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Intolerance of uncertainty as a predictor of anxiety severity and trajectory during the COVID-19 pandemic☆☆,☆

Rosanna Breaux [a,1], Kristin Naragon-Gainey [b,1], Benjamin A. Katz [c,2], Lisa R. Starr [d,2], Jeremy G. Stewart [e,2], Bethany A. Teachman [f,2], Katie L. Burkhouse [g,3], M. Kathleen Caulfield [h,3], Christine B. Cha [i,3], Samuel E. Cooper [j,3], Edwin Dalmaijer [k,3], Katie Kriegshauser [l,3], Susan Kusmierski [h,3], Cecile D. Ladouceur [m,3], Gordon J.G. Asmundson [n,4], Darlene M. Davis Goodwine [o,4], Eiko I. Fried [p,4], Ilana Gratch [q,4], Philip C. Kendall [r,4], Shmuel Lissek [s,4], Adrienne Manbeck [s,4], Tyler C. McFayden [t,4], Rebecca B. Price [u,4], Kathryn Roecklein [h,4], Aidan G.C. Wright [v,4], Iftah Yovel [w,4], Lauren S. Hallion [h,*,5]

[a] Department of Psychology, Virginia Tech, USA
[b] School of Psychological Science, University of Western Australia, Australia
[c] Department of Psychology, Stony Brook University, USA
[d] Department of Psychology, University of Rochester, USA
[e] Department of Psychology, Queen's University, UK
[f] Department of Psychology, University of Virginia, USA
[g] Department of Psychology, Penn State University, USA
[h] Department of Psychology, University of Pittsburgh, USA
[i] Department of Counseling and Clinical Psychology, Columbia University, USA
[j] Department of Psychiatry and Behavioral Sciences, University of Texas, Austin, USA
[k] School of Psychological Science, University of Bristol, UK
[l] Department of Psychology, University of Missouri, Kansas City, USA
[m] Department of Psychiatry, University of Pittsburgh, USA
[n] Department of Psychology, University of Regina, Canada
[o] Aidan Behavioral Health and Consulting, USA
[p] Department of Clinical Psychology, Leiden University, USA
[q] Department of Counseling and Clinical Psychology, Columbia University, USA
[r] Department of Psychology and Neuroscience, Temple University, USA
[s] Department of Psychology, University of Minnesota, Twin Cities, USA
[t] Carolina Institute for Developmental Disabilities, University of North Carolina at Chapel Hill, USA
[u] Departments of Psychiatry and Psychology, University of Pittsburgh, USA
[v] Department of Psychology, University of Michigan,USA
[w] Department of Psychology, Hebrew University of Jerusalem, Israel

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ABSTRACT

Background: Efforts to identify risk and resilience factors for anxiety severity and course during the COVID-19 pandemic have focused primarily on demographic rather than psychological variables. Intolerance of uncertainty (IU), a transdiagnostic risk factor for anxiety, may be a particularly relevant vulnerability factor.

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* Correspondence to: Department of Psychology, 210 South Bouquet, St, Pittsburgh, PA 15260, USA.
E-mail address: hallion@pitt.edu (L.S. Hallion).

[1] Denotes shared first authorship.
[2] Denotes level 1 author.
[3] Denotes level 2 author.
[4] Denotes level 3 author.
[5] Denotes senior (corresponding) author.

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COVID-19
Latent growth model

Method: $N = 641$ adults with pre-pandemic anxiety data reported their anxiety, IU, and other pandemic and mental health-related variables at least once and up to four times during the COVID-19 pandemic, with assessments beginning in May 2020 through March 2021.
Results: In preregistered analyses using latent growth models, higher IU at the first pandemic timepoint predicted more severe anxiety, but also a sharper decline in anxiety, across timepoints. This finding was robust to the addition of pre-pandemic anxiety and demographic predictors as covariates (in the full sample) as well as pre-pandemic depression severity (in participants for whom pre-pandemic depression data were available). Younger age, lower self/parent education, and self-reported history of COVID-19 illness at the first pandemic timepoint predicted more severe anxiety across timepoints with strong model fit, but did not predict anxiety trajectory.
Conclusions: IU prospectively predicted more severe anxiety but a sharper decrease in anxiety over time during the pandemic, including after adjustment for covariates. IU therefore appears to have unique and specific predictive utility with respect to anxiety in the context of the COVID-19 pandemic.

At the outset of the COVID-19 pandemic, concerns were raised regarding its potential adverse impacts on mental health. Early cross-sectional research confirmed many of these concerns, with a vast expanse of studies suggesting high rates of anxiety and depression worldwide (Deng et al., 2021; Santomauro et al., 2021; Shevlin et al., 2020). By contrast, studies that include pre-pandemic anxiety data are comparatively rare (Blendermann et al., 2023). Although the findings from several such longitudinal studies align with early predictions and cross-sectional research — namely, finding that anxiety-related symptoms tended to increase following the onset of the pandemic (Pan et al., 2021; Ramiz et al., 2021) — other studies fail to find within-person increases in anxiety (Krygsman et al., 2023; van den Besselaar et al., 2021), whereas others report a decrease (Brunoni et al., 2023). Perhaps the most consistent finding to emerge from these studies is variability, suggesting that anxiety severity and trajectory may vary as a function of demographic and psychological factors (Blendermann et al., 2023; Krygsman et al., 2023). Appropriately, calls have been raised to better characterize and predict initial severity as well as trajectory of responding (Aknin et al., 2022; Krygsman et al., 2023). Beyond the direct public health implications, identifying predictors of mental health impairments and resilience in the context of naturalistic stressors can inform theoretical frameworks in a manner that is difficult to achieve in the lab.

Demographic features have received empirical attention as potential predictors of well-being throughout the pandemic, with differential outcomes observed as a function of age (worse for younger people) and gender (worse outcomes for women; Blendermann et al., 2023), race/-ethnicity (worse for Black, Hispanic, and Asian participants; Thomeer et al., 2023), and socioeconomic status (Gambin et al., 2023). Although the identification of stable demographic predictors is informative from a public health perspective, potentially malleable psychological factors are of even greater theoretical and clinical relevance (Fancourt et al., 2021; Poh et al., 2021; Van der Velden et al., 2021). Intolerance of uncertainty (IU) is one psychological factor with pronounced theoretical and public health relevance in the pandemic context. IU is centrally characterized by a fear of the unknown and the tendency to consider even low-probability negative events as unacceptable or threatening (Carleton et al., 2007), particularly where ambiguous or absent information is salient or important to the individual (Birrell et al., 2011). In contemporary theoretical frameworks, individuals high in IU are proposed to devote a high degree of cognitive and emotional resources to seeking certainty. When certainty cannot be achieved, such individuals often experience intense distress and an inability to proceed (Birrell et al., 2011; Carleton et al., 2012; Dugas et al., 1998). Although IU is generally viewed as a trait-like phenomenon, it can be reduced through treatment (Kendall et al., 2020; McEvoy & Erceg-Hurn, 2016), highlighting its public health relevance as a potentially modifiable psychological risk factor.

The COVID-19 pandemic presents a potent context in which to test predictions about the role of IU in anxiety. The first several months of the pandemic were characterized by widespread uncertainty across a wide range of domains, including uncertainty regarding severity of the illness, availability and effectiveness of vaccines and other mitigation procedures, access to childcare and social connection, employment, finances, and more. Even as more information became available, much uncertainty remained, including questions about the effectiveness of mitigation procedures, long-term effects of the illness, and downstream social and occupational consequences. Consequently, higher IU should, in theory, predict an increase in anxious responding associated with the onset of the pandemic, and might also be expected to impact the course of anxious responding over the course of the pandemic. Individuals more tolerant of uncertainty may have experienced a reduction in anxiety sooner in the trajectory of the pandemic as information about risk and mitigation became available, whereas those who require a high level of certainty to feel assured may have continued to be preoccupied by the remaining unknowns.

Although a sizeable body of work has investigated the extent to which IU relates to anxiety during the pandemic, most of these studies focus on health anxiety or pandemic anxiety specifically. These studies tend to find that IU accounts for significant variance in health or pandemic anxiety. For example, a cross-sectional study of 550 crowdsourced adults in the United States found that IU incrementally predicted health anxiety beyond variance explained by demographic factors (Millroth & Frey, 2021). Another cross-sectional study using a similar sample ($N = 738$) found that IU incrementally predicted fear of COVID-19 beyond variance explained by general health anxiety.

Longitudinal studies of IU as a predictor of change in health anxiety, which typically include a first timepoint shortly after the onset of the pandemic, tend to find that higher IU early in the pandemic predicts higher health-related anxiety later in the pandemic. One such study ($N = 364$ crowdsourced adults in the United States) found that IU early in the pandemic prospectively predicted greater health anxiety one month later (Tull et al., 2020). A more recent study in 301 crowdsourced adults found that higher IU early in the pandemic predicted increased health anxiety six months later (Bredemeier et al., 2023). Another study of 2000 crowdsourced adults (Mertens et al., 2023) found that higher IU early in the pandemic predicted higher mean fear of COVID-19 across the pandemic. That study also found an interaction with time, such that increases in IU predicted increases in fear of COVID-19 over time. Finally, a study of 3062 Canadian and American adults did not find a hypothesized moderating effect of IU on the relationship between anxiety sensitivity and pandemic-related stress; however, that study did not examine potential main effects of IU (Paluszek et al., 2021). We are aware of only one existing study that included both a measure of IU and a pre-pandemic time point (Adamis et al.,in press), in which 310 adults who self-reported their IU in 2016 completed measures of COVID stress

syndrome and fear of coronavirus every two weeks for 30 weeks beginning May 2020. In that study, pre-pandemic IU predicted more severe pandemic-related anxiety; however, it did not interact with time to predict anxiety trajectory. Similar to other work, that study also did not include a pre-pandemic assessment.

The extant literature therefore suggests a relationship between IU early in the pandemic and subsequent health anxiety. However, because these studies did not include a pre-pandemic timepoint, it is difficult to disentangle preexisting individual differences from responses to the pandemic context. Moreover, all of the studies reviewed assessed health anxiety or even fear of COVID-19 specifically, leaving unanswered theoretically and clinically meaningful questions about the effects of IU on anxiety per se. This gap is important to address given the highly salient nature of health-related issues during the pandemic, which could plausibly lead to different mechanisms and trajectories of responding for health anxiety specifically compared to anxiety more generally. One of the few studies to examine the relationship between IU and general anxiety symptoms ($N = 2087$ adults from the UK, USA, and Australia; Andrews et al., 2023) found that high and moderate IU predicted a decrease in anxiety severity over the pandemic, while anxiety remained stable for those with low IU. Comparable studies from other countries suggest a broadly similar patterns of results globally (e.g., IU predicted anxiety in adults and older adults in Slovakia; Bavolar et al., 2023). However, these studies too are limited by the absence of pre-pandemic symptom data.

Several major challenges emerge when interpreting the literature on the role of IU and other predictors in the context of the COVID-19 pandemic. The first is the relative absence of pre-pandemic data. The ability to establish a temporal link between anxiety severity and the onset of the pandemic has pronounced theoretical implications. Elevated anxiety, measured early in the pandemic, does not distinguish between participants whose anxiety increased at the start of the pandemic versus those whose (already high) anxiety remained stable. If the goal is to study *pandemic-related* changes in mental health, pre-pandemic symptom data are crucial. The second interpretative challenge is the tendency for previous studies to report outcomes for health- or COVID-19-related anxiety only, with fewer studies reporting outcomes for clinically-relevant anxiety more broadly. Although health anxiety is of clinical and theoretical interest in its own right, it does not capture the full range of clinically-meaningful anxiety, and likely differs in important respects from more general anxiety when assessed within a public health emergency context. Consequently, there is a gap in the literature with respect to identifying pandemic-related changes in, and predictors of, the severity and trajectory of anxiety per se during the COVID-19 pandemic.

The present study investigated IU as a cross-sectional correlate and longitudinal predictor of anxiety severity and trajectory in a sample of 641 adults for whom pre-pandemic (≈ 2018–2019) anxiety data were available. Data were collected as part of the COVID-19 Mental Health Workgroup, a multisite, multinational collaboration aimed at characterizing pandemic-related changes in mental health. Data were collected in four waves spaced approximately six weeks apart, beginning in April 2020. Analyses were preregistered on the Open Science Framework during Wave 1 data collection (https://osf.io/h3ta7) and revised in 2022 in line with work published in that time and to better account for the observed structure of the data (see preregistration for details). We hypothesized that anxiety would gradually decrease from Wave 1 to Wave 4, controlling for Wave 0 (baseline) anxiety to account for pre-pandemic individual differences in anxiety severity. We further predicted that IU, COVID-19 burden, and several demographic predictors (woman or gender minority, lower socioeconomic status, racial minority status) at Wave 1 would predict higher mean anxiety and worse symptom trajectory (i.e., less improvement or greater worsening) from Wave 1 through Wave 4, controlling for pre-pandemic anxiety.

1. Methods

1.1. Participants

The COVID-19 Mental Health Workgroup sample comprises 1457 adults and youths who (a) provided anxiety-related mental health data before the pandemic (typically 2018 - 2019) in the context of prior research in various Workgroup labs, (b) gave consent to be re-contacted for future research, and (c) responded to an electronic invitation to participate in an online questionnaire-based study about mental health. Participants ($N = 641$) are adults who met these criteria *and* for whom pre-pandemic data were available from the Anxiety subscale of the Depression Anxiety and Stress Scale-21 (DASS-21; Henry & Crawford, 2005; Lovibond & Lovibond, 1995), representing a 9.82 % response rate (of 6527 adults with pre-pandemic DASS-Anxiety recontacted). DASS-21 Stress and Depression data were not consistently available for participants at Wave 0 and therefore were not examined in primary analyses; however, sensitivity analyses controlling for depression at the first pandemic timepoint are reported. Original sample characteristics vary by lab, but can be broadly categorized as unselected ($N = 290$) or selected for elevated anxiety-related psychopathology ($N = 351$). Participants who completed Wave 1 were eligible to participate in subsequent waves, with variable response rate (Wave 2: $N = 145$, Wave 3: $N = 360$, Wave 4: $N = 185$[6]). The following demographic characteristics refer to the sample at Wave 1. Participants primarily resided in the USA (77 %), UK (13 %), and Canada (3 %). The remaining participants were from other countries (2 %) or did not report their nationality (5 %). The mean age was 36.51 (range = 19–77). Participants were 70 % cisgender women, 27 % cisgender men, 2 % gender minority, and 1 % gender not reported. The sample was 83 % White, 10 % Asian, 6 % Black, 1 % American Indian or Native Alaskan, < 1 % Native Hawaiian/Pacific Islander, and 8 % Latino/a/x.

2. Measures

2.1. Anxiety severity

We measured pre-pandemic (Wave 0) and peri-pandemic anxiety severity (Waves 1–4) using the Anxiety subscale of the DASS-21 (DASS-21-Anx). The DASS-21-Anx includes 7 items that reflect cognitive ("I felt scared without any good reason"), affective ("I felt I was close to panic"), and physiological ("I was aware of dryness in my mouth") symptoms of anxiety, with an emphasis on panic- or fear-related symptoms. Scores were summed and doubled in accordance with standard DASS-21 scoring procedures (Lovibond & Lovibond, 1995). Higher scores indicate more severe anxiety in the past week. Prior research has demonstrated that the DASS-21 total and anxiety subscale scores have strong internal consistency, structural validity, and criterion validity (Henry & Crawford, 2005; Lee et al., 2019) as well as strong measurement invariance, convergent, and discriminant validity (Gomez et al., 2014) and large retest reliability coefficients ($r = .64 - .73$) across samples (Bottesi et al., 2015; Gomez et al., 2014; Lee et al., 2019). Cronbach's alpha at Waves 1 – 4 ranged from 0.83 to 0.87.

2.2. Wave 1 predictors

2.2.1. IU

We used the short form of the Intolerance of Uncertainty Scale (IUS-12; Carleton et al., 2007) to measure IU at Wave 1 only. The 12-item measure captures a tendency to prefer certainty (e.g., "One should always look ahead so as to avoid surprises"), and to view the possibility of negative future events as unacceptable (e.g., "Unforeseen events upset

[6] Logistical constraints (e.g., lack of administrative support due to hiring freezes) prevented some labs from administering Waves 2 and/or 4.

me greatly"). Higher total scores reflect greater IU. The IUS-12 has strong convergent and discriminant validity comparable to that of the original 27-item version (Freeston et al., 1994; Hong & Lee, 2015; Khawaja & Yu, 2010) and large test-retest reliability coefficients ($r = .77$ over two weeks) in clinical and non-clinical samples (Khawaja & Yu, 2010). Internal consistency at Wave 1 for the IUS-12 was 0.92.

2.2.2. COVID-19 illness

We assessed participants' history of COVID-19 illness using a modified version of item 17 from the CoRonavIruS Health Impact Survey (CRISIS V0.3; see Supplemental Materials). Responses were coded as 0 for participants who reported no COVID-19 signs/symptoms or who had some possible symptoms, but no diagnosis by a doctor. Responses were coded 1 for participants who indicated that they had a positive test or had received a diagnosis or presumed positive.

2.2.3. COVID-19 burden

Illness burden was assessed using the sum of responses to 5 yes/no questions, including (a) lived in a COVID-19 "hot spot", (b) were essential workers, (c) had conditions that conferred elevated risk for COVID-19 complications, (d) shared a household with a frontline healthcare provider, and (e) shared a household with someone diagnosed with (or presumed positive for) COVID-19 (Supplemental Materials). Item (e) was drawn from the CRISIS V0.3 and modified for the present study. Together, items used to quantify COVID-19 Burden produced a count variable that ranged from 0 (no to all items) to 5 (yes to all items). Internal consistency was poor (0.21 - 0.32); however, this was expected given the distinctness of items. The total score therefore exclusively represents number of items endorsed, rather than a latent construct.

2.2.4. Demographic variables

Participant demographics were assessed with 17 questions (see https://osf.io/h3ta7 for full list). Preregistered analyses focused on (a) gender (woman or gender minority versus man), (b) racial minority status (White versus other racial identity), and (c) self/parent education, a composite variable created from a *z*-score of participants' self-reported educational attainment (1 = 'primary education only' to 8 = 'doctoral degree or equivalent') and the highest level of education completed by their most-educated parent.

2.3. Data analytic overview

Mplus version 8.10 was used for all analyses. Missing data across waves were handled using robust full-information maximum likelihood estimation (MLR; Lee & Shi, 2021). We conducted a series of latent growth models to test whether Wave 1 predictor variables were associated with trajectories of anxiety severity from Wave 1 - 4, controlling for pre-pandemic anxiety severity (Wave 0). The trajectory intercept was set to reflect anxiety levels at Wave 1. To select the appropriate approach to modeling anxiety slopes, we first compared the fit of models that used linear versus quadratic versus time-varying observation slopes (i.e., individually-unique slope loadings reflecting days since January 1, 2020 to account for differences in assessment completion dates) using Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample size-adjusted BIC values to capture relative fit. For these indices, smaller values indicate better relative model fit. Next, we generated an unconditional model (no predictors), a model including only Wave 0 anxiety as a predictor, and then a conditional model with all preregistered predictor variables included. Age was not preregistered as a predictor, but was included in accordance with recent findings (Blendermann et al., 2023). All predictors and Wave 0 anxiety were also specified to predict the trajectory intercept (i.e., Wave 1 anxiety levels) given they are likely to be associated. The intercept results are not relevant to our primary hypotheses; however, we report them for the sake of completeness. Finally, to assess predictors of individual differences in anxiety across the four study waves (i.e., each person's average level of anxiety from Waves 1 – 4, holding constant their variability in anxiety over time), multilevel structural equation modeling was used with MLR estimation. Specifically, between-person variance in anxiety (holding constant within-person variance at each wave) was predicted from all pre-registered Wave 1 variables and Wave 0 anxiety.

We assessed the fit of tested models using incremental fit indices root mean square error of approximation (RMSEA), standardized root mean squared residual (SRMR), and the Comparative Fit Index (CFI). Per our preregistration (https://osf.io/h3ta7), we defined adequate fit as RMSEA $< .10$, CFI $> .90$, and SRMR $< .08$. These cutoffs are consistent with consensus recommendations for assessing model fit (e.g., Hu & Bentler, 1999). All predictor variables were allowed to covary in these models.

3. Results

3.1. Missing data

We calculated missingness under the conservative assumption that all observations should be available at each Wave for all participants who responded at Wave 1, except where Waves were not administered. Using this approach, missingness was 6 % at Wave 1, 62 % at Wave 2, 44 % at Wave 3 %, and 56 % at Wave 4. Because we only combined data from participants who consented to participate in the present study, we were unable to calculate whether individuals who consented to participate at Wave 1 differed in pre-pandemic (Wave 0) anxiety from those who declined. However, in logistic regressions predicting participation at Waves 2 – 4 including pre-pandemic anxiety, recruitment site, and sample type (selected or unselected) as covariates, pre-pandemic (Wave 0) anxiety was unrelated to retention at any Wave (see Supplemental Materials for complete results). Sample type predicted retention at all Waves, with better retention for participants from selected (versus unselected) samples. Recruitment site was also incrementally related to retention beyond sample type, possibly due to cross-site differences in original recruitment method (e.g., online versus in-person). In logistic regressions, when demographic characteristics (age, gender, race, parental education) as predictors, the only significant predictor was racial minority status, which predicted worse retention at Wave 3. See *Data Analytic Overview* (above) for a description of how missing data were handled in analyses.

3.2. Preliminary analyses and descriptive statistics

As assessed with the DASS-21-Anx, participants on average reported "moderate" levels of anxiety at Wave 0 and "mild" levels of anxiety across pandemic Waves; specifically, pre-pandemic DASS-21-Anx mean = 10.90 ($SD = 9.69$); Wave 1 = 8.58 ($SD = 7.78$); Wave 2 = 8.94 ($SD = 8.39$); Wave 3 = 7.56 ($SD = 7.37$); Wave 4 = 7.84 ($SD = 7.29$), where normal = 0–7, mild = 8–9, moderate = 10–14, severe = 15–18, and extremely severe = 20 + (Lovibond & Lovibond, 1995). Scores covered the full range of the scale (0 - 42). Table 1 shows zero-order correlations among the variables. Correlations among anxiety scores across the four pandemic timepoints were very strong (*r*s = .70 −.83), while correlations of pre-pandemic anxiety with peri-pandemic anxiety tended to be moderate (*r*s = .53 −.55). In addition, peri-pandemic anxiety was moderately associated with Wave 1 IU (*r*s = .38 −.46). Among the covariates, effect sizes with anxiety were generally small, though most were statistically significant (*r*s greater than |.06| are significant at $p < .05$); specifically, Wave 1 COVID-19 illness and COVID-19 burden (*r*s = .02 −.11) as well as racial minority status and woman/gender minority status (*r*s = .05 −.11) were associated with greater anxiety, and older age (*r*s = −.15 to −.23) and greater self/parent education (*r*s = −.08 to −.24) with less anxiety.

Data were collected across 11 sites that varied in regard to participant characteristics, study procedures, and geographic location. We

Table 1
Zero-order correlations among variables.

	1	2	3	4	5	6	7	8	9	10	11
1. Anxiety Wave 1											
2. Anxiety Wave 2	.77										
3. Anxiety Wave 3	.75	.83									
4. Anxiety Wave 4	.70	.75	.74								
5. Pre-COVID−19 Anxiety	.54	.53	.55	.53							
6. Intolerance of Uncertainty	.46	.43	.42	.38	.30						
7. COVID−19 Illness	.10	.09	.02	.08	.04	.01					
8. COVID−19 Burden	.11	.02	.06	.05	.09	−.00	.06				
9. Age	−.18	−.15	−.18	−.23	.00	−.15	−.04	−.10			
10. Racial Minority	.08	.11	.05	.11	.03	.02	−.01	.02	−.24		
11. Woman or Gender Minority	.08	.06	.10	.08	.06	.06	.02	.05	−.07	.04	
12. Self/Parent Education	−.08	−.24	−.11	−.14	−.05	−.04	−.01	.10	−.17	−.05	.03

Note. Correlations > |.06| are significant at $p < .05$. All covariates were assessed at Time 1, except pre-COVID anxiety.

initially planned a three-level model in which longitudinal assessments were nested in participants, who were nested in sites. The intraclass correlation indicated that site only accounted for 2.2 % of the variance in anxiety throughout the course of the study, suggesting minimal impact on the outcome variable. We therefore report results from two-level models, excluding site. However, the three-level models were run to evaluate the effect of site on anxiety (see "Sensitivity Analyses").

3.3. Prediction of trajectories of anxiety over time

Three unconditional latent growth models (i.e., growth models without any predictors) were first tested and compared to determine which trajectory (i.e., slope) fit the data best. Specifically, we compared models specifying (a) linear slope and (b) time-varying observations that allowed each person to have unique slope loadings determined by the date of their assessments (measured in days elapsed since January 1, 2020) and not restricted to linear slopes. Model fit as indexed by BIC, sample size-corrected BIC, and AIC are shown in Table 2. Although fit was not very different across the models, the linear model had the smallest/best relative values. We therefore deviated from our preregistered plan of using the time-varying observations model and instead used the linear model, given that it fit best and is more parsimonious.

Table 3 shows model fit and unstandardized latent growth model parameter estimates. The unconditional linear model had good fit based upon standard fit indices: $\chi^2(5) = 23.15$, $p < .001$, CFI = .973, RMSEA = .056, SRMR = .061. The mean slope was negative, indicating that, on average, individuals' anxiety tended to decline across the four pandemic timepoints. In addition, there was significant variability across participants with regard to intercepts (Wave 1 anxiety severity) but not slopes over time. Individuals with higher anxiety at Wave 1 tended to report a steeper decline in anxiety over time (slope-intercept $r = -.37$, $p < .001$). When pre-pandemic anxiety was added as a predictor (see Table 3), the model continued to fit the data well. Higher levels of pre-pandemic anxiety significantly predicted higher anxiety at Wave 1 ($\beta = .64$, $p < .001$), but it did not predict anxiety slope ($\beta = -.09$, $p = .55$). After accounting for pre-pandemic anxiety, the average slope was not significantly different from zero (−.05, $p = .71$).

We ran a final latent growth model that predicted the anxiety intercept and slope from pre-pandemic anxiety, Wave 1 IU, and covariates measured at Wave 1 (i.e., COVID-19 illness, COVID-19 burden, age, racial minority status, woman or gender minority, and self/parent education). Model fit was very good (Table 3). Standardized regression coefficients are shown in Table 4. Higher levels of pre-pandemic anxiety, higher Wave 1 IU, COVID-19 illness at Wave 1, younger age, and lower levels of self/parent education were associated with greater anxiety at Wave 1. In contrast, the only significant predictor of individuals' trajectories of anxiety over time (anxiety slope) was Wave 1 IU, wherein higher levels of IU prospectively predicted a greater decline in anxiety over time.

3.4. Predictors of levels of anxiety throughout the pandemic

A two-level multilevel model was run, in which the four pandemic timepoints were nested within participants. The intraclass correlation for anxiety was.75, indicating that 75 % of the variance in anxiety was due to individual differences in anxiety, whereas 25 % was due to change within individuals and error variance. Thus, anxiety was relatively stable throughout the study at the individual level. Pre-pandemic anxiety and the other Wave 1 covariates were tested as predictors of between-person anxiety (i.e., individual differences in overall anxiety

Table 2
Information criteria fit indices for unconditional latent growth models.

	AIC	BIC	$BIC_{sample\text{-}size\ adjusted}$
Linear slope	16265.382	16310.856	16282.269
Time-varying observation slopes	16267.368	16312.842	16284.255

Note. Smaller values indicate better model fit. AIC = Akaike information criteria; BIC = Bayesian information criteria.

Table 3
Linear latent growth model parameters and fit.

Model	Interceptmean	Interceptvar	Slopemean	Slopevar	χ2 (df)	CFI	RMSEA	SRMR
Unconditional model	8.62 * **	48.97 * **	−.16 *	.74	23.15 *** (5)	.973	.056	.061
Conditional model (pre-COVID anxiety)	3.88 * **	31.05 * **	−.05	.85	18.18 * (7)	.979	.051	.059
Conditional model (all predictors)	3.19	23.29 * **	2.31 * *	.83	56.45 *** (21)	.977	.038	.026

Note. For conditional models, residual parameter estimates are shown (e.g., means are intercepts, and variances are residual variances).
*p < .05
** p < .01
*** p < .001.

Table 4
Standardized regression parameter estimates and standard errors, predicting latent growth parameters and anxiety severity across Waves 1–4.

Predictor	Anxiety intercept	Anxiety slope	Anxiety Waves 1-4
Model 1			
Pre-COVID−19 Anxiety	.64 *** (.04)	−.09 (.15)	.66 *** (.04)
Model 2 (all predictors)			
Pre-COVID−19 Anxiety	.49 *** (.04)	−.02 (.12)	.52 *** (.03)
Intolerance of Uncertainty 1	.34 *** (.03)	−.27 ** (.10)	.32 *** (.03)
COVID−19 Diagnosis 1	.07 * (.03)	−.15 (.08)	.05 (.03)
COVID−19 Burden 1	.05 (.03)	−.15 (.09)	.03 (.03)
Age	−.14 *** (.03)	−.15 (.09)	−.17 *** (.03)
Racial Minority	.03 (.03)	−.06 (.09)	.02 (.03)
Woman or Gender Minority	.03 (.03)	.04 (.07)	.03 (.03)
Self/Parent Education	−.09 ** (.03)	−.14 (.09)	−.12 *** (.03)

Note.
* $p < .05$,
* * $p < .01$,
*** $p < .001$

throughout the four timepoints, holding constant within-person variability in anxiety). As shown in Table 4, higher levels of pre-pandemic anxiety, higher Wave 1 IU, younger age, and lower levels of self/parent education were associated with greater anxiety across the four assessments.

3.5. Sensitivity analyses

Several sensitivity analyses were conducted to assess the robustness of the findings. First, multilevel models accounting for variance by site were run (i.e., two-level latent growth models and three-level multilevel models), using Bayesian estimation to aid convergence. The pattern of findings and conclusions were the same for the unconditional latent growth model, conditional latent growth model with pre-pandemic anxiety as a predictor, and the model predicting between-person anxiety throughout the study. However, the latent growth model with all predictors did not converge upon a proper solution when run as a multilevel model accounting for site, and so these results could not be evaluated. Second, we re-ran analyses using days elapsed between January 1, 2020 and each person's first assessment as a covariate, to account for differences in first assessment completion (which could correspond to different temporal characteristics of the pandemic). Primary findings were unchanged with the addition of this covariate. Last, we included pre-pandemic depression levels from the DASS-21 as a covariate to examine the extent to which results may be specific to anxiety in a subsample of 461 participants for whom pre-pandemic depression data were available, and the primary findings again remained the same.

4. Discussion

The present study investigated IU, key demographic variables, self-reported history of COVID-19 illness, and pandemic-related burdens (e.g., being an essential worker) as predictors of anxiety severity and trajectory during the early- to mid-COVID-19 pandemic. A latent growth curve model that included a linear decreasing slope for anxiety and multiple covariates of interest was a strong fit to the data. Across the sample, anxiety decreased over time. Unexpectedly, this included a decrease in anxiety from the pre-pandemic to first pandemic timepoint. The slope for all pandemic timepoints became nonsignificant when pre-pandemic anxiety was controlled, underscoring the integrality of pre-pandemic symptom data to a complete picture of pandemic-related changes in anxiety. Notably, IU emerged as a robust predictor of anxiety severity and change in anxiety severity (slope) across the pandemic. Consistent with hypotheses, higher IU at Wave 1 predicted more severe anxiety across timepoints in the multilevel model. In contrast to hypotheses, higher IU at Wave 1 also predicted a sharper decrease in anxiety across timepoints in the latent growth model. This pattern remained significant after the other covariates, including pre-pandemic anxiety, were controlled, suggesting that IU may play a unique role as both a psychological risk and resilience factor. Findings also held in sensitivity analyses covarying baseline depression severity, suggesting potential specificity of the findings to anxiety. Higher pre-pandemic anxiety, self-reported history of COVID-19 illness at Wave 1, being younger, and lower parental education were all uniquely associated with anxiety severity throughout the study; however, none of the covariates predicted the trajectory of anxiety severity over the timepoints (i.e., slope).

Of particular interest is the finding that higher IU at Wave 1 predicted more severe anxiety across the study. This finding is consistent with our preregistered hypotheses and aligns with findings from previous studies linking IU to anxiety during the pandemic (e.g., Bavolar et al., 2023; Bredemeier et al., 2023). IU also predicted anxiety trajectory: although the sample as a whole showed a broad linear decrease in anxiety severity over successive timepoints, this decrease was sharper for individuals higher in IU. The variance explained by IU in both severity and trajectory was significant even after controlling for pre-pandemic anxiety, demographic characteristics, and other covariates, suggesting that the findings are unlikely to be accounted for by general distress or possible confounding variables. Rather, IU appears to have unique and specific predictive utility with respect to anxiety in the context of the COVID-19 pandemic.

The finding that IU predicted higher anxiety during the pandemic is broadly consistent with findings from cross-sectional and peri-pandemic empirical research (e.g., Adamis et al.,in press; Bredemeier et al., 2023; Millroth & Frey, 2021), and with theoretical frameworks that propose a mechanistic role for IU in maintaining anxiety (Dugas et al., 2004) and in predicting emotional responsivity to pandemic-related stressors (Paluszek et al., 2021). The persistent ambiguity of the early- to mid-pandemic context may have been uniquely distressing for uncertainty-intolerant individuals. By contrast, uncertainty-intolerant individuals may have disproportionately benefited from the emergence of new information (e.g., the efficacy of vaccines and mitigation procedures) as the pandemic progressed. Another possibility is that those individuals with high IU may have been especially likely to discontinue their regular pre-pandemic activities or adopt more-extreme safety precautions in an effort to eliminate risk, which could plausibly function to reduce anxiety (e.g., Carleton et al., 2019). Statistical explanations, such as regression to the mean, may also have contributed given that those with higher IU also started with more severe anxiety, although controlling for pre-pandemic anxiety helps to mitigate this concern. Regardless, this finding was contrary to our hypotheses, so these explanations are necessarily post hoc and speculative.

The finding that anxiety decreased from pre-pandemic to the first pandemic timepoint, although contrary to predictions, should not be overinterpreted. As a subset of the initial sample was recruited on the basis of elevated anxiety, regression to the mean may partially account

for this initial pattern. Additionally, respondents included only a portion of those invited to participate, raising selection bias as another possible explanation (e.g., individuals whose anxiety increased early in the pandemic could have been less likely to participate). Results from previous longitudinal studies also vary with respect to their conclusions regarding changes in anxiety from pre- to peri-pandemic (Blendermann et al., 2023; Krygsman et al., 2023), underscoring the importance of understanding individual differences and predictors of such trajectories.

Although no demographic indicators incrementally predicted trajectory, younger age and lower levels of self/parent education incrementally predicted higher overall levels of anxiety across the four assessments. Although racial minority status showed zero-order associations with severity, it did not incrementally predict any anxiety outcomes. Similarly, gender also did not incrementally predict anxiety severity or trajectory. This nonsignificant result was surprising in light of previous studies finding worsening of anxiety in women (Blendermann et al., 2023). However, both of these null results (race and gender) could be attributable, at least in part, to the underrepresentation of racially minoritized participants, cisgender men, and gender minority individuals in the dataset. By contrast, the finding that younger participants experienced greater anxiety than their older counterparts, despite being less medically vulnerable, is consistent with previous research (Blendermann et al., 2023). Although this finding accounts for baseline differences in anxiety, cohort effects are possible, and may be explained by rapidly-changing sociocultural factors beyond risk of illness per se. The finding that higher socioeconomic status incrementally predicted lower anxiety across timepoints is consistent with its conventionally-observed protective role (e.g., Muntaner et al., 2004). Any number of privileges associated with higher socioeconomic status could help to account for this result, such as increased access to a comfortable living space making social/physical distancing easier, services that reduced illness exposure, childcare services, reduced concerns tied to health care disparities, and employment that could be completed remotely, reducing concerns about job loss.

The present findings should be considered in the context of relative strengths and limitations of the study. All study measures were self-report; consequently, we cannot, for example, draw strong conclusions about COVID-19 illness per se as a predictor of anxiety. Whereas the overrepresentation of White, American, and cisgender women poses threats to generalizability, the use of psychometrically sound measurement and open science practices are strengths. Bearing this methodological profile in mind, the present findings highlight IU as a potentially important predictor of anxiety severity and trajectory during a markedly uncertain time. Whereas the finding for severity aligned with hypotheses (i.e., higher IU predicted higher overall severity), the finding for trajectory—higher IU prospectively predicting a sharper decrease in anxiety over time—was unexpected. One possible interpretation is that, as uncertainty resolved in the early months of the COVID-19 pandemic, so too did the anxiety of those individuals who are most disturbed by uncertainty. Although "objective" uncertainty is difficult to operationalize, it would be valuable for future research to probe the plausibility of this mechanistic interpretation in other datasets; for example, by charting the time course of external events such as vaccine development relative to anxiety symptom severity. If supported and replicated, such a finding would highlight uncertainty as a potentially valuable target for both clinical intervention and public health messaging in times of crisis.

CRediT authorship contribution statement

Christine B. Cha: Conceptualization. **Ilana Gratch:** Conceptualization. **Eiko I. Fried:** Conceptualization, Writing – review & editing. **Darlene Davis Goodwine:** Conceptualization, Methodology. **Gordon J. G. Asmundson:** Conceptualization, Writing – review & editing. **Cecile D. Ladouceur:** Conceptualization, Methodology, Writing – review & editing. **Susan Kusmierski:** Investigation. **Katie Kriegshauser:** Conceptualization, Resources. **Edwin Dalmaijer:** Data curation, Writing – review & editing. **Philip C. Kendall:** Conceptualization, Writing – review & editing. **Adrienne Manbeck:** Conceptualization, Investigation. **Shmuel Lissek:** Resources. **Bethany A. Teachman:** Writing – review & editing, Resources, Methodology, Conceptualization. **Jeremy G. Stewart:** Writing – review & editing, Writing – original draft, Resources, Methodology, Conceptualization. **Lisa R. Starr:** Writing – review & editing, Resources, Methodology, Conceptualization. **Iftah Yovel:** Resources. **Benjamin A. Katz:** Resources, Methodology, Conceptualization. **Aidan G.C. Wright:** Resources, Writing – review & editing. **Samuel E. Cooper:** Writing – review & editing, Resources, Conceptualization. **Kathryn Roecklein:** Resources, Writing – review & editing. **Kristin Naragon-Gainey:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Conceptualization. **Rebecca B. Price:** Resources. **Rosanna Breaux:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Conceptualization. **Tyler C. McFayden:** Conceptualization, Investigation. **Lauren S. Hallion:** Writing – review & editing, Writing – original draft, Supervision, Resources, Methodology, Conceptualization. **M. Kathleen Caulfield:** Data curation, Formal analysis, Writing – original draft. **Katie L. Burkhouse:** Conceptualization, Resources.

Declaration of Competing Interest

Lauren S. Hallion and Gordon J. G. Asmundson are Associate Editor and Editor-in-Chief at Journal of Anxiety Disorders, respectively, and receive financial support through payments for their editorial work on the journal. Neither author was involved in the review of the manuscript or the decision regarding its acceptance. We have no additional conflicts of interest to declare.

Data Availability

Data will be publicly available via the Open Science Framework.

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Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.janxdis.2024.102910.

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