university of groningen / faculty of behavioural and social sciences / research master

Master's thesis

Anxiety in Lockdown: A Natural Experiment's Insights

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Programme:	Research Master Behavioural and Social Sciences
Theme:	Lifespan Development and Socialization
ECs:	30
Date:	1-8-2024
Word count:	9067

Are there deviations of the Master's thesis from the proposed plan?

☒No

☐Yes, please explain below the deviations

Abstract

Anxiety negatively impacts our quality of life and affects us physically and mentally. Research shows conflicting evidence on how the COVID-19 pandemic and its lockdowns influenced people's anxiety. Therefore, this exploratory prospective study examines the relationship between the COVID-19 lockdowns and anxiety among 2153 Dutch participants of the ongoing Lifelines study. Wilcoxon signed-rank tests showed a decrease in median anxiety scores from pre-pandemic to lockdown times (Mdn = -0.38 to Mdn = -0.51, W = 1885171, $p < .001$). Across five models, Generalized Estimating Equation showed that pre-pandemic anxiety predicted anxiety during the first lockdown. Factors such as worrying, social anxiety, younger age, and being female were associated with increased anxiety during the lockdown. These findings showcase the complexity of anxiety during the COVID-19 lockdowns and highlight individual differences, thus the importance of personalized strategies; some people benefit from breaks from society to reduce anxiety, while others do not.

Keywords: Anxiety, COVID-19, Lockdowns, Lifelines, Isolation

Anxiety in Lockdown: A Natural Experiment's Insights

Most humans experience challenges and occasional nervousness in multiple areas of life, such as the workplace, home, or relationships. Occasional worry about past, present, or future events is normal. However, for some people, this worry turns into excessive persistence and cannot be turned off. This worry may indicate that someone suffers from an anxiety disorder, an umbrella term for a multitude of disorders and phobias with a wide range of symptoms (see Table 1; Anxiety Disorders - Symptoms and Causes, 2018). Unfortunately, anxiety disorders have a high lifetime prevalence, as 16% to 34% of people suffer from an anxiety disorder at some point during their lives (Somers et al., 2006; Bandelow & Michaelis, 2015). Furthermore, anxiety disorders typically have a persistent nature, meaning that once someone suffers from anxiety, it is difficult to shake off (Hovenkamp-Hermelink et al., 2021). Unsurprisingly, anxiety disorders can lead to a significant decrease in quality of life and physical effects like an increased risk for cardiovascular diseases or irritable bowel syndrome (Celano et al., 2016; Banerjee et al., 2017; Wilmer et al., 2021).

Table 1

Physical and Cognitive Symptoms of Anxiety Disorders

Symptom	PD	AP	SAD	GAD
Palpitations	x		x	
Sweating	x		x	
Trembling			x	
Shortness of breath	x			
Chest pain	x			
Nausea	x			

Symptom	PD	AP	SAD	GAD
Dizziness	x			
Excessive anxiety & Fear	x	x	x	x
Worry				x
Feeling on edge				x
Poor concentration				x
Avoidance	x		x	
Irritability				x
Fatigue				x
Muscle tension				x
Insomnia				x

Note. Adapted from DSM-5, APA, 2013 and Anxiety Disorders - Symptoms and Causes, 2018. PD = panic disorder; AP = agoraphobia; SAD = social anxiety disorder; GAD = generalized anxiety disorder.

On the bright side, certain factors can protect individuals from anxiety and phobic disorders or reduce the number and severity of symptoms. For example, social support and physical activity are associated with decreased anxiety symptoms (Reinelt et al., 2014; Hiles et al., 2017; Ströhle et al., 2007). In contrast, traits like high neuroticism, low extraversion, perceived loneliness, and low sociability can increase the risk of developing anxiety symptoms or disorders (Flensborg-Madsen et al., 2011; Struijs et al., 2021). Lastly, being female, having financial problems, chronic health issues, and experiencing major adverse life events are each associated with an increase in one's risk of experiencing anxiety disorders (Hovenkamp-Hermelink et al., 2021). In conclusion, many individual risk and protective factors influence anxiety disorders, and (un)fortunately, many of these factors are changeable, which provides opportunities for recovery from anxiety.

When we consider the risk factors of anxiety, particularly the role of major adverse life events, the COVID-19 pandemic stands out. With over 500 million officially confirmed cases and over 6 million deaths (Mai, 2022), the COVID-19 virus is the deadliest pandemic since the 1918 H1N1 influenza outbreak (Taubenberger & Morens, 2006; Patterson et al., 2021). In the Netherlands alone, nearly 23.000 lives were lost to the virus, leading to a decrease in the Dutch life expectancy by approximately half a year (*COVID-19 Deaths | WHO COVID-19 Dashboard*, n.d.; *World Health Organization: WHO, 2024*). To express the magnitude of the virus' effect on people: the threat of a COVID-19 infection, the co-occurring instability in a multitude of areas (for example, job and education), and the disruption of one's daily routine and life led many people to experience negative mental health consequences (Hao et al., 2020; Odriozola-González et al., 2020).

Additionally, many people did not receive adequate help as mental health services experienced an increase in patients and a shortage of staff and resources (*COVID-19 Deaths | WHO COVID-19 Dashboard*, n.d.). In order to keep the virus' death toll low, governments imposed strict lockdowns, urging people to stay at home to reduce social contact and thus the risk of infection. The imposed lockdowns varied greatly across countries in length and strictness. In the Netherlands, "intelligent lockdown measures" were imposed to protect the vulnerable members of society (Antonides & van Leeuwen, 2020). Thus, people did not only experience disruption to their lives due to the virus itself, but governments also imposed lockdown measures, leading to more disruption.

The effects of the lockdowns on people's mental health varied. On one hand, people experienced the positive effects of society coming to a standstill, with people reporting feeling more connected to others and rested (Gijzen et al., 2020). On the other hand, societal lockdown put a further strain on many people's mental health; for example, anxious people experienced a significant worsening of their symptoms (Busetta et al., 2021). People with

pre-existing mental health conditions experienced higher levels of anxiety, depression, and stress during the pandemic compared to their non-mentally ill peers, with one-quarter of people even reporting PTSD-like symptoms (Benke et al., 2020; Hao et al., 2020). A decrease in peoples' anxious moods from 23.65% (during lockdown) to 6.26% post-lockdown further indicates a negative influence of lockdowns on mental health (Liu et al., 2021). Furthermore, people with pre-existing panic and anxiety disorders experienced increasingly intense symptoms of anxiety during social isolation, a critical factor in lockdowns (Hao et al., 2020; Wu et al., 2021). The severity and number of negative life disruptions due to the COVID-19 pandemic and lockdowns put additional strain on people with pre-existing anxiety, worsening people's number and severity of symptoms.

Despite the widespread negative impact of COVID-19 and the associated lockdowns, it is important to recognize the positive effects of the lockdowns. A number of people experienced an improvement in their anxiety symptoms during the lockdowns. Studies report that 37% of individuals with pre-existing anxiety disorders felt better adapted to the lockdowns than their peers, and 21% of adolescents and 36% of students with high pre-pandemic anxiety felt less anxious during lockdowns (Tundo et al., 2021; Busetta et al., 2021; Hollenstein et al., 2021). This suggests that some anxious individuals thrived under the lockdowns. Consequently, the question arises as to *why* some people with pre-existing anxiety disorders thrived during the lockdowns while many others did not.

One possible explanation is the heterogeneity in experiences and circumstances; for example, personality factors such as neuroticism and openness moderated the intensity of youth anxiety (Mourelatos, 2021). Thus, the question arises what factors may have influenced people's mental health during the lockdowns. Hence, to investigate changes in anxiety during the pandemic, I examine the following research questions: (1) did the symptoms of people with pre-existing anxiety decrease during the COVID-19 lockdowns in comparison to pre-

pandemic times? In line with previous research, I expect to find a small but substantial group of people (20-33%) to whom this development of symptoms applies. (2) The second research question investigates what factors lead some people with pre-existing anxiety to thrive during the lockdowns while others did not. Here, I expect some well-established protective factors to decrease the number of people's anxiety symptoms, as well as risk factors to increase anxiety symptoms.

Although many studies have investigated the negative effects of the pandemic and lockdowns on mental health, the heterogeneity in anxiety during the lockdown, as well as risk and protective factors, are underexplored. Therefore, the results of this study should offer a deeper understanding not only of anxiety itself but also of the dynamics of anxiety and challenging circumstances and isolation. Additionally, this study's findings can have practical applications, offering real-life implications in areas such as the workplace and personalized anxiety easing strategies. The COVID-19 pandemic gives the unique opportunity to study the effects of isolation and stress on people's mental health in a natural experiment, comparing mental states before the pandemic and during the first lockdown.

My study has a two-phase structure with a short scoping review of anxiety's risk and protective factors in the COVID-19 lockdown context, to derive risk and protective factors that are examined in the subsequent explorative analysis of Lifelines data. In this second part of the study, I aim to answer the two research questions by analyzing Lifelines data using Generalized Estimating Equation (GEE) and Wilcoxon signed rank test.

Method: Scoping Review

The databases *PsycINFO*, *ERIC*, *MEDLINE*, and *SocIndex* were searched in early 2023 to find articles that fit this scoping review on anxiety disorders, with a search string that combines ‘anxiety disorders’, ‘generalized anxiety disorder,’ ‘social anxiety disorder,’ ‘panic disorder’ and ‘agora’. Additionally, a second search string used words related to the

lockdowns, such as ‘lockdown,’ ‘shutdown,’ and ‘stay at home order.’ Finally, a third string included terms related to longitudinal studies to ensure that anxiety was measured multiple times, namely: ‘longitudinal studies,’ ‘cohort analysis,’ ‘follow-up studies,’ ‘retrospective studies,’ ‘repeated measures,’ ‘cohort analy*,’ ‘pre-pandemic’ and ‘pre-pandemic.’ All search terms were separated with an OR, while AND connected the search strings per database search. Furthermore, an asterisk was placed after certain search terms to capture every form of spelling.

Inclusion and Exclusion Criteria

No restrictions were applied as to when and where the study was conducted. However, the study had to be in English, published in a peer-reviewed journal, and on human subjects. Furthermore, studies that used participants with specific jobs, such as nurses or society-relevant jobs, were excluded to avoid a fluctuation in anxiety levels and presence due to the stress of a front-line job. The main inclusion criteria were that the studies examined anxiety levels before and during a lockdown. Thus, the study had to be on an anxiety disorder or anxiety and measured anxiety before the pandemic started (31.12.2019), to avoid a temporary increase in anxiety brought on by the news of a virus taking peoples' lives. Logically, the second measurement of anxiety had to have taken place during a lockdown period to examine the effect of lockdowns on anxiety adequately.

Paper Selection and Information Retrieval

The first step of the search was conducted as described above, which resulted in 116 articles. Afterward, 24 duplicates were detected and deleted, resulting in 92 articles assessed for suitability for this review. After scanning the 92 articles, 49 articles could be ruled out as unfitting for this review by their titles. The abstracts of the remaining 43 articles were scanned, and 13 articles were selected for the full-text scan. Finally, seven articles were excluded, resulting in six final publications chosen for this review.

Results: Scoping Review

Study Characteristics

Considering the recent pandemic outbreak and thus interest in the effects of the lockdowns, it is unsurprising that one article was published in 2021 and the remaining in 2022. This also means more articles on the effects of the lockdowns on people's mental health may be published in 2023 and beyond. The baseline measurements of anxiety (T_0) all took place before the official outbreak of the COVID-19 pandemic, some going back to 2014. The second measurement (T_1) during the lockdowns started in four articles in April 2020 and lasted for two studies until May, for three studies until June or July, and another until September 2020. Three of the six included articles also collected and analyzed data at a third-time point (T_2) from late fall to early winter of 2020 (November/October-December). For further information on where the studies were conducted, their sample sizes and which instruments were used to measure anxiety see Appendix A.

Participants

Participants varied greatly in age and were not described in two articles. However, one of the articles described their participants as 50 years old and above, and the second article investigated mothers; thus, an age above 14 can be assumed. Besides those two articles, the youngest participant across all studies was 9 years old. Across all articles the average participants' ages ranged from $M = 11.7$ to $M = 58.1$.

Most T_1 measurements occurred during required lockdown periods that shifted to recommended lockdown throughout the measurement period. People generally felt more anxious during the lockdown period compared to pre-pandemic times. Multiple studies reported a significant increase in anxiety from T_0 baseline (pre-pandemic) to T_1 (lockdown), with one study reporting an increase in severe anxiety from 10% to 16% and mild anxiety from 16% to 23% (Barendse et al., 2022; Dickerson et al., 2022; Shi et al., 2022; Lu et al.,

2022). Lu et al. (2022) found that the significant increase in anxiety persisted to the second measurement time point. This means that people with pre-pandemic anxiety were more likely to suffer from increased lockdown anxiety during the first and second lockdowns as compared to people with no pre-existing anxiety.

However, the remaining two articles could not support the findings of an anxiety increase. Di Gessa and Price (2022) and Evans et al. (2021) did not find a significant change in anxiety symptoms during the lockdowns as compared to before the pandemic. Additionally, Barendse et al. (2022) performed a 'Leave out one' analysis, showing that detecting a significant increase in anxiety from pre-pandemic to lockdown measurements was unstable depending on which samples were included in their analysis.

For risk and protective factors, Dickerson et al. (2022) found factors such as insecurity (for example, housing, financial), isolation, and lack of social support to be risk factors for lockdown anxiety (see Appendix A). Additionally, Di Gessa and Price (2022) found that the lockdown posed a risk factor for anxiety. However, the effect was only significant when controlled for demographic variables and lost significance when controlled for other factors. To summarize, the lockdown, and isolation and insecurity related factors increased peoples' risk of suffering from lockdown anxiety. On the other hand, Shi et al. (2022) found that the quality of family relationships could protect individuals from lockdown anxiety. Therefore, the effects of those risk and protective factors (for example, isolation, worry) on lockdown anxiety were tested later in the Generalized Estimating Equation models.

Method: Quantitative Study

Lifelines

The current study utilizes data from the ongoing longitudinal Lifelines cohort study which includes health-related and biological data from ~167.000 northern Dutch participants for the last 30 years (McIntyre et al., 2021). Starting in 2006, participants began to fill out

questionnaires about their mental health, which spread across six assessment waves. Data on participants' experiences during the COVID-19 pandemic have been collected since March 30, 2020, through weekly or bi-weekly questionnaires (Scholtens et al., 2015; McIntyre et al., 2021).

The current study utilizes the Wave 3 subset (2019-2023) which also collected COVID-19-related mental health data. Specifically, I focus on the end-of-2019 data (September until December) and the beginning of the first lockdown (Q1; 30.03.2020 until 23.04.2020). The first pandemic measurement Wave Q1 captures the early beginnings of the required stay-at-home orders and had the highest response rate (41%) compared to the other waves in 2020 (McIntyre et al., 2021).

Sample

Lifelines collects data from approximately 10% of the general northern Dutch population, corresponding to ~ 167.000 participants. Lifelines has multiple criteria excluding people from participating in their surveys. Besides those, I only included participants who had completed the Wave 3 questionnaire before January 1, 2020, to avoid increased anxiety due to the COVID-19 outbreak.

Procedure

General practitioners recruited patients between the ages of 25 and 50 years, who, in turn, were asked to recruit their family members. Additionally, participants can join the Lifelines cohort by registering on their website. Exclusion criteria for participation are a life expectancy below 5 years, inability to make rational decisions, visit a general practitioner, fill out the questionnaire, or understand the Dutch language. Participants signed an informed consent form and received no compensation for their participation. Participants' data is anonymized and securely stored, accessible only via a secure server (Scholtens et al., 2015).

For the lockdown measurements (Q1), McIntyre et al. (2021) outlined in detail that 140.145 participants received an email link to the online COVID-19 questionnaires. The first questionnaire round took place on March 30, 2020, followed by six weekly invitations for follow-up questionnaires covering sociodemographic data, chronic illness, COVID-19-related, health-related, medication usage, mental health and well-being, corona-related well-being, social life, social relations, lifestyle changes, as well as additional questions for participants age 65 or older.

Variables

The Mini International Neuropsychiatric Interview (MINI) version 4 is a structured interview created to assess the 17 most common mental health disorders based on the DSM-4 and ICD-10 that can be administered in approximately 15 minutes (Sheehan et al.,1998). Lifelines previously used the MINI versions 1 through 4 with the current version (4) from 01.01.2014. The disorders and their number of items specifically assessed and used in Lifelines are major depressive disorder (16), dysthymia (9), panic disorder (18), agoraphobia (2), social phobia (4), and generalized anxiety disorder (10), counting 59 items in total. Starting in April 2020, the MINI was adjusted to assess anxiety in the context of the COVID-19 pandemic. Questions from the Q1 wave were adjusted to check for symptom presence in the past 7 days, and the number of items was reduced from 11 to six. The MINI was administered in person by a trained professional, whereas during the pandemic, the assessment moved online (McIntyre et al., 2012).

In the following section, the study variables are presented. Anxiety during the lockdown was the only dependent variable, with the rest of the variables being predictors. The anxiety-related variables are presented in Table 2 to avoid repetition of information.

Anxiety: Pre-Pandemic

Eleven MINI items assessed the independent variable: pre-pandemic anxiety. Participants indicated the presence of multiple anxiety symptoms in the past 30 days on the 11 items with a *yes* (1) or *no* (0). In the final calculation, pre-pandemic anxiety scores could range from 0 to 11. To spot differences in lockdown anxiety due to the severity of pre-pandemic anxiety, the variable was divided into different levels of anxiety. A score of 0 indicates no anxiety, 1 to 4 low anxiety, 5 to 8 medium anxiety, and 9 to 11 high anxiety.

Anxiety: Lockdown

During the lockdown, six items from the pre-pandemic anxiety assessment were included to form the dependent variable. Those items were changed to ask whether the symptoms were present in the past 7 days instead of 30 days. The possible answer options were *yes* (1) and *no* (0), summarized in an anxiety score ranging from 0 to 6.

Table 2

Concise Overview of the Anxiety Related Variables

Variable name	Items	Example question	Answer options	Score range
Agoraphobia	4	In the past month, were you fearful or embarrassed being watched, being the focus of attention, or fearful of being humiliated?	“Yes”, “no”	0-4
Social Anxiety	4	Do you fear these situations so much that you avoid them, or suffer through them, or need a companion to face them?	“Yes”, “no”	0-4
Panic Disorder	19	Did you have hot flashes or chills?	“Yes”, “no”	0-19
Generalized Anxiety	4	How many of the past 30 days did you remain in bed for more than half a day because of problems with your physical or mental health?	0-30	0-120

Note. Instrument to assess the variables = The Mini International Neuropsychiatric Interview (MINI) version 4 (Sheehan et al.,1998).

Worry

Five statements, including "I worry about getting sick myself" and fear of losing one's job, assessed worry during the lockdown. Answer options were *yes* (1) and *no* (0), resulting in a possible score from 0 to 5.

Health

Health was assessed before the pandemic by one question asking the participant, "How would you rate your health generally speaking?". The five possible answer options and corresponding health scores ranged from *poor* (-1) to *excellent* (3). Thus, participants could receive -1 to 3 points on health.

Feeling Connected

The feeling of connection to others was assessed during the pandemic by the participants rating the statement "I feel connected to all Dutch people (in the last 7 days)" on a five-point scale ranging from *totally disagree* (-2) to *totally agree* (2). Participants could receive between -2 and 2 points for this item.

Chronic Illness

Chronic illness was assessed during the lockdown by asking participants if they had a chronic illness, to which they could reply *yes* or *no*.

Isolation

The feeling of isolation during the pandemic was assessed by asking, "How socially isolated have you felt in the last 7 days?" Participants could answer this question on a scale from 1 (*no social isolation*) to 10 (*extreme isolation*).

Lastly, participants were asked to indicate the highest level of education they had completed, their age and gender.

Analysis Plan

Lifelines offers an incredible number of variables. I therefore selected my independent variables from the vast number available based on the previous scoping review

(see Appendix A), and other relevant, snowballed literature covering anxiety's risk and protective factors. To avoid redundancy and multicollinearity among the possible predictors, I identified conceptually close and strongly correlated variables. I then retained the most representative variables to ensure the robustness and concision of my analysis.

First, I examined the data distributions via the data's descriptive statistics (mean, standard deviation, frequencies, range) and histograms of all continuous variables. Skewness and kurtosis were calculated to check if the data distribution was symmetrical and/or tailed, and the mentioned histograms were visually inspected. A score above 7 for kurtosis indicated a heavy tail for the distribution, and a skewness value above 0.5 indicated a non-symmetrical distribution (Kim, 2013; Agresti, 2017). I visually checked for outliers using boxplots. As mentioned before, correlations were calculated to decide which predictors to include in the model and which variables could be used to impute potential missing data. The missing data analysis and imputation were conducted in R (version 4.3.2) and the descriptive, correlations and GEE models in SPSS (version 28). I pre-registered my analysis plan at the Open Science Framework on the 13.02.2023 (10.17605/OSF.IO/APM8G).

Multicollinearity

Highly correlated predictors may cause problems in the interpretability and validity of the GEE model results. This multicollinearity may lead to inflated standard errors for the coefficient estimates and difficulty interpreting the effects of the predictors on the outcome variable (Agresti, 2017). Therefore, it is crucial to ensure that the model predictors do not correlate with each other too strongly, typically described as a correlation >.80 (Agresti, 2017; Cohen, 1990). To check for multicollinearity, the variance inflation factor (VIF) was calculated and values of 5 and larger were taken as indicative of unacceptable multicollinearity (Kim, 2013).

Generalized Estimating Equation

Generalized Estimating Equation (GEE) is a method to estimate the parameters of a generalized linear model while also accounting for the within-person correlation structure across time (Ballinger, 2004). This makes GEE suitable for the longitudinal nature of this study's data. Another advantage of GEE is handling not-normally distributed data, as the distribution can be specified during the analysis (Ballinger, 2004). Thus, GEE is a technique that can handle longitudinal data while offering great flexibility when specifying the different distributions and accommodating the within-subject correlation across time.

Assumptions

Three assumptions must be met for the GEE models to provide valid and efficient results. First, the within-person correlation structure has to be specified for an efficient and correct estimation of the model coefficients (Fitzmaurice, 1995). Consequently, the correlation between, for example, pre-pandemic anxiety and lockdown anxiety for each individual has to be accounted for. For simplicity's sake, the independent correlation structure should be the first choice in which all the information within each person is assumed to be uncorrelated across time (Twisk, 2003). Since this study had two time points months apart, it would be false to assume that someone's anxiety at time point one will be uncorrelated to anxiety at time point two. Thus, the independent correlation structure cannot be assumed. Therefore, I chose the exchangeable structure. The exchangeable correlation structure assumes that the subjects' correlations are the same across all time points; this assumption is met since this study only has two measurement points.

Second, to accurately model the response and predictor variables the distribution of the outcome variable must be specified. Specifically, the outcome variable's distribution is crucial to estimate the model's variance correctly (Twisk, 2003). GEE allows the specification of exponential distributions, such as Normal, Poisson, and Negative binomial

(Ballinger, 2004; Twisk, 2003). The visual inspection of the outcome variable's distribution using a histogram showed a heavily skewed distribution to the right. Additionally, lockdown anxiety's variance was larger than its mean, indicating that the negative binomial distribution was the right choice (Ballinger, 2004; Gardner et al.,1995).

Third, the best link function has to be chosen to model the relationship between the response and predictor variables. The link function is chosen based on the distribution of the outcome variable; for the previously chosen negative binomial distribution, the log link function is commonly used (Ballinger, 2004).

Procedure

The analysis was run with five models, in which the predictors were added as groups following the recommendation by Gelman and Hill (2006). This way, the contribution of each predictor group, for example, demographics and anxiety-related variables, can be seen on the model's overall fit, and each predictor's significance and effect size. Thus, without adding unnecessary complexity, the best-fitting model can be chosen.

Model 1 was the simplest and examined lockdown anxiety predicted by pre-pandemic anxiety. The second model incorporated the three demographic variables: education level, gender, and age. Model 3 also included the four anxiety disorders: agoraphobia, social anxiety, generalized anxiety, and panic disorder. Model 4 expanded on Model 3 with interaction terms between pre-pandemic anxiety and the four anxiety disorders, to examine whether the anxiety disorders moderated the anxiety response to the lockdown. Lastly, Model 5 contained all the variables of Model 3, namely; pre-pandemic anxiety, education, gender, age, agoraphobia, social anxiety, generalized anxiety, and panic disorder. However, in Model 5 I also added the remaining lockdown-related predictors (worry, isolation, chronic illness, connection, health) to see if their contribution changed the relationship between lockdown anxiety and the previous predictors.

Effect Sizes

Relevant to this research is the commonly used effect size correlation (*r*). Based on Peterson and Brown (2005) and Richard et al. (2003), correlations (*r*) are categorized as small if their values are between .10 and .19, moderate ranging from .20 and .29, and large above .30. Since my study is explorative, practical significance (effect size) was given priority over statistical significance (p-values). This means in practice, p-values were evaluated as significant at $p < .05$ and not adjusted for multiple testing (Cohen, 1990; Nakagawa, 2004).

Goodness of Fit

Many measures of model fit, such as the Bayesian information criterion (BIC) or Akaike's information criterion (AIC), assume independence of observations (Cui, 2007). Since GEE can be used for correlated data, those techniques are inappropriate for estimating the fit of GEE models (Cui, 2007; Ballinger, 2004). Therefore, a modification of Akaike's information criterion, the quasi-likelihood under the independence model criterion (QIC), was used to compare the different nested models and to find the model with the best fit among the models (Cui, 2007). In practice, I compared the different models based on their QIC, and the model with the lowest QIC was selected as best fitting.

Missing Data

Missing data can be classified into three categories: missing completely at random (MCAR), missing at random (MAR), and missing not at random (MNAR; Van Buuren, 2018). The ignorable, thus most desirable type of missing data is MCAR, it implies that the missingness is unrelated to the data. Thus, every case has the same probability of missing (Van Buuren, 2018). For example, a faulty measurement tool may not collect data. MAR has a broader definition and is usually the assumption for most imputation techniques; it implies missingness because of the observed data, not the missing data. This means the probability of missing data is the same for every observation within a category. For example, older people

may feel uncomfortable sharing information about their mental health as compared to young people. Thus, the missingness of mental health is due to age and MAR. If MCAR or MAR do not hold, we have MNAR. In that case, the missing data is related to the missing data itself. This means in practice that people may not answer questions on their mental health because they feel ashamed of their answers.

Related to the missingness categories is attrition bias: meaning people drop out of a study. To assess the attrition bias and type of missing data present in this dataset, the frequencies of missingness per variable were calculated, and the missingness pattern was examined visually. Chi-square analyses were conducted for categorical variables, and the Wilcoxon signed rank test for continuous variables to check for possible relations between missingness and the variables' scores. A significant outcome pointed to a possible MNAR and attrition bias case. Fully conditional specification (FCS) multiple imputation from the R package *mice* (version 3.16.0) was used to impute the missing data (Van Buuren, 2018). FCS is a method to impute multivariate missing data in which each participant's missing observation is imputed individually based on scores on other items; this process is repeated multiple times per missing value, resulting in multiple imputed datasets used in the analysis. In practice, I ran the multiple imputations a number of times, resulting in a number of datasets for which I ran the analysis individually. Afterward, the results were pooled by calculating the mean to receive one number per parameter.

Sensitivity Analysis

To examine if imputing missing values influenced the GEE outcomes, a sensitivity analysis was performed by analyzing the imputed GEE models and comparing them to the original data GEE models. In the original dataset, missing cases were deleted listwise from the dataset.

Results: Quantitative Study

The 2153 participants[1] were predominantly female (61.9%) and aged 19 to 89 years (M = 54.3, SD = 12.7). Of the 2153 participants, 88 (3.1%) were practically educated, and 551 people (25.6%) had a medium level of education. Lastly, 880 or 40.1% of the participants had followed higher education, with 19 people holding a degree different from those covered by the answer options. Most variables had skewed distributions above the cut-off score of 0.5 except for age, isolation, worry, and health. Besides connection, the rest of the skewed distributions were skewed positively (see Table 3). Especially the anxiety-related variables showed extreme skewness levels ranging from 3.56 for generalized anxiety to 4.59 for social anxiety symptoms. Those extreme skewness levels may be explained by most people scoring very low on anxiety symptom levels, indicated by the low means of the highly skewed variables compared to the other variables, and visual inspection using histograms (see Table 3). However, most variables showed no extreme tail-ness in their distributions, demonstrated by the kurtosis values below the cut-off score of 7. Unsurprisingly, the anxiety disorders showed heavily positively tailed distributions ranging from 14.1 for generalized anxiety to 20.85 for social anxiety. Again, after inspecting the skewness, histograms, and kurtosis, people rarely scored higher than 0 on the anxiety variables, leading to heavily skewed and tailed distributions. Appropriate nonparametric statistical tests that can handle such distributions were used to accommodate the skewed and heavy-tailed distributions.

[1] The three separate datasets collected before the pandemic (Wave 3), additional questionnaires of Wave 3 and during the first lockdown from 30.03.2020 until 23.04.2020 (Q1) were combined into one dataset to ensure efficient analysis. To ensure that the news of an emerging virus did not influence people's anxiety, those who filled out Wave 3 after the first news reports of Covid-19 set for convenience to the 01.01.2020 were excluded listwise from the data set for Wave 3 and its additional questions. This step reduced the sample size from 65458 (Wave 3) to 2119 and 56159 to 1539 (additional questions). In the next step, the three datasets were combined; people who did not fill out Wave 3 and the additional questions were excluded listwise from the dataset.

Table 3

Descriptive Statistics and % of Missing Data for the Study Variables

Baseline characteristics	*M*	*SD*	Skewness	Kurtosis	Range	*n*	%	% missing data
Pre anxiety	2.1	3.1	1.47	1.03	0-11			0
Lockdown anxiety	0.8	1.5	1.98	3	0-6			30.1
Age	54.3	12.7	-0.26	-0.34	19-89			1.6
Connection	0.8	1	-0.8	0.55	-2-2			29.3
Generalized anxiety	5.9	14.5	3.56	14.1	0-110			2.3
Isolation	3.6	2.4	0.07	-1.18	0-9			32.2
Agoraphobia	0.2	0.7	4.34	18.93	0-4			2.2
Panic disorder	0.8	2.7	4.42	19.53	0-19			2.1
Social anxiety	0.2	0.7	4.59	20.85	0-4			1.9
Worry	6.3	2.9	0.21	0.24	0-16			28.8
Health	1.3	0.8	0.31	0.07	-1-3			12.5
Gender								1.6
Female						1333	61.9	
Education								28.6
Practical						88	4.1	
Medium						551	25.6	
High						880	40.9	
Other						19	0.9	
Anxiety levels								-
Non						1037	48.2	
Low						692	32.1	
Medium						273	12.7	
High						151	7	
Chronic Illness								31.6
Present						411	27.9	
Anxiety change pre-pandemic to lockdown								30.1

Baseline characteristics	*M*	*SD*	Skewness	Kurtosis	Range	*n*	%	% missing data
Decrease						431	28.6	
Stable						984	65.4	
Increase						90	6	

Correlations

The Spearman correlation coefficients between the outcome variable (anxiety T_1) and its predictors (e.g., anxiety T_2) were small to medium in size (see Table 4). Participants' age, perceived level of health, level of education, and feelings of connection to others showed small negative correlations ranging from r = -.01 (p > .05, education) to r = -.18 (p < .001, perceived health). This shows that although weak in strength, the older, and healthier, and more connected participants felt, the less likely they were to feel anxious during the lockdown period. On the other hand, feelings of isolation and symptoms of agoraphobia were associated with anxiety during the lockdown (r = .19, p < .001, r = .17, p < .001). The rest of the anxiety disorders and panic disorder symptoms showed a medium-sized association with lockdown anxiety, ranging in size from r = .21, p < .001 for panic disorder to r = .29, p < .001 for generalized anxiety disorders. Besides the anxiety and panic disorders, worry and anxiety before the pandemic (both r = .39, p < .001) showed the strongest correlations with anxiety during the lockdowns.

Table 4

Correlations for Study Variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13
1. Pre anxiety	-												
2. Lockdown anxiety	**.39**	-											
3. Anxiety level	**.98**	**.37**	-										
4. Age	**-.16**	**-.14**	**-.14**	-									
5. Education	-.00	-.01	.01	**-.29**	-								
6. Connection	**-.14**	**-.09**	**-.14**	**.31**	**-.14**	-							
7. Generalized anxiety	**.52**	**.29**	**.51**	**-.15**	.01	**-.13**	-						
8. Agoraphobia	**.24**	**.17**	**.23**	-.01	-.07*	.01	**.17**	-					
9. Panic disorder	**.32**	**.21**	**.31**	**-.14**	.02	-.05*	**.26**	**.40**	-				
10. Social anxiety	**.29**	**.21**	**.28**	**-.10**	.01	**-.09**	**.21**	**.18**	**.24**	-			
11.Isolation	**.12**	**.19**	**.11**	**-.09**	.05	-.01	**.12**	**.08**	.07*	**.07**	-		
12. Worry	**.21**	**.39**	**.20**	-.04	-.05	.12	**.19**	**.12**	**.10**	**.08**	**.34**	-	
13. Health	**-.31**	**-.18**	**-.30**	-.05*	**.14**	.06*	**-.33**	**-.15**	**-.17**	**-.13**	**-.07**	**-.18**	-

Note. Correlations significant at $^{*}p < .05$ and from $p < .001$ depicted in bold.

Missing Data

The descriptive statistics analysis revealed substantial missing data (Table 3). That lockdown anxiety had 30.1% missing data was concerning. However, steps were taken to handle this issue. To investigate the type of missing data and reasons for the missingness, participants who filled out both questionnaires were compared to those who only filled out the first questionnaire. The Wilcoxon signed rank test showed a significant difference between the drop-outs and completers for the variables age, generalized anxiety, worry, and pre-anxiety. People who filled out both waves were significantly older than the drop-outs ($M = 53.9$, $M = 51$, $W = 533462$, $p < .001$). For the other variables, the drop-outs scored

significantly higher on generalized anxiety (M = 6.6, M = 5.8, W = 422111, p <.001) worry (M = 6.7, M =6.2, W = 51102, p = .047) and pre-pandemic anxiety (M = 2.5, M = 1.96, W = 437739, p < .001) than completers. People who dropped out before completing the second questionnaire were older, more anxious, and more worried than the completers at the initial measurement.

Since the underlying reason for the drop-outs (pre-pandemic anxiety) was related to the outcome variable (lockdown anxiety), the missing data in the generalized anxiety, and lockdown anxiety was assumed to be MNAR. This could have potentially biased the results; thus, it was essential to appropriately handle this problem. Based on the minimal missing data in the remaining variables and a visual analysis of the missing data pattern, it was assumed that the remaining missing data were MAR. Although multiple imputations are commonly used to impute MAR data, the same theoretical framework can apply to MNAR data (Van Buuren, 2018). Thus, multiple imputation is fitting to impute all missing data in this sample (Van Buuren & Groothuis-Oudshoorn, 2011). According to Van Buuren (2018), the number of multiple imputations should equal the average percentage of missing data or fall within the range of 20 to 100. To be cautious, the number of multiple imputations was set to 50. Visually inspecting the convergence and other graphs to check the plausibility of the imputed data did not reveal any cause for concern, ensuring the reliability of the results.

Multicollinearity

The variance inflation factors (VIF) were calculated for all variables present in the models; since the multiple imputation method resulted in 50 individual datasets, the VIF was calculated for each variable in each dataset. Afterward, the VIF scores were manually checked. The highest VIFs were between 1.5 and 1.6, thus not exceeding the cut-off score of 5, indicating no problematic multicollinearity among the variables. This means that the

independent variables in the model are not highly correlated with each other, which is a positive sign for the validity of the model.

Primary Analysis: Generalized Estimating Equation

Before utilizing the more sophisticated GEE, I used a Wilcoxon signed rank test to test the first hypothesis (H1) that people experienced a decrease in anxiety from pre-pandemic times to the first lockdown. Since pre-pandemic anxiety was measured with 11 items and lockdown anxiety with six, it is logical that people were likely to score higher on pre-pandemic anxiety than lockdown anxiety. Simply comparing the means of the two variables would be pointless; thus, the variables were standardized, and their medians compared using the Wilcoxon signed rank test; the median of the variables was Mdn = -0.38 for pre-pandemic anxiety and Mdn = -0.51 for lockdown anxiety. The Wilcoxon signed rank test showed a significant difference between the two variables' medians (W = 1885171, $p <$ .001). This means that the median score for lockdown anxiety was significantly lower than the median score for pre-pandemic anxiety, indicating a decrease in anxiety levels from before the pandemic to the first lockdown. To give concrete numbers to which this decrease in anxiety from pre-pandemic to lockdown times applied, change scores were calculated from the standardized scores. A standard deviation above the mean (M = 0.06, SD = 1.07) indicated an increase in anxiety and one standard deviation below the mean indicated a decrease in anxiety. Of all participants, 431 (28.6%) experienced a decrease in their anxiety symptoms from before the pandemic to the lockdown, 984 (65.4%) remained stable, and 90 (6%) increased in anxiety. Those findings provide first evidence of a decrease in anxiety levels during the lockdown period. In the next step the GEE models were executed:

Model 1: Crude Model

The first model examined the effects of different anxiety levels *before* the pandemic on anxiety during the first lockdown ($T_0 \rightarrow T_1$). In all models, people with high anxiety before

the pandemic were used as the reference group to which the other levels of anxiety were compared. The results showed that people without pre-pandemic anxiety had lower odds of experiencing anxiety during the lockdowns than people with high anxiety (*OR* = 0.15, 95% CI [0.12, 0.19], $p < .001$). This means that people without pre-pandemic anxiety were also less likely to suffer from anxiety during the lockdowns. The same held for people with low and medium anxiety before the pandemic compared to the people with high anxiety before the pandemic with odds ratios of *OR* = 0.35 (95% CI [0.29, 0.44], $p < .001$) and *OR* = 0.71 (95% CI [0.58, 0.87], $p < .010$), respectively (QIC was 2254.26).

Model 2: Crude Model + Demographics

In the second model, the demographic variables education, gender, and age were added to the crude Model 1. The association between pre-pandemic anxiety and lockdown anxiety remained significant; however, the odds of experiencing lower lockdown anxiety reduced slightly for people with no, low, and medium anxiety as compared to highly anxious people before the pandemic. The odds ratios for no, low, and medium pre-pandemic anxiety were *OR* = 0.17 (95% CI [0.13, 0.21], $p < .001$); *OR* = 0.37 (95% CI [0.3, 0.46], $p < .001$); and *OR* = 0.74 (95% CI [0.6, 0.91], $p = .021$), respectively. This implies that the lower one's anxiety was before the lockdown, the lower the odds that the person suffered from anxiety during the lockdown. Age was associated with slightly decreased odds of experiencing anxiety during the lockdowns (*OR* = 0.99, 95% CI [0.98, 0.99], $p = .010$). Although the odds are small, this means the older someone is, the less likely they experienced anxiety during the lockdown. Being female, on the other hand, increased one's odds of experiencing lockdown anxiety as compared to being male (*OR* = 1.40, 95% CI [1.18, 1.67], $p = .002$). People's education did not have a significant effect on their odds of experiencing anxiety during the lockdowns. Compared to Model 1, the QIC decreased to 2218.89, indicating that Model 2 fit the data better than Model 1.

Model 3: Model 2 + Anxiety Disorders

Along with the pre-pandemic anxiety levels and demographic variables age, gender, and education level, Model 3 contained the four anxiety disorders: agoraphobia, generalized anxiety, social anxiety, and panic disorder. As seen in Model 2, the association between the pre-pandemic anxiety levels and lockdown anxiety weakened further, with medium pre-pandemic anxiety no longer being a significant predictor of lockdown anxiety. The odds ratios for no, low, and medium pre-pandemic anxiety were $OR = 0.21$, 95% CI [0.16, 0.29], $p < .001$; $OR = 0.47$, 95% CI [0.36, 0.61], $p < .001$; and $OR = 0.85$, 95% CI [0.67, 1.07], $p = .26$, respectively. Besides those changes, the associations between the demographic variables and lockdown anxiety remained stable in their odds ratios and remained significant.

The precise odds ratios for the demographic variables were for being female: $OR = 1.41$, 95% CI [1.18, 1.68], $p = .002$, age: $OR = 0.99$, 95% CI [0.98, 1], $p = .020$, and the education levels practical: $OR = 3.67$, 95% CI [0.82, 5.02], $p = .260$, medium: $OR = 1.63$, 95% CI [0.71, 3.87], $p = .460$, and high: $OR = 1.36$, 95% CI [0.61, 3.21], $p = .660$. Agoraphobia symptoms were not significantly associated with lockdown anxiety $B = 0.07$, $SE = 0.04$, 95% CI [-0.02, 0.15], $p = .230$; thus, regardless of the number of agoraphobia symptoms present before the pandemic, lockdown anxiety was not affected. The same holds for the number of days generalized anxiety symptoms were present; no significant effect was found: $B = 0.00$, $SE = 0.00$, 95% CI [-0.00, 0.00], $p = .800$. However, social anxiety symptom presence was significantly associated with lockdown anxiety, $B = 0.13$, $SE = 0.04$, 95% CI [0.05, 0.2], $p = .040$. In other words, the more social anxiety symptoms were present pre-pandemic, the more likely the person experienced anxiety during the lockdown. Additionally, panic disorder symptoms were also positively and significantly associated with lockdown anxiety $B = 0.03$, $SE = 0.01$, 95% CI [0.01, 0.05], $p = .040$. This suggests that the more panic disorder symptoms someone experienced before the pandemic, the more likely they were to

also be anxious during the lockdown period. Once again, the QIC decreased to 2202.84, indicating that Model 3 has the best model fit.

Model 4: Model 3 + Anxiety Interactions

Model 4 contained all variables present in Model 3, with the additional interactions between pre-pandemic anxiety and the other anxiety-related variables. Consistent with the previous models, the anxiety levels showed significant associations with lockdown anxiety. Interestingly, the odds of experiencing lockdown anxiety based on no, low, or medium pre-pandemic anxiety were lower in this model than in the previous ones. The odds ratios for no anxiety, low anxiety, and medium anxiety were $OR = 0.18$, 95% CI [0.13, 0.24], $p < .001$; $OR = 0.39$, 95% CI [0.29, 0.51], $p < .001$; and $OR = 0.72$, 95% CI [0.56, 0.94], $p = .045$, respectively. Both being female and age remained very similar in their odds ratios and significance. As previously mentioned, education level did not have a significant association with lockdown anxiety; the same held for agoraphobia and generalized anxiety symptoms. However, including the pre-pandemic anxiety and other anxiety-related interaction terms resulted in panic disorder symptoms no longer showing a significant association with lockdown anxiety $B = 0.05$, $SE = 0.02$, 95% CI [0.00, 0.18], $p = .052$. Social anxiety symptoms' association with lockdown anxiety remained significant: $B = 0.22$, $SE = 0.09$, 95% CI [0.04, 0.39] $p = .044$. None of the interaction terms between pre-pandemic anxiety and the other anxiety-related variables yielded significant associations with lockdown anxiety. In other words, none of the anxiety-related variables moderated the relationship between pre-pandemic anxiety and lockdown anxiety; this conveys that the relationship between pre-pandemic anxiety and lockdown anxiety does not differ based on any of the anxiety-related variables. Adding the interaction terms decreased the QIC for Model 4, although only slightly, from 2202.84 to 2201.19.

Model 5: Model 3 + Lockdown related variables

Model 5 included lockdown anxiety and pre-pandemic anxiety levels, demographic variables, and anxiety-related variables, and now I added additional lockdown-related variables. Compared to Model 4, none of the predictor's relationships with lockdown anxiety changed meaningfully. Of the four lockdown-related variables, only worry significantly associated with lockdown anxiety $B = 0.21$, $SE = 0.02$, 95% CI [0.18, 0.24], $p < .001$. Consequently, if a person generally worried a lot during the lockdown, they were more likely to be anxious. Having no chronic illness had no significant effect on lockdown anxiety, $B = -0.01$, $SE = 0.09$, 95% CI [-0.17, 0.19], $p = .940$. Thus, not being chronically ill did not result in less anxiety during the lockdown. Although feeling connected to others showed a negative association with lockdown anxiety, this association was also not significant, thus feeling connected did not reduce peoples' lockdown anxiety $B = -0.09$, $SE = 0.04$, 95% CI [-0.18, -.01], $p = .074$. Feeling isolated from others during the pandemic was not significantly related to lockdown anxiety $B = 0.03$, $SE = 0.02$, 95% CI [-0.02, 0.07], $p = .164$. Therefore, feeling isolated during the lockdown prevented people from feeling more anxious. Lastly, while participants' perceived level of health was negatively related to lockdown anxiety, the relationship was not significant ($B = -.11$, $SE = 0.07$, 95% CI [-0.24, .02], $p = .166$). The QIC of Model 4 was the lowest, with 1900.328; this indicates that accounting for the model complexity, Model 4 fit the data best.

Sensitivity Analysis

Compared to the GEE models with imputed data, the models with the original data after deleting the missing cases listwise yielded no dramatically different results (see Appendix B). More specifically, except for being female losing significance in Model 2 and the intercept in Model 5 turning significant, the significance of the results did not change. Otherwise, some changes in the *B* values and Odds Ratios occurred: the intercept of Model 2

changed from *B* = 0.84, *SE* = 0.48, 95% CI [-0.09, 1.77], *p* = .207 to *B* = 1.16, *SE* = 0.65, 95% CI [-0.12, 2.44], *p* = .080. Furthermore, in Model 2 being female was no longer significant, the parameters went from *B* = 0.34, *SE* = 0.09, 95% CI [0.16, 0.52], *p* = .002 to *B* = 0.30, *SE* = 0.13, 95% CI [0.05, 0.55], *p* = .017. Additionally, in Model 5 the intercept went from *B* = -0.69, *SE* = 0.5, 95% CI [-1.67, 0.28], *p* = .311 to *B* = -1.66, *SE* = 0.83, 95% CI [-3.29, -0.03], *p* = .046. In Model 5 the odds ratios also increased for practical and medium education when running the analysis on the complete data, for practical education from *OR* = 1.26, 95% CI [0.5, 3.28], *p* = .773 to *OR* = 3.86, 95% CI [0.89, 16.75], *p* = .071, and for medium education from *OR* = 1.17, 95% CI [0.48, 2.91], *p* = .884 to *OR* = 2.81, 95% CI [0.70, 11.26], *p* = .144.

Post-Hoc Power Analysis

Using the G*Power 3.1 software, I calculated the post hoc power for the analysis. Given the complexity and sheer number of predictors (13), I focused my analysis on the most relevant predictor, no pre-pandemic anxiety. For each model, the power was calculated based on the Wilcoxon signed rank test to account for the nonparametric nature of the data. The result showed that at a significance level (α) of .05 with 2153 participants, the achieved power (1-ß) was 1, meaning a 100% probability of correctly rejecting the null hypothesis when a true effect is present. This high power is due to the large sample size, and it offers the opportunity to detect negligible effects in this study.

Table 5

GEE Models for the Outcome Lockdown Anxiety With Multiple Imputed Data

	B	95% CI		*p*	*SE*	Wald chi square	*OR*	95% CI		QIC
		LL	UL					LL	UL	
Model 1										2254.26
Intercept	0.80	0.65	0.96	< .001	0.08	106.91	2.23	1.92	2.60	
Pre-pandemic anxiety										
No	-1.90	-2.13	-1.66	< .001	-1.9	255.7	0.15	0.12	0.19	

	B	95% CI		*p*	*SE*	Wald chi square	*OR*	95% CI		QIC
		LL	UL					LL	UL	
Low	-1.04	-1.24	-0.83	< .001	0.1	100.86	0.35	0.29	0.44	
Medium	-.34	-0.55	-.141	.008	0.1	11.35	0.71	0.58	0.87	
High	0									
Model 2										2218.89
Intercept	0.84	-0.09	1.77	.207	0.48	5.58	2.59	1.1	6.29	
Pre-pandemic anxiety										
No	-1.81	-2.05	-1.57	< .001	0.12	224.72	0.17	0.13	0.21	
Low	-0.99	-1.20	-0.78	< .001	0.11	89.32	0.37	0.3	0.46	
Medium	-0.30	-0.52	-0.09	.021	0.11	8.76	0.74	0.6	0.91	
High	0									
Female	0.34	0.16	0.52	.002	0.09	14.43	1.40	1.18	1.67	
Age	-0.01	-0.02	-0.01	.010	0.00	14.87	0.99	0.98	0.99	
Education										
Practical	0.62	-0.34	1.58	.296	0.49	1.91	1.95	0.74	5.34	
Medium	0.40	-0.50	4.1	.507	0.46	1.23	1.57	0.63	4.1	
High	0.20	-0.69	1.08	.734	0.45	0.91	1.29	0.52	3.34	
Model 3										2202.84
Intercept	0.47	-0.43	1.35	.481	0.45	2.83	1.8	0.78	4.23	
Pre-pandemic anxiety										
No	-1.56	-1.86	-1.26	< .001	0.16	106.30	0.21	0.16	0.29	
Low	-0.77	-1.03	-0.5	< .001	0.14	32.95	0.47	0.36	0.61	
Medium	-0.17	-0.4	0.07	.256	0.12	2.52	0.85	0.67	1.07.	
High	0									
Female	0.34	0.17	0.52	.002	0.10	14.88	1.41	1.18	1.68	
Age	-0.01	-0.02	-0.00	.020	0.00	12.35	0.99	0.98	1	
Education										
Practical	0.64	-0.21	1.52	.261	0.45	2.45	3.67	0.82	5.02	
Medium	0.42	-0.39	1.23	.462	0.41	1.65	1.63	0.71	3.87	
High	0.25	-0.56	1.05	.663	0.41	1.17	1.36	0.61	3.21	
Agoraphobia	0.07	-0.02	0.15	.231	0.04	2.95	1.07	0.98	1.16	
Generalized anxiety	0.00	-0.00	0.00	.796	0.00	0.42	1	1	1	
Social anxiety	0.13	0.05	0.2	.040	0.04	10.67	1.13	1.05	1.22	
Panic disorder	0.03	0.01	0.05	.036	0.01	6.29	1.03	1.01	1.05	
Model 4										2201.19
Intercept	0.56	-0.31	1.44	.391	0.45	3.53	1.98	0.87	4.62	
Pre-pandemic anxiety										
No	-1.74	-2.04	-1.44	< .001	0.15	130.38	0.18	0.13	0.24	
Low	-0.95	-1.23	-0.67	< .001	0.14	45.68	0.39	0.29	0.51	
Medium	-0.33	-0.59	-0.07	.045	0.13	6.77	0.72	0.56	0.94	
High	0									
Female	0.33	0.16	0.51	.003	0.09	14.17	1.41	1.17	1.66	
Age	-0.01	-0.02	-0.00	.023	0.00	11.84	0.99	0.98	1	
Education										
Practical	0.69	-0.17	1.55	.228	0.44	2.83	2.1	0.87	5.21	
Medium	0.46	-0.33	1.26	.423	0.41	1.96	1.71	0.75	3.99	
High	0.29	-0.50	1.08	.615	0.40	1.36	1.43	0.63	3.31	
Agoraphobia	0.13	-0.04	0.31	.262	0.09	3.09	1.15	0.96	1.37	
Generalized anxiety	0.01	-0.01	0.02	.428	0.01	1.48	1.01	1.01	1.02	
Social anxiety	0.22	0.04	0.39	.044	0.09	6.71	1.25	1.05	1.48	
Panic disorder	0.05	0.00	0.18	.052	0.02	5.04	1.05	1	1.11	

	B	95% CI		*p*	*SE*	Wald chi square	*OR*	95% CI		QIC
		LL	UL					LL	UL	
Pre-anxiety*Agoraphobia	-0.01	-0.03	0.01	.539	0.01	1.27	0.99	0.97	1.01	
Pre-anxiety *Panic disorder	-0.00	-0.01	0.00	.219	0.00	2.17	1	0.99	1	
Pre-anxiety *Social anxiety	-0.01	-0.04	0.01	.331	0.01	2.24	0.99	0.97	1.01	
Pre-anxiety *Generalized anxiety	-0.00	-0.00	0.00	.486	0.00	1.25	1	1	1	
Model 5										1900.33
Intercept	-0.69	-1.67	0.28	.311	0.5	2.58	0.55	0.22	1.43	
Pre-anxiety										
No	-1.31	-1.61	-1.02	< .001	0.15	76.94	0.27	0.2	0.36	
Low	-0.69	-0.95	-0.43	< .001	0.13	27.94	0.50	0.39	0.65	
Medium	-0.25	-0.49	-0.01	.087	0.12	4.53	0.78	0.62	0.99	
High										
Female	0.27	0.10	0.45	.013	0.09	10.16	1.32	1.11	1.56	
Age	-0.01	-0.02	-0.00	.032	0.00	10.09	0.99	0.98	1	
Education										
Practical	0.17	-0.74	1.08	.773	0.46	0.74	1.26	0.5	3.28	
Medium	0.09	-0.76	0.94	.884	0.43	1.04	1.17	0.48	2.91	
High	-0.07	-0.91	0.77	.908	0.43	1.24	1	0.42	2.46	
Agoraphobia	0.01	-0.08	0.09	.872	0.04	0.64	1.01	0.93	1.1	
Generalized anxiety	-0.00	-0.01	0.00	.761	0.00	0.47	1	0.99	1	
Social anxiety	0.12	0.05	0.2	.004	0.04	10.2	1.13	1.05	1.22	
Panic disorder	0.01	-0.01	0.03	.511	0.01	1.32	1.01	0.99	1.03	
No chronic illness	-0.01	-0.17	0.19	.940	0.09	0.53	1.01	0.84	1.21	
Connection	-0.09	-0.18	-0.01	.074	0.04	5.55	0.91	0.84	0.99	
Isolation	0.03	-0.01	0.07	.164	0.02	2.56	1.03	0.99	1.07	
Health	-0.11	-0.24	0.02	.166	0.07	3.35	0.90	0.79	1.02	
Worry	0.21	0.18	0.24	< .001	0.02	207.7	1.23	1.2	1.27	

Discussion

I fit this exploratory prospective study to investigate changes in peoples' anxiety from before the pandemic to the first lockdown of the COVID-19 pandemic among 2153 participants of the Lifelines sample. My comparison of pre-pandemic anxiety versus lockdown anxiety showed a significant decrease in median anxiety scores from pre-pandemic to lockdown times (using the Wilcoxon signed-rank test). Generalized estimating equations (GEE) and splitting the participants into groups based on pre-pandemic anxiety symptoms severity revealed that less pre-pandemic anxiety symptoms made people less likely to suffer

from anxiety during the pandemic lockdown. Thus, the lower the number of one's anxiety symptoms before the pandemic, the lower their odds of being anxious during the pandemic, and this change also applied to people with pre-existing anxiety. Therefore, I conclude that some people (28.6%) were less likely to experience anxiety during the lockdowns, indicating that pre-pandemic anxiety influenced the impact of the lockdown on anxiety.

The second research question aimed to answer which factors influenced people's anxiety during the lockdown. From the selected group of factors, worrying, suffering from social anxiety, and being a woman increased the odds of also suffering from anxiety during the lockdowns significantly. Whereas age decreased said odds. However, the rest of the predictors and interaction terms between the anxiety-related variables and pre-pandemic anxiety did not yield significant results in the final Model 5. However, panic disorder was also a significant predictor of lockdown anxiety in Model 2.

Interestingly, we could assume that social anxiety would be associated with a decrease in lockdown anxiety since less contact could translate into less anxiety-inducing interactions for socially anxious people. However, possibly contracting a virus and COVID-19 measures such as social distancing and wearing masks might have made dreadful social situations even more uncomfortable for socially anxious individuals, thus increasing their anxiety. A different explanation is offered by Eres et al. (2023), who found a significant association between loneliness and social anxiety. Due to the decrease in social contact, socially anxious people may have felt lonelier, which exacerbated their anxiety, leading to the results found in this study. Furthermore, social contact is identified as a coping strategy that may help people reduce their anxiety (Roohafza et al., 2014). Altogether, the findings of this study add to the body of research linking the pandemic to an increase and decrease in anxiety during the lockdown.

This study offers practical and theoretical implications. Since a portion of the sample decreased in anxiety from before the pandemic to the lockdown, some people may benefit from a short break from society by, for example, working from home. However, it is essential to consider the findings by Eres et al. (2023), which suggest that such breaks could lead to increased loneliness and worsened mental health. This study's contribution to the research on the COVID-19 pandemic, long bouts of isolation, and anxiety are multifaceted. The main contribution of this research is offering a new perspective on the conflicting evidence for and against improving anxiety during the pandemic. This study shows both are correct: around one third of people experienced an improvement in their anxiety, while others did not. Not only do those findings show the complexity of anxiety, but also how different levels and dynamics of anxiety deserve attention. For individuals, these findings can inform decisions about how to manage their anxiety, such as by taking breaks from social interactions but also being mindful of the potential for increased loneliness.

Furthermore, panic disorder and social anxiety symptoms being associated with an increase in anxiety during the lockdowns point out that even a lack of triggers in the immediate environment does not reliably result in a decrease in the specific anxiety. Thus, a sufferer of social anxiety may not feel less anxious by, for example, simply avoiding interactions with people, as other factors seem to play a role. Altogether, this study could bring clarity to peoples' anxiety experiences during the pandemic and also discover new questions to answer in future research.

From this reasoning, future research recommendations can be derived. The relationship between isolation and anxiety could be studied in an experience sampling study, shedding light on the relationship between anxiety and factors such as loneliness and enjoyable solitude as risk and protective factors of anxiety. Furthermore, it would be exciting to validate the results of this study by examining the long-lasting effects of isolation on

anxiety after the lockdown period and how anxiety varied across the different lockdowns. This way, we can study the impact of the lockdowns and the pandemic on mental health and its persistence, identifying potential harm to mental health and how to treat it. Another compelling study could explore if isolation on a personal or societal level differs; if everyone is isolated, one is most likely not missing out on social activities, and thus, the social isolation may not come at such a social, and work-related cost as if an individual is alone in their isolation. In other words, the perceived and objective costs of isolating oneself may be lower if everyone else is forced to join and too costly to experience if not everyone else is in lockdown. Additionally, conducting a qualitative study on people's anxiety during the COVID-19 pandemic, or future pandemics, could offer more detailed insights into the relationship between anxiety and its risk and protective factors. To summarize, this knowledge would validate and extend the knowledge gained from this research and benefit people in maintaining healthy mental spaces.

In the light of handing out theoretical and practical implications, as well as future research directions, it is essential to acknowledge the limitations of this study. First, the measurement of anxiety differed between the two time points (pre-pandemic and lockdown); this may affect the comparability of the data. Before the pandemic, anxiety was assessed using 11 items from the MINI asking about the past 30 days, while during the lockdown, a subset of six items from the MINI was used, asking about the past 7 days. Despite the lockdown items being included in the pre-pandemic questionnaire, the difference in the asked period (30 days vs. 7 days) and the reduced number of items may have introduced measurement inconsistencies. This variation might influence the observed differences in anxiety levels. The second limitation of this study is the technical limitations experienced during data analysis. R and SPSS could not fit standardized data into the GEE models. Therefore, I could not run the GEE models on the standardized data, which hindered my

findings' interpretability, robustness, and generalizability. Although the unstandardized models ran without problems and results were obtained, future research should aim to conduct their analysis on standardized values, especially with differences in measurement instruments for the same construct.

Conclusion

To summarize, compared to high anxiety, people with medium, low, and no anxiety had lower odds of experiencing anxiety during the lockdowns. Different factors such as age or gender can place one at risk or protect from anxiety during the lockdown periods. However, the strength of those findings may be impacted by some shortcomings in the methodology. The results highlight the complexity of mental health during pandemic lockdowns and, as always, express the need for future research to understand the complex dynamics between mental health and isolation fully.

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*Note: Studies marked with as asterisk * are included in the review*

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Appendix A

Information Gathered From the Scoping Review

Citation	Sample	Country	Study design	Date of collections	Type of analysis	How was anxiety assessed	Anxiety	Protective factors	Risk factors
(Dickerson et al., 2022)	1860 Pakistani mothers	UK	Longitudinal with two time points	(T1): 24.06.2017, (T2): 10.04.2020 - 30.06.2020	Logistic regression	GAD-7	Number of anxious mothers increased from 10% (n = 167) to 16% (n = 289).	-	Financial insecurity (OR = 6.03), food insecurity (OR = 3.46), housing insecurity (OR = 3.0), loneliness (OR = 8.5), no social support (OR = 2.13), no physical activity (OR = 2.55)
(Shi et al., 2022)	7958; age M = 11.74; 51.67% male	China	Cross-sectional	(T1): 23.12.2019–13.01.2020, (T2): 16.06.–08.07.2020	Cross-lagged structural equation modeling	SCARED	Anxiety at T1 was significantly associated with higher anxiety at T2 β = .373, SE = 0.076, ES = 0.373, p < .001	Family mutuality r = -.196, p < .001	--
(Evans et al., 2021)	254 undergraduates (86,22%); 18-31 years old; M = 19.76	UK	Longitudinal with two time points	(T0): autumn 2019, (T1): 04./05. 2020	Repeated measures ANOVA	Hospital Anxiety and Depression Scale (HADS)	No significant link between anxiety at T0 to T1.	-	--
(Barendse et al., 2022)	1339 adolescents (9–18 years old; 59% female, age M = 13.5 years	10 U.S., 1 Netherlands, 1 Peru	Longitudinal with two to ten time points	(T0): 01.2016 – 10.2019, (T1): 04.2020-09.2020	Linear mixed effect models	PROMIS Anxiety Scale, POMS Tension SCARED, MASC (pre)/CASPE- negative emotion (mid), RCADS Generalized Anxiety Scale, GAD-7, MASC-2	Pre-anxiety associated with anxiety during the lockdowns (b = 0.05, SE = 0.01, t(11) = 5.09, p < .001).		Restriction not significantly associated with less decrease in anxiety symptoms b = -0.01, SE = 0.01, t (11) = 1.28, p = .20
(Lu et al., 2022)	613, 50.4% female, age M = 58.1 years	France	Longitudinal with three time points	(T0): 11.2014 – 12.2019, (T1): 04.-05.2020, (T2): 10.-12.2020	Kruskal–Wallis test, Latent class mixed models	GAD-7	Significant increase in anxiety across T1 (M = 2.37, SD = 3.47) and T2 (M = 2.82, SD = 3.60) compared to T0 (M = 1.96, SD = 2.87).	-	--
(Di Gessa & Price, 2022)	5146 ≥50 years old	UK	Longitudinal with three time points	(T0): 2018/2019, (T1): 06./07.2020, (T2): 11./12.2020	Nested logistic or linear models	GAD-7	Staying at home was not significantly associated with an increase in anxiety OR = 1.18, 95% CI [0.80, 1.74], p > .05.	-	Shielding was associated with higher odds of anxiety symptoms when controlled for demographics OR = 4.37, 95% CI [2.54, 7.52], p < .001. Otherwise not.

Appendix B

Table of GEE Models With Complete Data

	B	95% CI		*p*	*SE*	Wald chi square	*OR*	95% CI		QIC
		LL	UL					LL	UL	
Model 1										1570.96
Intercept	0.75	0.54	0.95	< .001	0.11	49.09	2.11	1.71	2.68	
Pre-pandemic anxiety										
No	-1.86	-2.15	-1.56	< .001	0.15	151.29	0.16	0.12	0.21	
Low	-1.01	-1.27	-0.74	< .001	0.14	56.11	0.37	0.28	0.48	
Medium	-0.30	-0.57	-0.03	.027	0.14	4.98	0.74	0.57	0.97	
High	0									
Model 2										1183.43
Intercept	1.16	-0.12	2.44	.08	0.65	3.16	3.19	0.88	11.49	
Pre-pandemic anxiety										
No	-1.69	-2.04	-1.34	< .001	0.18	88.57	0.18	0.13	0.26	
Low	-0.92	-1.24	-0.61	< .001	0.16	33.16	0.47	0.29	0.55	
Medium	-0.29	-0.61	0.04	.089	0.17	2.89	0.75	0.54	1.05	
High										
Female	0.30	0.05	0.55	.017	0.13	5.66	1.35	1.05	1.73	
Age	-0.02	-0.03	-0.01	.001	0.01	10.33	0.99	0.98	0.99	
Education										
Practical	0.44	-0.93	1.82	.527	0.70	0.40	1.56	0.41	6.15	
Medium	0.20	-1.05	1.45	.754	0.64	0.17	1.22	0.35	4.28	
High	-0.01	-1.25	1.24	.991	0.64	0.00	0.99	0.29	3.45	
Model 3										1149.25
Intercept	0.74	-0.43	1.98	.21	0.59	1.55	2.09	0.65	6.78	
Pre-pandemic anxiety										
No	-1.47	-1.95	-0.99	< .001	0.25	33.45	0.23	0.14	0.37	
Low	-0.68	-1.11	-0.25	.002	0.22	9.46	0.51	0.33	0.78	
Medium	-0.15	-0.54	0.23	.438	0.26	0.60	0.86	0.58	1.26	
High										
Female	0.28	0.03	0.53	.026	0.13	4.98	1.33	1.04	1.78	
Age	-0.01	-0.02	-0.01	.003	0.01	8.88	0.99	0.98	1.04	
Education										
Practical	0.59	-0.61	1.86	.336	0.62	0.93	1.81	0.54	6.03	
Medium	0.29	-0.77	1.36	.589	0.55	0.29	1.34	0.46	3.91	
High	0.11	-0.95	1.17	.844	0.54	0.04	1.11	0.39	3.21	
Agoraphobia	0.06	-0.08	0.19	.391	0.07	0.74	1.06	0.93	1.21	
Generalized anxiety	-0.00	-0.01	0.01	.870	0.00	0.03	1	0.99	1.01	
Social anxiety	0.15	0.05	0.26	.005	0.05	7.77	1.16	1.05	1.29	
Panic disorder	0.04	0.00	0.08	.043	0.02	4.08	1.04	1.00	1.08	
Model 4										1148.21
Intercept	0.90	-0.24	2.04	.121	0.58	2.40	2.46	0.79	7.68	
Pre-pandemic anxiety										
No	-1.87	-2.26	-1.34	< .001	0.24	58.56	0.17	0.10	0.26	
Low	-1.01	-1.49	-0.58	< .001	0.22	20.97	0.36	0.24	0.56	
Medium	-0.44	-0.85	-0.03	.035	0.21	4.46	0.64	0.43	0.97	
High										
Female	0.27	0.02	0.52	.032	0.13	4.59	1.31	1.02	1.78	
Age	-0.02	-0.03	-0.01	.003	0.01	8.99	0.99	0.98	1.14	
Education										
Practical	0.69	-0.50	1.89	.256	0.61	1.29	2	0.60	6.62	

	B	95% CI		*p*	*SE*	Wald chi square	*OR*	95% CI		QIC
		LL	UL					LL	UL	
Medium	0.42	-0.64	1.49	.436	0.54	0.61	1.53	0.53	4.42	
High	0.23	-0.82	1.28	.670	0.54	0.18	1.26	0.44	3.65	
Agoraphobia	0.09	-0.17	0.35	.506	0.13	0.44	1.09	0.84	1.41	
Generalized anxiety	0.01	-0.00	0.03	.102	0.01	2.68	1.01	1.16	1.03	
Social anxiety	0.21	-0.03	0.45	.080	0.12	3.07	1.24	1.17	1.57	
Panic disorder	0.07	-0.00	0.14	.062	0.04	3.48	1.07	1.16	1.15	
Pre-anxiety*Agoraphobia	0.00	-0.03	0.04	.896	0.02	0.02	1.00	0.97	1.04	
Pre-anxiety *Panic disorder	-0.01	-0.02	0.00	.235	0.01	1.41	0.99	0.99	1.00	
Pre-anxiety *Social anxiety	-0.01	-0.04	0.02	.580	0.02	0.31	0.99	0.96	1.02	
Pre-anxiety *Generalized anxiety	-0.00	-0.00	0.00	.047	0.00	3.94	1.17	1.15	1.00	
Model 5										849.32
Intercept	-1.66	-3.29	-0.03	.046	0.83	3.99	0.19	0.04	0.97	
Pre-anxiety										
No	-1.21	-1.69	-0.73	< .001	0.24	24.62	0.38	0.19	0.48	
Low	-0.67	-1.11	-0.24	.002	0.22	9.35	0.51	0.33	0.79	
Medium	-0.25	-0.66	0.15	.220	0.21	1.51	0.78	0.52	1.16	
High										
Female	0.27	0.01	0.52	.039	0.13	4.26	1.3	1.01	1.68	
Age	-0.01	-0.03	-0.00	.012	0.01	6.34	0.99	0.98	1.06	
Education										
Practical	1.35	-0.12	2.82	.071	0.75	3.26	3.86	0.89	16.75	
Medium	1.03	-0.35	2.42	.144	0.71	2.13	2.81	0.70	11.26	
High	0.83	-0.56	2.22	.242	0.71	1.37	2.29	0.57	9.17	
Agoraphobia	-0.07	-0.24	0.16	.403	0.09	0.78	0.93	0.79	1.10	
Generalized anxiety	-0.00	-0.01	0.01	.599	0.00	0.28	1.18	0.99	1.01	
Social anxiety	0.19	0.08	0.30	< .001	0.06	11.56	1.21	1.08	1.35	
Panic disorder	0.03	-0.01	0.06	.135	0.02	2.24	1.03	0.99	1.06	
No chronic illness	0.00	-0.28	0.28	.994	0.14	0.00	1.00	0.76	1.32	
Connection	-0.08	-0.20	0.04	.181	.06	1.79	0.92	0.82	1.04	
Isolation	0.03	-0.02	0.09	.244	.03	1.36	1.03	0.98	1.09	
Health	-0.07	-0.28	0.13	.486	.10	0.49	0.93	0.76	1.14	
Worry	0.23	0.18	0.28	< .001	.02	92.31	1.26	1.20	1.32	