

## Trends and Characteristics of Suicide-Related Behaviors Before and After the COVID-19 Epidemic in Tottori, Japan: A Retrospective Study

Teruaki Hayashi,\* Takehiko Yamanashi,\* Masahiro Tanaka† and Masaaki Iwata\*

\*Department of Neuropsychiatry, Faculty of Medicine, Tottori University, Yonago 683-8503, Japan, and †Department of Psychiatry, Yao Municipal Hospital, Yao 581-0069, Japan

### ABSTRACT

**Background** In Japan, the number of suicides has increased since the coronavirus disease (COVID-19) epidemic. However, only a few studies have examined the trends among individuals who attempted suicide. In this study, we examined the background characteristics and motives of individuals who attempted suicide and visited the emergency room because of suicide-related behavior before and after the spread of COVID-19.

**Methods** This single-center retrospective observational study collected information from electronic medical records. We included patients who presented to the emergency department of Tottori University Hospital with suicide-related behaviors between May 1, 2017, to August 31, 2022. The period from May 1, 2017, through December 31, 2019, was designated as ‘the period before COVID-19’ (before-period), and that from January 1, 2020, through August 31, 2022, was designated as ‘the period after COVID-19’ (after-period). We compared the total number of cases, their background, and motives for suicide-related behaviors between the before- and after-periods.

**Results** The total number of suicide events was 304. Of these, 182 and 122 occurred during the before-period and after-period, respectively. The incidence of the F3 category of the International Classification of Diseases, 10<sup>th</sup> Revision, increased, while that of the F4 and F6 categories decreased during the after-period. The proportion of suicide attempts due to health problems decreased and that of work problems increased during the after-period.

**Conclusion** The total number of suicide-related behaviors decreased after the COVID-19 pandemic. This may be because patients with psychiatric disorders other than depression and schizophrenia often engage in suicidal behavior through non-fatal methods, such as drug overdose and wrist-cutting, which may have led

them to refrain from seeing a doctor. The proportion of suicidal motivation due to work-related fatigue has increased, perhaps because the quality and quantity of work changed significantly due to COVID-19.

**Key words** attempted; COVID-19; motivation for suicide-related behaviors; suicide

The number of suicide-related deaths in Japan reached 32,863 for the first time in 1998 and continued to exceed 30,000.<sup>1</sup> However, this figure has gradually declined since 2010, falling below 30,000 in 2012,<sup>1</sup> owing to ‘‘The Act on Suicide Prevention’’ enacted in 2006<sup>2</sup> and the implementation of suicide prevention measures tailored to local conditions. Although the number decreased to 20,169 in 2019, the lowest statistics since 1978, the situation remains serious, with more than 20,000 people still taking their own lives.<sup>1</sup>

Coronavirus disease (COVID-19) had spread worldwide by the end of December 2019. On January 30, 2020, the World Health Organization declared a state of emergency, and on March 11, 2020, it proclaimed the epidemic to be a pandemic. In Japan, several major outbreaks ranging from the first to the seventh waves have occurred so far, with more than 20 million people infected and 44,000 confirmed deaths as of September 30, 2022.<sup>3</sup> During this period, people’s lives were severely restricted, not due to by voluntary physical distancing, but also by the government’s edict to restrict social contact and gatherings, close schools, and promote remote work. The restricted lifestyle increased the risk of withdrawal<sup>4–6</sup> and spending more time with family members increased domestic violence.<sup>7</sup> Overall, this altered situation by COVID-19 worsened people’s mental health.<sup>8</sup>

This altered social milieu was partially responsible for the increase in the annual number of suicides by 912 (4.5%) to 21,081<sup>9</sup> in 2020 compared to 2019, before the spread of COVID-19. Although the number of suicides in 2021<sup>10</sup> was lower than that in 2020, it exceeded that in 2019.

The number of suicide deaths increased in Japan since the spread of COVID-19. However, only a few studies have examined the trends among individuals

Corresponding author: Takehiko Yamanashi, MD, PhD  
yamatake@tottori-u.ac.jp

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Abbreviations: COVID-19, coronavirus disease; ICD-10, International Classification of Diseases, 10<sup>th</sup> Revision; MHLW, Ministry of Health, Labour and Welfare

who attempted suicide.<sup>11</sup> In Japan, although the registration system for suicide attempts is not as accurate as that for suicide deaths, the Fire and Disaster Management Agency reported that there were 35,545 transports in 2019 for suicide attempts; the number has been declining since its peak in 2009.<sup>12</sup> Before the spread of COVID-19, several surveys reported that a higher proportion of suicide attempts was performed by women and younger individuals compared to those who had attempted to commit suicide in the past.<sup>13, 14</sup>

In this study, we examined the background characteristics and motives of individuals who attempted suicide and visited the emergency room before and after the spread of COVID-19. We postulated that any changes in motive for suicide may help in devising prevention and intervention measures, and assist in reducing the physical and mental burden in the event of a new pandemic or other natural disasters in the future.

## MATERIAL AND METHODS

### Study design

This single-center retrospective observational study examined information contained within the patients' electronic medical records. Participants were provided the opportunity to refuse (opt out) the study. This study was conducted in compliance with the ethical guidelines for medical research involving humans of the Ministry of Health, Labour and Welfare, Japan (MHLW), and was approved by the Ethical Review Committee of the Faculty of Medicine, Tottori University (approval number: 22A123).

### Patients

This study included patients who presented to the emergency department of Tottori University Hospital with suicide-related behavior between May 1, 2017, and August 31, 2022. This study only included individuals who attempted suicide, i.e., survivors, because the number of suicides that culminated in death was small (40 in all), and the information available was limited. Tottori University Hospital is a tertiary medical facility located in the western part of Tottori Prefecture, Japan (approximately 540,000 inhabitants within an area of 3,507 km<sup>2</sup>). It is an emergency critical care center designated by the MHLW and the prefecture, which is equipped with a sufficient number of multidisciplinary medical staff who provide 24-h emergency services to patients with life-threatening conditions. Tottori University Hospital is the only facility in the prefecture equipped with both an emergency critical care center and a psychiatry ward.

### Survey and assessment items

The period from January 1, 2020, through August 31, 2022, was defined as "the period after COVID-19" (after-period) since the first COVID-19 case was reported in January 2020 in Japan. Although Tottori Prefecture lagged behind the national epidemic, it is inferred that people in Tottori had a fear of COVID-19, and some of them began to change their lifestyle in January 2020. The period from May 1, 2017, through December 31, 2019, was designated as the equivalent 32-month "period before COVID-19" (before-period). The trends and characteristics of suicide-related behavior were compared between the two groups.

The definition of suicide-related behaviors was based on the description of the Columbia-Suicide Severity Rating Scale,<sup>15</sup> which is considered to have higher sensitivity and specificity compared to other suicide rating scales. Attempted suicide was defined as a situation where the suicide attempt is accompanied by some intention or desire to die and the person engages in self-harming behavior, or in which suicidal intent can be inferred clinically from the person's behavior or circumstances. Cases where the patient clearly denied suicidal intent at the time of examination, or if suicidal intent could be clinically denied from the patient's behavior or circumstances were excluded. Patients who had already died at the time of emergency transport to our hospital or those who died after arrival at the hospital were considered to have "completed suicide," whereas all other cases were considered "attempted suicide."

Data on patient characteristics, including age, sex, educational attainment, marital status, cohabitation, companions on arrival, psychiatric history and diagnoses based on the International Statistical Classification of Diseases and Related Health Problems, 10<sup>th</sup> Revision (ICD-10), method of self-harm, post-visit outcome, and history of suicide-related behaviors, were collected from the medical records of the emergency department.

Methods of self-harm were categorized as drug overdose, wrist-cutting, cutting/stabbing, ingestion of harmful foreign substances, hanging and jumping, carbon monoxide poisoning, and others. Psychotropic drugs, non-psychotropic medications, and over-the-counter medications were included in the drug-overdose category. Serious self-inflicted injuries with blades or sharp instruments were classified as cutting/stabbing injuries. The "other" category included acts such as dousing oneself with kerosene or banging one's head against a wall. When more than one method of self-harm was listed in the medical record, we selected the one that was most likely to affect the outcome.

Clinical outcomes were categorized as outpatient care only, hospitalization (either in the physical care or psychiatry department), and death. Patients who died after arrival or hospitalization were categorized as the fatality group.

The patient's psychiatric history and diagnoses were obtained from patients or their companions. Some patients received their first psychiatric diagnosis after consultation with a psychiatrist after a suicide attempt, but these data were not included in this analysis because of the limited number of cases.

Motives for suicide were classified into eight main categories according to the format of police statistics in Japan<sup>16</sup>: (i) family problems, (ii) health problems (physical and mental), (iii) economic and livelihood problems, (iv) work-related problems, (v) romantic problems, (vi) school-related problems, (vii) others, and (viii) unknown. The content of the medical records has been reviewed and assigned according to these categories by the authors. Each major category was further subdivided into 53 subcategories.

### Statistical analysis

A *t*-test was used to compare the means of continuous variables, and Fisher's exact test was used to compare the proportions of the nominal variables between the two groups. All statistical analyses were conducted using EZR version 1.52 (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R version 4.02 (R Foundation for Statistical Computing, Vienna, Austria). It is a modified version of R-Commander designed to perform statistical functions frequently used in biostatistics.<sup>17</sup>

## RESULTS

A total of 304 suicide-related behavioral events were detected in 228 patients throughout the study period, of which 182 occurred before COVID-19 and 122 after COVID-19, with an observed decrease of 33.0%. The number of patients who exhibited only one suicide-related behavior during this period was 113 before COVID-19 and 89 after COVID-19. The other 102 attempts (33.6%) were performed by 26 individuals who had repeatedly attempted suicide two or more times. Of these, 11 patients exhibited suicide-related behavior only before COVID-19, 7 patients exhibited suicide-related behavior after COVID-19, and 8 patients exhibited suicide-related behavior both before and after COVID-19 (Table 1, Fig. 1).

### Participants' characteristics (*n* = 228)

The male:female ratio was 40:94 before COVID-19 and

**Table 1. Number of suicide-related behaviors**

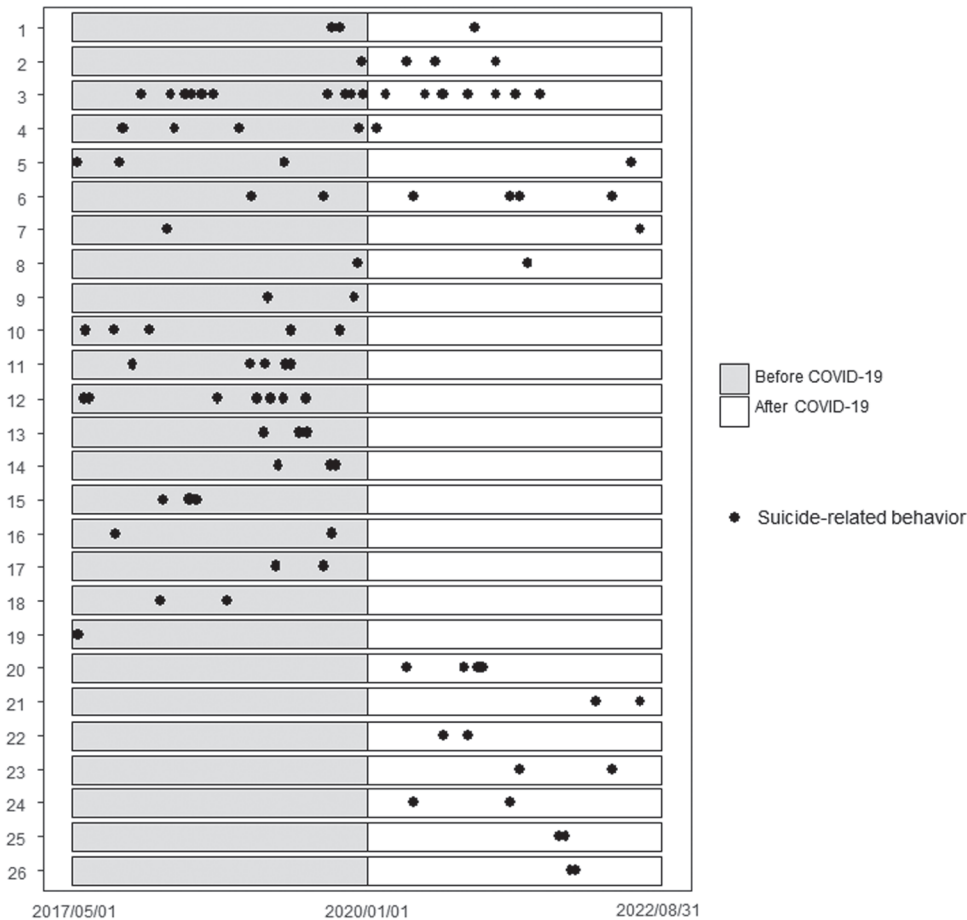
|                   | <i>n</i> | Total number of cases | Spread of COVID-19 |       |
|-------------------|----------|-----------------------|--------------------|-------|
|                   |          |                       | before             | after |
|                   | 228      | 304                   | 182                | 122   |
| Only once         | 202      | 202                   | 113                | 89    |
| More than 2 times | 26       | 102                   | 69                 | 33    |
| 2                 | 13       | 26                    | 14                 | 12    |
| 3                 | 3        | 9                     | 9                  | 0     |
| 4                 | 2        | 8                     | 5                  | 3     |
| 5                 | 4        | 20                    | 15                 | 5     |
| 6                 | 2        | 12                    | 7                  | 5     |
| 7                 | 1        | 7                     | 7                  | 0     |
| 20                | 1        | 20                    | 12                 | 8     |

COVID-19, coronavirus disease.

35:59 after COVID-19. The participants' mean age was 36.8 (SD = 17.9) years before COVID-19 and 39.2 (SD = 18.3) years after COVID-19. The mean age of men and women in each group was 40.7 (SD = 19.1) and 35.1 (SD = 17.2) years ( $P = 0.10$ ); and 36.2 (SD = 16.8) and 41.0 (SD = 19.0) years ( $P = 0.22$ ) in the before- and after-periods, respectively. The before- and after-COVID-19 groups did not differ significantly with respect to educational attainment, marital status, cohabitation, and history of psychiatric care. There was an increase in the diagnosis of the ICD-10 category F3, while that of the F4 and F6 categories decreased after COVID-19 (Table 2).

### All cases of suicide-related behaviors (*n* = 304)

The proportion of patients accompanied by companions on arrival was higher during the after-period ( $P = 0.02$ ) (Table 3). There were no major differences between the specific methods of suicide-related behaviors before and after COVID-19, with drug overdose and wrist-cutting accounting for approximately 75% of the methods. There was no significant difference in the clinical outcomes after the emergency visit between the before- and after-periods ( $P = 0.89$ ). There was also no significant difference in the duration of hospitalization before and after COVID-19 [6.85, 95% CI (3.71–10.00); 7.01, 95%CI (2.03–11.99);  $P = 0.96$ ] (Table 3). The methods of suicide-related behavior were examined only in patients diagnosed with the F2, F3, F4, and F6 categories, since they accounted for about 75% of the psychiatric diagnoses (Table 4). The frequency of drug overdose in the F2 category was 75% before COVID-19 and 50% after COVID-19, significantly decreasing by 25%. In the F3 category, drug overdose and wrist-cutting combined



**Fig. 1.** Distribution of cases with more than 2 times suicide-related behaviors before and after COVID-19.

accounted for 75% of cases before COVID-19 but decreased to 67.7% after COVID-19. In the F4 category, the proportion of drug overdose and wrist-cutting decreased from 87.8% before COVID-19 to 80.0% after COVID-19 but still accounted for a large proportion; in the F6 category, both methods accounted for 90% of cases before and after COVID-19.

**Causes and motives for suicide-related behavior**

After COVID-19, the proportion of suicide attempts due to health problems tended to decrease and the proportion of work problems tended to increase, but the difference was not significant except for unknown causes (Fisher’s Exact test for major items:  $P = 0.53$ ) (Table 5).

**Psychiatric diagnosis of cases with more than 2 suicide-related behaviors**

The F4 and F6 categories accounted for more than half of the total cases (Table 6).

**DISCUSSION**

There have been reports of no significant change in the suicide rates at the beginning of the COVID-19 outbreak<sup>18</sup> while some studies reported a decline in suicide rates.<sup>19, 20</sup> However, since then, studies have reported a significant increase in suicide rates among women<sup>21</sup> and a decrease in the first half but an increase in the second half of 2020.<sup>22</sup> According to the National Police Agency of Japan, the number of suicides was 55,014 between May 1, 2017, and December 31, 2019, and 56,652 between January 1, 2020, and August 31, 2022, indicating an increase after the spread of COVID-19 during the time corresponding to our study period.<sup>9</sup> Furthermore, one study reported an increase in suicide attempts after COVID-19.<sup>11</sup> Based on this evidence, we expected an increase in our study as well. However, our study showed a 33.0% decline in the frequency of suicide-related behavior after COVID-19. This decline was particularly prominent in the F4 and F6 categories, where wrist-cutting and drug overdose combined accounted for approximately 80% of the method of suicide in these

**Table 2. Patient characteristics**

| Classification                 | All participants | Spread of COVID-19 |           | <i>P</i> | Statistical test |
|--------------------------------|------------------|--------------------|-----------|----------|------------------|
|                                |                  | Before             | After     |          |                  |
| <i>n</i>                       | 228              | 134                | 94        |          |                  |
| Mean age – years               | 37.8             | 36.8               | 39.2      | 0.32     | <i>t</i> = –1.00 |
| SD                             | 18.1             | 17.9               | 18.3      |          |                  |
| Male                           | 38.6             | 40.7               | 36.2      | 0.29     | <i>t</i> = 1.06  |
| SD                             | 18.1             | 19.1               | 16.8      |          |                  |
| Female                         | 37.4             | 35.1               | 41.0      | 0.051    | <i>t</i> = –1.97 |
| SD                             | 18.1             | 17.2               | 19.0      |          |                  |
| Female sex ( <i>n</i> )        | 153              | 94                 | 59        | 0.26     | Fisher's Exact   |
| %                              | 67.1             | 70.1               | 62.8      |          |                  |
| Educational attainment         |                  |                    |           | 0.76     | Fisher's Exact   |
| Middle school graduate         | 33 (14.5)        | 19 (17.4)          | 14 (20.0) |          |                  |
| High school graduate           | 79 (34.6)        | 48 (44.0)          | 31 (44.3) |          |                  |
| College educated               | 35 (15.4)        | 20 (18.3)          | 15 (21.4) |          |                  |
| Current student                | 32 (14.0)        | 22 (20.2)          | 10 (14.3) |          |                  |
| Unknown                        | 49 (21.5)        | 25                 | 24        |          |                  |
| Marital status                 |                  |                    |           | 0.21     | Fisher's Exact   |
| Married                        | 136 (59.6)       | 85 (64.9)          | 51 (56.0) |          |                  |
| Unmarried                      | 86 (37.7)        | 46 (35.1)          | 40 (44.0) |          |                  |
| Unknown                        | 6 (2.6)          | 3                  | 3         |          |                  |
| Cohabitation                   |                  |                    |           | > 0.99   | Fisher's Exact   |
| Yes                            | 179 (78.5)       | 106 (79.1)         | 73 (78.5) |          |                  |
| None                           | 48 (21.1)        | 28 (20.9)          | 20 (21.5) |          |                  |
| Unknown                        | 1 (0.4)          | 0                  | 1         |          |                  |
| History of psychiatric visits  |                  |                    |           | > 0.99   | Fisher's Exact   |
| Yes                            | 51 (21.7)        | 30 (22.4)          | 21 (22.8) |          |                  |
| None                           | 175 (74.5)       | 104 (77.6)         | 71 (77.2) |          |                  |
| Unknown                        | 2 (0.85)         | 0                  | 2         |          |                  |
| Psychiatric diagnosis (f.code) |                  |                    |           |          |                  |
| F0                             | 1 (0.4)          | 1 (0.7)            | 0 (0.0)   |          |                  |
| F1                             | 1 (0.4)          | 1 (0.7)            | 0 (0.0)   |          |                  |
| F2                             | 26 (11.4)        | 16 (11.9)          | 10 (10.6) |          |                  |
| F3                             | 57 (25.0)        | 25 (18.7)          | 32 (34.0) |          |                  |
| F4                             | 44 (19.3)        | 29 (21.6)          | 15 (16.0) |          |                  |
| F5                             | 1 (0.4)          | 1 (0.7)            | 0 (0.0)   |          |                  |
| F6                             | 14 (6.1)         | 11 (8.2)           | 3 (3.2)   |          |                  |
| F7                             | 11 (4.8)         | 6 (4.5)            | 5 (5.3)   |          |                  |
| F8                             | 15 (6.6)         | 11 (8.2)           | 4 (4.3)   |          |                  |
| F9                             | 3 (1.3)          | 2 (1.5)            | 1 (1.1)   |          |                  |
| Disease name unknown           | 2 (0.9)          | 1 (0.7)            | 1 (1.1)   |          |                  |
| No history of hospital visits  | 51 (22.4)        | 30 (22.4)          | 21 (22.3) |          |                  |
| Unknown hospital history       | 2 (0.9)          | 0 (0.0)            | 2 (2.1)   |          |                  |

F0: Organic, including symptomatic, mental disorders. F1: Mental and behavioural disorders due to psychoactive substance use. F2: Schizophrenia, schizotypal and delusional disorders. F3: Mood (affective) disorders. F4: Neurotic, stress-related and somatoform disorders. F5: Behavioral syndromes associated with physiological disturbances and physical factors. F6: Disorders of adult personality and behaviour. F7: Mental retardation. F8: Disorders of psychological development. F9: Behavioral and emotional disorders with onset usually occurring in childhood and adolescence. COVID-19, coronavirus disease



**Table 3. All cases of suicide-related behaviors**

| Classification                                | n(%)             | Spread of COVID-19 |                   | P    | Statistical test |
|---|------------------|--------------------|-------------------|------|------------------|
|   |                  | Before             | After             |      |                  |
| Total number of cases                         | 304              | 182                | 122               |      |                  |
| Companions on arrival after attempted suicide |                  |                    |                   | 0.02 | Fisher's Exact   |
| Yes   | 231 (76.0)       | 130 (71.4)         | 101 (83.5)        |      |                  |
| None  | 72 (23.7)        | 52 (28.6)          | 20 (16.5)         |      |                  |
| Unknown                                       | 1 (0.3)          | 0                  | 1                 |      |                  |
| Specific method of suicide-related behaviors  |                  |                    |                   |      |                  |
| Drug overdose                                 | 189 (61.0)       | 114 (62.6)         | 75 (61.5)         |      |                  |
| Wrist-cutting                                 | 45 (14.5)        | 26 (14.3)          | 19 (15.6)         |      |                  |
| Cutting/stabbing                              | 11 (3.6)         | 5 (2.7)            | 6 (4.9)           |      |                  |
| Ingestion of foreign substances               | 15 (4.8)         | 12 (6.6)           | 3 (2.5)           |      |                  |
| Hanging                                       | 18 (5.8)         | 10 (5.5)           | 8 (6.6)           |      |                  |
| Jumping                                       | 12 (3.9)         | 7 (3.8)            | 5 (4.1)           |      |                  |
| Briquette                                     | 9 (2.9)          | 5 (2.7)            | 4 (3.3)           |      |                  |
| Others  | 5 (1.6)          | 3 (1.6)            | 2 (1.6)           |      |                  |
| Outcome after emergency visit                 |                  |                    |                   | 0.89 | Fisher's Exact   |
| Without hospitalization                       | 138 (45.4)       | 83 (45.6)          | 55 (45.1)         |      |                  |
| Hospitalized in physical department           | 115 (37.8)       | 70 (38.5)          | 45 (36.9)         |      |                  |
| Hospitalized in psychiatric department        | 51 (16.8)        | 29 (15.9)          | 22 (18.0)         |      |                  |
| Period of hospitalization                     | 6.91 [4.19-9.64] | 6.85 [3.71-10.00]  | 7.01 [2.03-11.99] | 0.96 | $t = -0.06$      |
| Psychiatric diagnosis (f.code)                |                  |                    |                   |      |                  |
| F0  | 1 (0.3)          | 1 (0.5)            | 0 (0.0)           |      |                  |
| F1  | 1 (0.3)          | 1 (0.8)            | 0 (0.0)           |      |                  |
| F2  | 28 (9.0)         | 16 (8.8)           | 12 (9.8)          |      |                  |
| F3  | 66 (21.2)        | 32 (17.6)          | 34 (27.9)         |      |                  |
| F4  | 61 (19.6)        | 41 (22.5)          | 20 (16.4)         |      |                  |
| F5  | 1 (0.3)          | 1 (0.5)            | 0 (0.0)           |      |                  |
| F6  | 46 (14.8)        | 33 (18.1)          | 13 (10.7)         |      |                  |
| F7  | 19 (6.1)         | 10 (5.5)           | 9 (7.4)           |      |                  |
| F8  | 17 (5.5)         | 12 (6.6)           | 5 (4.1)           |      |                  |
| F9  | 7 (2.3)          | 2 (1.1)            | 5 (4.1)           |      |                  |
| Disease name unknown                          | 2 (0.6)          | 1 (0.5)            | 1 (0.8)           |      |                  |
| No history of hospital visits                 | 53 (17.0)        | 32 (17.6)          | 21 (17.2)         |      |                  |
| Unknown hospital history                      | 2 (0.6)          | 0 (0.0)            | 2 (1.6)           |      |                  |

F0: Organic, including symptomatic, mental disorders. F1: Mental and behavioural disorders due to psychoactive substance use. F2: Schizophrenia, schizotypal and delusional disorders. F3: Mood (affective) disorders. F4: Neurotic, stress-related and somatoform disorders. F5: Behavioral syndromes associated with physiological disturbances and physical factors. F6: Disorders of adult personality and behaviour. F7: Mental retardation. F8: Disorders of psychological development. F9: Behavioral and emotional disorders with onset usually occurring in childhood and adolescence. COVID-19, coronavirus disease

two groups of patients who attempted suicide both before and after COVID-19 (Table 4). Since these methods are impulsive and non-fatal, fear of the possibility of COVID-19 infection in the emergency room could have

discouraged them from attempting suicide or visiting the emergency room. The high proportion of F4 cases among all cases before COVID-19 in our study is consistent with previous reports.<sup>13, 23</sup> Only the incidence of

**Table 4. Specific method of suicide-related behaviors (F2, F3, F4, F6)**

| Classification                  | F2        |                    |          | F3        |                    |           | F4        |                    |           | F6        |                    |          |
|---------------------------------|-----------|--------------------|----------|-----------|--------------------|-----------|-----------|--------------------|-----------|-----------|--------------------|----------|
|                                 | n(%)      | Spread of COVID-19 |          | n(%)      | Spread of COVID-19 |           | n(%)      | Spread of COVID-19 |           | n(%)      | Spread of COVID-19 |          |
|                                 |           | Before             | After    |           | Before             | After     |           | Before             | After     |           | Before             | After    |
|                                 | 28        | 16                 | 12       | 66        | 32                 | 34        | 61        | 41                 | 20        | 46        | 33                 | 13       |
| Drug overdose                   | 18 (64.3) | 12 (75.0)          | 6 (50.0) | 45 (68.2) | 24 (75.0)          | 21 (61.8) | 44 (72.1) | 31 (75.6)          | 13 (65.0) | 23 (50.0) | 18 (54.5)          | 5 (38.5) |
| Wrist-cutting                   | 1 (3.6)   | 0 (0.0)            | 1 (8.3)  | 2 (3.0)   | 0 (0.0)            | 2 (5.9)   | 8 (13.1)  | 5 (12.2)           | 3 (15.0)  | 20 (43.5) | 12 (36.4)          | 8 (61.5) |
| Cutting/stabbing                | 3 (10.7)  | 2 (12.5)           | 1 (8.3)  | 4 (6.1)   | 1 (3.1)            | 3 (8.8)   | 3 (5.0)   | 0 (0.0)            | 3 (8.8)   | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  |
| Ingestion of foreign substances | 1 (3.6)   | 1 (6.2)            | 0 (0.0)  | 5 (7.6)   | 3 (9.4)            | 2 (5.9)   | 6 (9.9)   | 4 (9.8)            | 2 (5.9)   | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  |
| Hanging                         | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  | 6 (9.1)   | 2 (6.3)            | 4 (11.8)  | 5 (8.2)   | 1 (2.4)            | 4 (11.8)  | 1 (2.2)   | 1 (3.0)            | 0 (0.0)  |
| Jumping                         | 4 (14.3)  | 1 (6.2)            | 3 (25.0) | 2 (3.0)   | 1 (3.1)            | 1 (2.9)   | 1 (1.6)   | 0 (0.0)            | 1 (2.9)   | 2 (4.3)   | 2 (6.1)            | 0 (0.0)  |
| Briquette                       | 1 (3.6)   | 0 (0.0)            | 1 (8.3)  | 1 (1.5)   | 1 (3.1)            | 0 (0.0)   | 0 (0.0)   | 0 (0.0)            | 0 (0.0)   | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  |
| Others                          | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  | 1 (1.5)   | 0 (0.0)            | 1 (2.9)   | 1 (1.6)   | 0 (0.0)            | 1 (2.9)   | 0 (0.0)   | 0 (0.0)            | 0 (0.0)  |

COVID-19, coronavirus disease.

F3 diagnoses increased after COVID-19. Wrist-cutting and drug overdose accounted for 67.7% of cases in the F3 category after COVID-19 (Table 4), which was lower than that for F4 and F6, since more lethal measures were undertaken. This may reflect a strong desire for death. The reason for the decrease in the diagnoses of F2 and F8, and the group with no history of hospital visits is unknown and will form the subject of future research. Twenty-six patients attempted suicide two or more times, for a total of 102 attempts, accounting for 33.6% of the total events in our study. A major decrease in the number of repeat attempts from 69 to 33 was observed after COVID-19 (Table 1), which may be attributed to the fact that approximately 50% of the 26 patients were classified as F4 or F6 (Table 6).

In this study, there was no difference in the presence of cohabitation between the before- and after-periods. However, the percentage of patients accompanied by companions on arrival was higher in the after-period. Initially, we expected that after COVID-19, the number of companions accompanying the patient who attempted suicide would decrease due to the higher risk of contracting COVID-19 when visiting a hospital, but this was not the case. The reason for this is unknown and warrants further investigation. Before the COVID-19 outbreak, health problems (31.8%), family problems (30.6%), work problems (9.2%), and romantic problems (9.2%) were the leading motives of suicide attempts (in this descending order), while after the spread, the frequency changed as follows: family problems (29.9%), health problems (23.9%), and work problems (17.1%). Although the percentage of health problems

decreased in the after-period, a perusal of the ICD-10 categories revealed that this decrease was not due to the decrease in the prevalence of depression and schizophrenia (Table 5). It was probably due to the decrease in F4 and F6, as noted above. The percentage of suicide attempts due to work problems increased from 9.2% to 17.1%. Examination of the sub-categories under work problems showed that the percentage of work-related fatigue increased significantly after COVID-19, while the proportion of professional inter-personal relationships and failure at work also increased slightly (Table 5). Studies have reported that reduced work hours and the introduction of telecommuting to prevent the spread of COVID-19 may have improved productivity and mental health,<sup>24,25</sup> and although we expected to find a decrease in the work-related fatigue items in this study, this was not the case. Telecommuting may improve mental health, but it may manifest as job fatigue because of working on the computer for a large part of the day and lack of direct inter-personal contact. However, no study has supported this hypothesis.

### Limitations

This study had several limitations. First, it was not possible to assess the causative relationship between the COVID-19 epidemic and the decrease in suicide attempts, owing to the descriptive epidemiological design of the study. In addition, although the motives for suicide were identified, they were assessed from medical records and were not directly identified during emergency room visits. Second, in the case of suicide attempts, patients may not always call an ambulance,

**Table 5. Causes and motives for suicide-related behaviors**

| Classification                           | Sub-item | n(%)      | Spread of COVID-19 |           | P    | Statistical test |
|--|----------|-----------|--------------------|-----------|------|------------------|
|  |          |           | Before             | After     |      |                  |
|  |          | 304       | 182                | 122       |      |                  |
| Family problems                          |          | 88 (28.9) | 53 (30.6)          | 35 (29.9) | 0.53 | Fisher's Exact   |
|  | a        | 31 (10.2) | 17 (9.8)           | 14 (12.0) |      |                  |
|  | b        | 29 (9.5)  | 17 (9.8)           | 12 (10.3) |      |                  |
|  | c        | 19 (6.3)  | 14 (8.1)           | 5 (4.3)   |      |                  |
|  | e        | 1 (0.3)   | 1 (0.6)            | 0 (0.0)   |      |                  |
|  | g        | 5 (1.6)   | 4 (2.3)            | 1 (0.9)   |      |                  |
|  | i        | 2 (0.7)   | 0 (0.0)            | 2 (1.7)   |      |                  |
|  | j        | 1 (0.3)   | 0 (0.0)            | 1 (0.9)   |      |                  |
| Health problems<br>(Physical and mental) |          | 83 (27.3) | 55 (31.8)          | 28 (23.9) |      |                  |
|  | a        | 3 (1.0)   | 2 (1.2)            | 1 (0.9)   |      |                  |
|  | b        | 26 (8.6)  | 16 (9.2)           | 10 (8.5)  |      |                  |
|  | c        | 13 (4.3)  | 6 (3.5)            | 7 (6.0)   |      |                  |
|  | d,e,f    | 40 (13.2) | 30 (17.3)          | 10 (8.5)  |      |                  |
|  | g        | 1 (0.3)   | 1 (0.6)            | 0 (0.0)   |      |                  |
| Financial/living problems                |          | 16 (5.3)  | 9 (5.2)            | 7 (6.0)   |      |                  |
|  | c        | 3 (1.0)   | 1 (0.6)            | 2 (1.7)   |      |                  |
|  | e        | 7 (2.3)   | 4 (2.3)            | 3 (2.6)   |      |                  |
|  | f        | 4 (1.3)   | 2 (1.2)            | 2 (1.7)   |      |                  |
|  | k        | 2 (0.7)   | 2 (1.2)            | 0 (0.0)   |      |                  |
| Work problems                            |          | 36 (11.8) | 16 (9.2)           | 20 (17.1) |      |                  |
|  | a        | 4 (1.3)   | 2 (1.2)            | 2 (1.7)   |      |                  |
|  | b        | 9 (3.0)   | 4 (2.3)            | 5 (4.3)   |      |                  |
|  | d        | 23 (7.6)  | 10 (5.8)           | 13 (11.1) |      |                  |
| Gender problems                          |          | 27 (8.9)  | 16 (9.2)           | 11 (9.4)  |      |                  |
|  | b        | 2 (0.7)   | 1 (0.6)            | 1 (0.9)   |      |                  |
|  | d        | 25 (8.2)  | 15 (8.7)           | 10 (8.5)  |      |                  |
| School problems                          |          | 8 (2.6)   | 5 (2.9)            | 3 (2.6)   |      |                  |
|  | c        | 3 (1.0)   | 1 (0.6)            | 2 (1.7)   |      |                  |
|  | e        | 2 (0.7)   | 2 (1.2)            | 0 (0.0)   |      |                  |
|  | f        | 1 (0.3)   | 0 (0.0)            | 1 (0.9)   |      |                  |
|  | g        | 2 (0.7)   | 2 (1.2)            | 0 (0.0)   |      |                  |
| Others                                   |          | 32 (10.5) | 19 (11.1)          | 13 (11.1) |      |                  |
|  | a        | 1 (0.3)   | 1 (0.6)            | 0 (0.0)   |      |                  |
|  | d        | 3 (1.0)   | 2 (1.2)            | 1 (0.9)   |      |                  |
|  | e        | 2 (0.7)   | 2 (1.2)            | 0 (0.0)   |      |                  |
|  | f        | 26 (8.6)  | 14 (8.1)           | 12 (10.3) |      |                  |
| Unknown                                  |          | 14 (4.6)  | 9                  | 5         |      |                  |

Family problems; (a) Conflict between parent and child (b) Marital conflict (c) Conflict between other family members (d) Death of family member (e) Hopeless situation for the family (f) Severe verbal reprimand (g) Stress of raising children (h) Physical and/or verbal abuse (i) Exhaustion from caring for infirm family (j) Other family problems. Health problems (physical and mental); (a) Physical illness (b) Depression (c) Schizophrenia (d) Alcoholism (e) Drug abuse (f) Other mental illness (g) Physical disability (h) Other health problems. Financial/living problems; (a) Bankruptcy/business failure (b) Struggling business (c) Unemployment (d) Unable to find employment (e) Economic hardships (f) Overloaded with debt (g) Assumption of excessive debt (h) Debt (other) (i) Harassment by debt-collectors (j) Suicide for death benefit (k) Other financial problems. Work problems; (a) Failure at work (b) Inter-personal relations at work (c) Trouble adjusting to changing work environment (d) Work-related fatigue (e) Other work problems. Gender-specific problems; (a) Marital problems (b) Heartbreak (c) Extra-marital affair (d) Conflict in relationship (e) Other romantic problems. School problems; (a) Entrance examination problems (b) Problems related to academic future © Disappointment with grades (d) Inter-personal relations with teachers (e) Bullying (f) Conflict with friends at school (g) Other school problem. Others; (a) Public disclosure of crime (b) Crime victim (c) Copycat suicide (d) Loneliness (e) Neighborhood problems (f) Other. COVID-19, coronavirus disease 2019



**Table 6. Psychiatric diagnosis of patients who exhibited more than 2 suicide-related behaviors**

| Psychiatric diagnosis (f.code) | n(%)     |
|--------------------------------|----------|
|                                | 26       |
| F0                             | 0 (0.0)  |
| F1                             | 0 (0.0)  |
| F2                             | 2 (7.7)  |
| F3                             | 4 (15.4) |
| F4                             | 7 (26.9) |
| F5                             | 1 (3.8)  |
| F6                             | 6 (23.1) |
| F7                             | 3 (11.5) |
| F8                             | 1 (3.8)  |
| F9                             | 1 (3.8)  |
| No history of hospital visits  | 1 (3.8)  |

F0: Organic, including symptomatic, mental disorders. F1: Mental and behavioral disorders due to psychoactive substance use. F2: Schizophrenia, schizotypal and delusional disorders. F3: Mood (affective) disorders. F4: Neurotic, stress-related and somatoform disorders. F5: Behavioral syndromes associated with physiological disturbances and physical factors. F6: Disorders of adult personality and behavior. F7: Mental retardation. F8: Disorders of psychological development. F9: Behavioral and emotional disorders with onset usually occurring in childhood and adolescence.

and services may have been disrupted, especially during the COVID-19 epidemic. Thus, the number of suicide attempts may have been underestimated in this study. Third, statistical tests were not performed when comparing each subgroup due to the small sample size and to avoid the overuse of statistical methods. In the future, the more precise methods of comparison should be employed and a larger sample should be investigated to obtain more definitive findings. Fourth, although Tottori University Hospital is a core medical facility in the study area, the patients who visited the hospital represent only a portion of suicide attempts in Tottori Prefecture. Therefore, the generalizability of the findings is limited. Further studies are needed to expand the scope of research to include emergency medical institutions without psychiatrists, single-department psychiatric hospitals, psychiatric clinics, and other facilities. Finally, the special characteristics of the study area must be considered. Although the Japanese government's COVID-19 measures were applied to all prefectures, detailed behavioral restrictions were left to the discretion of each local government. Tottori Prefecture is one of the regions in Japan to have been affected by the COVID-19 epidemic considerably later than other

prefectures. This is partly due to its small population, but also because behavioral restrictions were more stringent than in any other prefecture. Therefore, the results of our study may not be applicable to all of Japan.

### AUTHOR CONTRIBUTIONS

Teruaki Hayashi collected and organized the clinical data, analyzed the initial preparation, and wrote the first draft of the manuscript. Takehiko Yamanashi and Masahiro Tanaka analyzed the data and critically reviewed the manuscript. Masaaki Iwata conceived the study, planned its design and coordination, and edited the final manuscript.

### ETHICAL APPROVAL STATEMENT

This study was conducted in compliance with the ethical guidelines for medical research involving humans and approved by the Faculty of Medicine, Tottori University Ethical Review Committee (approval number: 22A123).

### PATIENT CONSENT STATEMENT

The opportunity for the research participants to refuse (opt out) was guaranteed, instead of obtaining consent.

### DATA AVAILABILITY STATEMENT

Data supporting the findings of this study are available from the corresponding author Takehiko Yamanashi upon reasonable request.

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