Longitudinal analysis of the UK COVID-19 Psychological Wellbeing Study: Trajectories of anxiety, depression and COVID-19-related stress symptomology

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ABSTRACT

COVID-19 has had a negative impact on the mental health of individuals. The aim of the COVID-19 Psychological Wellbeing Study was to identify trajectories of anxiety, depression and COVID-19-related traumatic stress (CV19TS) symptomology during the first UK national lockdown. We also sought to explore risk and protective factors. The study was a longitudinal, three-wave survey of UK adults conducted online. Analysis used growth mixture modelling and logistic regressions. Data was collected from 1958 adults. A robust 4-class model for anxiety, depression, and CV19TS symptomology distinguished participants in relation to the severity and stability of symptomology. Classes described low and stable and high and stable symptomology, and symptomology that improved or declined across the study period. Several risk and protection factors were identified as predicting membership of classes (e.g., mental health factors, sociodemographic factors and COVID-19 worries). This study reports trajectories describing a differential impact of COVID-19 on the mental health of UK adults. Some adults experienced psychological distress throughout, some were more vulnerable in the early weeks, and for others vulnerability was delayed. These findings emphasise the need for appropriate mental health support interventions to promote improved outcomes in the COVID-19 recovery phase and future pandemics.

1. Introduction

While COVID-19 pervaded the narrative of 2020, the disease is still novel and the short, medium and long term physical, psychological and social consequences remain under investigation. Although it is possible to draw on knowledge from previous epidemics (e.g., SARS, MERS), COVID-19 has emerged to be different in scale and impact, extending beyond those known to have had the disease to include whole populations. So much so that Horesh and Brown (2020) have characterized COVID-19 as a mass trauma event; an assertion supported by empirical research investigating trauma and mental health outcomes during the pandemic in both the UK and internationally (Shevlin et al., 2021; Wang et al., 2021a; 2021b). COVID-19 is a pandemic characterised by the need for change in the most fundamental aspects of human society, our interpersonal behaviors and social connections. Consequently, it is predicted to have major implications for mental health, and early evidence suggests some groups of people will be impacted disproportionately (Armour et al., 2020; Fancourt et al., 2020; Kirby, 2020; O'Connor et al., 2020).

Of importance in the context of mental health are the public health countermeasures that continue to be imposed, requiring significant cognitive and behavioral modifications in the way individuals live their daily lives (e.g., O'Connor et al., 2021; Marroquin et al., 2020). People are asked to increase their vigilance and change behaviors around hygiene, use facial coverings and maintain physical distance, and this is coupled with confinement (i.e., self-isolation and quarantining), home working and furlough, and home schooling. These measures are entirely new to the majority and managing this increases cognitive-behavioral demands and the risk of psychological distress (Marroquin et al., 2020). Findings from previous events suggest anxiety is an important facilitator of positive behavior (e.g., hygiene practices), but too much may reduce compliance with health protection measures (Taylor, 2019).

Further, many of the countermeasures reduce the opportunity for people experiencing distress to access formal (e.g., GP) and informal (e.g., social networks) coping resources (Johnson et al., 2021).

Research is critical to the development and implementation of interventions in the post-pandemic period to ameliorate negative impact and build resilience mechanisms for the future. COVID-19 research priorities include monitoring mental health to understand the nature of problems, and the identification of high-risk groups and risk and protection factors (Holmes et al., 2020; O'Connor et al., 2020). To achieve this, country-specific data is essential for the development of localized understanding and intervention (Rajkumar, 2020). Countries are socio-culturally diverse and each has responded differently to the pandemic (Yan et al., 2020). As the virus travelled the globe, some countries, the UK included, were witness to the effects of the virus itself and the countermeasures. It is not known what affect being an anticipatory audience might have had on the psychological preparedness of individuals, but it is predicted the threat generated by media reporting of the deteriorating situation in countries such as Italy and Spain would have contributed to psychological distress in the UK population (Horesh and Brown, 2020; Schmid and Muldoon 2015).

Studies with a monitoring function have started to be reported. Primarily cross-sectional, they provide consistent cross-country evidence of people experiencing moderate to severe mental health problems (e.g., Fernandez et al., 2020; Wang et al., 2020a); increased rates of clinically significant depression and anxiety (Palgi et al., 2020; Zhu et al., 2020), loneliness (Palgi et al., 2020), fear (Ahorsu et al., 2020) and distress (Fernandez et al., 2020). Conversely, a study in the Netherlands showed no increase in anxiety and depression on previous years (van der Velden et al., 2020). At the start of the UK's first national lockdown rates of psychological distress were significantly increased compared to the previous 6 years (Pierce et al., 2020). Anxiety symptomology was highest at the start of lockdown and showed improvement over time; rates of depression were also high at the start but evidence about change is inconsistent (Fancourt et al., 2020; O'Connor et al., 2020). Shevlin and colleagues (2021) also noted that during the first 3 months of the UK's first UK lockdown, scores on a composite measure of anxiety and depression remained relatively stable while PTSD declined. The authors additionally report trajectories of mental health which included low and stable symptoms, improving symptoms, increasing symptoms, and high and stable symptoms.

Several studies have sought to identify groups at higher risk of psychological distress. For example, female respondents have reported higher rates of distress than males in the early period of the pandemic (Alonzi et al., 2020; Fernandez et al., 2020; González-Sanguino et al., 2020; Pappa et al., 2020; Palgi et al., 2020; Zhu et al., 2020) and this gendered pattern has been replicated in the UK (Fancourt et al., 2020; O'Conner et al., 2020; Shevlin et al., 2021; Smith et al., 2020). Age has also emerged as an important risk factor. Despite considerable variation in the definition of 'older' versus 'younger', there is evidence younger people are at increased risk of psychological distress than older people. In the UK, anxiety and depression symptomology has been reported as highest in younger adults ($<$ 35 years) with a pattern of incremental improvement across age groups with lowest levels in those 60 years and older (Fancourt et al., 2020; O'Conner et al., 2020; Smith et al., 2020). Other identified risk factors for poor mental health include having an existing physical and/or mental health condition (Alonzi et al., 2020; Fernandez et al., 2020; O'Connor et al., 2020; Shevlin et al., 2021; Smith et al., 2020), self-reported loneliness (González-Sanguino et al., 2020; Palgi et al., 2020; Shevlin et al 2021), being employed (Nikčević et al., 2021), and lower socioeconomic grouping (O'Connor et al., 2020; Shevlin et al., 2021; Smith et al., 2020).

Adding to the emerging evidence base about the impact of COVID-19 on mental health is critical, and country-specific data is needed to for the development of contextualized intervention. Therefore, the aims of the COVID-19 Psychological Wellbeing Study (CV19PWS) were to identify trajectories of anxiety, depression and COVID-19-related traumatic stress (CV19TS) symptomology in the twelve-week period following the first national lockdown in the UK. We also sought to explore risk and protective characteristics associated with those mental health trajectories.

2. Methods

Full details of the CV19PWS are available in a methodology overview paper (Armour et al., 2020), what is described here are the details that contextualize the data included in the present analysis.

2.1. Study design

The CV19PWS was a longitudinal, multi-wave online survey hosted on Qualtrics to ensure it was both rapidly and widely available to potential participants. Wave 1 launched on March 23rd 2020, the day the UK Government announced a national lockdown would begin on March 26th and the survey closed on June 25th 2020. Participants were asked to complete wave 2 data collection one month after completion of wave 1, and wave 3 data collection two months after completion of wave 1. The study was approved by the Faculty of Engineering and Physical Sciences Ethical Committee at Queen's University Belfast (EPS 20_96) and Glasgow Caledonian University's Health and Life Sciences Ethics Committee (HLS/PSWAHS/19/157).

2.2. Recruitment and procedure

A convenience sample of participants was recruited via a social media campaign and the online participant panel *Prolific*. Members of the *Prolific* panel have been found to produce high quality data and they tend to be more diverse and naive to survey completion than members of other online participant panels (Peer et al., 2017). To be eligible, potential participants had to be 18 years or older, resident in the UK at the time of completion, and they had to have a level of English that allowed for unaided participation. Participants recruited via *Prolific* were compensated for their time (£1–2) and participant recruited via social media were entered into a prize draw for one of six £150 vouchers.

Potential participants to wave 1 accessed a participant information sheet online via circulated hyperlinks. This was followed with an online consent process. Participants then completed the survey, which was designed to take less than 30 min. A minimum completion time was set at 8 min and 3 s to screen out automated completion.

Wave 1 participants were contacted by email to complete wave 2 one month following completion of wave 1, and then contacted to complete wave 3 a month later. Wave 1 participants who did not complete wave 2 but who did not actively withdraw were contacted to complete wave 3. The consent process was completed at each wave of data collection. At baseline, females, people with higher educational attainment, and people from Northern Ireland and Scotland were over-represented relative to the demographic profile of the UK (see Armour et al. (2020) for more information).

2.3. Measures

The survey was comprised of several standardized measures and newly developed items. In response to the development of the pandemic, additional items were added to the survey in waves 2 and 3. Full details, including the psychometric details, about the items included in the survey are published elsewhere (Armour et al., 2020).

Participants were asked to provide sociodemographic information: country of residence, gender, age, relationship status, living arrangements, education, employment status, and whether or not they, or someone in their family, was a key worker, their current and previous physical and mental health. A series of items were developed to capture COVID-19 specific experience. There were questions about living status (e.g., living as normal, self-isolating), and about participants'

experiences, and the experience of close family and friends, of symptoms, testing, diagnosis, quarantining, and COVID-related death. Items also assessed participants' level of worry about a range of COVID-related aspects of daily life including quarantine/self-isolation, infection concern, stigmatization due to exposure, job security, financial implications, food shortages, the government's and health care systems ability to manage the outbreak, border closures and the impact of school/university closures.

Generalized anxiety symptomology was assessed using the Generalized Anxiety Disorder scale (GAD-7; Spitzer et al. 2006). Participants are asked to reflect on the previous 2 weeks in answering the seven items. Higher total scores reflect higher levels of severity (range 0–21) (Spitzer et al., 2006). A score of 10 or more is likely to meet the diagnostic criteria for an anxiety disorder. The Patient Health Questionnaire (PHQ-9; Kroenke et al., 2001) was used to assess symptoms of major depressive disorder over the previous 2 weeks. Nine items were summed to generate a total score, higher scores indicating higher levels depressive symptomology (range 0–27). A score of 10 or more is likely to meet the diagnostic criteria for major depressive disorder.

Prior trauma exposure was assessed using the Life Events Checklist for DSM-5 (LEC-5; Weathers et al., 2013a). In addition to the 17 items asking about exposure to a PTSD 'Criterion A' traumatic event, 'Coronavirus' was added. Participants were asked if 18 stressful life events had ever happened to them (Yes / No). COVID-19-related traumatic stress (CV19TS) symptomology was assessed with the PTSD Checklist for DSM-5 (PCL-5; Weathers et al., 2013b), which has 20 items organized into four clusters. To ensure assessment was of CV19TS related to people's wide ranging COVID-19 experiences these items were presented after the COVID-19 experience and worry items and participants were asked to think about their COVID-19 experiences when indicating how much each symptom bothered them over the past month (Murphy et al., 2017).

Loneliness was assessed using the UCLA Three-Item Loneliness Scale (Hughes et al., 2004). The items measure the key dimensions of loneliness ('social connectedness', 'relational connectedness' and 'self-perceived connectedness'). Higher scores reflect higher levels of loneliness. Perceived social support was assessed using the Perceived Social Support Questionnaire–Brief Form (Kliem et al., 2015). Higher scores reflect higher levels of perceived social support. Finally, the presence and pursuit of meaning in life was assessed using the Meaning in Life Questionnaire (MLQ; Steger et al., 2006). Higher scores (range 7–35) on the sub-scales represent increased presence of meaning in life and more active seeking of the meaning or purpose in the respondent's life.

2.4. Data analysis

Data were screened and cases removed prior to analysis if the respondent: did not provide data that allowed assessment against the inclusion criteria, or they did not meet these; didn't complete any of the survey items; or, completed the survey in less than the minimum time.

Descriptive statistical analyses were conducted in SPSS v25 and growth mixture modelling (GMM) conducted using Mplus Version 8.0 (Muthén and Muthén, 1998) using a robust maximum likelihood estimation. A three step GMM analyze (Asparouhou and Muthén, 2014) was conducted on each of the three mental health outcomes, using data from baseline, and the two monthly follow-ups. The 3-step model began with the stipulation of an unconditional growth model of one class, followed by estimation of increasing class memberships which were assessed for fit. For all three outcomes models were estimated with one to six classes.

A range of fit indices were employed to determine the optimum class solution for each outcome, including the Akaike Information Criterion (AIC; Akaike, 1998), the Bayesian Information Criterion (BIC; Schwarz, 1978), and the sample-size adjusted BIC (ABIC; Sclove, 1987). Smaller values on each of these indices are indications of better model fit. In addition, the Vuong-Lo-Mendell-Rubin (LMR) statistic (Lo et al., 2001)

and the adjusted Lo-Mendell-Rubin likelihood-ratio test (ALRT) were examined. Both LMR and ALRT compare the estimated model with a model with one less class, and significant p-values indicate the estimated model is a better proposed solution to the model with one less class. Finally, the entropy statistic was examined. Entropy values closer to 1.0 indicate greater delineation of classes in the model (Celeux and Soromenho, 1996).

In this analysis the selection of the optimal solution for each mental health outcome was based on all fit statistics, entropy and consideration of the parsimoniousness of the models, the theoretical justification for the class trajectories and the interpretability of the classes (Bauer and Curran, 2003; Muthén, 2003). Once an optimal class solution was identified, the third step was multinomial regression of class membership on covariates of interest. Covariates entered into the model were demographic characteristics of gender (male as reference category), age, relationship status (married as reference category), whether participant lived in a house or other dwelling (other as reference category), whether the participant lived alone (lived with others as reference category), whether the participant lived in an urban or rural area (urban as reference category), whether the participant was employed as a key worker (non-key worker as reference category). Risk factors for mental ill-health included were the presence of pre-existing mental health condition, presence of pre-existing physical health condition, loneliness at baseline, and baseline score on the mental health measures not included in the growth model class (anxiety and CV19TS in the GMM for depression; depression and CV19TS for the anxiety GMM; and depression and anxiety for the GMM of CV19TS). Protective/resilience factors included were baseline social support, baseline meaning in life scores, both presence of meaning and search for meaning. Levels of worry in relation to COVID-19 were also included to assess the relative contribution of these COVID-19-specific concerns to the overall levels of symptomology reported by the individuals. Multi-collinearity of variables entered into the regression models was examined using correlation analysis prior to estimation of the regression models, and no independent variables excluded on this basis. Logistic regression models resulted in odds ratios for each pairwise comparison of the outcome classes.

2.5. Results

The survey was completed by 1958 individuals (29.5% male) at baseline, 85% ($n = 1660$) went on to complete the follow-up at month 2, and 80% ($n = 1573$) completed at month 3. The demographic profile of the participant sample remained consistent across all follow-up points. However, there was greater attrition among females at wave 2 compared to males (16.3% and 12.3% respectively, $\chi^2(1) = 5.105, p = .024$), and of younger participants at wave 3 (males (25.1% of 18–24 year olds, 22.7% of 24–34 year olds, 19.3% of 35–44 year olds, 13.6% of 45–54 year olds, 13,0% of 55–64 year olds, and 6.9% of 65 years and older, $\chi^2(5) = 26.993, p < .001$). Participant characteristics at baseline are reported in Armour et al. (2020). Using MLR estimation and TYPE=MIXTURE the sample size was 1941, 1945 and 1946 for depression, anxiety and CV19TS growth models respectively. The association among the three mental health outcomes at each time-point and across time-points was assessed using correlation analyses to identify multi-collinearity. This revealed significant correlations (range 0.70 – to 0.82), indicated of between 49% and 67% shared variance in constructs among the three outcomes at baseline, and weaker associations longitudinally (see Table 1). Additionally, assessment of the three mental health outcomes with the COVID-19 related worries, to ensure they were distinct from the mental health symptomology measures, revealed weak significant associations all below a magnitude of 0.5.

2.6. Identification of trajectory classes

In the models estimated for anxiety, depression and CV19TS each increase in class number resulted in a better fitting solution until the

Table 1
Correlation coefficients among anxiety, depression, PTSD at all time points and baseline COVID-19 related worries.

	Anxiety Wave 1	Depression Wave 1	PTSD Wave 1	Anxiety Wave 2	Depression Wave 2	PTSD Wave 2	Anxiety Wave 3	Depression Wave 3	PTSD Wave 3
Anxiety Wave 1									
Depression Wave 1	.820**								
PTSD Wave 1	.807***	.806***							
Anxiety Wave 2	.750***	.697***	.682***						
Depression Wave 2	.655***	.771***	.648***	.817***					
PTSD Wave 2	.663***	.710***	.734***	.786***	.823***				
Anxiety Wave 3	.664***	.648***	.629***	.782***	.702***	.699***			
Depression Wave 3	.583***	.715***	.606***	.700***	.820***	.723***	.820***		
PTSD Wave 3	.597***	.655***	.681***	.690***	.715***	..800***	.797***	.813***	
COVID related worries									
Self-isolation and quarantine	.438***	.394***	.425***	.366***	.318***	.319***	.326***	.300***	.299***
Being infected	.397***	.267***	.356***	.346***	.238***	.266***	.268***	.198***	.215***
Infecting others	.337***	.230***	.304***	.270***	.185***	.232***	.242***	.179***	.210***
Being stigmatised due to infection	.283***	.265***	.321***	.278***	.240***	.281***	.266***	.232***	.285***
Financial implications	.298***	.286***	.298***	.292***	.266***	.247***	.244***	.245***	.223***
Food shortages	.388***	.359***	.404***	.370***	.336***	.336***	.325***	.315***	.333***
Government ability to manage	.334***	.292***	.345***	.293***	.271***	.291***	.259***	.275***	<281***
Health services ability to cope with patients	.341***	.288***	.310***	.303***	.252***	.254***	.265***	.249***	.229***
Impact of school closures on children	.254***	.228^^^	.265***	.239***	.185***	.202***	.196***	.174***	.179***
Impact of University move to online tuition on young adults	.266***	.246***	.293***	.241***	.191***	.227***	.195***	.178***	.221***
Impact of border closures	.253***	.249***	.300***	.247***	.213***	.243***	.220***	.221***	.230***

*** = p < .001

addition of the fifth. AIC, BIC and ABIC values were only slightly decreased in the 5-class solution, and the LMR and ALRT were both non-significant, indicating no improvement in fit over the 4-class model. For depression, the addition of a fifth class saw a decrease in entropy to 0.81 and resulted in a class with a very low proportion of the sample (< 1%) and a trajectory identical to another in all but the final time point. For anxiety, the addition of a fifth class also saw a sizeable decrease in entropy to 0.77. For CV19TS the addition of a fifth class saw a decrease in entropy to 0.83. Therefore, the 4-class solution was judged to be optimal for all three outcomes, with a substantial reduction in AIC, BIC and ABIC, significant LMR and ALRT values, and the highest entropy value of all estimated solutions (depression = 0.82, anxiety = 0.85, PTSD = 0.85).

Fit indices for the class solutions for all three health outcomes are available in Table 2, and class proportions and mean intercept and slope in Table 3. The interpretation of each of the four classes for the three mental health outcomes were similar. The first reflected a 'high and stable' symptomology class, where participants recorded symptomology of the mental health outcome at a clinically significant level consistently across all time points. The second was a 'low and stable' symptomology class where symptomology was consistently low at all time points. The third was an 'increasing symptomology' class where participants reported low symptomology at baseline with delayed onset to clinically significant levels in subsequent time points. The fourth was an 'improving symptomology' class where participants reported high and clinically significant symptomology at baseline that improved to lower, non-clinical levels at subsequent time points (see Fig. 1).

2.7. Prediction of class membership

Logistic regression models were estimated to regress the mental health outcome classes on the covariates of interest, and pairwise comparisons of each class reported (Tables 4–6). The participants in the 'low and stable' class for each mental health outcome were consider to have faired best, thus, this class was used as the reference class.

2.7.1. Depression
Membership of the 'high and stable' class was associated with higher

Table 2
Fit indices of unconditional GMM models for depression, anxiety and CV19TS.

	1	2	3	4	5
Depression					
AIC	30359.809	299.504	29875.844	29697.395	29629.145
BIC	30404.377	30054.785	29953.838	29792.101	29730.564
ABIC	30378.961	30019.837	29909.360	29738.092	29667.023
LMR		372.305***	123.660***	302.264*	84.250**
ALRT		356.604***	118.445***	194.692*	80.687**
Entropy		.81	.80	.82	.81
Anxiety					
AIC	29743.061	29281.887	29154.578	28890.265	28856.260
BIC	29787.666	29345.190	29232.600	28985.007	28967.721
ABIC	29762.249	29310.243	29188.122	28930.997	28904.180
LMR		465.194***	135.309*	270.315***	40.005 (p = .16)
ALRT		445.582***	129.605*	258.916***	38.319 (p = .17)
Entropy		.85	.82	.85	.77
CV19TS					
AIC	40645.628	40119.256	39883.614	39720.470	39624.989
BIC	40690.216	40180.565	39961.643	39815.220	39736.470
ABIC	40664.800	40145.618	39917.165	39761.211	39672.90
LMR		532.371***	241.643***	169.143*	101.481 (p = .27)
ALRT		509.928***	231.456***	162.013*	97.203 (p = .26)
Entropy		.85	.82	.85	.83

Notes: AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion; aBIC = sample-size adjusted BIC; LMR = Vuong-Lo-Mendell-Rubin; ALRT adjusted Lo-Mendell-Rubin likelihood-ratio test (ALRT); * = p < .05, ** = p < 0.01, *** = p < 0.001

baseline loneliness, anxiety and CV19TS scores. Adults who reported a pre-existing mental health condition at baseline were twice as likely to be in the 'high and stable' than the 'low and stable' class. In contrast higher meaning in life scores at baseline were associated with 14% lower odds of being in the 'high and stable' class.

In comparison to 'low and stable', membership of the 'increasing symptomology' class was associated with higher CV19TS at baseline and greater worry at baseline about stigma or rejection because of COVID-19

Table 3
Optimal class solution for three mental health outcomes.

	Depression			Anxiety			CV19TS		
Class	%	Mean I (SE)	Mean S (SE)	%	Mean I (SE)	Mean S (SE)	%	Mean I (SE)	Mean S (SE)
Improving	8	16.34 (0.62)	-4.31 (0.32)	12	15.38 (0.35)	-4.18 (0.20)	10	41.19 (1.55)	-12.77 (0.76)
Increasing	5	7.28 (0.72)	4.54 (0.77)	5	6.83 (0.48)	4.32 (0.34)	5	17.14 (2.38)	12.37 (2.08)
Low stable	75	5.03 (0.17)	-0.04 (0.08)	71	4.36 (0.12)	-0.18 (0.05)	75	12.36 (0.41)	-1.25 (0.19)
High stable	12	18.18 (0.61)	0.01 (0.23)	12	16.55 (0.33)	-0.47 (0.18)	10	50.07 (2.06)	-0.02 (0.80)

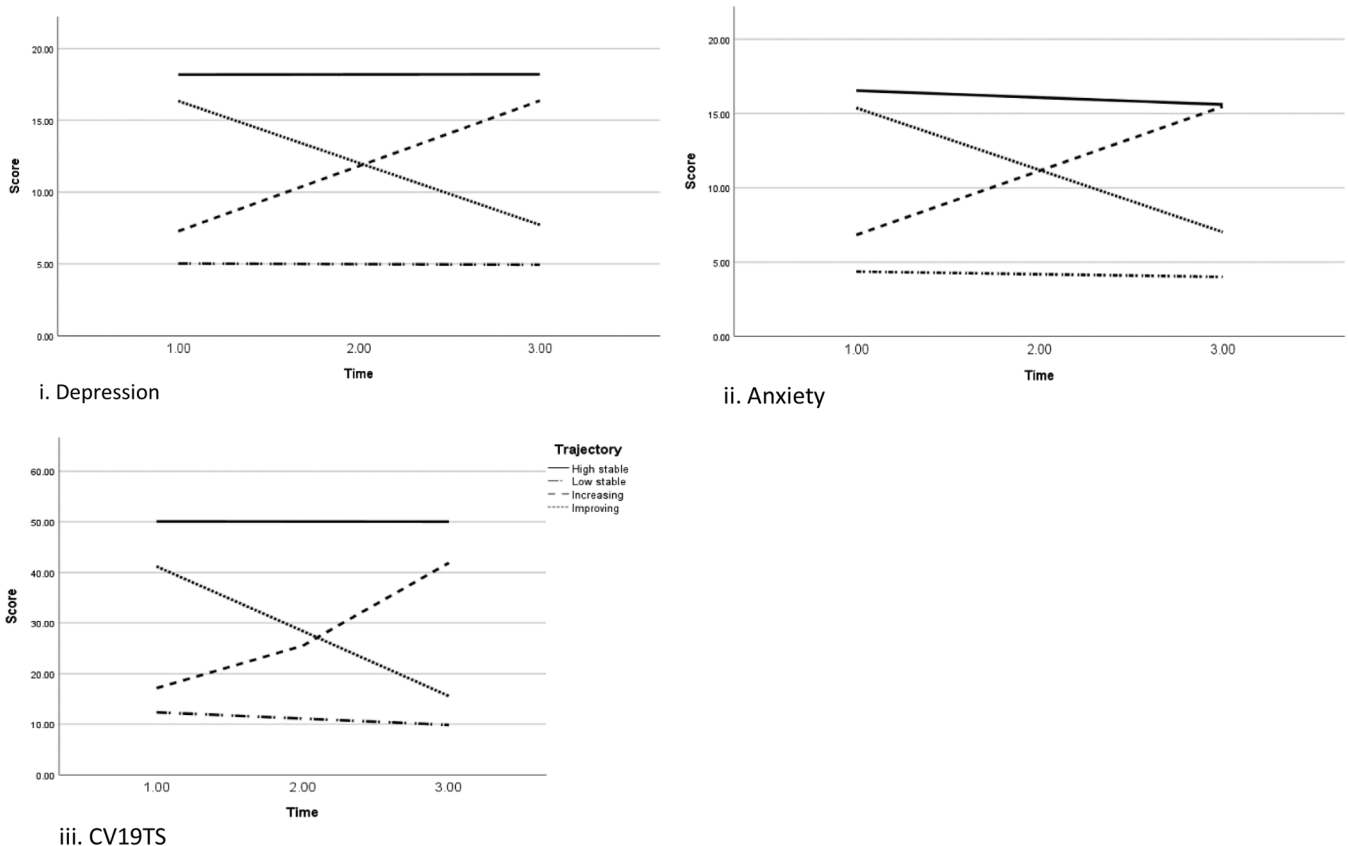i. Depression

ii. Anxiety

iii. CV19TS

Fig. 1. Trajectories for depression, anxiety and CV19TS.

exposure.

Single adults had odds over twice as high of being in the 'improving symptomology' class than the 'low and stable' class, whereas those who were separated/divorced/widowed had 60% lower odds of membership. Living in a household with children at baseline, irrespective of parenthood status, was associated with 2.5 times higher odds of being in the 'improving symptomology' class. Membership of this class was also associated with higher baseline loneliness, anxiety and CVTS scores. Worry about infecting others was associated with lower odds of being in this class.

2.7.2. Anxiety

Membership of the 'high and stable' anxiety class was associated with higher baseline depression and CV19TS scores, and higher levels of baseline worry about having to self-isolate or quarantine, becoming infected with COVID-19, and the ability of health systems to provide care for COVID-19 patients.

Females had 4.6 times higher odds of being in the 'improving symptomology' class than the low and stable class. Higher depression and CV19TS scores at baseline, and higher levels of worry about being infected with COVID-19 also increased the odds of being in the 'improving symptomology' class.

Participants who were older and who were single had lower odds of being in the 'increasing symptomology' class. In contrast, having been separated/divorced/widowed and having higher CV19TS scores and increased worry about stigma or rejection as a result of COVID-19 exposure]) at baseline increased the odds of being in the 'increasing symptomology' class.

2.7.3. CV19TS

Female participants had 64% lower odds of being in the 'high and stable' class than 'low and stable'. Higher baseline scores for loneliness, depression and anxiety, and increased worry about the government's ability to manage COVID-19 were associated with higher odds of being in the 'high and stable' class. Adults with a pre-existing mental health condition had 2.5 times higher odds, and adults with previous experience of trauma had 5.3 times higher odds of being in the 'high and stable' class than the 'low and stable' class.

Similarly, females had 66% lower odds of being in the 'improving symptomology' class. Higher baseline depression and worry about the government's ability to manage the pandemic, and having a pre-existing mental health condition all increased the odds of being in this class for CV19TS.

The odds of being in the CV19TS 'increasing symptomology' class

Table 4
Logistic regression pairwise comparisons of covariates and depression classes, *n* = 1921.

	High stable	Increasing	Improving
Demographics			
Gender (male = reference)			
Female	1.34	1.18	1.05
	(0.47–3.82)	(0.58–2.41)	(0.42–2.65)
Age	0.98	0.98	1.01
	(0.93–1.03)	(0.94–1.02)	(0.98–1.05)
Relationship status (married = reference)			
Single	1.99	0.83	**2.51**
	(0.95–4.17)	(0.42–1.64)	**(1.24–5.09)**
Separated/Divorced/ Widowed	0.51	1.21	**0.40**
	(0.24–1.08)	(0.61–2.40)	**(0.20–0.81)**
Whether live in house or other (other = reference)			
Live in house	1.03	0.52	1.00
	(0.39–2.74)	(0.26–1.05)	(0.37–2.70)
Whether other adults in house (other adults in house = reference)			
Lone adult in house	1.35	1.56	1.00
	(0.45–4.07)	(0.73–3.35)	(0.40–2.50)
Whether children present in the house (no children = reference)			
Children in house	1.52	1.64	**2.47**
	(0.56–4.16)	(0.84–3.23)	**(1.15–5.30)**
Employment status (unemployed = reference)			
Employed	1.03	1.40	1.10
	(0.37–2.86)	(0.59–3.34)	(0.45–2.70)
Whether live in urban or rural area (urban = reference)			
Live in rural area	1.07	1.06	0.75
	(0.40–2.87)	(0.47–2.39)	(0.33–1.69)
Whether a key worker or not (non-keyworker = reference)			
Key worker	1.18	0.94	0.92
	(0.45–3.11)	(0.45–1.95)	(0.42–2.01)
Risk factors			
Loneliness at baseline	**1.67**	1.22	**1.47**
	(1.24–2.70)	(0.99–1.50)	**(1.16–1.87)**
Pre-existing physical health condition (no condition = reference)			
Has a pre-existing physical health condition	2.10	1.54	1.32
	(0.94–4.73)	(0.80–2.98)	(0.61–2.86)
Pre-existing mental health condition (no condition = reference)			
Has a pre-existing mental health condition	**2.47**	1.13	1.15
	(1.09–5.99)	(0.53–2.38)	(0.57–2.29)
Baseline anxiety score	**1.44**	0.94	**1.38**
	(1.27–1.62)	(0.54–1.04)	**(1.24–1.55)**
BaselineCV19TS score	**1.10**	**1.06**	**1.09**
	(1.06–1.14)	**(1.02–1.10)**	**(1.05–1.12)**
Protective factors			
Social support at baseline	0.95	1.05	1.01
	(0.88–1.02)	(0.99–1.12)	(0.94–1.08)
Meaning of life – presence	**0.86**	0.92	0.92
	(0.78–0.95)	(0.85–1.00)	(0.84–1.00)
Meaning of life – pursuit	0.96	1.00	0.97
	(0.89–1.05)	(0.94–1.06)	(0.92–1.02)
Covid Related worries			
Self-isolation and quarantine	1.17	1.07	1.18
	(0.81–1.69)	(0.75–1.54)	(0.84–1.66)
Being infected	0.72	1.02	0.92
	(0.48–1.09)	(0.74–1.42)	(0.64–1.36)
Infecting others	0.68	0.80	**0.60**
	(0.40–1.14)	(0.55–1.15)	**(0.35–0.93)**
Being stigmatised due to infection	1.11	**1.44**	1.22
	(0.78–1.59)	**(1.08–1.93)**	(0.87–1.72)
Financial implications	1.11	1.14	1.12
	(0.78–1.57)	(0.86–1.51)	(0.84–1.48)
Food shortages	1.16	0.91	0.85
	(0.76–1.78)	(0.64–1.30)	(0.61–1.78)
Government ability to manage	1.26	1.22	1.06
	(0.81–1.98)	(0.85–1.77)	(0.70–1.59)
Health services ability to cope with patients	1.04	0.99	1.17
	(0.60–1.81)	(0.64–1.53)	(0.70–1.98)
Impact of school closures on children	1.08	1.02	1.03
	(0.71–1.64)	(0.73—1.45)	(0.70–1.50)
Impact of University move to online tuition on young adults	0.83	0.91	1.03
	(0.55–1.25)	(0.66–1.26)	(0.71–1.49)
Impact of border closures	1.04	1.03	0.94
	(0.75–1.46)	(0.78–1.37)	(0.70–1.28)

Table 5
Logistic regression pairwise comparisons of covariates and anxiety classes, *n* = 1921.

	High stable	Increasing	Improving
Demographics			
Gender (male = reference)			
Female	2.25	1.58	**4.55**
	(0.83–6.13)	(0.75–3.31)	**(2.07–9.99)**
Age	0.95	**0.95**	0.98
	(0.91–1.00)	**(0.92–0.98)**	(0.95–1.01)
Relationship status (married = reference)			
Single	0.50	**0.51**	0.71
	(0.23–1.10)	**(0.30–0.87)**	(0.40–1.28)
Separated/Divorced/ Widowed	2.04	**1.98**	1.41
	(0.92–4.53)	**(1.15–3.40)**	(0.78–2.53)
Whether live in house or other (other = reference)			
Live in house	0.95	0.68	0.89
	(0.64–2.59)	(0.34–1.35)	(0.46–1.74)
Whether other adults in house (other adults in house = reference)			
Lone adult in house	1.23	1.06	0.61
	(0.46–2.59)	(0.47–2.42)	(0.25–1.31)
Whether children present in the house (no children = reference)			
Children in house	1.23	1.16	1.38
	(0.41–3.68)	(0.59–2.28)	(0.77–2.49)
Employment status (unemployed = reference)			
Employed	1.38	0.77	1.38
	(0.49–3.86)	(0.35–1.68)	(0.68–2.81)
Whether live in urban or rural area (urban = reference)			
Live in rural area	1.41	0.85	1.01
	(0.60–3.28)	(0.40–1.77)	(0.56–1.83)
Key worker status (non-keyworker = reference)			
Key worker	1.03	0.87	0.96
	(0.37–2.85)	(0.42–1.81)	(0.54–1.72)
Risk factors			
Loneliness at baseline	1.00	1.11	1.01
	(0.77–1.29)	(0.89–1.39)	(0.85–1.20)
Pre-existing physical health condition (no condition = reference)			
Has a pre-existing physical health condition	1.24	1.22	1.06
	(0.57–2.68)	(0.63–2.36)	(0.59–1.91)
Pre-existing mental health condition (no condition = reference)			
Has a pre-existing mental health condition	2.08	1.63	1.36
	(0.83–5.20)	(0.90–2.98)	(0.77–2.40)
Baseline depression score	**1.56**	1.08	**1.32**
	(1.32–1.85)	(0.99–1.19)	**(1.23–1.42)**
Baseline CV19TS score	**1.11**	**1.06**	**1.09**
	(1.07–1.15)	**(1.02–1.09)**	**(0.06–1.12)**
Protective factors			
Social support at baseline	0.98	1.02	1.03
	(0.91–1.06)	(0.96–1.08)	(0.98–1.09)
Meaning of life – presence	1.02	1.02	1.06
	(0.92–1.13)	(0.95–1.10)	(0.99–1.15)
Meaning of life – pursuit	1.03	1.04	1.02
	(0.95–1.12)	(0.97–1.11)	(0.97–1.08)
Covid Related worries			
Self-isolation and quarantine	**1.92**	0.91	1.32
	(1.25–2.95)	(0.63–1.30)	(1.00–1.74)
Being infected	**1.85**	0.85	**1.50**
	(1.05–3.26)	(0.62–1.16)	**(1.10–2.05)**
Infecting others	1.12	1.09	1.14
	(0.75–1.68)	(0.80–1.49)	(0.84–1.54)
Being stigmatised due to infection	1.34	**1.36**	1.01
	(0.94–1.91)	**(1.01–1.84)**	(0.79–1.28)
Financial implications	1.24	0.95	1.06
	(0.82–1.89)	(0.73–1.23)	(0.84–1.35)
Food shortages	1.06	0.88	0.98
	(0.72–1.57)	(0.61–1.27)	(0.74–1.29)
Government ability to manage	1.19	0.99	0.96
	(0.75–1.90)	(0.73–1.36)	(0.70–1.31)
Health services ability to cope with patients	**1.81**	1.10	1.02
	(1.06–3.10)	(0.78–1.56)	(0.72–1.45)
Impact of school closures on children	0.75	1.07	0.83
	(0.43–1.30)	(0.75–1.52)	(0.60–1.16)
Impact of University move to online tuition on young adults	0.93	0.98	1.22
	(0.58–1.47)	(0.72–1.34)	(0.92–1.64)
Impact of border closures	0.73	0.98	0.95
	(0.49–1.08)	(0.73–1.30)	(0.76–1.19)

Table 6

Logistic regression pairwise comparisons of covariates and CV19TS classes, $n = 1921$.

	High stable	Increasing	Improving
Demographics			
Gender (male = reference)			
Female	**0.36**	1.12	**0.34**
	(0.14–0.96)	(0.52–2.45)	**(0.17–0.70)**
Age	1.00	0.97	0.99
	(0.96–1.04)	(0.94–1.00)	(0.96–1.02)
Relationship status (married = reference)			
Single	1.26	0.78	1.28
	(0.53–2.98)	(0.41–1.51)	(0.69–2.40)
Separated/Divorced/ Widowed	0.80	1.28	0.77
	(0.33–1.90)	(0.66–2.46)	(0.41–1.45)
Whether live in house or other (other = reference)			
Live in house	1.19	0.82	1.10
	(0.45–3.13)	(0.41–1.63)	(0.51–2.36)
Whether other adults in house (other adults in house = reference)			
Lone adult in house	1.35	1.22	0.69
	(0.44–4.16)	(0.47–3.11)	(0.31–1.57)
Whether children present in the house (no children = reference)			
Children in house	0.62	1.09	1.13
	(0.25–1.51)	(0.52–2.29)	(0.57–2.24)
Employment status (unemployed = reference)			
Employed	0.66	0.71	0.66
	(0.24–1.81)	(0.33–1.52)	(0.32–1.36)
Whether live in urban or rural area (urban = reference)			
Live in rural area	0.44	0.82	0.77
	(0.16–1.20)	(0.39–1.72)	(0.38–1.58)
Key worker status (non-keyworker = reference)			
Key worker	1.37	1.69	1.77
	(0.62–3.05)	(0.82–3.45)	(0.93–3.35)
Risk factors			
Loneliness at baseline	**1.30**	1.23	1.13
	(1.04–1.63)	(0.98–1.56)	(0.94–1.36)
Pre-existing physical health condition (no condition = reference)			
Has a pre-existing physical health condition	2.05	0.79	1.01
	(0.96–4.38)	(0.38–1.64)	(0.55–1.86)
Pre-existing mental health condition (no condition = reference)			
Has a pre-existing mental health condition	**2.50**	1.40	1.09
	(1.05–5.95)	(0.70–2.80)	(0.61–1.94)
Baseline depression score	**1.38**	1.10	**1.24**
	(1.25–1.52)	(1.00–1.19)	**(1.14–1.35)**
Baseline Anxiety score	**1.34**	1.07	**1.31**
	(1.19–1.49)	(0.99–1.16)	**(1.20–1.42)**
Previous trauma experience	**5.28**	0.90	1.05
	(1.01–17.74)	(0.48–1.78)	(0.53–2.13)
Protective factors			
Social support at baseline	1.07	1.01	1.04
	(1.00–1.15)	(0.95–1.07)	(0.97–1.11)
Meaning of life – presence	0.99	1.02	1.02
	(0.90–1.07)	(0.94–1.10)	(0.95–1.09)
Meaning of life – pursuit	1.00	1.01	1.01
	(0.95–1.06)	(0.95–1.07)	(0.96–1.05)
Covid Related worries			
Self-isolation and quarantine	1.03	0.80	0.92
	(0.72–1.48)	(0.54–1.17)	(0.68–1.24)
Being infected	1.23	0.90	1.29
	(0.80–1.88)	(0.63–1.30)	(0.89–1.86)
Infecting others	1.28	1.16	1.15
	(0.77–2.12)	(0.80–1.69)	(0.80–1.67)
Being stigmatised due to infection	1.23	**1.48**	0.95
	(0.88–1.72)	**(1.12–2.00)**	(0.71–1.28)
Financial implications	1.10	1.11	1.15
	(0.76–1.59)	(0.85–1.46)	(0.89–1.49)
Food shortages	1.58	0.98	0.92
	(0.70–1.59)	(0.70–1.39)	(0.67–1.28)
Government ability to manage	**1.58**	1.25	**1.48**
	(1.03–2.42)	(0.87–1.81)	**(1.04–2.09)**
Health services ability to cope with patients	0.73	0.69	0.80
	(0.42–1.28)	(0.48–1.00)	(0.50–1.29)
Impact of school closures on children	1.01	1.12	1.18
	(0.72–1.43)	(0.81–1.55)	(0.87–1.62)
	1.08	1.04	1.03
	(0.76–1.53)	(0.80–1.37)	(0.76–1.39)

Table 6 (*continued*)

	High stable	Increasing	Improving
Impact of University move to online tuition on young adults			
Impact of border closures	1.18	0.93	1.20
	(0.86–1.61)	(0.74–1.21)	(0.91–1.59)

was only associated with baseline worry about stigma or rejection as a result of COVID-19 exposure.

3. Discussion

The first aim of this study was to investigate the longitudinal trajectory of anxiety, depression and CV19TS symptomology across the first 12 weeks of the UK's first national COVID-19 lockdown. The analysis identified a robust 4-class model for all three outcomes, and the four trajectories uniquely distinguished participants in relation to the severity and stability of symptomology. These findings provide more depth of understanding about the range of experiences of individuals than studies that have reported a single trajectory for full samples, which tend to be initially high but ameliorate across time (e.g., Fancourt et al., 2020; O'Connor et al., 2020). They also support the emerging picture, noted above, of COVID-19 having a differential impact on the mental health of populations (e.g., Shevlin et al. 2021).

Two thirds of the sample ('low and stable' class) self-reported mental health symptomology suggestive of considerable resilience to the unprecedented demands of lockdown. However, at any point in time, around one fifth of the sample had clinically significant anxiety and depression symptoms and one sixth had elevated CV19TS symptoms suggestive of difficulties adjusting to the pandemic in the context of their own life circumstances. These rates are considerably higher than reported in UK samples pre-pandemic (Arias de al Torre et al., 2021; Löwe et al., 2008), but they are similar to other UK COVID-19 studies (e.g., Fancourt et al., 2020; O'Connor et al., 2020) and they reinforce the need for additional mental health support for the adult population in the recovery phase and beyond.

Adults in the 'high and stable' trajectory for depression, anxiety, and PTSD (approximately one tenth of the sample) reported clinically significant symptomology across the 12 weeks. Without a pre-pandemic data we cannot establish the chronicity of these symptoms; however, it is likely they reflect, at least in part, an ongoing response to the threat generated by the emerging global impact of COVID-19 and the countermeasures imposed during the UK lockdown (Horesh and Brown, 2020). Importantly, a not insubstantial portion of this sample were in need of mental health support during lockdown, when the majority of services were inaccessible prior to the pivot to virtual provision (Johnson et al., 2021).

While the 'high and stable' trajectory describes individuals who may have been living with existing mental health problems during COVID-19, the other trajectories demonstrate that some adults experienced change in their mental health as a direct response to the pandemic. Those with increasing symptomology (approximately 5% on each outcome) displayed an ability to cope with the pandemic in the early weeks, but their resilience declined and their symptomology reached clinically significant cut offs 4 weeks in. This contrast to adults (approximately one tenth of the sample on each outcome) who reported clinically significant distress responses in the early weeks that improved as the pandemic progressed. These individuals may have experienced a stress response in the early weeks but developed ways of coping with the new circumstances, or they may feel they benefited from some of the countermeasures; for example, reduced commuting, furlough reducing work-related stress. Indeed, there is evidence elsewhere of adults reporting high levels of optimism for the future during the early phase of the pandemic (Fisher et al., 2020).

In line with aim two, several factors were identified that increased the risk of, or protected against, participants being in one of the three classes with elevated and clinically significant psychological distress at some point during the study. These included mental health and socio-demographic factors and COVID-19 worries.

Mirroring previous research (Fancourt et al., 2020; O'Connor et al., 2020), mental health status at the start of the UK lockdown was a key distinguishing factor in the trajectory of psychological distress. Across all three outcomes, elevated anxiety and depression scores and/or a pre-existing mental health condition were identified as risk factors for clinically significant symptomology in the first 4 weeks. However, they were not identified as risk factors for symptomology that emerged during the study. This is an important finding because it highlights a group of individuals who did not have baseline sensitization to anxiety and depression symptomology but who were adversely affected during the pandemic. High levels of CV19TS at baseline were identified as a risk factor for the development or maintenance of psychological distress at any point over the 12 weeks. The fact that prior trauma exposure was not a predictor of depression and anxiety but baseline CV19TS symptoms were is important evidence that the anticipatory audience and lockdown phases of the pandemic presented as traumatic events for some participants and resulted in peritraumatic stress symptomology (Horesh and Brown, 2020; Lahav, 2020).

Having meaning in life is constructed as a mental health protective factor, and while it was associated with increased likelihood that participants would not report elevated depression scores during the study (i. e., be in the 'low and stable' group) it was not protective in the context of anxiety or CV19TS. Loneliness at baseline increased the risk of experiencing clinically significant depression symptomology in the first 4 weeks of lockdown, but not symptomology that developed over the course of lockdown. For some participants, the 'high and stable' group, this persisted but others showed improvement (i.e., 'improving symptomology' class).

Previous studies have reported a range of sociodemographic factors predictive of psychological distress during COVID-19, with gender and age being particularly important. Our findings provide more depth to this and the finding in relation to gender contrasts with previous research. In this study gender wasn't a risk factor for depression, and while females were more likely to have clinically significant anxiety scores at the start of lockdown they showed improvement over time. Moreover, being female was protective in relation to CV19TS, with females more likely to report 'low and stable' CV19TS symptomology. This finding is at odds with the literature in that being female is an established risk factor for traumatic stress (Olff, 2017). It may be that this reflects a gendered response to the evidence that males experience worse COVID-19 morbidity and higher mortality than females. Future research will be needed to determine if this pattern of self-report is sustained or if females report increasing CV19TS symptomology in the longer term; delayed response in females has been reported in other contexts (Lassemo et al., 2017). However, it is in this study females were overrepresented and males underrepresented (see Armour et al., 2020) and the pattern identified here may be a methodological artefact.

No other sociodemographic variables discriminated between participants who faired best and those who experienced clinically significant psychological distress over the 12 weeks. However, age, relationship status and the living in a house with children were all predictive of change in mental health status during COVID-19. Being single was protective in the context of depression and anxiety. Single adults were more likely to show a pattern of improving depression symptomology and less likely to report worsening anxiety than their married counterparts. Adults who were divorced, separated or widowed were more likely to have 'low and stable' depression symptomology than married adults, but they were at increased risk of worsening anxiety. Adults living in a house with children were more likely to report high levels of depression at the start of lockdown, with improvement over time.

Several worries discriminated between participants who did and did not experience psychological distress during lockdown, and the majority of these increased the risk of distress and reflected worries about extrinsic factors. Worries associated with distress early in lockdown (i.e., 'high and stable' and 'improving symptomology') were focused on health-related concerns being promoted to the public at the time – becoming infected, having to quarantine/self-isolate and the ability of the NHS to cope – and they were predictive only of anxiety symptomology. Worry about being stigmatized/rejected by others because of exposure to COVID-19 was predictive of psychological distress that developed during lockdown. Perhaps because promotion of counter-measures placed emphasis on individual behavior, so there was concern that in contracting COVID-19 others may perceive the individual as having contravened these measures. In contrast, worries about infecting other people, an intrinsic concern, was associated with decreased odds of presenting with depression symptomology. This suggests psychological distress may be associated with increased worry about things that individuals have little control over whereas the absence of distress does not diminish worries but it is associated with a change focus of worry to things that the individual can control.

3.1. Limitations

A critical strength of this study lies in its rapid response, providing evidence about the impact of the pandemic from the start of the UK's first national lockdown. It adds to the global evidence base about the mental health implications of the pandemic and it provides a contextualised picture of UK adult metal health that can be mapped against critical events in the UK's response; however, a number of limitations must be noted. The sample was neither random nor representative of the UK population (see Armour et al. 2020), meaning the data cannot be used to extrapolate the prevalence of psychological distress during the pandemic to the larger population. However, viewed alongside other UK studies (e.g., O'Connor et al., 2021, Shevlin et al., 2021), it serves a monitoring function and adds to the body of evidence of the mental health impacts of the COVID-19 pandemic, and the factors associated with different mental health outcomes in the UK. The study was conducted entirely online and this may impact the type of respondent, potentially excluding those with limited digital engagement. The data was self-report which means that it is meaningful for the recording of symptomology but it cannot serve a diagnostic function.

In conclusion, this study adds to the growing evidence showing that the COVID-19 pandemic has had a substantial impact on the mental health of adults in the UK (e.g., Fancourt et al., 2020; O'Connor et al., 2020; O'Connor et al., 2021; Pierce et al., 2020; Shevlin et al., 2021). This is among the first studies to report trajectories describing differential impact across the UK population in 12 weeks of the first lockdown, demonstrating that some adults experienced psychological distress throughout, some were more vulnerable in the early weeks, and for others vulnerability was delayed. Of note in this study, and in contrast to others, anxiety and depression were investigated separately, and in addition to traumatic stress, in an attempt to fully investigate mental health symptomology during the pandemic. The pattern of trajectories described here supports that of existing international research (Daly and Robinson, 2021; Fancourt et al., 2020; O'Connor et al., 2021; Riehm et al., 2021; Shevlin et al., 2021; Wang et al., 2020b), suggesting that for most people mental health symptomology may be relative stable, and any increases temporary, but for a smaller proportion of individuals mental health symptoms are consistently high or increased during the pandemic.

Moreover, a range of risk and protection factors were identified. Each of the groups identified could have benefited from appropriate intervention to support improved outcomes. Even in a recovery phase it is expected that the formulation of a 'new normal' will continue to require adjustment in the behavior of individuals and communities with consequences for mental health, it is critical that the data generated in this

study informs planning for the journey out of COVID-19 and future pandemic responses.

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Data availability

Data cannot be shared publicly because of privacy and ethical restrictions. Data are available from the corresponding author and/or the PI (Armour: c.armour@qub.ac.uk) for researchers who meet the criteria for access to confidential data, in conjunction with an appropriate data sharing agreement.

Declarations of Competing Interest

None.

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