Bachelor Thesis

The impact of pandemic restrictions on mental health during COVID-19 in Germany

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Abstract

The impact of the COVID-19 pandemic on mental health is a major concern worldwide. This study examines the impact of pandemic restrictions on mental health during the COVID-19 pandemic in Germany. The unique strength of this study lies in the extensive dataset of over 500,000 responses obtained from the Global UMD CTIS data in conjunction with the complementary German Corona data. Using this data, we examine the association between pandemic restrictions and levels of anxiety and depression, among other factors. Results indicate that the overall impact of pandemic restrictions on mental health was small to minimal. Remarkably, my findings deviate from some previous research, revealing a discrepancy between my results and the prevailing literature. The general containment measures derived from the German Corona data showed a significant small positive association with anxiety and depression, suggesting that increased stringency of restrictions was associated with higher levels of anxiety and depression. However, the effects of other pandemic restrictions, such as mask obligations and restrictions on schools and daycare centers, showed limited associations with anxiety and depression levels. In addition, age, gender, education level, employment status, and place of residence were significant factors influencing mental health outcomes. These findings highlight the need for a comprehensive understanding of the multiple factors affecting mental health during the pandemic. They also provide a new perspective on the impact of pandemic restrictions and contribute to targeted interventions and support strategies to promote mental well-being in similar contexts.

Contents

1. Introduction

The COVID-19 pandemic has had a profound impact on many aspects of society, including mental health outcomes. Several studies and meta-studies also found that there was a significant but statistically small increase in general mental health symptoms after the COVID-19 outbreak, as well as an increased prevalence of depression in the general population (Bueno-Notivol et al., 2021; Ettman et al., 2020; McGinty et al., 2020; Robinson et al., 2022). Governments around the world had implemented a range of measures to contain the spread of the virus, including pandemic restrictions such as lockdowns, school closures, and mask mandates (see subsection 2.1.2 for more details on restrictions during COVID-19 in Germany). While these restrictions have been critical to public health, their impact on mental well-being has been the subject of intense research, with mixed results from different studies, ranging from no effect to strongly negative. (Prati & Mancini, 2021). Understanding the impact of these restrictions on mental health is essential not only for managing the immediate effects of the COVID-19 pandemic, but also for developing future response strategies.

This paper seeks to analyze the impact of pandemic restrictions on mental health during COVID-19 in Germany, building on a theoretical framework that encompasses the measurement of mental health, the specific restrictions implemented in Germany, and their influence on mental well-being. This study is distinguished by its use of a large and robust dataset of over 500,000 responses, which exceeds the sample size of most comparable studies. The data sources include the Global COVID-19 Trends and Impact Survey (CTIS) and Corona data Germany (Kreuter et al., 2020; Statistisches Bundesamt, 2023). Both data sets were measured on a daily basis, making it possible to link daily pandemic measures at the state level to individual mental health, which was assessed through a few very simple questions due to time constraints in the survey. The observation period spans from May 20, 2021 to June 25, 2022, allowing for a thorough examination of the relationship between pandemic restrictions and mental well-being.

This research paper is structured into three main sections. The first section provides a theoretical framework, covering the measurement of mental health, the influence of pandemic restrictions on mental well-being, and the specific context of COVID-19 in Germany. It also introduces the Global COVID-19 Trends and Impact Survey (CTIS) and the Corona data Germany, focusing on the measures index of the federal states per day. The next section presents the methods and results. It outlines the data structure and types, describes the analysis conducted to examine the association between mental health variables and restriction data, and discusses the modeling techniques used. The final section of this paper summarizes the findings on the impact of pandemic restrictions on mental health during COVID-19 in Germany, discusses the limitations of the study, and suggests directions for further research.

2. Theory and materials

2.1. Theoretical Framework

The theory section of this paper provides a framework for understanding the complex interplay between restrictions and mental health during the COVID-19 pandemic. This section begins by examining different measurements of mental health and the various approaches used to assess the psychological well-being of individuals. By exploring these measurement approaches, a framework is established for evaluating the impact of pandemic restrictions on mental health outcomes. Next, the analysis delves into the specific restrictions imposed during the COVID-19 pandemic in Germany, including social distancing guidelines, travel restrictions, and lockdown measures. By gaining a deeper understanding of the specific constraints faced by individuals in Germany, a clearer picture emerges regarding the challenges they encountered and the potential consequences on their mental well-being. We finally summarize previous resarch on the influence of these constraints on mental health outcomes, taking into account a broader context that extends beyond Germany. Examining existing literature and empirical evidence, we explore the psychological effects of prolonged isolation, disruptions in daily routines, economic uncertainties, and fears related to the pandemic. We aim to achieve a comprehensive understanding of the complex interplay between restrictions and mental health during the COVID-19 pandemic by synthesizing these findings. Overall, the theoretical background presented in this section guides the subsequent analysis and modeling (sections 3.2 and 3.3), with the aim of shedding light on the impact of pandemic restrictions on mental health in the context of a global crisis.

2.1.1. Measurement of mental health

Measuring mental health is a complex and multifaceted process. A wide variety of instruments and methods are used to assess the psychological well-being of individuals, and the choice of instrument depends on the purpose of the assessment and the specific constructs being assessed. Mental health can be assessed at the individual or population level.

One common method is through self-report questionnaires, which are often used in both research and clinical practice. Self-report questionnaires involve individuals answering a series of questions about their thoughts, feelings, and behaviors, providing valuable insight into their mental state (Johnson et al., 2019). One widely used self-report measure of depression is the Patient Health Questionnaire (PHQ-9) (Kroenke et al., 2001). The PHQ-9 is a nine-item questionnaire that assesses symptoms such as depressed mood, loss of interest, and sleep disturbance. Participants rate the frequency of each symptom on a scale from 0 (not at all) to 3 (nearly every day), with higher scores indicating more severe symptoms. The PHQ-9 has demonstrated strong reliability and validity in clinical and research settings for measuring the severity of depression (Kroenke et al., 2001). Another commonly used self-report measure is the Generalized Anxiety Disorder-7 (GAD-7), which assesses symptoms of generalized anxiety disorder (Spitzer et al., 2006). The GAD-7 consists of seven items that assess symptoms such as worry, restlessness, and irritability. Participants rate the frequency of each symptom on a scale from 0 (not at all) to 3 (nearly every day), with higher scores indicating more severe symptoms. The GAD-7 has been shown to be a reliable and valid measure of generalized anxiety disorder in clinical practice and research (Spitzer et al., 2006).

Another common method of measuring mental health is through physiological measures (Charles & Nixon, 2019). One such measure is heart rate variability (HRV), a non-invasive physiological measure that reflects the variability in time between successive heartbeats. HRV has been used to assess the function of the autonomic nervous system (ANS), which is involved in regulating the body's physiological response to stress (Kemp & Quintana, 2013). HRV has been shown to be a sensitive indicator of psychological stress and has been used in research studies to assess the impact of stress on mental health outcomes.

The use of mobile applications to measure mental health is also becoming increasingly popular. These applications typically use smartphone surveys and sensors to measure and monitor various physiological and behavioral indicators of mental health, such as physical activity (Gaggioli et al., 2013). While mobile applications provide a convenient and accessible way to measure mental health, the validity and reliability of these measures have yet to be fully established.

During the COVID-19 pandemic, web-based surveys were used to assess the impact of the pandemic on mental health outcomes. One such survey conducted in China found high levels of anxiety, depression, and sleep disturbance among the general population (Huang & Zhao, 2020). Another cross-sectional study conducted in Germany revealed a noteworthy rise in symptoms of depression, anxiety, and distress, alongside a decline in overall health status since the onset of the COVID-19 pandemic (Bäuerle, Steinbach, et al., 2020).

The data for this study came from the Global COVID-19 Trends and Impact Survey (subsection 2.2), which was also a global COVID-19 symptom survey conducted online, in which the measurement of mental health played only a small role (Kreuter et al., 2020). These studies highlight the importance of using appropriate measurement tools and methods to assess the impact of the pandemic on mental health outcomes.
In summary, measuring mental health is a complex process that requires the use of appropriate tools and methods. Self-report questionnaires, physiological measures such as HRV, mobile applications and web-based surveys are all useful tools for assessing mental health outcomes. During the COVID-19 pandemic, web-based surveys were an essential tool for assessing the impact of the pandemic on mental health outcomes. The development of new and innovative measurement tools and methods is essential to improve the accuracy and reliability of mental health assessments.

2.1.2. Restrictions during COVID-19 in Germany

Since the beginning of the COVID-19 pandemic, the German government has implemented various restrictions to mitigate the spread of the virus. These restrictions have included measures such as social distancing, mandatory masks, limits on the number of people who can gather in public, mandatory remote work, and the closure of non-essential businesses (Bundesministerium für Gesundheit, 2023; Follmer, 2021). These measures were implemented to reduce the transmission of the virus, protect vulnerable populations, and prevent health care systems from being overwhelmed.
One of the first measures implemented in Germany was the closure of schools and universities. On March 13, 2020, the German government announced the closure of all schools and daycare facilities in the country, affecting more than 11 million students (Süddeutsche Zeitung, 2020). This measure was taken to reduce the risk of transmission among children and adolescents who were thought to be potential carriers of the virus, a claim that was not clearly proven (Liu et al., 2020; Zimmermann & Curtis, 2020).
In addition to closing schools, the German government also implemented a ban on large public gatherings. On March 22, 2020, the government announced that gatherings of more than two people would be banned (Bundesregierung, 2020b). This measure was intended to limit the spread of the virus in public spaces and reduce the burden on the health care system.
As the pandemic continued, the German government introduced additional measures to further restrict public life. In December 2020, Germany entered a strict lockdown, which included the closure of all non-essential businesses, a ban on all public gatherings, and the closure of schools and daycare facilities (Bundesregierung, 2020a). This lockdown was intended to reduce the number of COVID-19 cases during the holiday season, which was seen as a potential risk for increased transmission due to travel and social gatherings.
From April 23 to June 30, 2021, Germany implemented the Fourth Law for the Protection of the Population in an Epidemic Situation of National Significance, commonly known as the "Federal Emergency Brake", which included stricter contact restrictions and a curfew from 10 p.m. to 5 a.m. in areas with a seven-day incidence rate above 100 (Deutscher Bundestag, 2021). In addition, the law included a provision allowing for special regulations for vaccinated, tested, and recovered individuals. Based on this provision, the COVID-19 Protective Measures Exceptions Ordinance was enacted on May 4, 2021. The law expired on June 30, 2021, and the last county to have restrictions in place was Hildburghausen on June 11, 2021.
From August 23, 2021, a nationwide 3G rule (geimpft, getestet, genesen - vaccinated, recovered, tested) was enforced in Germany (Bundesregierung, 2021). People who meet in publicly accessible indoor spaces such as restaurants, cinemas, hairdressers, fitness studios, swimming pools, sports halls, events, hospitals, rehabilitation or care facilities, and nursing homes, must prove that they have been vaccinated, recovered or tested negative. The negative test result must not be older than 24 hours for rapid tests or 48 hours for PCR tests. Exceptions are made for school children who are regularly tested and for infants. The 3G rule is suspended if the seven-day incidence rate in a county or urban area is consistently below 35. The mask and social distancing requirements are still mandatory on public transportation and in stores.
On November 24, 2021, the modifications to the German Infection Protection Act came into effect after receiving unanimous approval by the Bundesrat the day before (Bundesministerium für Gesundheit, 2021). Among the changes are the reintroduction of the work-from-home mandate, mandatory testing for employees in certain industries, and the implementation of the 3G rule for public transportation and domestic flights. While individual states can enforce measures like mask mandates and event restrictions, school closures, curfews, and business shutdowns are no longer permitted.
The Infection Protection Act (IfSG) set the expiration date of Germany's nationwide COVID-19 restrictions,

which included limits on gatherings and mask mandates in retail stores, on March 19, 2022 (Bundesregierung, 2022). After a transitional period, which ended on April 3, 2022, there were no longer any nationwide restrictions on gatherings or mask mandates in retail stores, but masks were still mandatory on public transportation and long-distance travel.
The restrictions implemented by the German government have had a significant impact on the daily lives of many people in the country. The closure of schools has created challenges for parents who have had to balance work and childcare responsibilities, and the ban on public gatherings has made it difficult for people to connect with friends and family (Ngima & Tsering, 2020). In addition, the closure of non-essential businesses has had an economic impact on individuals and industries across the country (Bauer & Weber, 2021). Despite these challenges, the restrictions have been effective in reducing the spread of the virus in Germany (Wieler et al., 2021).

2.1.3. Influence of constraints on mental health

The COVID-19 pandemic has had a significant impact on mental health worldwide. The measures implemented to contain the spread of the virus, including lockdowns, social distancing, and mandatory masks, have disrupted daily routines and activities, resulting in feelings of insecurity and distress among individuals. While these measures have been effective in reducing transmission of the virus, their association with increased rates of anxiety, depression, and loneliness among the population remains not fully clear, with varying results from different studies ranging from no effect to strongly negative, generally showing a small negative effect (Prati & Mancini, 2021).
A study conducted among adults in Germany by Benke et al. (2020) found that restrictions imposed to contain the spread of COVID-19 were associated with negative mental health outcomes. Higher levels of restrictions were associated with more loneliness, higher psychosocial distress, and lower life satisfaction. Being in a risk group for severe COVID-19, having a history of mental health problems, being unemployed, having less education, and being younger were all associated with negative mental health outcomes of COVID-19 public health interventions. Similarly, the study conducted by Ammar et al. (2020) with a global scope showed that home confinement had a negative effect on both mental-well-being and on mood and feelings. Another study conducted in Italy during the COVID-19 lockdown found that individuals experienced significant changes in cognitive functioning and mental health (Fiorenzato et al., 2021). Depression, anxiety, abnormal sleep, and decreased libido were all more common during the lockdown, especially among women, those under 45, and those who worked from home or were underemployed. Frequent consumers of COVID-19 mass media information or residents of highly infected communities reported higher depression and anxiety symptoms.
It is suggested that one of the main factors contributing to a potential negative impact of pandemic restrictions on mental health is social isolation. One study has linked the closure of businesses and schools and restrictions on social gatherings to increased rates of sadness and anxiety. (Chaabane et al., 2021). Individuals who were already socially isolated before the pandemic, such as those living alone, may be particularly vulnerable to the potential negative effects of social isolation (Koma et al., 2020). Another study suggests that young adults may be particularly vulnerable to the potential negative effects of social isolation (Sojli et al., 2021).
In addition, economic hardship resulting from the pandemic and restrictions has also been associated with increased mental health problems. Loss of income, unemployment, and reduced workload have been linked to increased rates of anxiety and depression (Witteveen & Velthorst, 2020). Individuals who have lost their jobs or experienced reduced income due to the pandemic and its restrictions are more likely to experience mental health problems than those who have not been economically affected. In addition, the economic impact of the pandemic has been unevenly distributed, with individuals from marginalized communities and those in low-wage jobs disproportionately affected (Gould & Kassa, 2021).
The impact of the restrictions on mental health has not been uniform across all population groups. Studies have shown that individuals with pre-existing mental health conditions, such as anxiety and depression, are particularly vulnerable to the negative effects of the pandemic and the restrictions (Lewis et al., 2022). Psychiatric patients also experienced higher levels of anxiety, depression, stress, and insomnia during the COVID-19 pandemic and lockdown, and were therefore more severely affected (Hao et al., 2020). Women, younger adults, and individuals with lower incomes have also been shown to be more vulnerable to the negative mental health effects of the pandemic and its restrictions (Bäuerle, Teufel, et al., 2020; Purtle, 2020).
The long-term effects of the pandemic and its restrictions on mental health are not yet fully understood.

However, it is clear that the negative impact on mental health is not limited to the duration of the restrictions. Studies have shown that the impact of the pandemic on mental health is likely to persist even after the pandemic is over (Bourmistrova et al., 2022). The trauma and stress associated with the pandemic, along with the potential long-term economic consequences, may continue to impact mental health for years to come.
Therefore, it is crucial for policymakers and healthcare providers to take into account the potential long-term impact on mental health when making decisions regarding pandemic-related restrictions. The United Nations has highlighted the need for action on mental health in a policy brief (United Nations, 2020). Mental health should be prioritized in policy decisions and resources should be allocated to support the mental health needs of individuals during and after the pandemic. Recommended actions include ensuring widespread availability of mental health care and supporting recovery from COVID-19 by building additional mental health services.
The full extent of the impact of COVID-19 restrictions on mental health is not yet fully understood, highlighting the importance of further research in this area. While social isolation, economic hardship and other factors have been identified as potential contributors to negative mental health outcomes during the pandemic, the extent of their impact is not yet fully known. The long-term impact of the pandemic on mental health is also unclear. Therefore, more research is needed to understand the relationship between COVID-19 restrictions and mental health outcomes and to identify effective interventions that can help mitigate any negative effects.

2.2. Global COVID-19 Trends and Impact Survey (CTIS)

"The University of Maryland Social Data Science Center Global COVID-19 Trends and Impact Survey, in partnership with Facebook" (UMD Global CTIS)[1] serves as the primary data source for this study. During the survey period, a representative sample of Facebook users aged 18 and over were invited to report on symptoms, social distancing behavior, mental health issues, and financial constraints on a daily basis. To reduce non-response and coverage bias, Facebook provided weights. The United States were not included in the UMD Global CTIS (Kreuter et al., 2020). The Global COVID-19 Trends and Impact Survey Open Data API and the **CTIS R** package were used to access and import the survey data for the analysis (Fan et al., 2020; Haensch & Xiong, 2021). Further information on the data, such as variable names and specifications, can be found in the section 3.1.

2.3. Corona data Germany: Measures index federal states per day

In addition to the Global COVID-19 Trends and Impact Survey, I also used the "Corona-Daten Deutschland" as a secondary data source for my analysis (Statistisches Bundesamt, 2023). The "Corona-Daten Deutschland" data collection was created as part of a project commissioned by the German Federal Ministry of Economic Affairs and Climate Protection. An interdisciplinary consortium consisting of the infas Institute for Applied Social Sciences, the infas 360 GmbH, and the Institute for Hygiene and Public Health at the University Hospital Bonn was tasked with collecting and consolidating small-area data on the COVID-19 crisis in Germany (Bundesministerium für Wirtschaft und Klimaschutz, 2021). The dataset used from this collection is the **Maßnahmenindex Bundesländer pro Tag**[2] which provides daily information on regional containment measures. Further information about this dataset, such as variable names and specifications, can also be found in the 3.1 section.

[1] Link to UMD Global CTIS: https://covidmap.umd.edu/
[2] Link to the "Maßnahmenindex Bundesländer pro Tag" dataset:
https://www.corona-daten-deutschland.de/dataset/massnahmenindex_bundeslaender_pro_tag

3. Methods and Results

This section presents the methods and results of our study of the impact of COVID-19 restrictions on mental health in Germany. It contains three subsections: Data structure and types (subsection 3.1), which presents the data with all its variables and specifications; Analysis (subsection 3.2), which presents an in-depth analysis of the UMD Global CTIS and German Restrictions data and their combination; and Model (subsection 3.3), which describes the model used to assess the impact of pandemic restrictions on mental health (Kreuter et al., 2020; Statistisches Bundesamt, 2023).

3.1. Data structure and types

In this subsection, we will examine the data structure and types of our combined dataset, which consists of two main data sources: the UMD Global CTIS and the German restriction data, presented above in subsections 2.2 and 2.3 (Kreuter et al., 2020; Statistisches Bundesamt, 2023). These two datasets were merged to create a comprehensive dataset for our analysis and modeling. First, I present the variables collected in the UMD Global CTIS study, followed by a description of the variables in the Corona data Germany.

The combined dataset contains a total of 522,070 observations with no missing values, covering the period from May 20, 2021 to June 25, 2022 (Table 1 and 2). The variables from `D1` to `E7a`, presented in Table 1 and 2, belong to the the UMD Global CTIS study (Kreuter et al., 2020). The index variables, on the other hand, are derived from the Corona data Germany (Statistisches Bundesamt, 2023). Examining Table 1, which provides an overview of the categorical variables, we observe our two key variables of interest, `D1` and `D2`. These variables aim to measure anxiety and depression, respectively. They are scored on a five-point Likert scale, ranging from "None of the time" to "All of the time". The age variable is divided into seven groups, starting from "18-24" and progressing in 10-year increments until "75+". Possible values for the gender variable include male, female, other and a prefer-not-to-answer option. The highest level of education completed is divided into six groups: "No formal schooling", "Less than primary school", "Primary school completed", "Secondary school completed", "High school (or equivalent) completed", "College/pre-university/University completed", and "University post-graduate degree completed". UMD Global CTIS also asked whether the participants live in a city, town or rural area (Kreuter et al., 2020). Finally, there is a variable that assesses whether respondents have worked for pay in the past 4 weeks.

Table 1. *Summary statistics of categorical variables (n = 522,070).*

Variables	N	%	Med	Mean	IQR
During the past 7 days, how often did you feel so nervous that nothing could calm you down? (D1)	522070	–	–	–	–
None of the time	362875	69.51	–	–	–
A little of the time	82481	15.8	–	–	–
Some of the time	58261	11.16	–	–	–
Most of the time	12668	2.426	–	–	–
All the time	5785	1.108	–	–	–
During the past 7 days, how often did you feel so depressed that nothing could cheer you up? (D2)	522070	–	–	–	–
None of the time	306068	58.63	–	–	–
A little of the time	94338	18.07	–	–	–
Some of the time	84521	16.19	–	–	–
Most of the time	25523	4.889	–	–	–
All the time	11620	2.226	–	–	–
What is your age? (E4)	522070	–	–	–	–
18-24	20251	3.879	–	–	–
25-34	90475	17.33	–	–	–
35-44	124396	23.83	–	–	–
45-54	119116	22.82	–	–	–
55-64	105750	20.26	–	–	–
65-74	50577	9.688	–	–	–
75+	11505	2.204	–	–	–
What is your gender? (E3)	522070	–	–	–	–
Male	226811	43.44	–	–	–
Female	290789	55.7	–	–	–
Other	1501	0.2875	–	–	–
Prefer not to answer	2969	0.5687	–	–	–
What is the highest level of education that you have completed? (E8)	522070	–	–	–	–
No formal schooling	1784	0.3417	–	–	–
Less than primary school	3857	0.7388	–	–	–
Primary school completed	22476	4.305	–	–	–
Secondary school complete	168656	32.31	–	–	–
High school (or equivalent) completed	166316	31.86	–	–	–
College/ pre-university/ University completed	107209	20.54	–	–	–
University post-graduate degree completed	51772	9.917	–	–	–
Which of these best describes the area where you are currently staying? (E2)	522070	–	–	–	–
City	201459	38.59	–	–	–
Town	147563	28.26	–	–	–
Village or rural area	173048	33.15	–	–	–
In the past 4 weeks, did you do any work for pay? (D7a)	522070	–	–	–	–
Yes	376772	72.17	–	–	–
No	145298	27.83	–	–	–

In addition to the categorical variables, we have several other numerical variables in our dataset, as shown in Table 2. These variables include the number of people who slept in the place where respondents stayed last night (`E5`) and the number of rooms used for sleeping in that place (`E7a`). In addition, we have several index variables from the dataset of German Corona data that represent the severity of containment measures prescribed per day, measured at the federal state level in Germany (Statistisches Bundesamt, 2023). These include the index for general containment measures, the index for secondary schools, the index for primary schools, the index for daycare centers, and the index for mask obligation. These index variables are scored on a scale from 0 to 100, indicating the severity of the containment measures imposed on each specific aspect.

Table 2. *Summary statistics of numerical variables (n = 522,070).*

Variables	N	%	Med	Mean	IQR
How many people slept in the place where you stayed last night (including yourself)? (E5)	522070	–	2	2.555	2
How many rooms are used for sleeping in the place where you are staying? (E7a)	522070	–	2	1.975	2
Index (0-100%) for the severity of containment measures imposed per day: General (bl_mn_idx_t)	522070	–	40.32	35.62	15.82
Index (0-100) for the severity of containment measures prescribed per day: Secondary schools (bl_mn_idx_t_m02a)	522070	–	40.6	39.71	39.6
Index (0-100) for the severity of containment measures prescribed per day: Elementary Schools (bl_mn_idx_t_m02b)	522070	–	40.6	36.6	19.8
Index (0-100) for the severity of containment measures prescribed per day: Daycare centers (bl_mn_idx_t_m3)	522070	–	20.8	29.45	19.8
Index (0-100) for the severity of containment measures prescribed per day: Mask obligation (bl_mn_idx_t_m16)	522070	–	56	51.16	22

Analyzing the data from Table 1, we see that about 30.5% of respondents reported feeling so nervous that nothing could calm them down at least "some of the time" during the past 7 days (variable `D1`). Specifically, 15.8% answered "a little of the time", 11.2% answered "some of the time", 2.4% answered "most of the time", and 1.1% answered "all of the time" when it came to their level of anxiety. Looking at feelings of depression (variable `D2`), 41.4% of respondents reported experiencing moments when nothing could cheer them up at least "some of the time" during the past 7 days. Specifically, 18.1% responded "a little of the time", 16.2% responded "some of the time", 4.9% responded "most of the time", and 2.2% responded "all of the time" to the question about feeling depressed. In comparing feelings of anxiety (variable `D1`) and depression (variable `D2`) among the respondents, we observe that 69.5% reported no nervousness during the past 7 days, whereas 58.6% reported no feelings of depression during the same period. This suggests that a higher percentage of individuals experienced some level of depression compared to anxiety. Analyzing the age distribution, we found that the majority of respondents fell into the 35-44 age group (23.8%), followed by 45-54 (22.8%), 55-64 (20.3%), and 25-34 (17.3%). Gender distribution showed 55.7% female and 43.4% male respondents. With regard to education, the majority of respondents (62.3%) have at least a high school education. The distribution of respondents' residences shows a balanced representation of different geographic settings. The majority (72.1%) were engaged in paid work, while 27.8% were not.
Table 2 provides additional insight, showing that respondents had an average of 2.555 people staying with them and an average of 1.975 rooms used for sleeping at their current location. The average severity index for general containment measures was 35.620, indicating the overall level of severity for the given data. In addition, specific indexes were recorded for different sectors. Secondary schools had an index of 39.710, while elementary schools, daycare centers, and mask obligation had indexes of 36.597, 29.454, and 51.160, respectively. The interquartile range (IQR) for these indices varied, highlighting the distribution and variability of severity levels within each category.

In summary, the analysis of the data highlights the prevalence of anxiety and depression among respondents, with a higher percentage experiencing some level of depression compared to anxiety. In addition, the study provides valuable insights into the demographic characteristics and contextual factors surrounding the data. This information forms the basis for subsequent analysis and modeling of the collected data.

3.2. Analysis

In this analysis section, we examine the impact of COVID-19 restrictions on mental health, focusing on anxiety and depression, using the data presented in the subsection above (subsection 3.1). We examine observations over time, weekday patterns, relative frequencies, and the relationship between mental health variables and the severity of restrictions.

Looking at Figure 1, which plots the number of observations of our two target variables anxiety and depression over time, a very similar temporal distribution can be seen.
The variable anxiety (D1) shows a distributed pattern with two peaks over time. On average, 1299 daily observations were recorded for anxiety. (Figure 1A). These peaks occur around mid-August and the end of November 2021, with the number of daily observations slightly below 2000 during those periods. From 20 May to mid-August 2021, the daily number of observations increased steadily, with a temporary drop in June. After mid-August, the number of observations began to decrease until the second half of October. From then on, the number of observations gradually increased until the end of November 2021. After that, the number of observations decreased to an average of about 900 observations. The temporal distribution of the depressive (D2) variable shows a very similar pattern (Figure 1B).
These observed patterns match my expected distribution over time, indicating a robust and consistent trend without significant fluctuations.

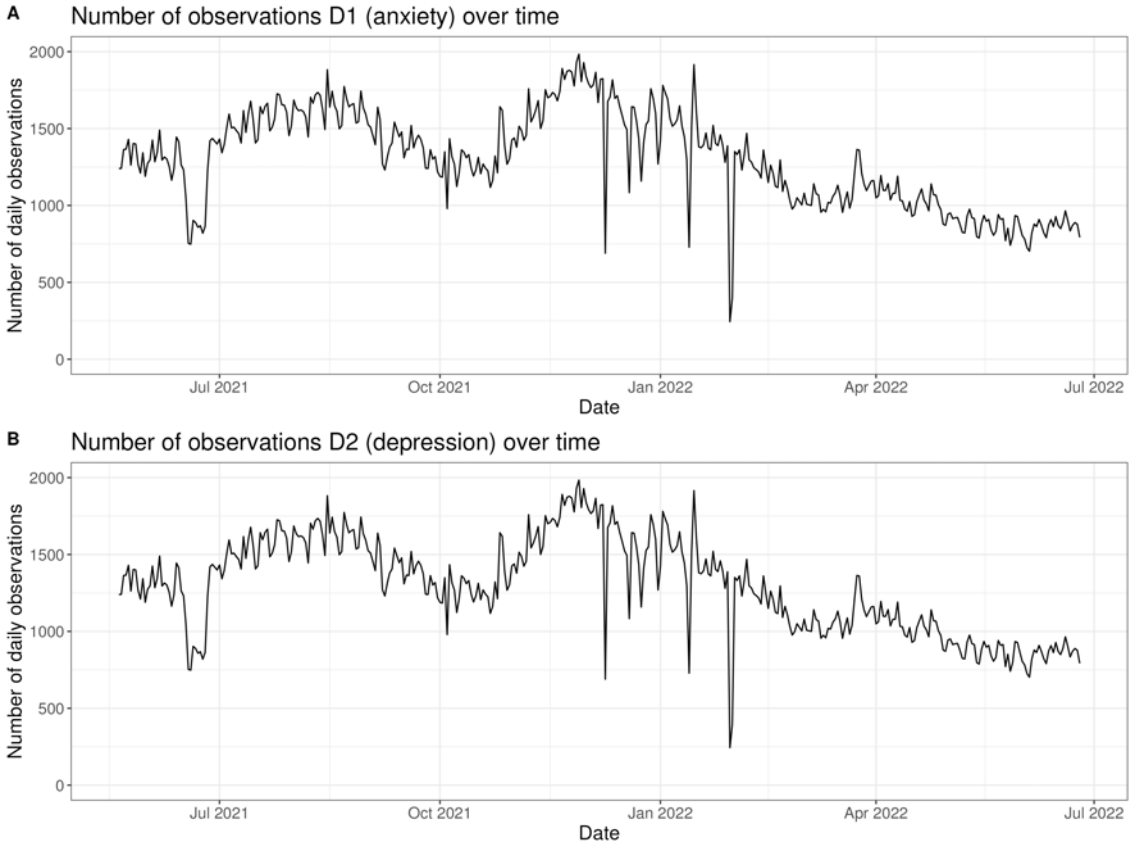

Figure 1. Observations of D1 (anxiety) and D2 (depression) over time. *Number of observations D1 (anxiety) over time (**A**). Number of observations D2 (depression) over time (**B**). Daily aggregated data: Observation period May 20, 2021 to June 25, 2022.*

Next, we will examine Figure 2, looking at the relative frequencies of the possible values of our two target variables, anxiety and depression, measured from May 20, 2021 to June 25, 2022.

Consistent with the findings discussed in subsection 3.1, our analysis shows that feelings of depression have a higher prevalence compared to feelings of anxiety. Furthermore, the discrepancy in levels between the categories is evident, with an average daily relative frequency of 69.4% for the category "None of the time" for anxiety and 58.6% for depression. In addition, the relative frequencies for the remaining categories also show noticeable differences. For the variable anxiety, the average daily relative frequencies are 15.9% for "A little of the time", 11.2% for "Some of the time", 2,45% for "Most of the time", and 1.1% for "All the time". Similarly, for variable depression, the average daily relative frequencies are 18.1% for "A little of the time", 16.2% for "Some of the time", 4.9% for "Most of the time", and 2.2% for "All the time".
The temporal analysis of the relative frequencies for the anxiety variable shows that the distribution of categories for both variables remained relatively stable until the second half of November 2021 (Figure 2A). Thereafter, a slight shift in levels occurred, characterized by a decrease in the relative frequency of the "None of the time" category and an increase in the relative frequencies of all other categories, especially "Some of the time" and "Most of the time", until mid-March 2022. After that, the relative frequencies return to their previous levels. For depression, a very similar pattern can be seen over time (Figure 2B).

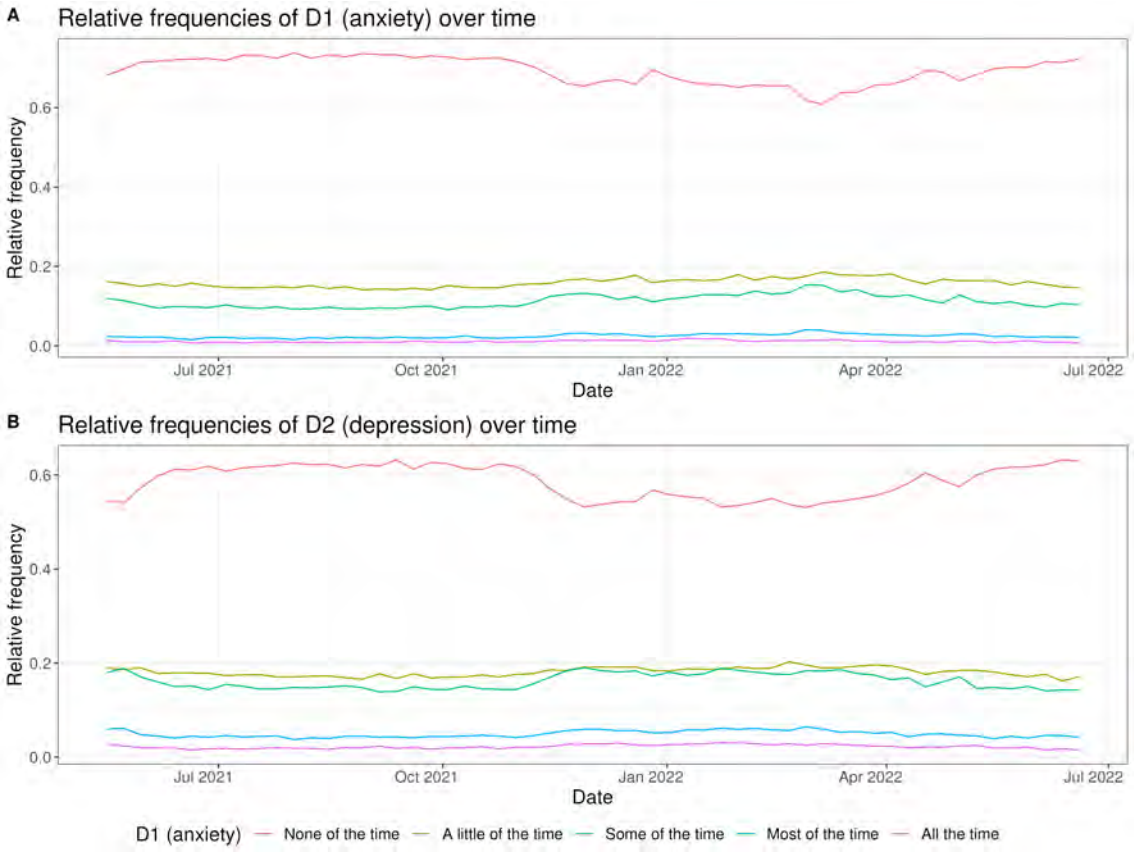

Figure 2. Relative frequencies of D1 (anxiety) and D2 (depression) over time. *Relative frequencies of D1 (anxiety) over time (**A**). Relative frequencies of D2 (depression) over time (**B**). Weekly aggregated data: Observation period May 20, 2021 to June 25, 2022.*

These findings underscore the temporal dynamics in the prevalence of anxiety and depression, revealing variations in the level of distress experienced by individuals over the time period analyzed. While the frequent changes in pandemic restrictions in Germany mentioned in subsection 2.1.2 might have led to the expectation of more frequent and pronounced fluctuations, the observed patterns indicate a more moderate and stable distribution over time.

Figure 3 shows the distribution of relative frequencies for the variables anxiety and depression across different weekdays. Examining the relationship between weekdays and anxiety/depression is a relevant aspect to investigate in this study. Understanding how the prevalence of these mental health conditions varies across different days of the week can provide valuable insights into the potential impact of weekly cycles on individuals' well-being. By analyzing the distribution of relative frequencies for anxiety and depression across weekdays, we can gain a better understanding of whether certain days are associated with higher or lower levels of distress. It is important to note that anxiety and depression were assessed in relation to the last 7 days (see subsection 3.1). Nevertheless, there may be differences in reported levels of mental health between different days of the week. This analysis contributes to our overall exploration of the temporal dynamics and patterns of anxiety and depression during the study period. The figure displaying the absolute number of observations for the anxiety and depression variable per weekday (Figure 9) as well as a figure illustrating the number of observations for each federal state (Figure 10) can be found in the appendix.
For anxiety, we observe that the category "None of the time" exhibits the highest relative frequency consistently across all weekdays, ranging from 0.690 to 0.697 (Figure 3A). The category "A little of the time" shows a relatively consistent relative frequency across weekdays, ranging from 0.155 to 0.160. The category "Some of the time" also exhibits a consistent pattern, with relative frequencies ranging from 0.109 to 0.114. Finally, the categories "Most of the time" and "All the time" have the lowest relative frequencies, varying between 0.023 and 0.026, and 0.011 and 0.012, respectively. The relative frequencies of the anxiety variable show little to no variation across days of the week, indicating that responses do not vary substantially depending on the day of the week.

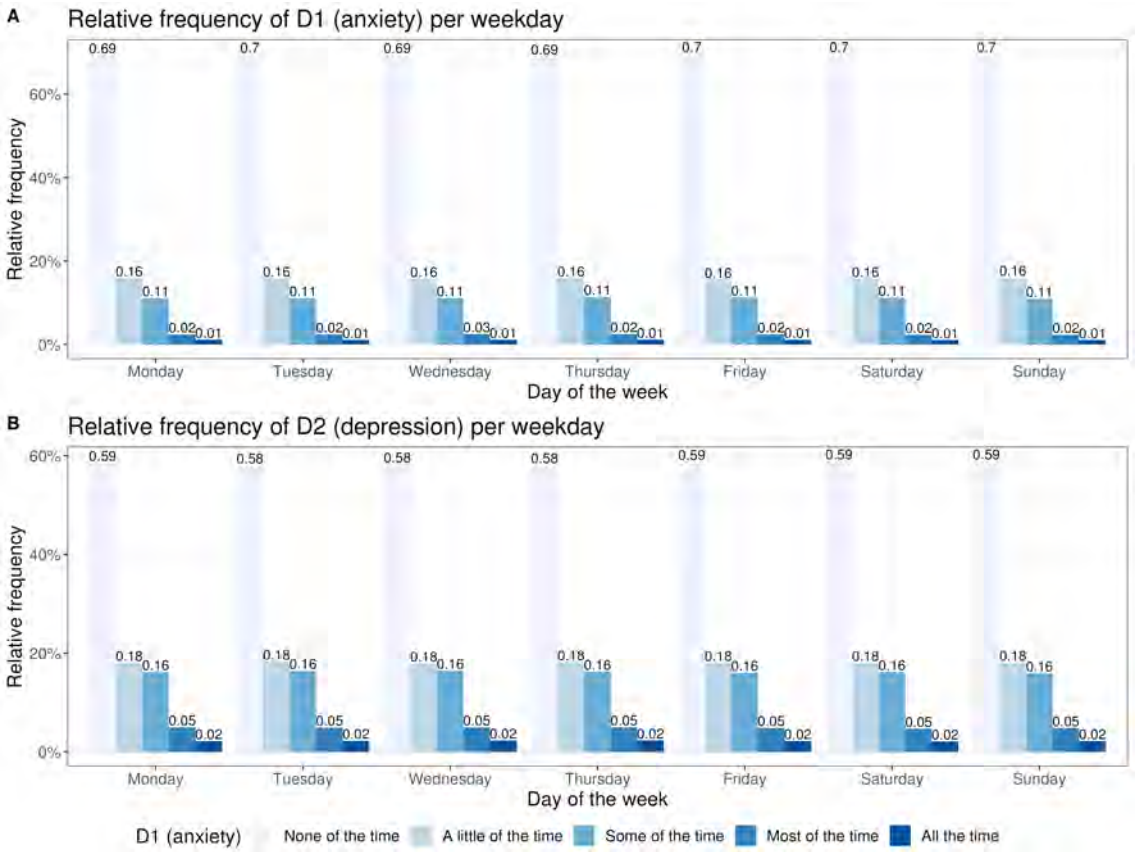

Figure 3. Relative frequencies of D1 (anxiety) and D2 (depression) per weekday. *Relative frequencies of D1 (anxiety) per weekday (**A**). Relative frequencies of D2 (depression) per weekday (**B**). Data aggregated per weekday: Observation period May 20, 2021 to June 25, 2022.*

For depression, the analysis of relative frequencies per weekday reveals a very similar patterns (Figure 3B). The category "None of the time" consistently maintains the highest relative frequency across all weekdays, ranging from 0.581 to 0.589. Similarly, the category "A little of the time" shows relatively consistent relative frequencies, ranging from 0.180 to 0.183. The category "Some of the time" also exhibits a stable pattern, with relative frequencies ranging from 0.159 to 0.165. In contrast, the categories "Most of the time" and "All the time" demonstrate the lowest relative frequencies, fluctuating between 0.047 and 0.050, and 0.021 and 0.023, respectively. These findings suggest that the reported levels of depression, remain relatively consistent throughout the week, with minor variations observed among the different categories.

Based on the previously observed patterns and similarities between anxiety and depression, we further examined their relationship using Pearson's chi-squared test, Spearman's rank correlation coefficient, and cross-tabulation analysis.
The Pearson's chi-squared test yielded a chi-squared value of 317,646 with 16 degrees of freedom (df), resulting in a p-value < 0.001, indicating a highly significant association (Table 3). In addition, the Spearman rank correlation coefficient between anxiety and depression is 0.601, indicating a moderate positive correlation. The frequencies observed in the Table 3 indicate that as the level of anxiety increases from "None of the time" to "All of the time", there is a corresponding increase in the level of depression from "None of the time" to "All of the time". All in all, these results suggest that there is a meaningful and consistent relationship between anxiety and depression levels. Specifically, higher levels of anxiety are consistently associated with higher levels of depression, and vice versa.
The significant chi-squared test and moderate positive correlation coefficient provide evidence for the similarity and co-occurrence of anxiety and depression. These findings underscore the importance of gaining a understanding of the relationship between these mental health conditions. It is crucial to recognize that anxiety and depression, while interconnected, also demonstrate clinical and statistical differences (Stavrakaki & Vargo, 1986).

D1 (anxiety)	D2 (depression)				
	None of the time	A little of the time	Some of the time	Most of the time	All the time
None of the time	277553	49222	29182	4615	2303
A little of the time	22247	32470	22193	4393	1178
Some of the time	5252	11600	28960	9805	2644
Most of the time	387	811	3504	5633	2333
All the time	629	235	682	1077	3162

Table 3. Crosstable of variables D1 (anxiety) and D2 (depression). *n = 522,070; Observation period May 20, 2021 to June 25, 2022.*

After focusing on the variables of anxiety and depression and establishing their association and co-occurrence, we now shift our focus to exploring the German restriction data using the provided dataset of German Corona data (see subsection 2.3) before looking at the relationship between pandemic restrictions and mental health (Statistisches Bundesamt, 2023).
Looking at the index of general containment measures, shown in Figure 4, we observe temporal fluctuations and regional disparities across the federal states. This index provides a daily representation of German general containment measures, and our study focuses on the period from May 20, 2021 to June 25, 2022,

as indicated by the two vertical dashed lines. Throughout this period, the index exhibited a range of values, with Saarland recording the lowest value of 1 from June 16, 2021, to July 8, 2021, and Bavaria reaching the highest value of 65 from May 21, 2021, to May 24, 2021. After the first quarter of 2022, there is a noticeable decrease in the index, which drops to about 10. An example representation of one federal state, in this case Bavaria, is provided in the appendix (Figure 11), along with visualizations of the other restriction indices (Figure 12).

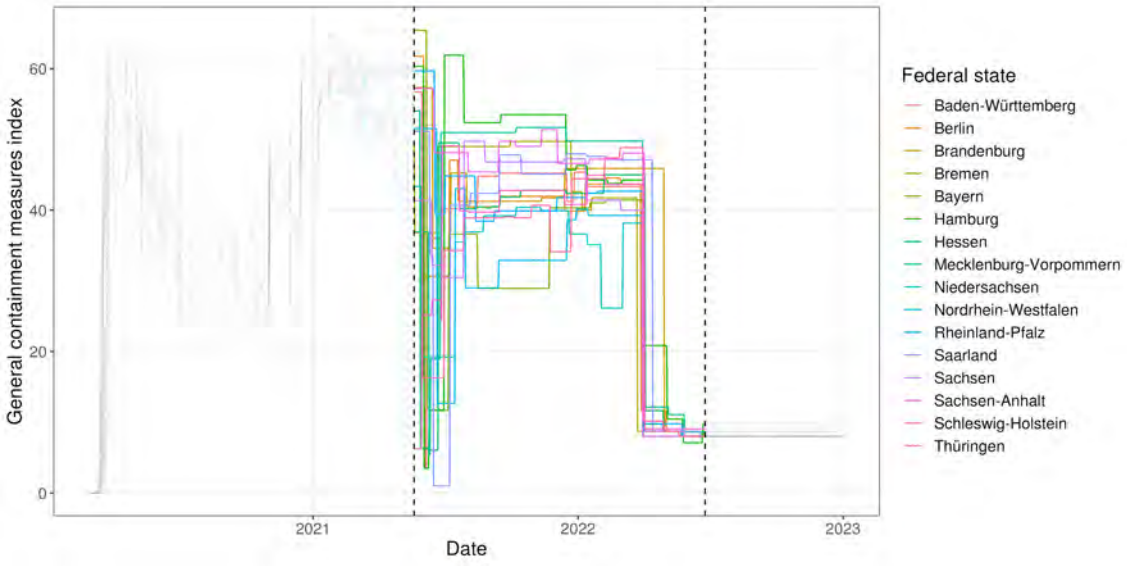

Figure 4. German general containment measures index over time per federal states. *Data aggregated per day: Relevant observation period May 20, 2021 to June 25, 2022.*

After examining the variables for anxiety, depression, and the German restriction data separatly, our focus now shifts to the bivariate relationships between mental health and the restriction indices. This analysis lays the foundation for the following subsection of the model (Subsection 3.3).
The following analysis uses only the general containment measures index, rather than including all indices, as it provides a more comprehensive and robust understanding of the impact of COVID-19 restrictions on mental health in Germany. This focused approach enhances the clarity and coherence of our analysis, allowing for easier interpretation and understanding of the research findings.

Figure 5 provides a visual representation of the relative frequencies of the anxiety and depression categories in relation to the general containment measures implemented in Germany. The general containment measures index is rounded to the nearest integer. All observations contain at least 10 responses for each mental health category across the index values. The figure highlights the impact of the general containment measures on the distribution and variation of mental health categories. As mentioned in the 3.1 subsection, the number of observations, given as count in the figure, for the different anxiety categories is very different and must be taken into account when comparing these categories.
Exploring the relationship between anxiety categories and the general containment measures index, our study presents a line plot (Figure 5A) showcasing the relative frequencies of various anxiety categories across different general containment measuresindex values. When analyzing the figure, we observe a lack of substantial variation or discernible trends across different index scores. The relative frequencies of the anxiety categories show minimal fluctuation, suggesting that the containment measures implemented may not have a substantial impact on anxiety levels.
Similarly, when examining the relationship between depression categories and the general containment measures index (Figure 5B), we observe a similar theme with a slightly greater degree of variation. However,

no systematic trends emerge from the analysis. The relative frequencies of the depression categories show small fluctuations without clear patterns, suggesting that the impact of containment measures on depression levels may be limited.

These collective observations suggest that the general containment measures implemented have a limited association with both anxiety and depression levels. The relative stability and lack of consistent trends suggest the existence of other influential factors that contribute to the experience and severity of anxiety and depression symptoms.

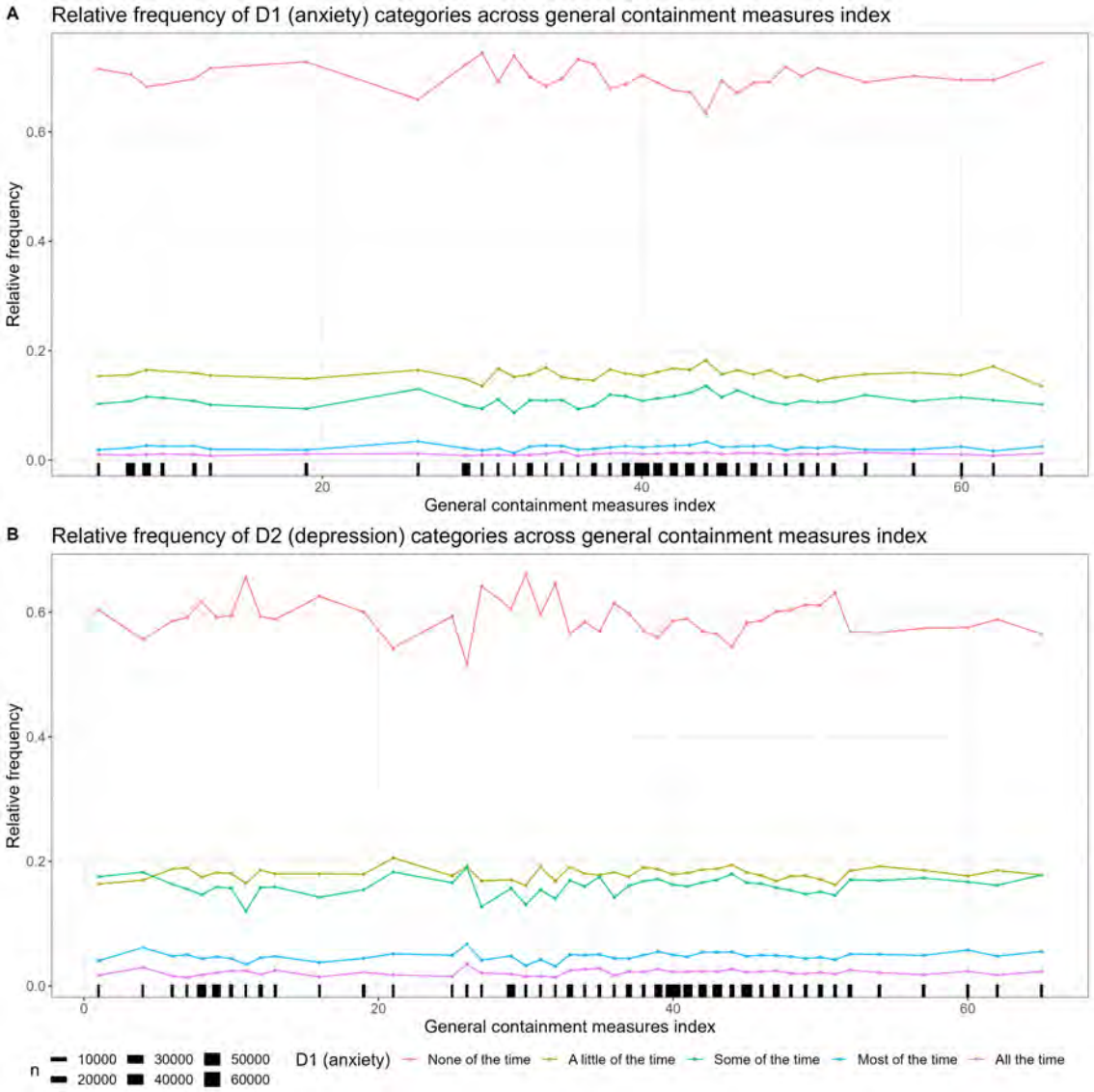

Figure 5. Relative frequency of mental health categories across general containment measures index. *Relative frequency of D1 (anxiety) categories across general containment measures index (**A**). Relative frequency of D2 (depression) categories across general containment measures index (**B**). Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Observations with at least 10 responses for each mental health category across index scores.*

To gain a deeper understanding of the underlying dynamics, we will now examine the relationship between mental health categories and the general containment measures index, while considering the influence of

other covariates. In particular, we will focus on age as an illustrative example, recognizing its potential impact on mental health outcomes. Supplementary figures examining the relationship between the general containment measures index and other categorical covariates can be found in the appendix (Figures 13, 14, 15, 16, 17, 18, 19, 20).
By faceting the previous figure based on these covariates, we will be able to explore potential interactions and effects, thereby providing a more comprehensive and nuanced understanding of the intricate relationship between mental health categories and the general containment measures index. This further analysis will allow us to uncover potential subgroups and shed light on the factors that shape the association between mental health outcomes and the containment measures implemented.

Figure 6 shows the relative frequency of anxiety categories across the general containment measures index, specifically examined within different age groups. The general containment measures index is rounded to the nearest whole number. Each age group in the analysis includes observations with at least three responses for each anxiety category across the range of index scores. This ensures sufficient data availability for a robust analysis and increases the reliability of the results.
In analyzing the relationship between anxiety categories and the general containment measures index across age groups, several notable findings emerge. First, there are discernible differences in the levels of anxiety categories across age groups. Specifically, younger individuals tend to report higher levels of anxiety than older individuals. This suggests that anxiety may be more prevalent in the younger population, with a greater likelihood of experiencing feelings of nervousness.
Regarding the association between anxiety categories and the general containment measures index, similar to the previous analysis, no clear pattern or systematic relationship can be observed. The relative frequencies of the anxiety categories show slight variations at different index levels, but no consistent trend emerges. These findings suggest that the general containment measures implemented may not have a strong direct impact on anxiety levels across age groups.
Overall, the analysis highlights the complex nature of the relationship between anxiety categories, age groups, and the general containment measures index. While younger individuals tend to experience higher levels of anxiety, there is no clear relationship between anxiety levels and the general containment measures index. This suggests the presence of other influential factors that contribute to anxiety symptoms beyond the containment measures implemented.

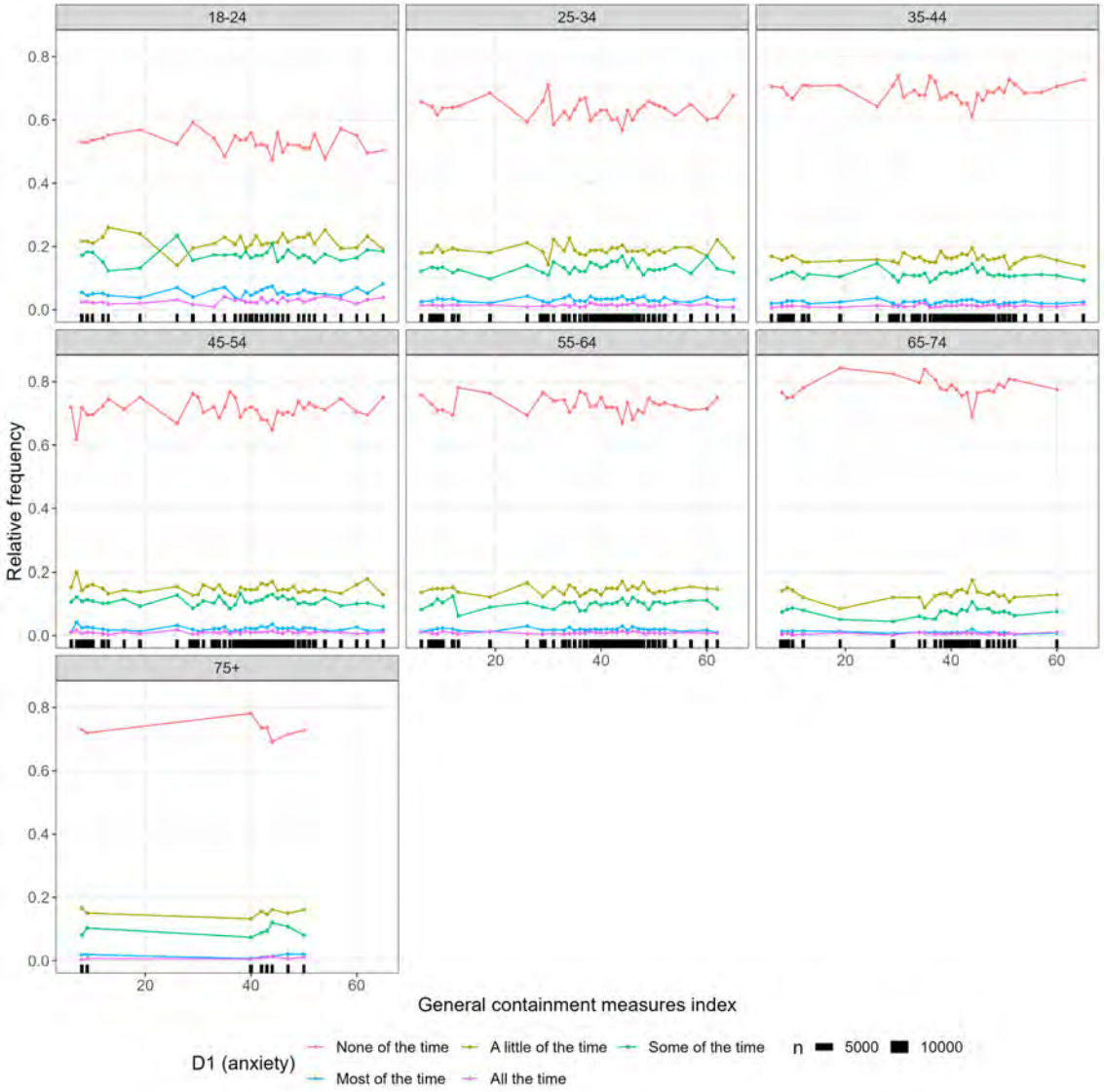

Figure 6. Relative frequency of D1 (anxiety) categories across general containment measures index per age group. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each age group includes observations with at least 3 responses for each anxiety category across index scores.*

Continuing the analysis, we also examined the relationship between depression categories and the general measures index across different age groups (Figure 7). The results shed light on the prevalence and variation of depression levels within these age groups. First, the data reveal a clear difference in levels of depression between age groups. Similar to the findings for anxiety, younger individuals tend to report higher levels of depression compared to older individuals. This finding suggests that feelings of depression are more prevalent among the younger population, with a higher likelihood of experiencing depressive symptoms.

In addition, analysis of the relationship between depression categories and the general containment measures index reveals more pronounced variations, particularly among the younger age groups. The 18-24 age group shows the most notable variation, with an extremely high level of depression reported for a general containment measures index of 25. This suggests that certain index scores may be associated with elevated levels of depression, particularly among the younger age group. However, there is no consistent pattern or trend across the range of Index scores.

In summary, analysis of the depression categories across age groups and of the general containment measures index reveals a clear difference in levels, with younger individuals reporting higher levels of depression. In addition, the variation in depression levels is more pronounced in the younger age groups, with no consistent

pattern observed across index scores. These findings underscore the complexity of the relationship between depression, age, and the containment measures implemented, and highlight the need for further exploration of contributing factors beyond the containment measures themselves.

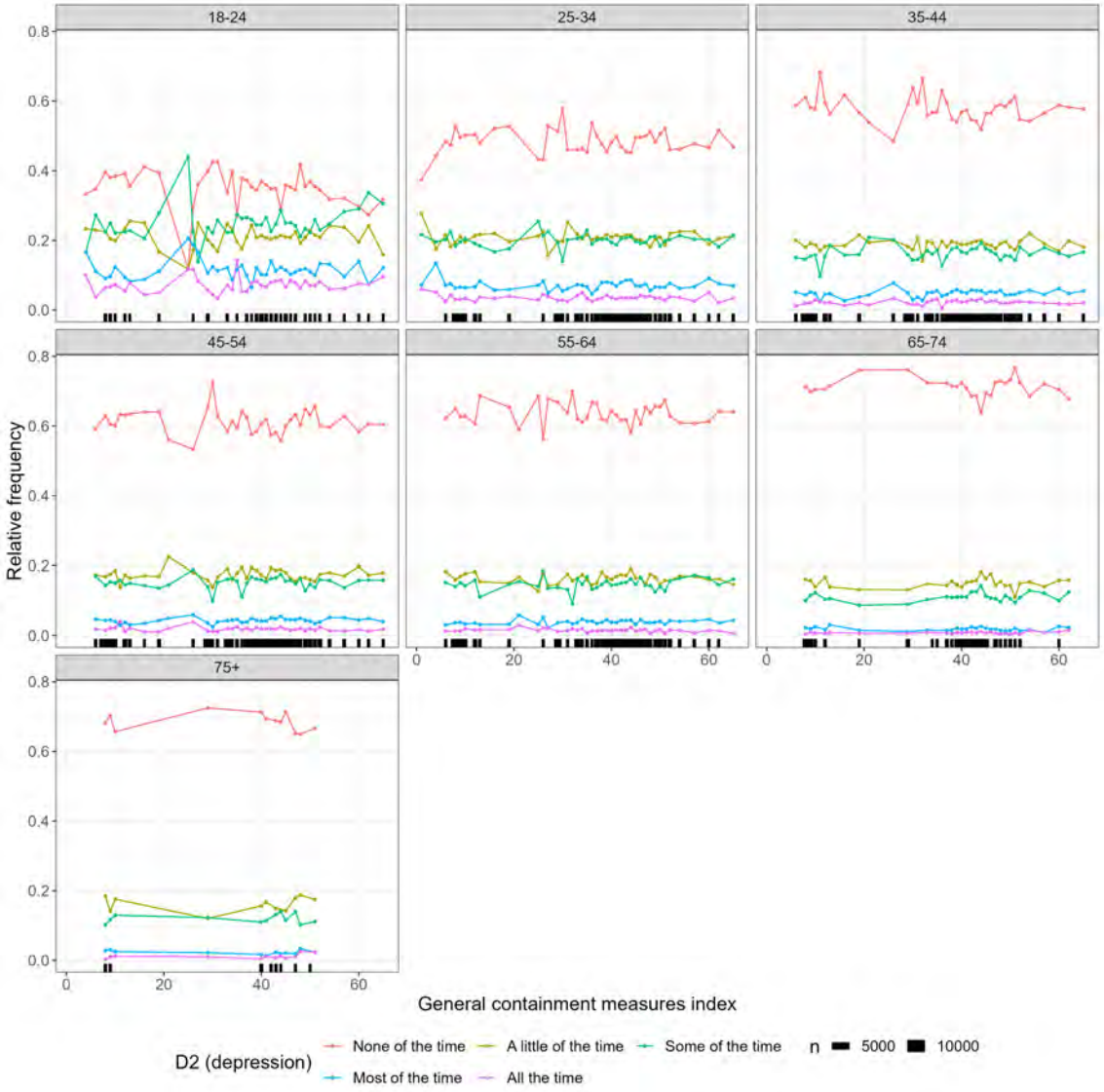

Figure 7. Relative frequency of D2 (depression) categories across general containment measures index per age group. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each age group includes observations with at least 3 responses for each anxiety category across index scores.*

Analysis of anxiety and depression levels across age groups in relation to the overall containment measures index shows no clear pattern or consistent trend. Younger individuals consistently report higher levels of anxiety and depression, indicating their vulnerability to mental health problems during pandemic restrictions.

In this analysis, mental health variables, restriction variables, and the relationship between mental health and restriction indices were examined in detail. These findings underscore the need to examine the impact of various covariates on mental health outcomes. In subsection 3.3, we present a comprehensive modeling approach that includes additional factors such as education, place of residence, and employment status. By incorporating these covariates, we aim to gain a deeper understanding of the specific effects of pandemic restrictions on mental health during COVID-19 in Germany.

3.3. Model

In the previous sections, we conducted a comprehensive analysis of mental health variables, restriction variables, and their relationships in the context of the COVID-19 pandemic in Germany. Our examination of these variables provided valuable insights into the prevalence and distribution of anxiety and depression levels across different restriction indices, age groups, and other relevant factors. However, to gain a more nuanced understanding of the impact of pandemic restrictions on mental health outcomes, it is crucial to consider the influence of additional covariates. In this subsection, we present an extended modeling approach that includes important covariates such as education, place of residence, and employment status. By including these covariates, we aim to further explore the complex interplay between pandemic restrictions, mental health, and various socio-demographic factors.

For the purposes of our modeling analysis, we transformed the continuous variables anxiety and depression into binary variables. This approach is consistent with the methodology used by the Global UMD CTIS for the corresponding indicators in the publicly available aggregate data. Specifically, we created a binary variable called "anxious" coded as true for individuals reporting the highest two categories of anxiety, namely " Most of the time" and " All of the time" (Fan et al., 2020). Similarly, we used the same procedure to create the binary variable "depressed" for the depression variable. This binary representation facilitates the use of logistic regression models in our subsequent analyses, allowing us to examine the factors associated with elevated levels of anxiety and depression. By dichotomizing the variables, we aim to simplify the interpretation and increase the interpretability of the regression results.

For modeling, I used logistic regression models to examine the relationships between our target variables (anxiety and depression) and a number of covariates. The covariates included age (E4), gender (E3), education level (E8), place of residence (E2), number of people who slept in the same place (E5), number of rooms used for sleeping (E7a), and paid employment status (D7a).
To take into account the severity of the containment measures implemented, I included the five indices representing different aspects of the measures: the general containment measures index, the index for secondary schools, the index for primary schools, the index for day care centers, and the index for mask obligation. For better visualization, these indices are scaled by a factor of 100. It is important to note that such a change did not occur in the data and should be considered carefully, especially when compared with other variables.
To establish a reference point for our categorical covariates, I set specific reference categories. The reference categories were "45-54" for age (E4), "Male" for gender (E3), "Secondary school complete" for education level (E8), "Town" for place of residence (E2), and "No" for paid work status (D7a). The logistic regression model for anxiety and depression can be represented by the linear predictor as follows:

$$\begin{aligned}\log\left(\frac{P(\text{anxious}_i = 1)}{1 - P(\text{anxious}_i = 1)}\right) &= \beta_0 + \beta_1 \cdot \text{General\_index}_i + \beta_2 \cdot \text{Secondary\_school\_index}_i \\ &+ \beta_3 \cdot \text{Elementary\_school\_index}_i + \beta_4 \cdot \text{Daycare\_center\_index}_i \\ &+ \beta_5 \cdot \text{Mask\_obligation\_index}_i + \beta_6 \cdot \text{Age}_i + \beta_7 \cdot \text{Gender}_i \\ &+ \beta_8 \cdot \text{Education\_level}_i + \beta_9 \cdot \text{Place\_of\_residence}_i \\ &+ \beta_{10} \cdot \text{Number\_of\_people\_slept\_in\_same\_place}_i \\ &+ \beta_{11} \cdot \text{Paid\_work\_status}_i \\ &+ \beta_{12} \cdot \text{Number\_of\_rooms\_used\_for\_sleeping}_i\end{aligned}$$

$$\log\left(\frac{P(\text{depressed}_i = 1)}{1 - P(\text{depressed}_i = 1)}\right) = \beta_0 + \beta_1 \cdot \text{General\_index}_i + \beta_2 \cdot \text{Secondary\_school\_index}_i$$

$$\begin{aligned}
&+ \beta_3 \cdot \text{Elementary_school_index}_i + \beta_4 \cdot \text{Daycare_center_index}_i \\
&+ \beta_5 \cdot \text{Mask_obligation_index}_i + \beta_6 \cdot \text{Age}_i + \beta_7 \cdot \text{Gender}_i \\
&+ \beta_8 \cdot \text{Education_level}_i + \beta_9 \cdot \text{Place_of_residence}_i \\
&+ \beta_{10} \cdot \text{Number_of_people_slept_in_same_place}_i \\
&+ \beta_{11} \cdot \text{Paid_work_status}_i \\
&+ \beta_{12} \cdot \text{Number_of_rooms_used_for_sleeping}_i
\end{aligned}$$

Figure 8 displays the odds ratios of the effects on anxiety and depression.
For individuals experiencing anxiety, all coefficients in our analysis were found to be statistically significant ($P < 0.01$), with the exception of the index for elementary schools, the category of high school (or equivalent) completed in terms of educational level, and the place of living city.
For individuals with depression, our model analysis revealed that all coefficients were statistically significant ($P < 0.01$), except for the indices related to secondary schools and elementary schools and the category of primary school completed regarding education level.
A close examination of the forest plot reveals very similar patterns for the two dependent variables, anxiety and depression (Figure 8). In particular, the odds ratios associated with the various measure indices scaled by 100, with the exception of the General Containment Measures Index, are found to be quite close to one, suggesting a small impact on the two mental health variables under investigation. These results suggest that these measure indices may have limited predictive or explanatory value in relation to anxiety and depression. The general containment measures index shows a moderate association with the two target variables anxious and depressed.
In contrast to the four indicators with smaller odds ratios, most of the other variables have significantly higher odds ratios, indicating a substantial impact on mental health outcomes. In particular, variables such as age, gender, education level, and recent employment status (i.e., whether the respondent has had a paid job in the past 4 weeks) show considerable explanatory power in relation to mental health. These findings highlight the influential role of these factors in shaping the mental well-being of individuals.

These results suggest that, on average, younger respondents had higher levels of reported anxiety and depression than older respondents. Specifically, individuals between the ages of 18 and 24 were, on average, 2.116 times more likely to experience anxiety and 2.882 times more likely to experience depression than were individuals between the ages of 45 and 54, holding all other variables constant (c.p.). In contrast, individuals aged 65-74 were, on average, 0.325 times more likely to experience anxiety and 0.274 times more likely to experience depression than the reference category (aged 45-54), holding all other variables constant (c.p.).
Female respondents were, on average, 38.4% more likely to experience anxiety than their male counterparts, (c.p.). Similarly, female respondents were 23.6% more likely to be depressed than male respondents (c.p.).
Educational level appears to have played a significant role in the manifestation of anxiety and depression. The results indicate that lower levels of education were associated with a higher likelihood of experiencing anxiety and depression. For example, respondents with no formal education were, on average, 112.8% more likely to be anxious than those with a secondary education, holding all other variables constant (c.p.). Similarly, respondents with no formal education were, on average, 52.4% more likely to be depressed than those with a secondary education, holding all other variables constant (c.p.). These results suggest that individuals with limited educational attainment had an increased vulnerability to anxiety and depression during the study period. The presence of paid employment appears to have a significant impact on levels of anxiety and depression. Respondents who reported having paid work in the past 4 weeks were, on average, 0.522 times as likely to be anxious and 0.505 times as likely to be depressed as those without paid work (c.p.). This indicated that individuals with paid work were, on average, 47.8% less likely to experience anxiety and 49.5% less likely to experience depression than their counterparts without paid work (c.p.).

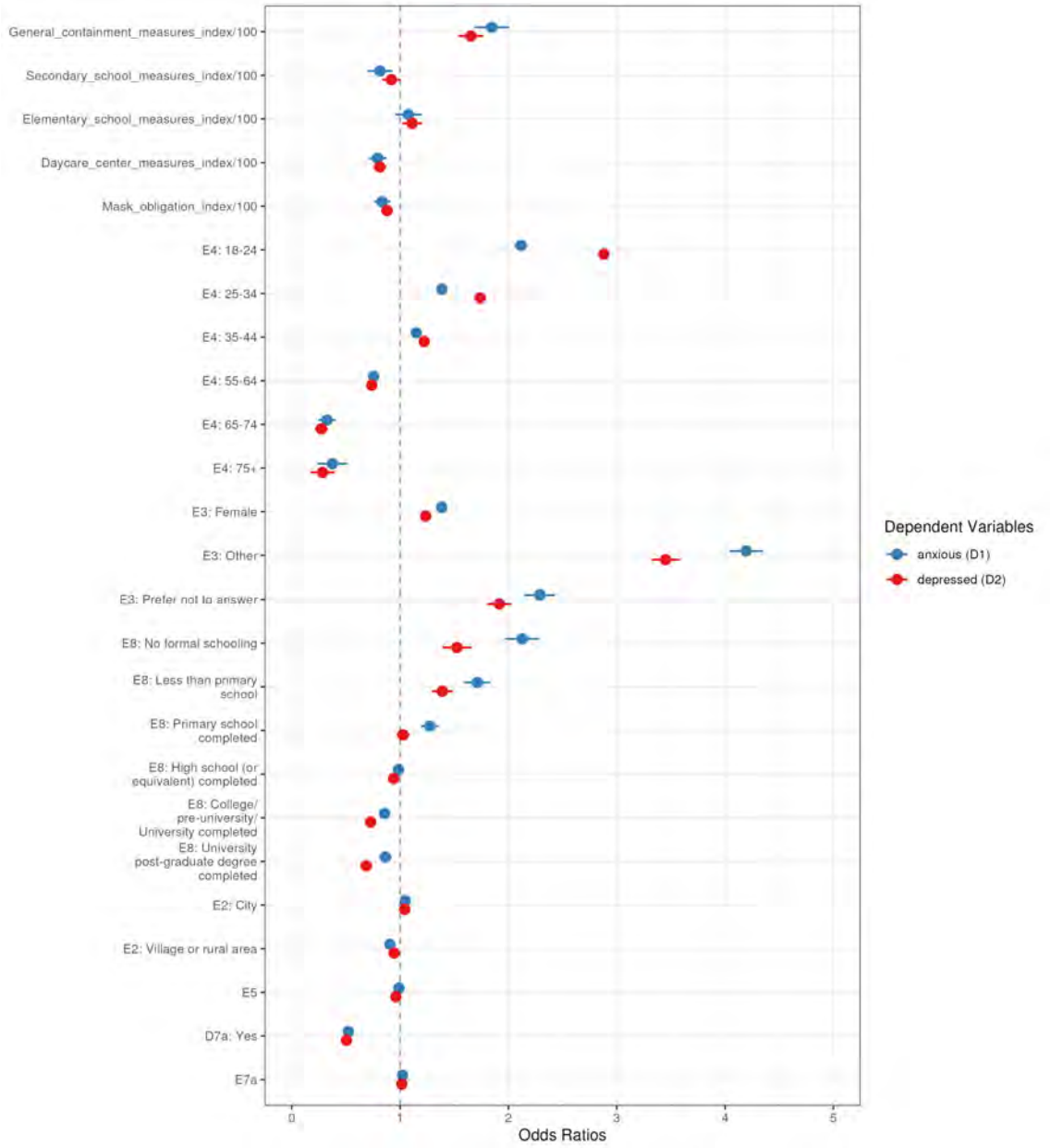

Figure 8. Effects Associated with Mental Health. *Odds ratios of effects on anxiety and depression; Observation period May 20, 2021 to June 25.*

The place of living also played a significant role in relation to anxiety and depression levels. Comparing to the reference category of individuals living in towns, respondents residing in cities were, on average, 4.7% more likely to experience anxiety, while those living in villages or rural areas were 9.8% less likely to experience anxiety. Similarly, individuals in cities were 4.2% more likely to experience depression, whereas those in villages or rural areas were 5.7% less likely to experience depression. These findings suggest that the urban environment may be associated with a higher likelihood of anxiety and depression, while living in villages or rural areas may have a protective effect on mental health.

In contrast to these relevant variables, all of the measures indices except the general containment measures index appeared to play little or no role in anxiety and depression. Only the general containment measures index and the elementary school measures index had odds ratios greater than one for both anxiety and depression, with only the general containment measures index being significant. That is, for the other indices, including measures for secondary schools, daycare centers, and mask obligation, the odds of being anxious and depressed decreased as the index increased, indicating stricter pandemic restrictions, holding all other variables constant (c.p.). The most relevant index in terms of impact on mental health appeared to

be the general containment measures index. For every 10 point increase in the index, respondents were on average 6.15% more likely to be anxious and 5.04% more likely to be depressed, holding all other variables constant (c.p.). Nevertheless, the results suggest that the pandemic restrictions appeared to have had small effect on mental health during the study period.

These results provide evidence for the associations between variables such as age, gender, education level, and employment status and the likelihood of experiencing anxiety and depression during COVID-19. However, the impact of pandemic restrictions, as measured by the indices, on mental health was small. Only the general containment measures showed a small significant negative effect on anxiety and depression. Overall, the results suggest that the pandemic restrictions had a limited impact on mental health during the study period.

4. Discussion

This study examined the impact of pandemic restrictions on mental health using a uniquely comprehensive dataset of over 500,000 responses. The data were obtained from the UMD Global CTIS survey data combined with the German Corona data (Kreuter et al., 2020; Statistisches Bundesamt, 2023). The observation period for the study covered a significant timeframe from May 20, 2021, to June 25, 2022.

In general, a key finding of my study is that the impact of pandemic restrictions, as measured by the restriction indices, including general containment measures, secondary school measures, elementary school measures, daycare center measures, and mask obligations, on mental health in Germany was small to minimal. Only the general containment measures showed a significant small negative effect on mental health, suggesting that other variables play a more prominent role in explaining mental health outcomes. The secondary school measures, elementary school measures, daycare center measures, and mask obligations showed either a minimal positive association or no significant effect on mental health. A minimal positive association suggests that stricter implementation of these measures was associated with a small increase in mental well-being. However, the magnitude of this effect was not substantial. The analysis of anxiety and depression levels in relation to the overall containment measures reveals no discernible pattern or consistent trend. This lack of consistency persists even when considering different age groups and other relevant factors.

Interestingly, our findings contrast with some previous studies that found a stronger association between pandemic restrictions and mental health (Ammar et al., 2020; Fiorenzato et al., 2021). The results of my study are generally consistent with the meta-analysis by Prati and Mancini (2021), which also found a generally small effect of COVID-19 pandemic restrictions on mental health symptoms in the general population when comparing different studies, similar to the small effect of general containment measures on mental health found in this study. By examining the impact of pandemic restrictions on mental health in Germany, including the exploration of additional factors, our study contributes to the need for further research in this area. It highlights the importance of a comprehensive understanding of the multiple factors that influence mental well-being during crises.

Consistently, our results show a significant association between age, gender, education level, and employment status with the likelihood of experiencing anxiety and depression. Younger respondents and those with lower levels of education were found to be more vulnerable to these mental health conditions. These findings are also supported by other general mental health studies that suggest older age groups are more resilient than younger ones (Gooding et al., 2012; Thomas et al., 2016). In addition, those without paid employment and women reported higher levels of anxiety and depression. These findings are consistent with existing research highlighting the importance of these factors in mental health outcomes (Benke et al., 2020). While my study found that women appeared to be more vulnerable to mental health problems during the pandemic, it is important to recognize that men may be less likely to openly admit mental health problems (Sagar-Ouriaghli et al., 2019). Furthermore, my study explored the impact of residential location on mental health outcomes. We found that people living in towns had an increased likelihood of being anxious or depressed compared to those living in villages or rural areas.

Despite the significant findings and contributions of this study, there are several limitations that should be acknowledged. First and foremost, it is important to note that the data used in this study was collected exclusively from Facebook users who participated in the UMD Global CTIS (Kreuter et al., 2020). While this sampling strategy introduces potential biases and limitations, as it may not fully represent the entire German population, it is worth noting that the Facebook user base is generally stable and diverse, encompassing a wide range of individuals. Secondly, to measure pandemic restrictions, the study utilized Corona data Germany, which includes various indices such as general containment measures, secondary school measures, elementary school measures, daycare center measures, and mask obligations. It is important to acknowledge that these indices may not perfectly capture the extent and impact of the restrictions implemented. In addition, it is critical to consider the time frame of the study, which focused exclusively on the period from May 20, 2021 to June 25, 2022. This narrower timeframe was chosen due to the availability of the education level variable in the UMD Global CTIS data, rather than encompassing a longer period such as the entire COVID-19 pandemic or beyond (Kreuter et al., 2020). It is important to recognize that the findings may not reflect the long-term effects of the pandemic or account for potential changes in mental health patterns over a longer period of time. Finally, the study relied on very simple self-reported measures of anxiety and depression, which may be subject to recall or social desirability bias. The subjective nature of these measures may also introduce variability in reporting across individuals, potentially affecting the accuracy and reliability of the results.

In addition, while the models used in this study accounted for several demographic and socioeconomic variables, there may still be unobserved or unmeasured factors that could influence mental health outcomes. Other contextual factors, such as social support, living conditions, access to health care, and individual coping mechanisms, were not explicitly included in the analysis. Future research should consider including a broader range of variables to capture the complexity and multifaceted nature of mental health. Finally, it is important to note that this study focused on the German population, and the findings may not be directly generalizable to other countries or regions. The impact of pandemic restrictions on mental health may vary in different cultural, social and economic contexts. Therefore, caution should be exercised when extrapolating the findings to other populations.

In conclusion, this study provides important insights into the impact of pandemic restrictions on mental health in Germany. The results show small to minimal overall effects of these restrictions on mental well-being, suggesting that other factors may play a more prominent role in explaining mental health outcomes. Specifically, the study found that only general containment measures showed a small negative effect on mental health, while secondary school measures, elementary school measures, daycare center measures, and mask obligations showed either minimal positive associations or no significant effects. The study also identifies significant associations between age, gender, education level, employment status and mental health outcomes. These findings contrast with some previous research that found a stronger association between pandemic restrictions and mental health (Ammar et al., 2020; Fiorenzato et al., 2021). However, the findings also contribute to the existing literature and are consistent with the meta-analysis by Prati and Mancini (2021), which highlights the generally relatively small impact of COVID-19 pandemic restrictions on mental health symptoms in the general population. These findings underscore the importance of comprehensive research that considers multiple factors that influence mental well-being and have implications for educators, policymakers, and mental health professionals seeking to address the impact of pandemic restrictions on mental health.

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Data Availability Statement. The code for this paper is available on Github. The data used from the UMD Global CTIS is under restricted access (see https://covidmap.umd.edu/). The data used from the Corona data Germany is publicly available (see https://www.corona-daten-deutschland.de/dataset/massnahmenindex_bundeslaender_pro_tag).

Used tools. ChatGPT (https://openai.com/blog/chatgpt), DeepL (https://deepl.com/), Elicit (https://elicit.org/), LRZ AI Systems, Overleaf (https://www.overleaf.com/), R (Studio)

A. Appendix

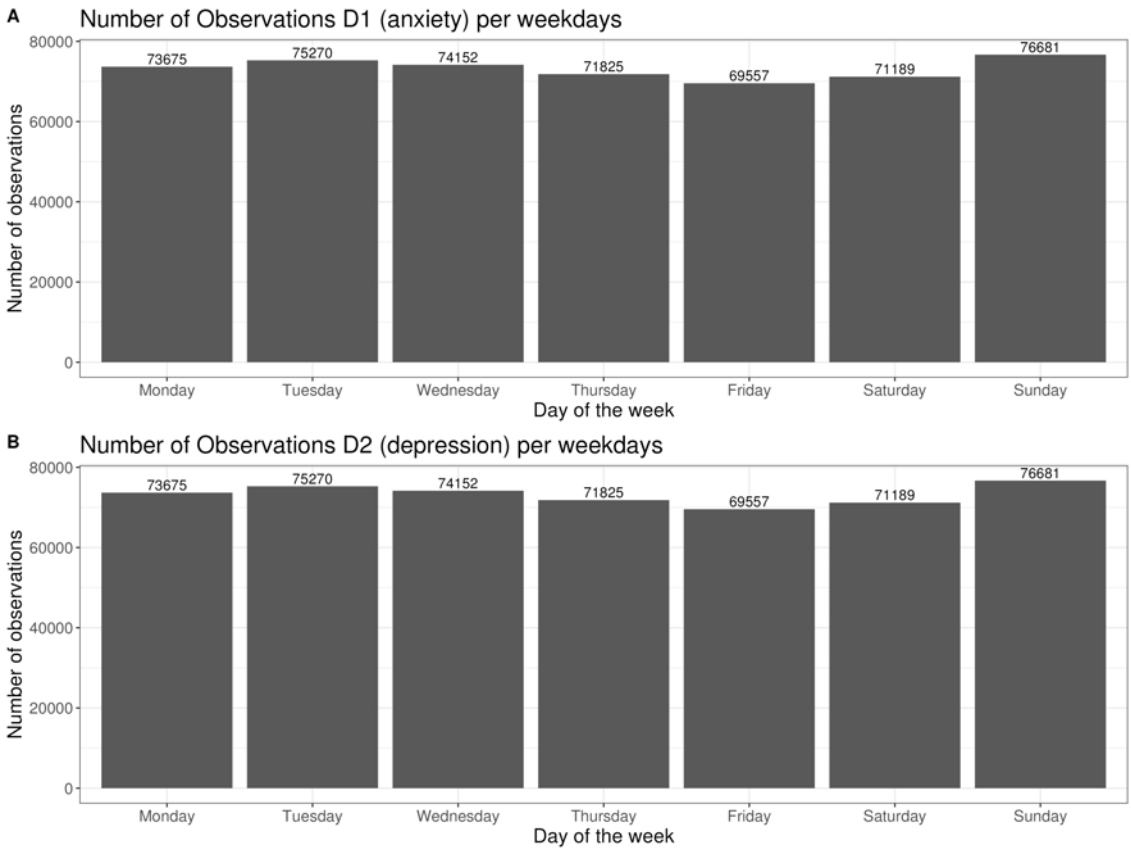

Figure 9. Observations of D1 (anxiety) and D2 (depression) per weekday. *Number of observations D1 (anxiety) per weekday (**A**). Relative frequencies D2 (depression) per weekday (**B**). Data aggregated per weekday: Observation period May 20, 2021 to June 25, 2022.*

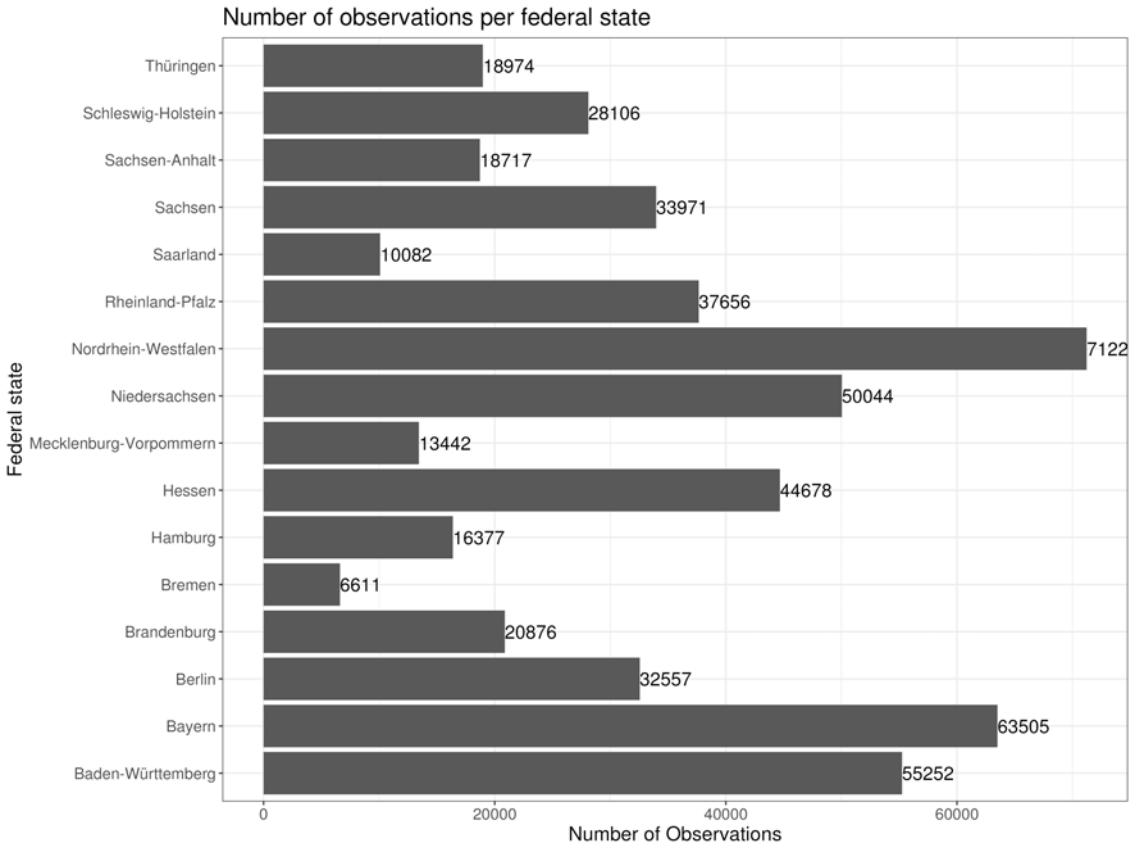

Figure 10. Number of observations per federal state. *n = 522,070; Observation period May 20, 2021 to June 25, 2022.*

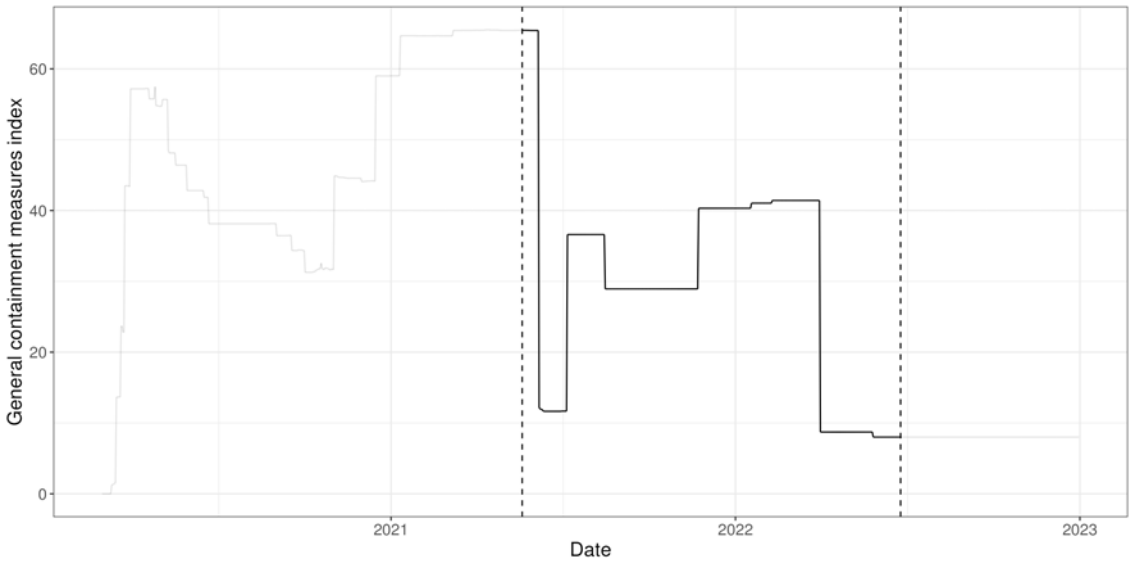

Figure 11. German general containment measures index over time in Bavaria. *Data aggregated per day: Relevant observation period May 20, 2021 to June 25, 2022.*

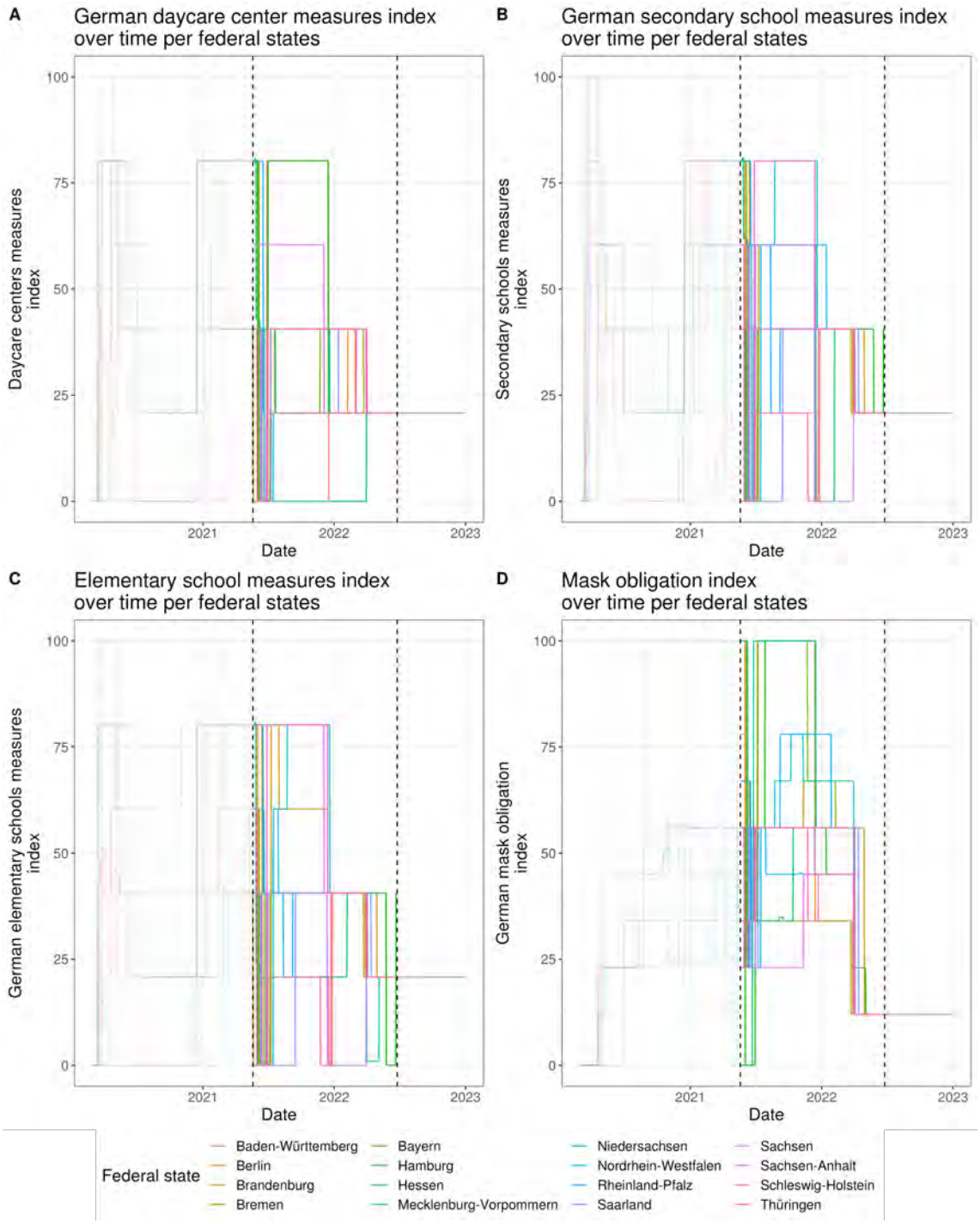

Figure 12. German measures indexes over time per federal states. *German daycare center measures index over time per federal states (**A**). German secondary school measures index over time per federal states (**B**). German elementary school measures index over time per federal states (**C**). German mask obligation index over time per federal states (**D**). Data aggregated per day: Relevant observation period May 20, 2021 to June 25, 2022.*

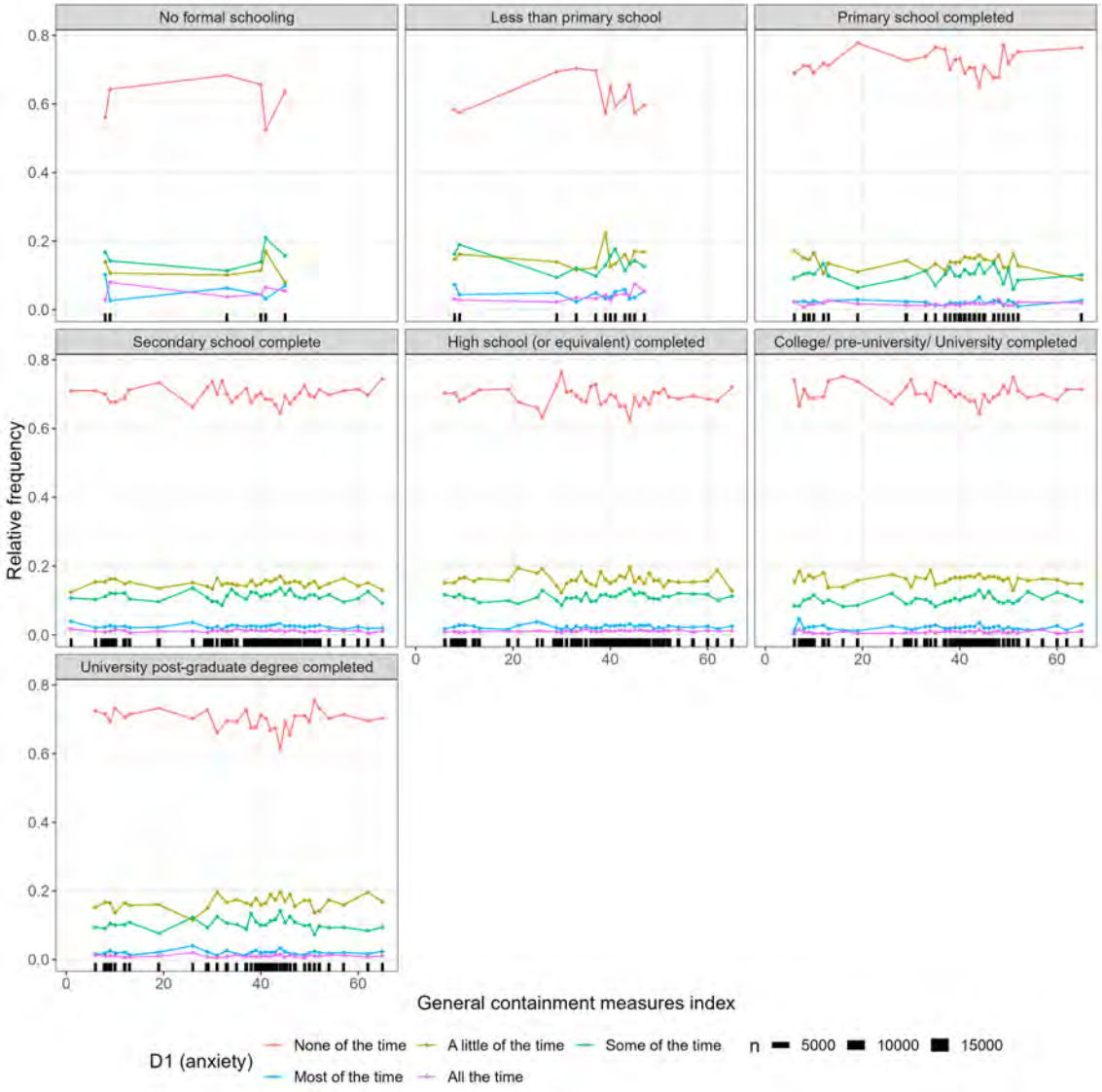

Figure 13. Relative frequency of D1 (anxiety) categories across general containment measures index per education level. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each education level includes observations with at least 3 responses for each anxiety category across index scores.*

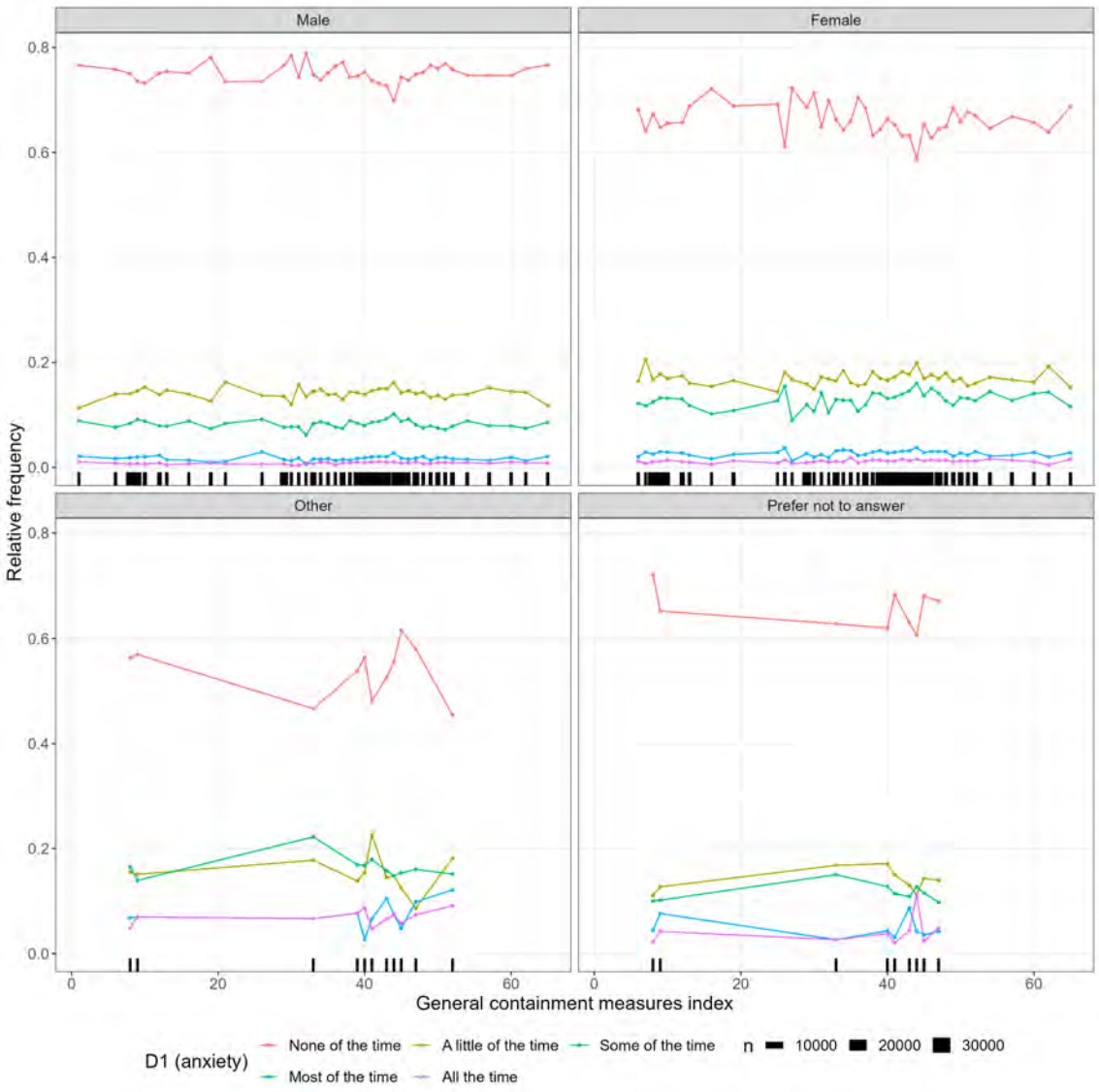

Figure 14. Relative frequency of D1 (anxiety) categories across general containment measures index per gender. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each gender includes observations with at least 3 responses for each anxiety category across index scores.*

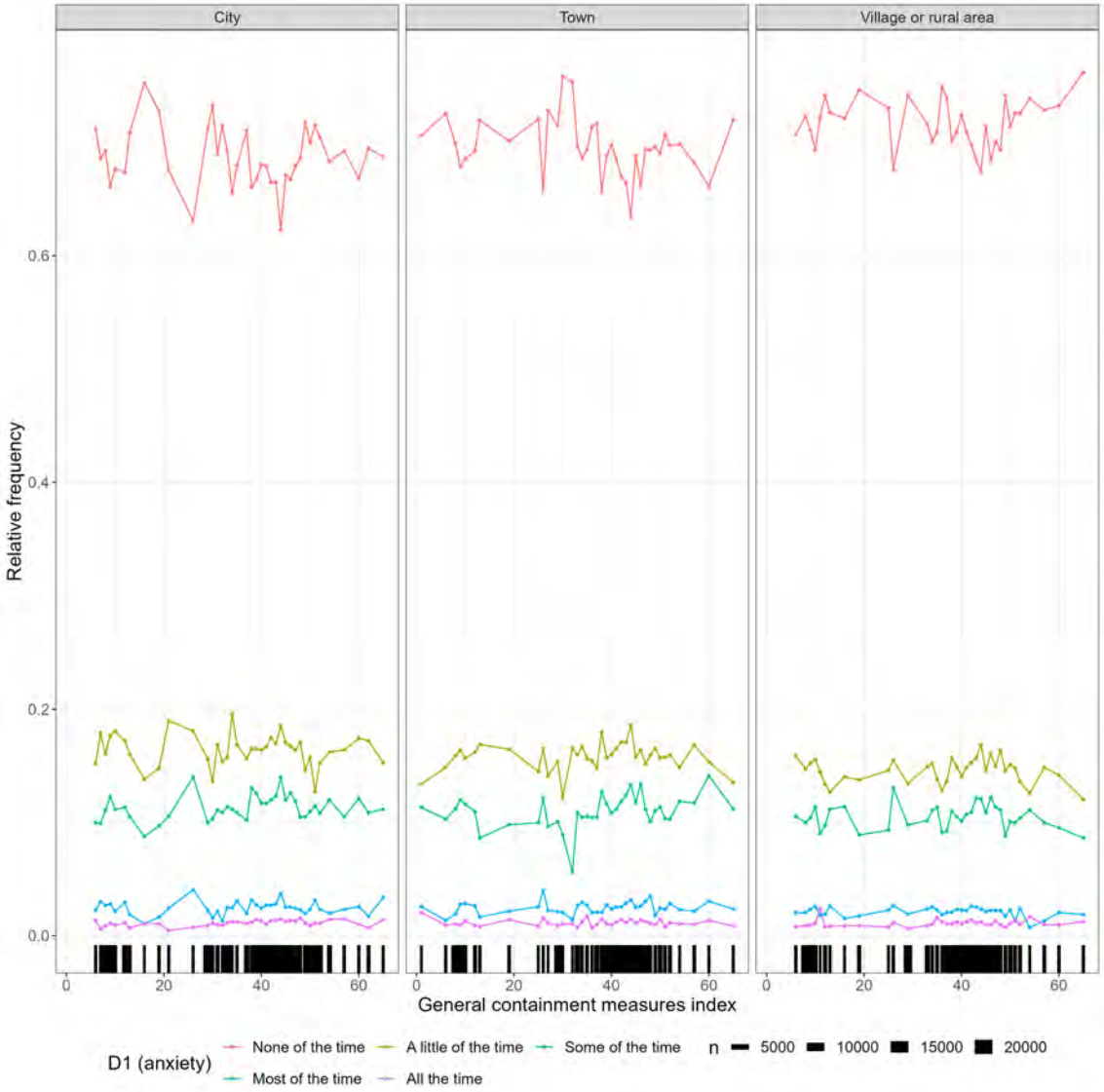

Figure 15. Relative frequency of D1 (anxiety) categories across general containment measures index per place of living. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each place of living includes observations with at least 3 responses for each anxiety category across index scores.*

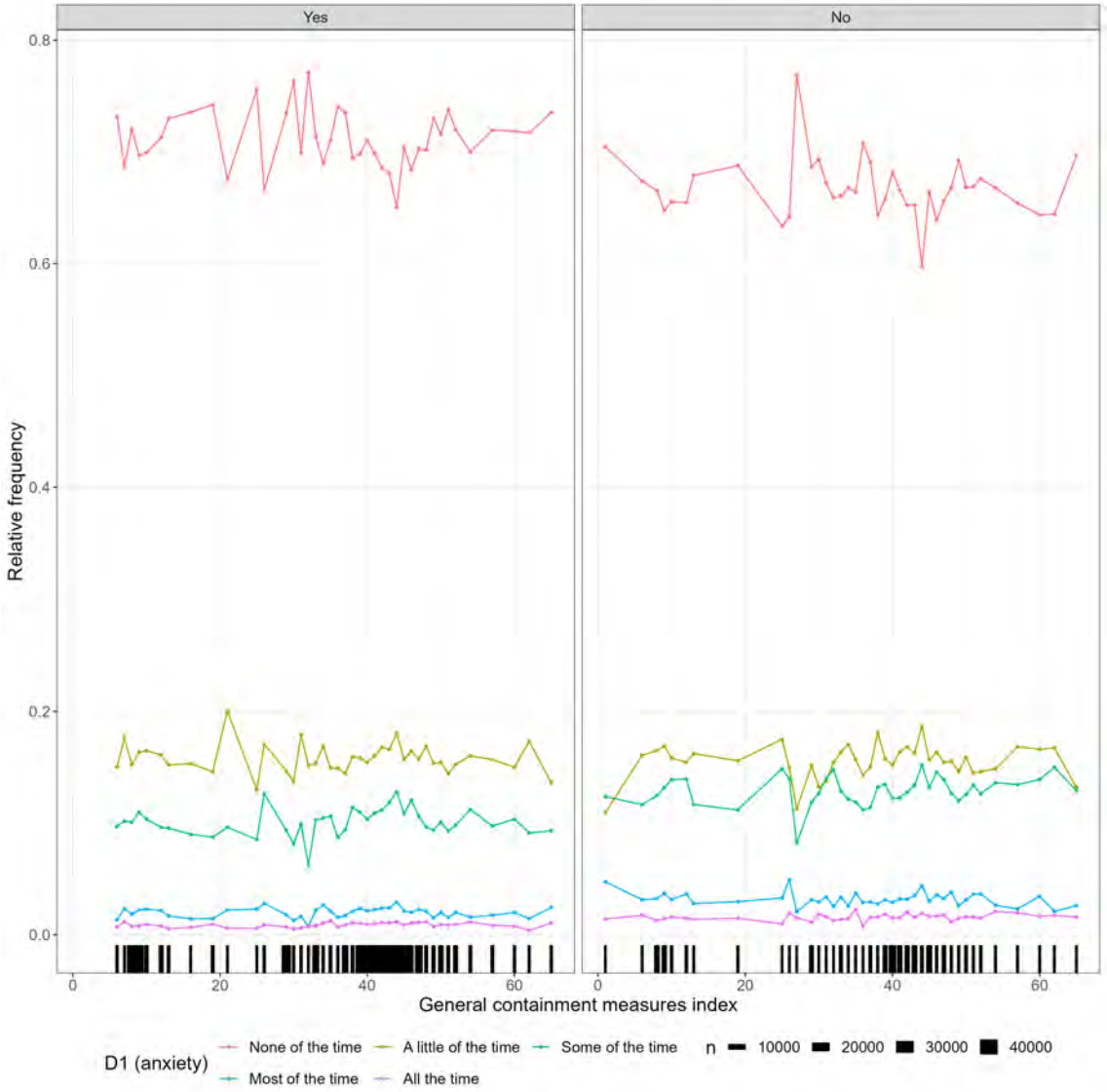

Figure 16. Relative frequency of D1 (anxiety) categories across general containment measures index per paid work category. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each paid work category includes observations with at least 3 responses for each anxiety category across index scores.*

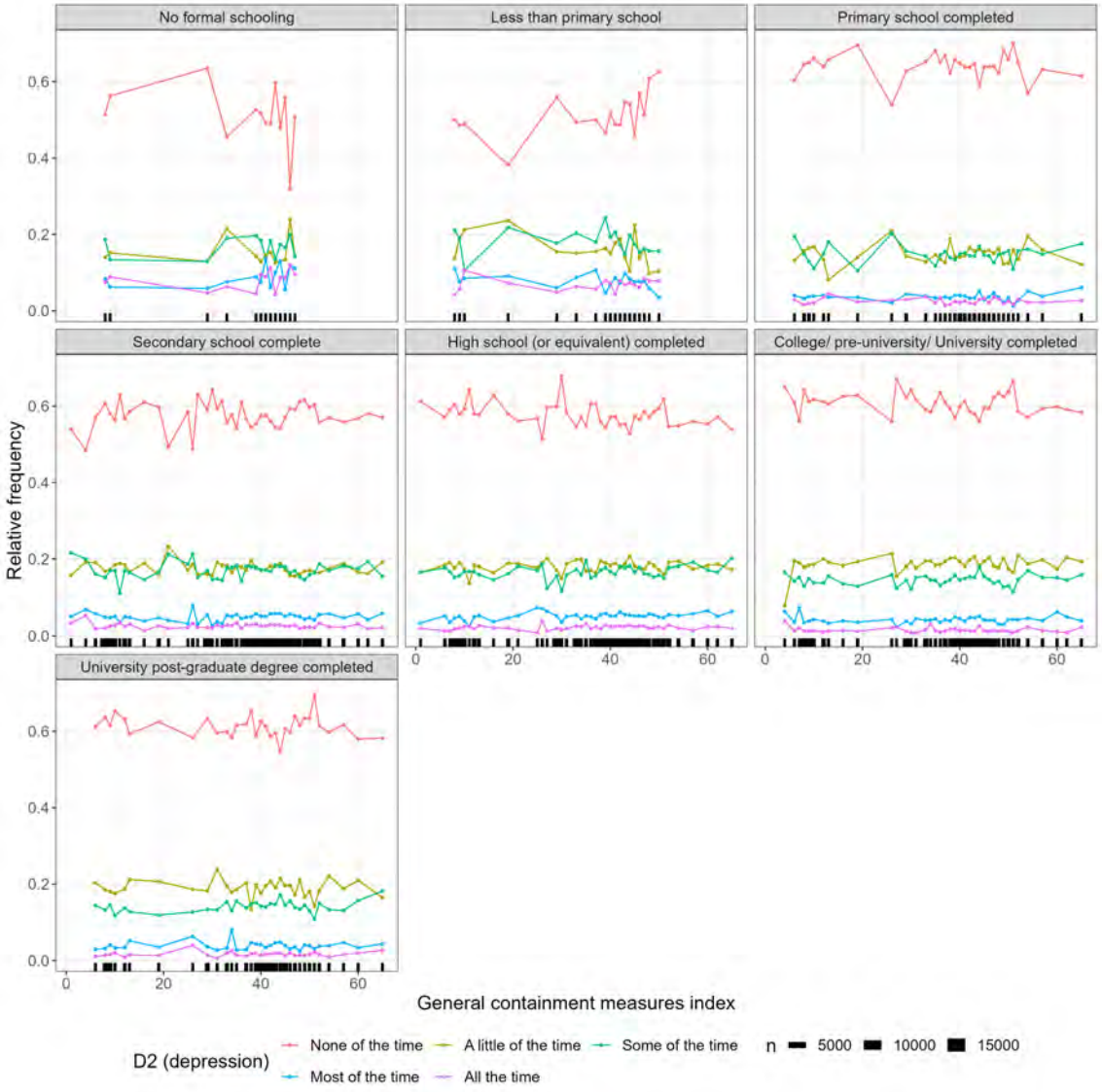

Figure 17. Relative frequency of D2 (depression) categories across general containment measures index per education level. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each education level includes observations with at least 3 responses for each anxiety category across index scores.*

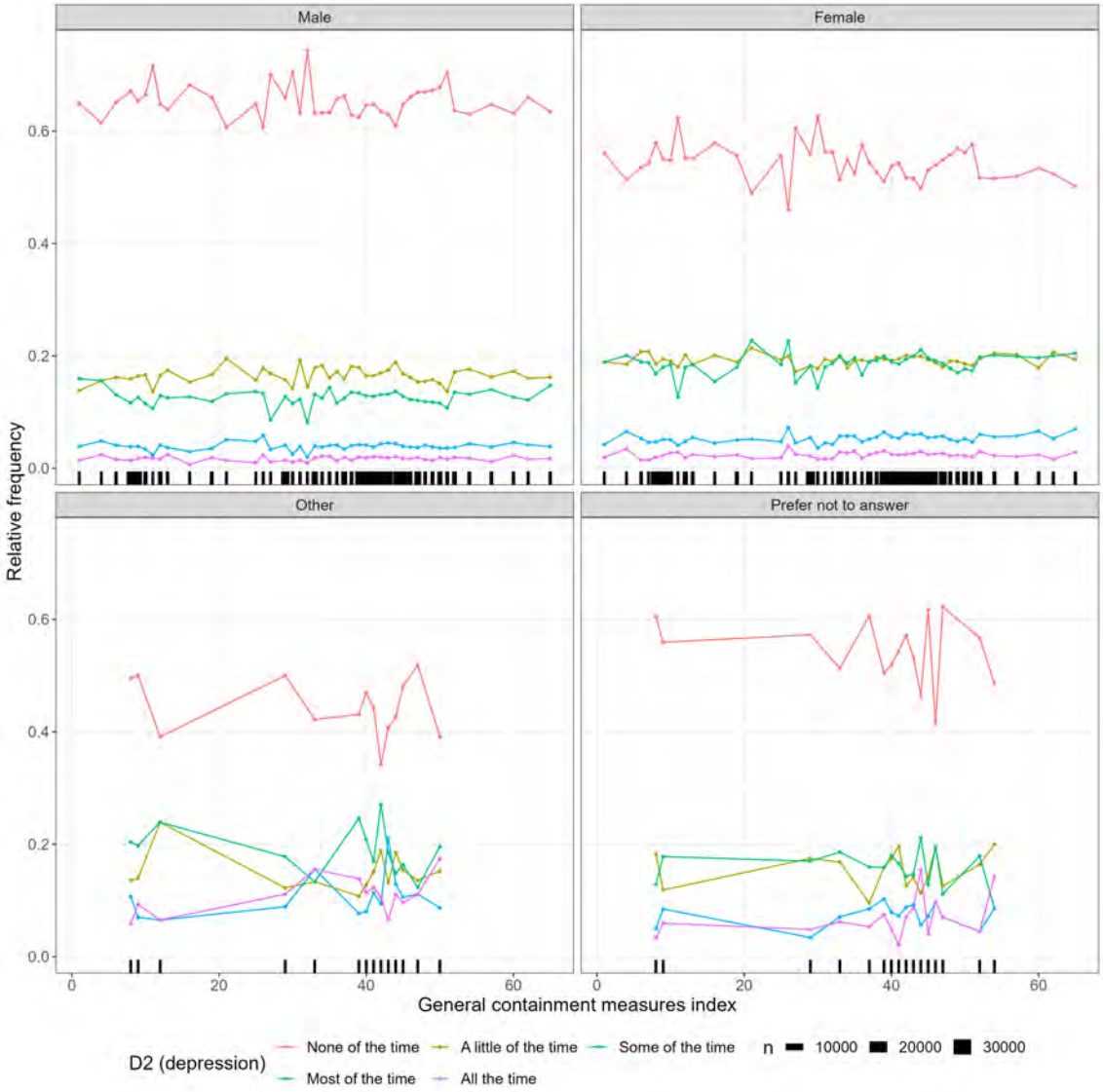

Figure 18. Relative frequency of D2 (depression) categories across general containment measures index per gender. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each gender includes observations with at least 3 responses for each anxiety category across index scores.*

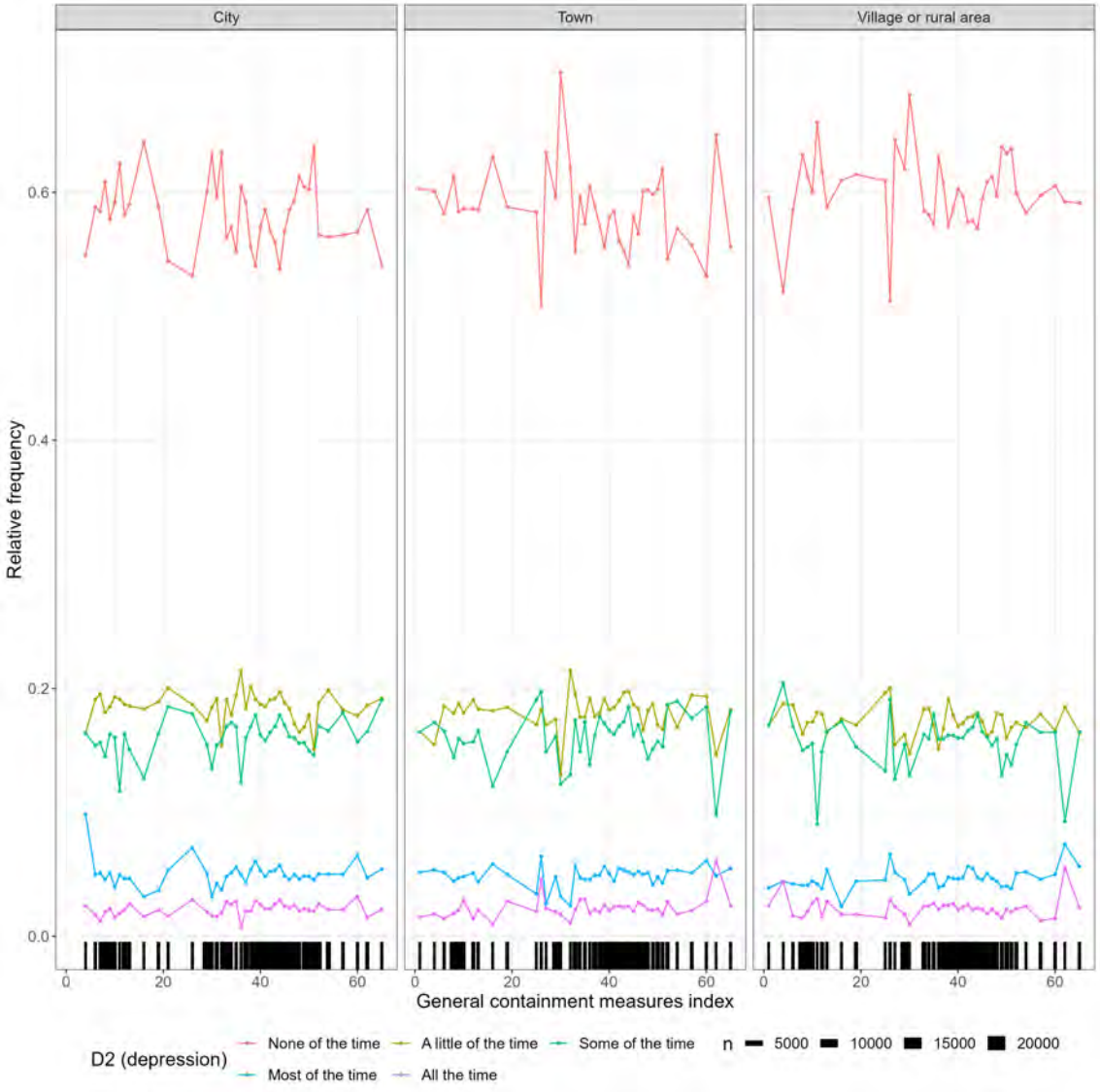

Figure 19. Relative frequency of D2 (depression) categories across general containment measures index per place of living. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each place of living includes observations with at least 3 responses for each anxiety category across index scores.*

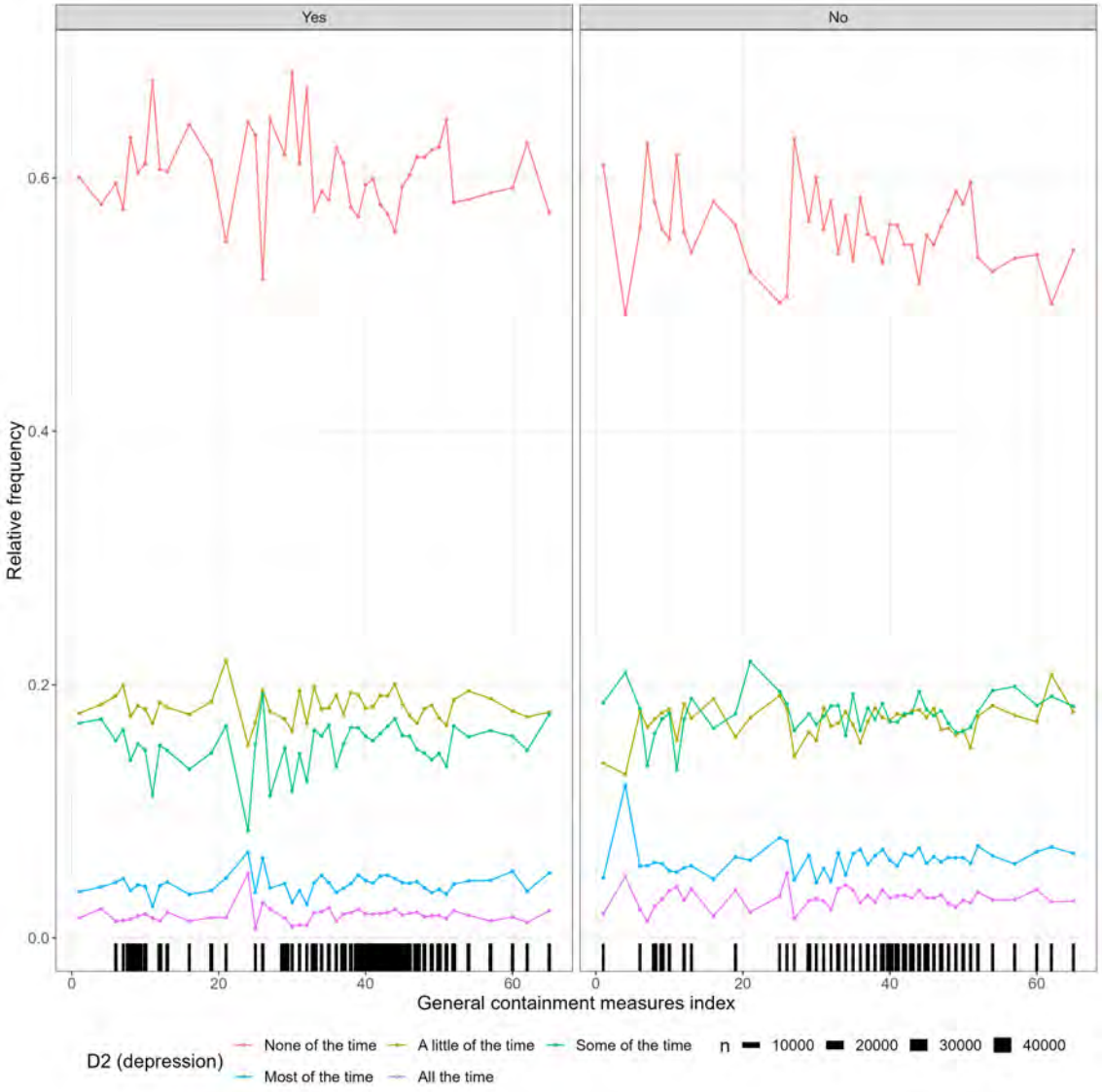

Figure 20. Relative frequency of D2 (depression) categories across general containment measures index per paid work category. *Data aggregated per day: Observation period May 20, 2021 to June 25, 2022; General containment measures index is rounded to the nearest integer; Each paid work category includes observations with at least 3 responses for each anxiety category across index scores.*

Declaration of originality

I hereby confirm that I have written the accompanying thesis by myself, without contributions from any sources other than those cited in the text and acknowledgements. This applies also to all graphics, drawings, maps and images included in the thesis.

The work has not yet been submitted to any other examining authority and has not yet been not yet published.

Munich, _____ _____

Place, date Christian Hobelsberger