Effects of the COVID-19 pandemic on suicide attempts in a rural region in Germany : a 5-year observational study

Arand, Jule Jannick

UNIVERSITY OF SPLIT
SCHOOL OF MEDICINE

Jule Jannick Arand

EFFECTS OF THE COVID-19 PANDEMIC ON SUICIDE ATTEMPTS IN A RURAL REGION IN GERMANY, A 5-YEAR OBSERVATIONAL STUDY

Diploma thesis

Academic year:
2021/2022

Mentor:
Johannes Brachmann, MD, PhD

Coburg, July 2022

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First and foremost, I would like to thank Ulrich Kastner, for being there when I needed help and guiding me through the entire research project over the last years. For your patience support whenever I needed it. Thank you!

A special thanks to Johannes Brachmann for being a supportive mentor.

For my friends and family for their continuous support that they have shown me throughout my years. Especially to my partner Richard that has always been there for me, for which I will be forever grateful.

Furthermore, I am beyond proud to be part of a research group dealing with suicidality at the University Hospital in Jena and the psychiatric clinic in Hildburghausen. Working in this field has fulfilled me for years and I am happy to be able to contribute to the field of suicide prevention.

Finally, I would like to thank the University of Split School of Medicine and the Medical School REGIOMED for giving me the opportunity to complete my MD degree here in Croatia.

LIST OF ABBREVIATIONS

ASA	American Psychiatric Association
COVID-19	Coronavirus disease 2019
DSM	Diagnostic and Statistical Manual of Mental Disorders
HIAA-5	5-Hydroxyindoleacetic acid
HPA- AXIS	Hypothalamic-pituitary-adrenal axis
ICD	International Classification of Disease
NSSI	Non-suicidal Self-Injury
RKI	Robert Koch Institute
SA	Suicide attempt
SARS	Severe acute respiratory syndrome
SB	Suicidal behavior
SBD	Suicide behavior disorder
SI	Suicidal ideation

1. INTRODUCTION

1.1. Definitions

The American Psychiatric Association's (ASA) Diagnostic and Statistical Manual of Mental Disorders (DSM) is a classification scheme created to standardize and streamline clinical diagnostic processes. Over the past decades it has become a default reference system in the field of mental health. The DSM classifications are harmonized with the International Classification of Diseases (ICD) of the World Health Organization, which is the official coding system used in the United States. Although DSM-5 provides a categorical classification of various psychiatric diseases, it is to remember that mental illnesses often cannot be classified into single categories and frequently span multiple diagnoses (1).

The definitions of suicidal behavior disorder (SBD) and non-suicidal self-injury (NSSI) suggested by the DSM-5 under the section "Conditions for Further Study" are presented in Table 1 and Table 2.

Table 1. DSM-5 criteria of suicidal behavior disorder (SBD)

Proposed Criteria
A. Within the last 24 months, the individual has made a suicide attempt. **Note:** A suicide attempt is a self-initiated sequence of behaviors by an individual who, at the time of initiation, expected that the set of actions would lead to his or her own death. The "time of initiation" is the time when a behavior took place that involved applying the method.)
B. The act does not meet criteria for nonsuicidal self-injury—that is, it does not involve self-injury directed to the surface of the body undertaken to induce relief from a negative feeling/cognitive state or to achieve a positive mood state.
C. The diagnosis is not applied to suicidal ideation or to preparatory acts.
D. The act was not initiated during a state of delirium or confusion.
E. The act was not undertaken solely for a political or religious objective.
Specify if: **Current:** Not more than 12 months since the last attempt. **In early remission:** 12–24 months since the last attempt.

Data are presented and taken directly from the American Psychiatric Association (1)

Table 2. DSM-5 criteria of non-suicidal self-injury (NSSI)

Proposed Criteria

A. In the last year, the individual has, on 5 or more days, engaged in intentional self-inflicted damage to the surface of his or her body of a sort likely to induce bleeding, bruising, or pain (e.g., cutting, burning, stabbing, hitting, excessive rubbing), with the expectation that the injury will lead to only minor or moderate physical harm (i.e., there is no suicidal intent).

   Note: The absence of suicidal intent has either been stated by the individual or can be inferred by the individual's repeated engagement in a behavior that the individual knows, or has learned, is not likely to result in death.

B. The individual engages in the self-injurious behavior with one or more of the following expectations:

   1. To obtain relief from a negative feeling or cognitive state.
   2. To resolve an interpersonal difficulty.
   3. To induce a positive feeling state.

   Note: The desired relief or response is experienced during or shortly after the self-injury, and the individual may display patterns of behavior suggesting a dependence on repeatedly engaging in it.

C. The intentional self-injury is associated with at least one of the following:

   1. Interpersonal difficulties or negative feelings or thoughts, such as depression, anxiety, tension, anger, generalized distress, or self-criticism, occurring in the period immediately prior to the self-injurious act.
   2. Prior to engaging in the act, a period of preoccupation with the intended behavior that is difficult to control.
   3. Thinking about self-injury that occurs frequently, even when it is not acted upon.

D. The behavior is not socially sanctioned (e.g., body piercing, tattooing, part of a religious or cultural ritual) and is not restricted to picking a scab or nail biting.

E. The behavior or its consequences cause clinically significant distress or interference in interpersonal, academic, or other important areas of functioning.

F. The behavior does not occur exclusively during psychotic episodes, delirium, substance intoxication, or substance withdrawal. In individuals with a neurodevelopmental disorder, the behavior is not part of a pattern of repetitive stereotypies. The behavior is not better explained by another mental disorder or medical condition (e.g., psychotic disorder, autism spectrum disorder, intellectual disability, Lesch-Nyhan syndrome, stereotypic movement disorder with self-injury, trichotillomania [hair-pulling disorder], excoriation [skin-picking] disorder).

Data are presented and taken directly from the American Psychiatric Association (1)

Suicide is a highest priority phenomenon worldwide. It can be understood as self-inflicted violence. A person tries to end their own life due to a series of factors related to biological, psychological and environmental issues (2). Suicidality or suicidal behavior, in turn, is assumed to be the collection of suicidal thoughts, the planning of the suicidal act and the suicide attempt (3). Most of the time, suicide is not a manifestation of inner or outer freedom or choice. Instead, it is a result of subjective/objective distress. Most acutely suicidal patients experience an indefinitely lasting "emotional chaos" also referred to as “suicidal mode” in which self-determination is restricted. The period between the suicidal ideation and the act is often less than 24 hours (4).

Recent retrospective research delineates seven distinct categories of “suicidality”: completed suicide, suicide attempt, preparatory acts toward imminent suicidal behavior, suicidal ideation, self-injurious behavior without intent to die, nondeliberate self-harm, and self-harm behavior with unknown suicidal intent (5).

“Suicidal ideation” can range from passive death wishes, to active thoughts of committing suicide, to having a specific detailed suicidal plan with the intention of putting the plan into action (6).

1.2. Epidemiology

Despite a large number of suicide prevention programs in Germany, suicide figures have been rising again since 2007. The underlying reasons and spatiotemporal risk patterns are poorly understood (7).

According to the Federal Statistical Office of Germany a total of 9,206 people died by suicide in 2020. That was more than 25 people a day. Compared with 2019 (9,041 suicides), there was a slight increase. There were significant differences in suicide rates within the federal states: Looking at the death rate per 100,000 inhabitants, North Rhine-Westphalia had the fewest suicides with 7.6 suicides per 100,000 inhabitants (8). In Thuringia, the federal state to which the following study refers, the suicide rate was 15.7 (9). The highest rate, 15.9, was in Saxony-Anhalt. Suicides predominate among men (8).

Suicide attempt rates are much higher compared to suicide rates. They happen to be between 80-150 per 100,000. In the years around midlife and predominantly among women they are especially accentuated (4).

There is only little information on the cross-national prevalence of suicidal ideation in spite of its obvious public health importance. The standardized period prevalence for all suicidal

ideation varied from 1.1 to 19.8% in a study from the Outcome of Depression International Network (ODIN), that uses an epidemiological sampling frame to offer information on the prevalence, risk factors, and outcome of depressive disorders in rural and urban settings within the European Union (EU). There was less variation for significant suicidal ideation (10).

1.3. Risk Factors

The main risk factors for suicide defined by Wolfersdorf and Hegerl in their german book “Therapie psychischer Erkrankungen” published in 2019 are the followig (4):

- previous suicide attempts or initiated suicidal acts
- concrete suicide preparations (e.g., collecting pills)
- mental illnesses with a high risk (e.g., depression, bipolar disorder, schizophrenia, alcohol dependence)
- suicides in family history and other models.
- experience of violence (e.g., sexual abuse) in childhood and adolescence
- delusional syndromes (e.g., hypochondriacal delusions, delusions of guilt)
- life events (e.g., job loss, existential crisis, separation from partner)
- male gender
- older age
- severe physical illness, unbearable pain
- personality accentuation, especially high sickliness and/or high aggression potential
- strong inner restlessness, pronounced sleep disturbances
- non-compliance with therapy measures

1.4. Pathophysiology

Suicidal behavior has no established pathophysiological foundation, just like many other psychiatric disorders. The HPA axis dysregulation shown by dexamethasone non-suppression and low CSF fluid 5-hydroxyindoleacetic acid (5-HIAA) are now the most promising biological predictors of suicidal behavior (11, 12). So far, no biological marker has been discovered that is sensitive or accurate enough to be recommended for routine clinical usage. Clinical investigations that are exact enough to show the complexity of the brain-mind interaction involved in suicidal tendencies are still incredibly rare (13).

1.5. Primary, Secondary and Tertiary Prevention

Suicide prevention can be primary, secondary, or tertiary. The goal of primary suicide prevention is to decrease the incidence of new suicide cases among the general community. The ultimate objective is to keep people from ever reaching that stage where they might consider suicide. For instance, encouraging connectedness among peers and family members helps achieve this purpose. Secondary suicide prevention, also called intervention, focuses on decreasing the likelihood of a suicide attempt in high-risk patients. An imaginable example would be the recognition of a schoolboy with depression by a trained teacher and his further referral to a health professional for management of his depression. Tertiary suicide prevention, so called "postventions", occurs in response to completed suicides or suicide attempts. On the one hand it goals in diminishing suicide contagion (clusters of suicides in a geographical area that occur predominantly among teenagers) and copy-cat suicides. On the other hand, it aims in connecting suicide attempters to supportive services to prevent future attempts (14).

Secondary suicide prevention is particularly important but not always given the attention that it deserves. In part, this negligence is due to the fact, that research into secondary prevention is only just starting to be applied to clinical practice (13).

In a recent systematic review of suicide prevention strategies, Mann et al., found evidence of effectiveness in five secondary suicide prevention methods: pharmacological interventions, psychological interventions, follow-up care, reduced access to lethal means, and responsible media reporting of suicide. The most frequently prescribed drugs in this context are antidepressants, although research shows mixed results in their effectiveness of reducing suicides and suicide attempts. Psychological therapy that targets the repetition of suicidal thoughts and behaviors as well as treatment adherence through follow-up care appear to be the most beneficial for suicidal patients. Many studies show that suicides by particular methods (e.g., firearms, domestic gas) diminish after the introduction of legal restrictions that prohibit the access to beforementioned means. Although our knowledge of secondary prevention of suicide continues to increase steadily, there are still many gaps in research and it remains essential that these continue to be addressed in future clinical studies (15).

1.6. Rationale for screening

In the United States, data from the late 1980s and early 1990s show that about 38% of adults went to their primary care physician within a month of committing suicide. In elderly

persons, this percentage was much greater (between 50% and 70%). However, only 20% of them will have visited a mental health professional during that time. (16).

General practitioners and the psychiatric outpatient departments seem to be contact points for suicidal patients, who often appear with other public concerns. It is important that they are recognized and intercepted at that point.

Because of these observations, physician guidelines developed by regulatory agencies and professional organizations recommend that general physicians routinely screen for depressive symptoms. However, these guidelines recommend screening for suicide risk only among patients who screen positive for depression or substance abuse (17, 18).

1.7. Outcome measurements

There are a variety of scales and scores that can be used to assess suicidality as well as the effectiveness of treatment.

Some score scales tend to be widely used by mental health professionals, especially psychiatrists and psychologists, to evaluate the aspects related to suicide – such as impetus, planning, intention, previous attempts, and others. Two of these instruments are two validated questionnaires, the Beck Scale for Suicide Ideation (BSI) (19) and The Columbia – Suicide Severity Rating Scale (C-SSRS) (20).

1.8. COVID-19 pandemic and mental health

The novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) spread worldwide within shortest time after being discovered in Wuhan, China in late December 2019. On January 27, 2020, the first case of COVID-19 infection was confirmed in Germany. There were four epidemiologically distinct phases taken into consideration for the description of the pandemic course until 2021, also depicted in figure 1. Phase 0 covers the period from calendar week 5/2020 to 9/2020. Mainly sporadic cases and regionally limited outbreaks were observed during this time period. This was followed by Phase 1 (Weeks 10–20, 2020), with 175.013 cases statewide and made up the first COVID-19 wave. In southern Thuringia, the region studied, there were still only sporadic cases of disease observed. Phase 2, also called the "summer plateau", depicted rather mild progressions (week 21/2020 to 39/2020). The second COVID-19 wave in Germany, which peaked at the end of 2020, was a defining feature of phase 3 (week 40/2020 to 8/2021). Regionally, this wave was registered in mid-October 2020, then

persisted through June 2021, and was associated with noticeable strain on inpatient care. The Phase 4 presenting the third COVID-19- wave is set for the period from calendar week 9/2021 to week 23/2021. In this time period there was a significant increase in caseload both throughout Germany and southern Thuringia. The subsequent plateau phase in 2021 (phase 5) starts with week 24 (21, 22).

Overall, the COVID-19 pandemic disproportionately affected the rural population in southern Thuringia. COVID-19 mortality rates in the most severely affected areas are twice as high as mortality rates in other areas of the Federal Republic, and this increase also persisted stably over an extended period of time. Infection rates ranged from 13.7 to 20.31/100,000 inhabitants in the service region, depending on the municipality, compared to 9.62/100,000 inhabitants for the same period nationwide. The lethality rate, with values between 2.5% and 3.23% of the cases, is also significantly higher than that in Germany with 1.45% (22).

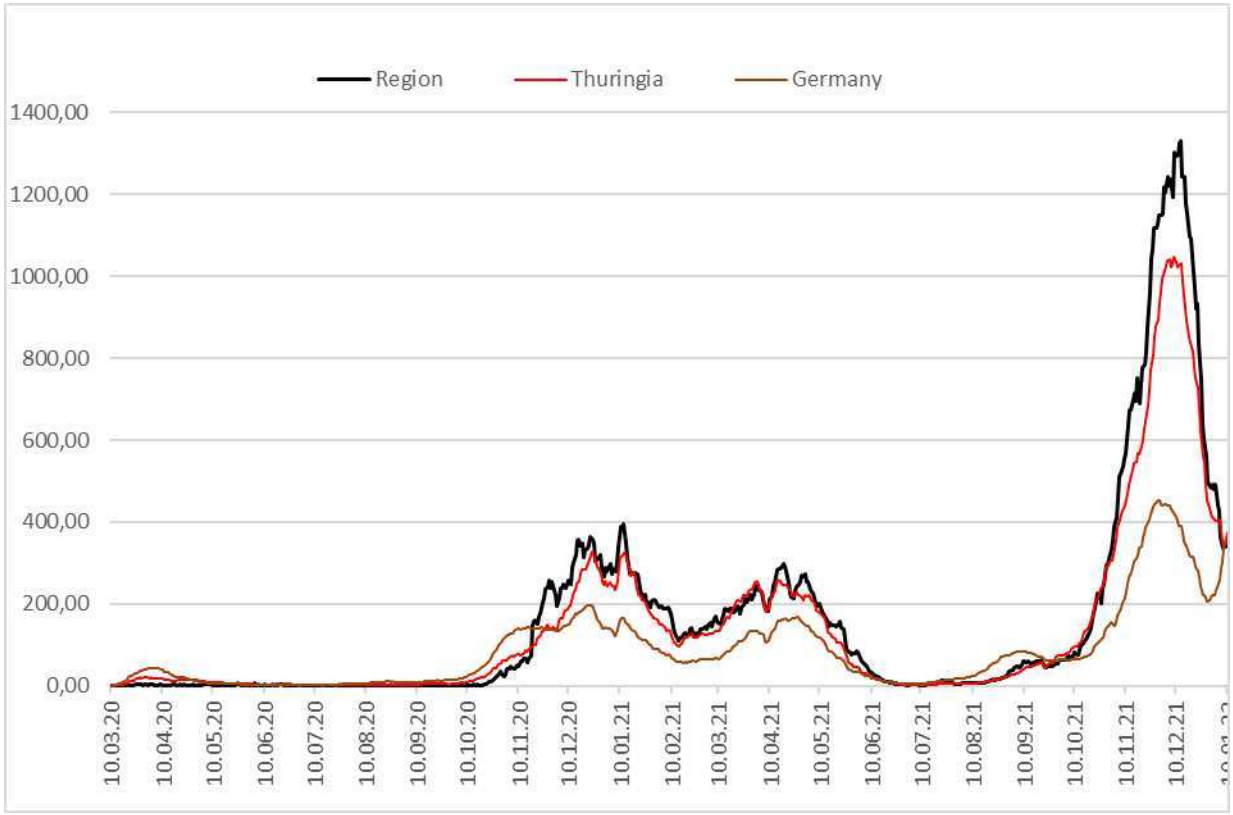

Figure 1. Change of 7-day COVID-19 incidence per 100.000 inhabitants in Germany, Thuringia and the studied region from March 2020 until January 2022 according to data derived from the RKI (22)

In order to contain the COVID-19 pandemic during its peak phases, abundant restrictive measures have temporarily been introduced. Beginning in March 2020, the government took considerable steps in Germany (23) and Thuringia (24), which had a profound impact on social and public life. People significantly limited their private contacts, the majority of stores were closed, as were educational institutions, kindergartens, cultural centers, sports and recreation centers, hotels, and restaurants. The stringent containment measures imposed a financial and social load on people worldwide. According to research, cases of depression and anxiety disorders increased by 27.6% and 25.6%, respectively, during previous pandemics (26). It would be therefore plausible to assume that the COVID-19 pandemic surges suicidal ideation and possibly suicidal behavior, including suicide attempts and suicides, when considering the strong association between depressive disorders and suicidal ideations (27).

The development of suicide risk is complex, as suicide and suicide attempts are multicausal behaviors with numerous state- and trait-dependent aspects. Contributions from biological, psychological, clinical, social and environmental factors play particularly critical roles (28, 29). According to a Finnish study the majority (80%) of suicide decedents had stressful life events within three months prior to their death (30). It would be conceivable that individuals who have experienced job loss, monetary worries, and interpersonal difficulties as a result of the Covid-19 pandemic may be at greater suicidal risk. (31).

COVID-19 is not the first global crisis to have a significant impact on people's mental health. Worth mentioning here are past epidemics, such as severe acute respiratory syndrome (SARS) and economic crises (32, 33). Research has shown that in phases of increasing unemployment or substantial economic uncertainty across Europe the suicide rates increased (34). For instance, the number of suicides related to SARS epidemics increased by 30% in Hong Kong (32). Common reasons why people ultimately choose suicide is the feeling of being a burden to the for the social environment. This is a significant finding because as postulated in Thomas Joiner's "Interpersonal Theory of Suicidal Behavior", "Thwarted Belongingness" and "Perceived Burdensomeness" are two key elements that trigger SB in vulnerable people (35, 36). The sense of not belonging to a respected group is referred to as "Thwarted Belongingness." "Perceived Burdensomeness" refers to the idea or sentiment that one's demise would match the environment's sense of relief. An online survey was used in a recent study to support a substantial link between the perceived burdens of the COVID-19 pandemic, both interpersonal aspects, and elevated suicide risk (36). A connection between COVID-19-related events and past month SIs among adults in the United States was reported by another online study (37). Increased rates of SI and suicide attempts were found in a meta-analysis of 54 studies, which

contrasted these rates with those seen in pre-pandemic findings (38). However, the cross-sectional data used in all of this research limited the ability to show actual significant links between the pandemic to suicidal ideation or suicidal behavior. More longitudinal research that addresses the relationship between COVID-19 and suicidal behavior is required.

Most of the longitudinal studies available target the impact of the COVID-19 pandemic on suicide case rates, gaining the data mostly from National Death Registers. Findings from these studies are rather inconsistent and vary significantly with the different countries they are conducted in. In the Austrian state of Tyrol, Deisenhammer et al. discovered a significant decline in suicide rates during the first six months of the COVID-19 pandemic compared to the corresponding periods of the years prior (39). Leske et al., who investigated real-time suicide data in Queensland, Australia from Feb 1 to Aug 31, 2020, did not discover any change in suicide rates compared to the pre-pandemic period (40). Contrary, Osaki et al. reported an increase in suicide rates during the second pandemic wave in Japan (41). Looking at research findings from Germany, Leipzig, during the Covid-19 pandemic, suicide rates were constant compared to earlier years, according to Radeloff et al. (42).

There is less research that analyzes the suicide attempt rates in hospital settings. The few published studies also draw rather inhomogeneous conclusions. Travis-Lumer et al. found that the “mass social trauma” of the COVID-19 pandemic was associated with a lower suicide attempt rate compared to the pre-pandemic interval in Israel (43). These findings are consistent with the observed decline in suicide behavior during lockdowns in several other nations (44, 45). In contrast, consultation for suicidal ideation and suicide attempts have increased in Barcelona during the COVID-19 pandemic period compared to the previous two years especially in young people (46). Because of the discrepancy of studies regarding a topic that is extremely relevant worldwide, research that focuses the time course of suicide attempt rates is of outmost importance.

1.9. Suicide and seasonality

Seasonal changes in suicide rates throughout the year is a well-known phenomenon, with the springtime suicide peak being the most prevalent (47, 48). Although the empirical finding of seasonal peaks in suicidality has been frequently reproduced, the underlying causes are still not completely understood and seem to be multifactorial in origin. Coimbra et al. demonstrated a seasonal profile of suicidality, with the most often reported seasons being spring and summer. They suggested the impact of an environmental modulator being the cause of seasonal variations. After a systematic review of the literature between 1979 and 2011, Woo et al. developed a model that attempts to capture the individual modulators as depicted in figure 2 (49). The risk factors proposed to be associated with the seasonal fluctuations comprise environmental determinants, including physical, chemical, and biological factors (50-57).

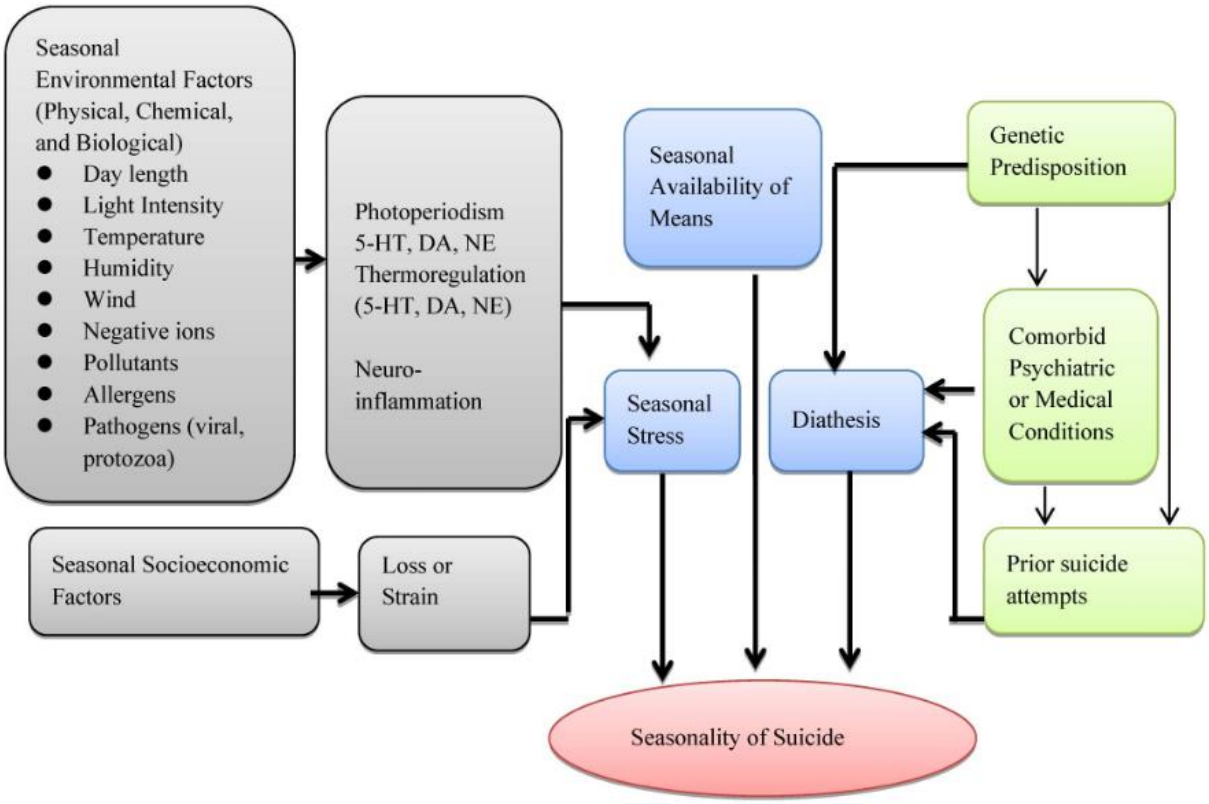

Figure 2. A model of potential modulators that are hypothetically involved in the seasonal variations of suicide. HT = 5-hydroxytryptamine; DA = dopamine; NE = norepinephrine. This model was created by Woo et al. in 2012 (49).

It has been expansively studied, that there are differences in seasonality of suicides according to gender. Findings however yield rather inconsistent results. Whereas some studies highlight a more pronounced seasonal variation in males (58-60), other studies stress female gender as being more affected by seasonal fluctuations (62, 63).

It is important to mention that most of the literature available is investigating completed suicides and not suicide attempts. Available data are limited, therefore only cautious conclusions can be drawn. There were studies that found a significant seasonal variation in suicide attempts but the observed patterns were inconsistent and no generalizable time period for an increase in suicide attempt rates can be defined at the moment. Yip et al. published the first paper that investigated both seasonality of suicides and suicide attempts at the same time. They found a significantly different seasonal distribution, indicating that suicide attempt and suicides are overlapping but non-identical entities (61).

The data showing the strongest effects concerning the association between seasonality and suicidality are derived from the late 20th century (64-66). Recent research describes diminishing seasonal patterns in many nations. A Swiss study investigating the behavior of the seasonality pattern between the late 19th and the end of the 20th century was able to depict a diminishing of those repeating yearly variations (67). Other longitudinal studies conducted from the late 20th century till the 21th century replicated those findings (68, 69).

2. OBJECTIVES

2.1. Aim of the study

The COVID-19 pandemic's effect on the suicide attempts is still uncertain. It is essential to conduct systematic studies on the immediate and long-term effects of the COVID-19 epidemic on suicide attempt rates and seasonal patterns in order to introduce suicide prevention strategies that are appropriate for the current circumstances. The aim of the study is to investigate changes in the caseload of patients after a suicide attempt (SA) as defined according to DSM-5 criteria of suicidal behavior disorder (SBD) admitted to the Helios Fachkliniken Hildburghausen, Thuringia, in the time interval between January 1, 2017 to December 31, 2021.

2.2. Primary objective

This study's main goal is to inspect if the number of patients who have attempted suicide changes once pandemic containments start to take effect in March 2020. The measure is the admission number of patients after suicide attempt per month during the study period. Another primary objective is the examination of the seasonality pattern of attempted suicide rates between 2017 and 2021.

2.3. Secondary objective

The secondary objectives of this study are related to subgroup analyses. The aim is to invest, whether there are disparities in admission rates prior to and during the pandemic between gender and three defined age groups: young adults (aged 18 to 35 years), middle-aged adults (aged 35 to 55 years), and older adults (aged over 55 years).

3. METHODS

3.1. Study design

Data collection covered the period from Jan 1, 2017, to Dec 31, 2021. Adult patients with a suicide attempt within the previous four weeks (n=825) as defined by the DSM-5 criteria for Suicidal Behavior Disorder (SBD) admitted to the Department of Psychiatry and Psychotherapy, Helios Fachkliniken Hildburghausen, Thuringia were included.

As the government started to implement the restrictions beginning in March 2020, Mar 9, 2020 was used as the beginning of the defined period of the COVID-19 pandemic in our study setting (23, 24).

3.2. Settings

The Helios Fachkliniken Hildburghausen is a central care provider in the federal state of Thuringia. The supply region is predominantly rural with a population density of 97.69 inhabitants per km². The study region's population average age is 47.9 years, which is higher than the average German average age (44.5 years, 2019) (25).

Of the patients admitted during the study period, 91.8% came from the primary care region. A total of 14,502 patients were admitted during the study period, with 27.01 days being the average duration of stay. Holding admissions constant during the pre-pandemic study period with a mean admission of 3131 patients per year (M=3131.67 SD=52.01), total admissions decreased by 15.0% to 2623 patients annually in 2020 and by another 5.5% to 2484 patients in 2021. The proportion of scheduled admissions dropped by 13.8% overall compared to the pandemic period, where 1577 patients were admitted to the psychiatric ward by plan (M:1577.67 SD:52.93). Conversely, the percentage of emergency admissions and transfers from outside hospitals in the pandemic period increased from the previous 50.3% to 53.8% in 2020 and 54.4% in 2021.

The results presented in this diploma thesis are part of a study that is in the review phase about to be published in a scientific paper. It was financed by the federal ministry of health (BMG) and Helios Kliniken GmbH, being part of a suicide prevention project ("Network for suicide prevention in Thuringia"), Grant-ID: 2020_0224. Bundesministerium für Gesundheit (BMG; Federal Ministry of Health, ZMVI1-2517FSB143) (90).

3.3. Participants

In total, 825 adult males and females were admitted to inpatient psychiatric care following a suicide attempt within the previous four weeks, as shown in Table 1. A suicide attempt (SA) was defined based on the DSM-5 criteria for the current suicidal behavior disorder (SBD): "A self-initiated sequence of behaviors by an individual who, at the time of initiation, expected that the set of actions would lead to his or her death" (1). It is noteworthy, that a clear distinction between the existing diagnosis of suicidal behavior disorder (SBD) and non-suicidal self-injury (NSSI) was made. Patients meeting the criteria for non-suicidal self-injury (NSSI) were excluded in the present study. This is in contrast to other studies that include NSSI when accessing suicidal behavior. Moreover, other exclusion criteria were acts motivated by ideology, self-harm behavior in states like delirium and suicidal ideation or planning without action.

3.4. Ethical approval

The study was approved by the regional ethics committee of the Thuringia State Chamber of Physicians in Germany (22319/2021/147). The methods used in this study, according to the author, adhere to the 2013 revision of the 1975 Helsinki Declaration as well as the relevant national and institutional committees on human experimentation's ethical norms.

3.5. Data source

Demographic information and admission data were taken from the hospital information system, being part of the individual patient records. The analysis was built on the basis of the medical and psychological admission findings, the results of the physical examination, and the summary doctor's letter. Gender, date of suicide attempt, date of birth, date of admission, admission diagnosis, and total number of recorded suicide attempts were the data elements that were abstracted.

3.6. Statistical methods

We used R version 4.1.0 and the package stats version 3.6.2 to carry out all the analyses for this study; the codes are available upon request.

Given that the data investigated count data across time (number of attempts reported daily). The count time series' autocorrelation and partial autocorrelation were studied before performing the statistical analyses, to see if a pattern reoccurred across time. A quasi-Poisson regression model was additionally used in consideration of possible overdispersion. As the Poisson regression and quasi-Poisson regression models yielded similar results, the Poisson regression's results are presented in the form of tables and figures in the sections following. A *P*-value $\leq 0{,}05$ was considered to be statistically significant.

An interrupted time-series Poisson regression model was applied to investigate changes in suicide attempt rates before and during the COVID-19 pandemic. The impact of a pandemic, time trend, and the interaction of both factors were analyzed. In the second model periodic pattern of seasonality and its interaction with the pandemic were investigated. When modeling the count time series this technique is been widely used (40). For modeling seasonality, the Fourier series was applied with sine and cos with the interval of actual four seasons in each year on a monthly fixed interval from January 2017 till the end of December 2021.

Separate Poisson regressions for gender and for the three defined age groups (72) were modeled to examine the impact of the pandemic on suicide attempt rates within specific subgroups of patients: male, female, young adults (aged 18 to 35 years), middle-aged adults (aged 35 to 55 years), and older adults (aged over 55 years).

4. RESULTS

The investigation of the count time series' autocorrelation and partial autocorrelation yielded the observation that the monthly suicide attempt (SA) occurrence across the years is non-random but follows a seasonal pattern (Figures 3), a frequently observed finding (48).

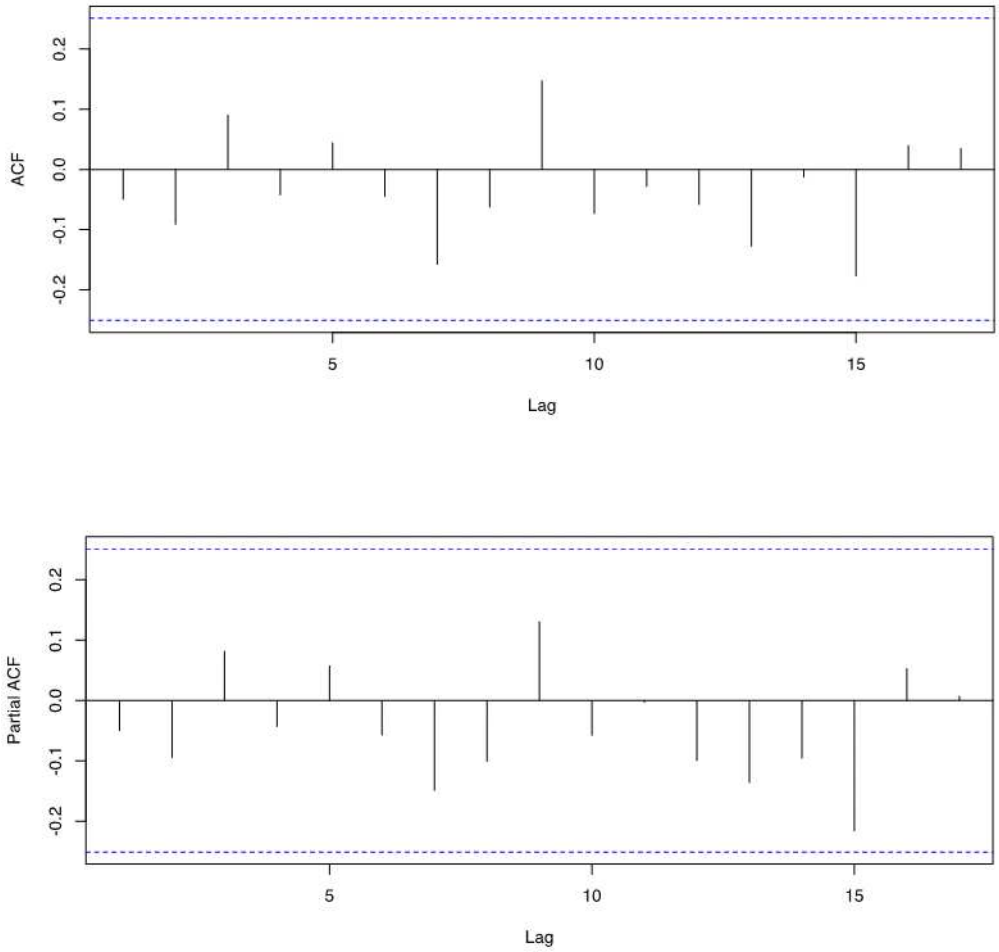

Figure 3. Displays the results of the autocorrelation and partial autocorrelation. The x-axis presents the number of lags, and the y-axis shows the autocorrelation and partial autocorrelation, respectively.

The data of suicide attempts were collected from January 1, 2017 until 31, 2022. In total, 825 suicide attempts were registered with the mean age of 46.2 ± 19.7, including 380 (46.1 %) females and 445 (53.9%) males (Table 3). The average number of SA per month was 13.52 with a variance of 12.58 and the standard deviation of 3.54.

Table 3. Demographic and clinical characteristics of the investigated sample of patients after SA from 2017 to 2021

	Pre-pandemic (N=520)	Pandemic (N=305)	Overall (N=825)
Age			
Mean (SD)	45·8 (19·5)	47·1 (20·1)	46·2 (19·7)
Median	44·2	43·5	44·2
Gender			
F	247 (47·5%)	133 (43·6%)	380 (46·1%)
M	273 (52·5%)	172 (56·4%)	445 (53·9%)
ICD-10 diagnoses			
F0	16·0 (3·1%)	19·0 (6·2%)	35·0 (4·2%)
F1	76·0 (14·6%)	44·0 (14·4%)	120 (14·5%)
F2	35·0 (6·7%)	26·0 (8·5%)	61·0 (7·4%)
F3	319 (61·3%)	172 (56·4%)	491 (59·5%)
F4	69·0 (13·3%)	38·0 (12·5%)	107 (13·0%)
F7	0 (0%)	3·00 (1·0%)	3·00 (0·4%)
F6	5·00 (1·0%)	0 (0%)	5·00 (0·6%)
n.a.	0 (0%)	3·00 (1·0%)	3·00 (0·4%)
Age categories			
< 35	197 (37·9%)	105 (34·4%)	302 (36·6%)
35-55	158 (30·4%)	88 (28·9%)	246 (29·8%)
> 55	265 (31·7%)	112 (36·7%)	277 (33·6%)

As presented in Table 4, the average number of SA per month before and during the pandemic are nearly identical (before: mean ± variance: 13.33 ± 15.75, after: mean ± variance: 13.86 ± 7.26), but the variances significantly differed indicating diminished monthly fluctuations in SA during the pandemic (Levene's test; F-value: 4.16, *P*-value: 0.046).

4.1. Results of the Poisson regression

There was no significant impact of the pandemic on the occurrence of SA in the whole group observable, both unadjusted and adjusted for the seasonality in the Poisson regression models. Moreover, no significant trend regarding SA numbers nor a significant interaction between pandemic and the trend was found (Figure 3 and table 4). SA peaked around October or November before the COVID-19 pandemic, as seen in Figure 1. Table 5 shows that the pandemic had a significant impact on the seasonal pattern, showing a change in monthly fluctuation in SA after March 2020 (z-value = -2.239, *P*-value = 0.025).

Table 4. Results of the interrupted time-series Poisson regression for the entire group modeling the COVID-19 pandemic, trend, and their interactions

	Estimate	**StdErr**	**z**	***p***	**2·50%**	**97·50%**
(Intercept)	3.043	0.45	6.758	0.000	2.161	3.926
COVID-19 pandemic	-0.406	0.459	-0.886	0.376	-1.306	0.493
Trend	-0.008	0.009	-0.924	0.356	-0.026	0.009
Interaction of COVID-19 pandemic and trend	0.006	0.010	0.606	0.544	-0.013	0.025

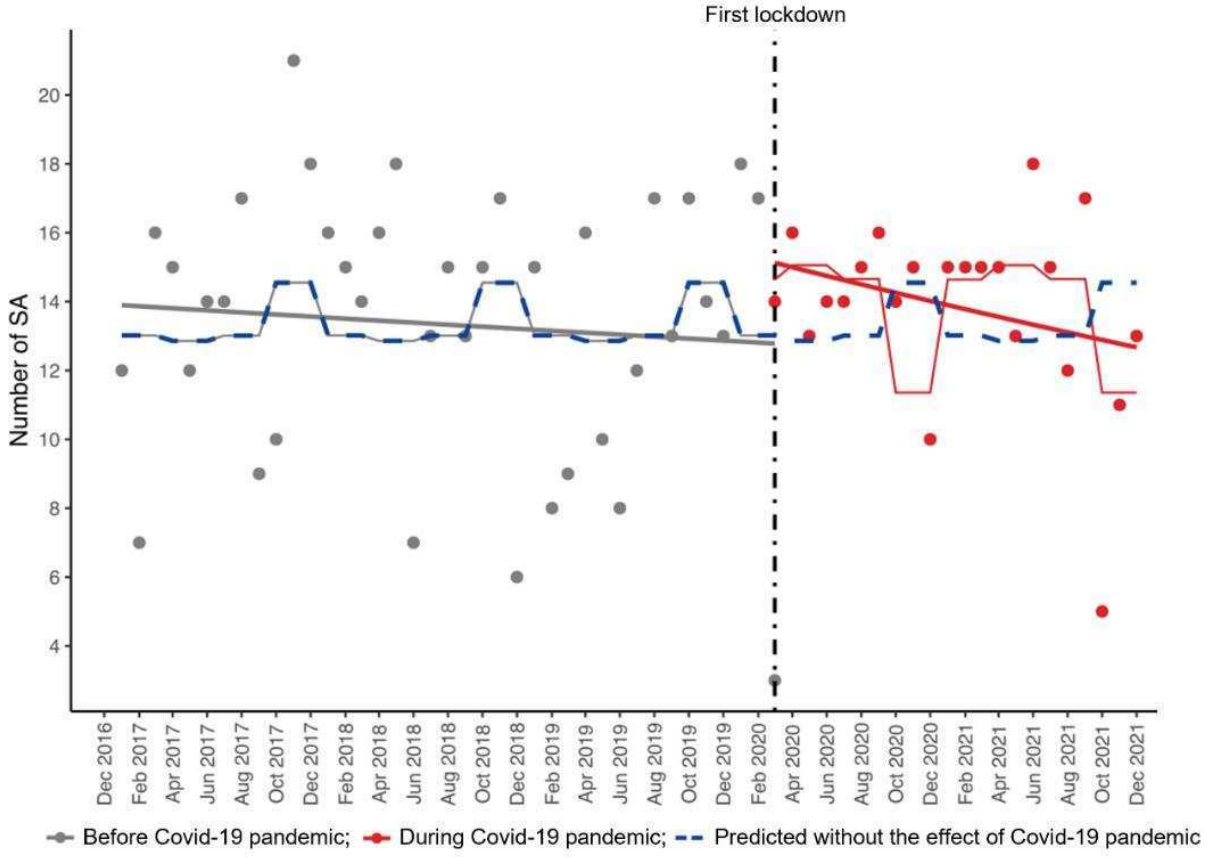

Figure 3. Monthly suicide attempts and temporal trends from 2017 until 2021. The red dots represent the monthly number of SA during the pandemic, while the grey dots represent the pre-pandemic numbers. The average progression before and after the initial lockdown are shown by the solid grey and red lines, respectively. The modeled seasonality pattern is shown by the curved grey solid line, while the seasonality pattern following March 2020 is shown by the curved red solid line. The Poisson regression projected based on data collected before to COVID-19 lockdown is shown by the dashed blue line.

Table 5. Results of the interrupted time-series Poisson regression for the entire group modeling the COVID-19 pandemic, seasonality, and their interactions

	Estimate	**StdErr**	**z**	***p***	**2·50%**	**97·50%**
(Intercept)	2.529	0.08	31.798	0.000	2.373	2.685
COVID-19 pandemic	0.106	0.098	1.075	0.283	-0.087	0.298
Seasonality	0.08	0.041	1.939	0.052	-0.001	0.161
Interaction of COVID-19 pandemic and seasonality	-0.115	0.051	-2.239	0.025	-0.216	-0.014

4.2. Subgroup analyses

4.2.1. Effects of the COVID-19 pandemic on specific age groups

Regarding the impact of the pandemic on the age groups, there were no significant effects of the pandemic on SA occurrence in all three age groups. Neither significant trends nor significant interactions could be observed for older and middle-aged adults (Table 6 and 7), even if the group older adults depicted a more substantial increase in the number of SA during the pandemic than before pandemic, as seen in Figure 4.

Table 6. Results of the interrupted time-series Poisson regression for the older adults modeling COVID-19 pandemic, trend, as well as the interaction between COVID-19 pandemic and trend

Aged > 55 years	**Estimate**	**StdErr**	**z**	***p***	**2·50%**	**97·50%**
(Intercept)	0.413	0.763	0.541	0.588	-1.082	1.908
COVID-19 pandemic	0.837	0.781	1.071	0.284	-0.694	2.368
Trend	0.024	0.015	1.62	0.105	-0.005	0.054
Interaction of COVID-19 pandemic and trend	-0.013	0.017	-0.81	0.418	-0.046	0.019

Table 7. Results of the interrupted time-series Poisson regression for middle-aged adults modeling COVID-19 pandemic, trend, as well as the interaction between COVID-19 pandemic and trend

Aged 35-55 years	Estimate	StdErr	z	*p*	2·50%	97·50%
(Intercept)	2.319	0.816	2.841	0.004	0.719	3.919
COVID-19 pandemic	-0.822	0.832	-0.988	0.323	-2.451	0.808
Trend	-0.019	0.017	-1.144	0.253	-0.052	0.014
Interaction of COVID-19 pandemic and trend	0.015	0.018	0.841	0.400	-0.02	0.051

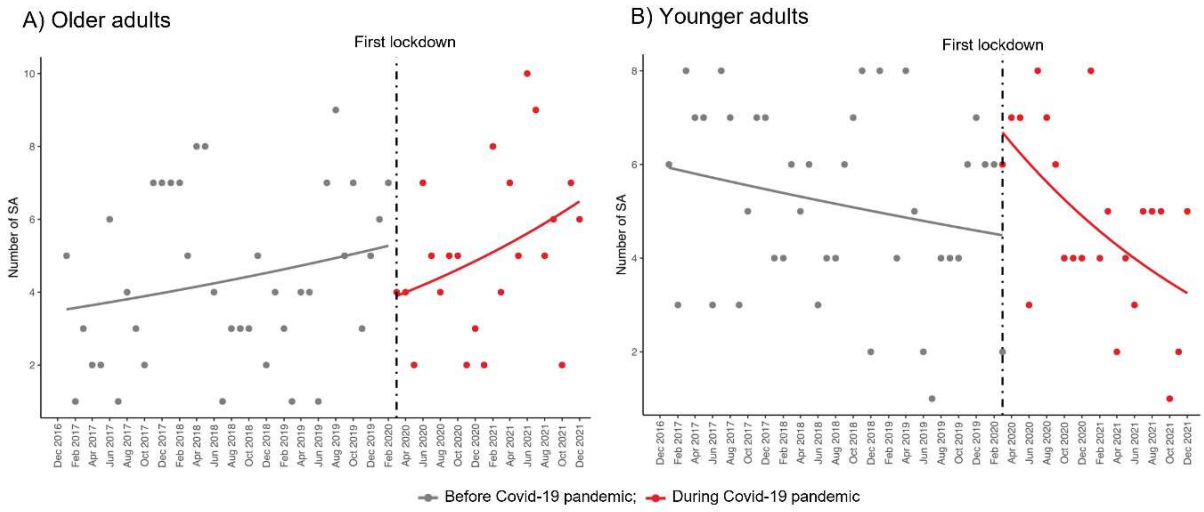

Figure 4. Monthly suicide attempts and time trends from 2017 to 2021 in specific age groups, comparing pre-pandemic and pandemic data. The grey points indicate the number of SA before the first lockdown and the red points depict the number of SA after the first lockdown. The vertical black dashed line is indicating the time point of the first lockdown (March 2020). The curvy grey solid line represents the regression line before the first lockdown and the curvy red solid line is showing the regression line after the first lockdown, both adjusted for seasonality.

In the group of younger adults (Table 8), the time trend indicated a significant overall decrease in SA (z-value = -2.189, *P*-value = 0.029).

Table 8. Results of the interrupted time-series Poisson regression for younger adults modeling COVID-19 pandemic, trend, as well as the interaction between COVID-19 pandemic and trend

Aged 18-35 years	**Estimate**	**StdErr**	**z**	**p**	**2·50%**	**97·50%**
(Intercept)	3.200	0.743	4.304	0.000	1.743	4.657
COVID-19 pandemic	-1.410	0.757	-1.863	0.062	-2.892	0.073
Trend	-0.034	0.015	-2.189	0.029	-0.064	-0.004
Interaction of COVID-19 pandemic and trend	0.026	0.017	1.561	0.119	-0.007	0.059

As indicated in Figure 4, comparing time trends between older and younger adults, we observed a significant interaction between both age groups and the time trend (Table 9; z-value= 2.934, *P*-value= 0.003) showing increasing SA numbers in older adults and decreasing number in younger adults as pandemic proceeded.

Table 9. Results of the interrupted time-series Poisson regression modeling COVID-19 pandemic, trend, age (younger and older adults), and the interaction between COVID-19 pandemic and trend as well as trend and age

	Estimate	**StdErr**	**z**	**p**	**2·50%**	**97·50%**
(Intercept)	2.449	0.444	5.521	0.000	1.579	3.318
COVID-19 pandemic	-0.611	0.381	-1.605	0.109	-1.357	0.135
Trend	-0.018	0.009	-2.088	0.037	-0.035	-0.001
Age (younger and older adults)	-1.542	0.565	-2.731	0.006	-2.649	-0.436
Interaction of COVID-19 pandemic and trend	0.008	0.005	1.695	0.090	-0.001	0.017
Interaction of trend and age	0.025	0.008	2.934	0.003	0.008	0.041

4.2.2. Effects of the covid-19 pandemic on males and females

According to our findings, the COVID-19 pandemic had no significant impact on SA occurrence in males and females and on trends in both (Table 9 and 10). A significant effect of the COVID-19 pandemic on the seasonality pattern of SA was only observed in male patients (z-value= -2.411, *P*-value= 0.016), which showed similar significant pandemic related effect on seasonality patterns as the whole group (Figure 3 and Table 11).

Table 9. Results of the interrupted time-series Poisson regression for males modeling COVID-19 pandemic, trend, as well as the interaction between COVID-19 pandemic and trend

Males	**Estimate**	**StdErr**	**z**	***p***	**2·50%**	**97·50%**
(Intercept)	2.94	0.596	4.933	0.000	1.772	4.109
COVID-19 pandemic	-1.016	0.609	-1.669	0.095	-2.209	0.177
Trend	-0.018	0.012	-1.484	0.138	-0.041	0.006
Interaction of COVID-19 pandemic and trend	0.019	0.013	1.435	0.151	-0.007	0.044

Table 10. Results of the interrupted time-series Poisson regression for females modeling COVID-19 pandemic, trend, as well as the interaction between COVID-19 pandemic and trend

Females	**Estimate**	**StdErr**	**z**	***p***	**2·50%**	**97·50%**
(Intercept)	1.601	0.689	2.322	0.020	0.25	2.952
COVID-19 pandemic	0.365	0.701	0.521	0.602	-1.008	1.738
Trend	0.004	0.014	0.291	0.771	-0.023	0.03
Interaction of COVID-19 pandemic and trend	-0.01	0.015	-0.686	0.493	-0.039	0.019

Table 11. Results of the interrupted time-series Poisson regression for males modeling COVID-19 pandemic, seasonality as well as the interaction of COVID-19 pandemic and seasonality

Males	**Estimate**	**StdErr**	**z**	**p**	**2·50%**	**97·50%**
(Intercept)	1.909	0.11	17.338	0.000	1.693	2.125
COVID-19 pandemic	0.105	0.135	0.78	0.435	-0.159	0.37
Seasonality	0.114	0.057	2.012	0.044	0.003	0.225
Interaction of COVID-19 pandemic and seasonality	-0.169	0.07	-2.411	0.016	-0.307	-0.032

Table 12. Results of the interrupted time-series Poisson regression for femaes modeling COVID-19 pandemic, seasonality as well as the interaction of COVID-19 pandemic and seasonality

Females	**Estimate**	**StdErr**	**z**	**p**	**2·50%**	**97·50%**
(Intercept)	1.752	0.115	15.222	0.000	1.527	1.978
COVID-19 pandemic	0.108	0.144	0.756	0.450	-0.173	0.39
Seasonality	0.039	0.060	0.643	0.520	-0.079	0.157
Interaction of COVID-19 pandemic and seasonality	-0.05	0.075	-0.668	0.504	-0.198	0.097

5. DISCUSSION

The anticipation, that there would be a significant increase in suicide attempt rates after the COVID-10 pandemic outbreak in mid-March 2020 due to the introduction of restricting measurements was not met. Contrary to our hypothesis, to find a significant effect on the number of suicide attempts, the Poisson regression analysis did not reveal any significant differences in the overall SA occurrence or trends during the pandemic compared to the pre-pandemic years. Even though past epidemics, such as severe acute respiratory syndrome (SARS), economic crises, and the present COVID-19 pandemic, considerably affected mental health (26, 32-34, 38, 45), recent studies demonstrated no significant effect of the pandemic on suicide rates in Australia (40) and Leipzig, Germany (42). Together with our results on suicide attempts, these findings support the notion that the COVID-19 pandemic and related measures generally had no direct impact on suicidal behavior. Although it has been demonstrated that the COVID-19 pandemic increases suicidal ideation (37), it appears not to be enough to trigger suicidal behavior, at least to date. A relative increase in regional suicide cases would be a conceivable way to explain the absence of an increase in the suicide attempt rates. However, no statement can be made in this regard at present, since the death statistics are published with a one-year delay.

Distinct and significantly different trends regarding the SA occurrence were observed in older and younger adults in the present study. Whereas in the latter group, a decreasing SA occurrence was observed during the pandemic, an opposite effect was revealed in older adults, suggesting an increasing number of SA (although non-significant) with the persistence of the pandemic. The group of young individuals (18-35 years) comprises employed or family-involved individuals, that were particularly challenged during the pandemic with child care and job demands. A phenomenon described by many studies is the so called “pulling together” effect (74-76). It defines the feeling of belonging, triggered by a situation that is the same for all people in the population. Referring to Thomas Joiner's "Interpersonal Theory of Suicidal Behavior", "Thwarted Belongingness" and "Perceived Burdensomeness" are two key elements that trigger SB in vulnerable people (35). “Pulling together”, and thus expanding the sense of belonging, may have prevented vulnerable people from taking their own lives, thus decreasing SA rates, especially in the young generation. In contrast, there is reason to believe that encouragement for home isolation by the government and fear of infection in emergency departments and clinics potentially may have led to decreased help-seeking. A study of Carr et al. illustrated, that patients of all ages sought less help in the early stages of the pandemic, in particular in the UK (45). Other studies were able to confirm this hypothesis (77). Research on other pandemics, such as severe acute respiratory syndrome (SARS) (32, 33), has previously

demonstrated that the mental health of older individuals is generally more affected by pandemics than that of the younger generation (78, 79). Massive limitations were put in place to safeguard vulnerable populations, particularly the elderly, who, according to observations, were at a substantially higher risk of passing away from COVID-19 infection. For instance, approximately 50% of COVID-19 fatalities in Germany were among elderly care facilities (80), and the fatality rate for COVID-19 patients over the age of 55 approached 15% (22). The risk of acquiring the disease and the perception that one was burdening the younger generation as a result of severe societal restrictions may have led to an increase in pessimistic thoughts in the elderly. Further investigations are imperative here regarding motivation to attempt suicide in the older generation. It is important to determine whether the reduction in suicide attempt rates among younger patients or the increase among older patients is a temporary phenomenon and should therefore be the primary goal of further research. In addition, there are first indications of a higher suicide attempt rate of adolescent patients, therefore especially the age group of 12-18 years must be explicitly included into following longitudinal observations (81-84).

As male gender is a well-known risk factor for suicide (4), studies have found that the case rates of suicide attempts and non-suicidal self-injury (NSSI) were significantly higher in women than in men (85-88). The present study showed that the distribution of suicide attempts between men and women was approximately equal. It can be presumed that the reason for this is due to the strict delineation of the study population with primary suicidal behavior according to DSM-5 and from patients with non-suicidal self-injurious behavior (NSSI). We assume that in the English declaration both entities are often combined and recommend a clearer linguistic separation.

A novel conclusion resulting from the conducted study was the observation of a significant impact of the COVID-19 pandemic on the seasonal fluctuation and periodic variability of suicide attempt rates. The decrease in the seasonal pattern we observed during the COVID-19 pandemic especially in males emphasizes the prevailing crisis and highlights the lack of reliability of previous predictive models. The analysis's findings suggest that the COVID-19 pandemic's impact on suicide attempt rates was superior to possible meteorological factors. However, the knowledge of future patterns of expected case numbers is essential in standard care of various patient groups. It remains to be seen whether the acute crisis led only to a temporary reduction in seasonality or if this result should be incorporated into further predictive patterns. Future surveys of seasonal patterns and caseloads of suicidality will allow for a better assessment of how public policies to contain a pandemic affect the mental health of different populations, particularly in comparison between rural and more urban regions. It has

to be kept in mind, that seasonality patterns in suicides tended to diminish since the beginning of the 20th century in Western countries. Seasonal fluctuations can therefore only be considered a universal and homogeneous phenomenon to a limited extent. It remains unclear to what extent these patterns can still have a general predictive value (67-69).

5.1. Strengths and limitations

Strengths of the current comprehensive longitudinal study are the exploitation of real-time data for a continuous and complete 5-year interval. Precise data was obtained by defining primary suicidal behavior (SBD) by DSM-5 criteria and distancing it from other non-suicidal behaviors. Moreover, all suspected suicide attempts were inspected by at least two investigators. An additional strength of the study is, that due to due to legal requirements, patients after attempted suicide are solely admitted to the Helios Fachkliniken Hildburghausen being a central care provider. As a result, potential assumptions can be made about how the COVID-19 pandemic may have affected the frequency of suicide attempts in that particular rural area from the data that are currently available.

Although the current overall group results give some certainty about the short-term effects of the COVID-19 pandemic, they do not give information about the long-term consequences, limiting the study. Additional research is required to examine the generalizability to other rural regions in Germany and around the world. Future research that is more powerful will also be necessary to look more closely at the subgroup analyses, especially concentrating on the older population.

It remains unclear to what extent outpatient care and other support systems were involved in treating psychiatric patients. It would be plausible that patients who had attempted suicide initially received treatment in an emergency room without being transferred to psychiatry for additional therapy. Patients may also have made increased use of outpatient services during suicidal crises. As there is no data available on these topics an exact interpretation of the findings current study is only possible under reserve. In addition, it is plausible that an increase in regional suicides during the same period led to a decrease in the number of cases of suicide attempts. This cannot be discussed at the present time, as the death statistics are only published with a delay of approximately one year.

There were also no patients with acute COVID-19 symptomatology in the overall group studied. By state guidelines, psychiatric hospitals were excluded from primary care of symptomatic COVID-19 patients. Therefore, concurrent acute COVID-19 infection and a

suicide attempt may have resulted in patients not being transferred to continuing psychiatric care by the primary treating hospitals, but instead being cared for in isolation wards then discharged home. Another group of patients that was not included in our study were adolescent patients. As there are first indications of a post-pandemic significant increase in suicide attempt rates of adolescent patients, this poses a limitation to the current study. Clarification of this hypothesis should be the goal of future studies.

In summary, the pandemic containment strategies designed primarily to save vulnerable individuals also run the danger of unanticipated negative consequences. To reverse observed negative trends and successfully address new hazards in the post-pandemic period, we advise refocusing suicide prevention efforts, especially for the elderly. Additionally, in future planning for pandemic preparedness and infection prevention, politicians and mental health professionals should take lessons learned into account.

6. CONCLUSION

With the present study the following conclusions can be drawn:

1. The COVID-19 pandemic did not have a significant impact on the occurrence of SA in the overall group.

2. There was no significant impact of the COVID-19 pandemic on SA occurrence in males and females and on trends in both groups.

3. Subgroup analysis revealed a significant difference in SA trends after pandemic in older adults (>55 years) compared with younger adults (18-35 years); SA numbers increased in older adults (but non-significantly) and decreased in younger adults as the pandemic progressed.

4. During the pandemic, there was a significant change of the seasonal variation and periodic variability of SA, especially in men.

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8. SUMMARY

Background: People's mental health was negatively affected by the restrictions on public life during the COVID-19 pandemic. Systematic research on the short- and long-term consequences of the COVID-19 pandemic on suicidal behavior is fundamental for developing suicide-preventive measures adapted to the current situation.

Methods: Between January 1, 2017, and December 31, 2021, we included patient records that met the DMS-5 criteria for suicidal behavior disorders (n = 825) admitted to a psychiatric hospital in a rural region in Germany. To examine the impact of the pandemic on SA occurrence, time trends, and seasonal variations, we used interrupted time-series Poisson regression models.

Results: There was no significant effect of the pandemic on the occurrence of SA in the overall group. However, we observed a significant impact of the pandemic on the seasonal pattern of SA, also the variance differed significantly (pre-pandemic mean ± variance: 13·33 ± 15·75, pandemic: mean ± variance: 13·86 ± 7·26), indicating less periodic variation in SA during the pandemic. Male patients and young adults mainly contributed to this overall effect. Subgroup analysis revealed a significant difference in SA trends after pandemic in older adults (>55 years) compared with younger adults (18-35 years); SA numbers increased in older adults and decreased in younger adults as the pandemic progressed.

Limitations: Adolescent patients and patients with a COVID-19 infection were not included into the current study. It remains unclear to which extend emergency departments and outpatient care had contact with the patients after SA, potentially not referring them to psychiatric hospitals in the crisis situation.

Conclusions: Public life restrictions in the rural region during the COVID-19 pandemic appear to have had a differential impact on suicidality in individual age groups. The changes in seasonal patterns could be the result of changing stresses and perspectives during the crisis and could differ from urban populations.

9. CROATIAN SUMMARY

Naslov: Učinci pandemije COVID – 19 na pokušaje samoubojstva u ruralnom području Njemačke, petogodišnja opservacijska studija.

Ciljevi: Pandemija COVID-19 i povezane mjere suzbijanja kao što su zabrane kretanja (lockdown), društvena ograničenja, zatvaranje škola i poduzeća su dovele do društvenih i financijskih opterećenja, što je značajno narušilo mentalno zdravlje brojnih ljudi diljem svijeta. Stoga smo analizirali je li sve navedeno utjecalo na pojavu pokušaja samoubojstava (SA) u razdoblju pandemije.

Materijali i metode: Uključili smo podatke pacijenata prema kriterijima DMS-5 za poremećaje suicidalnog ponašanja (n=825) u periodu od 1. siječnja 2017. do 31. prosinca 2021. godine. Primijenili smo Poissonove regresijske modele prekinutih vremenskih serija kako bi istražili učinak pandemije na pojavu SA, vremenske trendove i sezonske obrasce.

Rezultati: Nije bilo značajnog učinka pandemije na pojavu SA u cjelokupnoj skupini. Međutim, primijetili smo značajan utjecaj pandemije na sezonski obrazac SA: varijanca se značajno razlikovala (srednja vrijednost prije pandemije ± varijanca: 13·33 ± 15·75, srednja vrijednost za vrijeme pandemije ± varijanca: 13·86 ± 7·26), što ukazuje na manje periodične varijacije SA tijekom pandemije. Pacijenti muškog spola i mlađe odrasle osobe su većinom pridonijeli ovom ukupnom učinku. Analiza podskupina je otkrila značajnu razliku u trendovima SA nakon pandemije u starijih odraslih osoba (>55 years) u usporedbi s mlađim odraslim osobama (18-35 godina starosti); broj SA se povećao u starijih osoba, a smanjio u mlađih odraslih osoba kako je pandemija napredovala.

Zaključci: Općenito gledajući, pandemija COVID -19 i povezane mjere nisu značajno utjecale na pojavu SA, ali su značajno utjecale na dinamiku. Utjecaj pandemije na sezonski uzorak suicidalnosti bio je snažniji nego na ostale poznate varijable osobito u osoba muškog spola i mlađih odraslih osoba. Osim toga, čini se da je pandemija, u svom napredovanju, različito utjecala na suicidalno ponašanje kod različitih dobnih skupina.