screening tool to ascertain putative AN or BN diagnosis (Luck et al., 2002), however, it does not have 'gold-standard' diagnostic validity (e.g. a clinical or DSM-5 structured interview), nor does it allow for a separate analysis between clinical groups. Another limitation comes from the fact that the PD-GIS factor E consists only of two items, whereas more items are preferable to capture behavioral domains in general. Another limitation in the use of baseline scores from a previous round of data collection in 2017–18 rather than immediately prior to the beginning of the COVID-19 pandemic. While this may introduce measurement error in respect to the immediate effect of the pandemic, it also allows for an examination of the cohort over an adequate period of time to identify meaningful change in the clinical characteristics (e.g. the development of an eating disorder which may be insidious). Furthermore, using historical baseline data in longitudinal COVID-19 research is considered a reasonable approach [41], while gathering data of this magnitude of diversity immediately prior to the pandemic would have been opportunistic. Another limitation comes from the fact that we did not correct for multiple comparisons in the final regression step, which can increase the possibility of Type 1 error. However, in hierarchical regression the statistical tests are not performed simultaneously but rather in sequence, with worse fitting models (even those with statistically significant results) being discarded for a better model. As such, the lack of correction is less critical, due to the model elimination process providing a degree of fine-tuning and removal of random artefacts. A final limitation comes from the use of regression analysis which always contains a degree of collinearity effects. In this dataset, we did not have any bivariate correlations of 0.8 or above that would indicate a major collinearity issue [42] (see Supplemental Fig. S3). However, this does not exclude the possibility of collinear relationships involving more than two variables. Our data included facets of impulsivity and compulsivity which are known to be relatively collinear. Common solutions include dropping collinear variables, which may introduce a different kind of bias in the coefficients, or data transformations (e.g. PCA) to achieve a new orthogonal matrix, at the cost of interpretability [42]. We argue that the facets of behavior examined in this study unavoidably contain a degree of collinearity, both cross-sectionally and longitudinally, and while this may affect estimation accuracy, we considered keeping and reporting all predictors as examined as the most meaningful approach.

5. Conclusion

We have quantitatively examined the impact of the COVID-19 pandemic during the summer of 2020 and ascertained associations of concurrent eating disorder psychopathology, including self-reported pandemic impact and concurrent and longitudinal behavioral traits, while adjusting for baseline demographics, history of trauma and a range of behavioral and clinical characteristics including history of eating disorder symptoms. Experiencing more conflict at home during the pandemic significantly associated with concurrent eating disorder symptoms. Sensation seeking (longitudinally) and lack of perseverance impulsivity (concurrently) influence concurrent eating disorder, as well. The study highlights the importance of impulsivity traits and the immediate environment and family dynamics as important associations of eating disorder symptomatology within the context of the COVID-19 pandemic.

Author contribution

KI, analyzed the data, and led on drafting the manuscript. SRC, PJ, and ETB designed the study protocol and were lead investigators. RH and JB conducted the data collection and initial curation. AW and JB provided support with preprocessing and management of the NSPN baseline data (for the supplement). KI produced Supplemental Figs. S4–6 based on R code written by AW. All authors contributed to the writing of the manuscript and approved the final version for submission.

Funding

Data availability statement

The data that support the findings of this study are available on request from the corresponding author, subject to agreement of the Chief Investigator. The data are not publicly available due to privacy or ethical restrictions.

Declaration of Competing Interest

Dr. Chamberlain's involvement in this research was funded by a

Acknowledgements

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.comppsych.2022.152304.

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