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## Changes in Subjective Sleep, Physical Condition, and Mental Health during the COVID-19 Pandemic: A Nationwide Survey in Japan

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### ABSTRACT

This study aimed to investigate how people's subjective health changed after the coronavirus disease 2019 (COVID-19) pandemic. This survey was conducted in May 2021 as a nationwide online self-reported survey in Japan. The respondents indicated how their sleep, physical condition, and mental state altered after the pandemic. Furthermore, they answered questionnaires about their intention to get vaccinated, the means of gathering information, etc. A logistic regression analysis was performed. Of the 2,573 responses, there was a decline of approximately 13.6%, 14.0%, and 23.8% in subjective sleep, physical condition, and mental health after the pandemic, respectively. The logistic regression analysis demonstrated that regarding sleep, the affected group was younger, got vaccinated against influenza annually, had lower income, experienced poor sleep quality in the past month, and had worse physical and psychiatric symptoms than before the pandemic. Concerning the physical condition, the affected group lived alone, witnessed deficient sleep quality in the past month, and had deteriorated mental health status than before the COVID-19 pandemic. In terms of mental status, the affected group was younger, females, had access to more sources of information, and experienced worse sleep and physical conditions than the unchanged or improved group ( $p < 0.05$ ). Each group indicated an association with the background factors, confirming that the subjective sleep, physical condition, and mental state affected each other. From a preventive perspective, the results of this study suggested that factors such as youth, gender, sleep quality, pregnancy, reduced income, and greater access to information, may be necessary for physical and mental support. The above-mentioned factors should be considered in light of community life and approached accordingly.

**Keywords:** COVID-19; Pandemic; Mental health; Sleep quality; Physical health; Public health

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## 1. Introduction

The coronavirus disease 2019 (COVID-19) pandemic began in 2020 and rapidly spread worldwide, infecting more than 500 million people and causing over 6.3 million deaths by June 2022 <sup>[1]</sup>. However, the Japanese infection rate was lower than that of the Organization for Economic Co-operation and Development (OECD) countries. The Japanese government declared a state of emergency four times between April 2020 and July 2021 <sup>[2]</sup>. The Japanese emergency declaration was not a lockdown mandate as in other countries; however, a request for voluntary restraint by the citizens. Although most Japanese residents complied with the request, some did not, thus creating an atmosphere of mutual monitoring of each other's behavior in some areas.

The COVID-19 vaccination has proven to be highly effective in decreasing the disease's spread and severity, with a significant reduction in the risk of serious outcomes in vaccinated individuals <sup>[3]</sup>. The COVID-19 vaccine was approved by the World Health Organization for emergency use in December 2020 and in February 2021 in Japan, with the vaccination beginning immediately <sup>[4]</sup>.

In Japan, the first state of emergency was declared nationwide in April and May 2020, with requests to refrain from leaving the house and restrictions on various activities. Examples include changes in daily life, such as school closures, online classes, working from home due to the development of telework, and limited opening hours for restaurants. It has been predicted that these restrictive and unforeseeable changes in social situations have had a significant impact on our physical and mental states. The psychosomatic effects of COVID-19 have been studied using data from 13,052,788 individuals from the United States (U.S.) Department of Veterans Affairs. The research reported that people with COVID-19 were at an increased risk of various psychiatric disorders (anxiety disorders, depression, adjustment disorder, opioid use disorder, non-opioid substance use disorder, neurocognitive impairment, sleep disturbances, etc.) <sup>[5]</sup>. A bidirectional relationship between psychiatric disorders and COVID-19 was also

identified which may lead to adverse mental health events <sup>[6]</sup>. In a study involving 13,829 Australian adults examining the association between COVID-19 restrictions and depressive and anxiety symptoms, about one-quarter of the respondents reported mild to moderate symptoms <sup>[7]</sup>. In a review of 43 articles regarding the effects of COVID-19 on anxiety, depression, and other mental health effects, 77% (n = 33) and 56% (n = 26) showed a relationship between the COVID-19 pandemic with the anxiety symptoms and depression or depressive symptoms, respectively; moreover, seven papers demonstrated sleep changes, reporting that they found a relationship between the COVID-19 pandemic and the anxiety symptoms <sup>[8]</sup>.

In addition, Alimoradi et al.'s meta-analysis of previous studies regarding the effect of COVID-19 on sleep reported 31%, 18%, and 57% prevalence of sleep problems among health professionals, the general population, and COVID-19 patients, respectively, indicating that sleep problems were positively associated with the depressive and anxiety symptoms among the three groups <sup>[9]</sup>. Chew et al. examined the relationship between COVID-19 and physical symptoms in health care workers <sup>[10]</sup>. In their research, the most reported physical symptom during the COVID-19 outbreak was headache at 31.9%. Those with physical symptoms also had higher rates of depression, anxiety, stress, and post-traumatic stress disorder (PTSD); furthermore, the study suggested that physical symptoms and psychological outcomes may be bidirectional <sup>[10]</sup>. COVID-19 and its vaccine produced considerable misinformation and conspiracy theories. However, a recent study suggested that social media is responsible for spreading misinformation <sup>[11]</sup>. The means of gathering information on COVID-19 has been found to influence subsequent health care <sup>[12-18]</sup>. This research summarized the variables identified as factors in previous studies and investigated what factors affected the mental state, sleep, and physical health. By examining these aspects, we would be able to identify the factors of those whose multiple mental and physical conditions deteriorated, and thus, identify the characteristics of

those who need greater attention due to mental and physical deterioration and those who need more intervention and support. This is significant because it could recognize the aspects of intervention and support. The analysis was conducted on a group of people who experienced a more extensive deterioration in any one of the following areas: sleep, physical condition, and mental state. In addition, we examined a group of individuals with severe exacerbations in which all these three areas had deteriorated.

We conducted a national survey with the aim to investigate how the COVID-19-related restrictive situation affected people's subjective sleep, physical condition, and mental state during the pandemic in Japan. Furthermore, we assessed the factors related to those states.

## 2. Methods

### 2.1 Study design and samples

This web-based, self-reported questionnaire survey was conducted in May 2021 using a large Internet survey agency (GMO RESEARCH, Inc., Tokyo, Japan: <https://gmo-research.com/>) that had approximately 20 million registered panelists; further, the study was a stratified random sample of 2.2 million active users by age and gender. The company distributed and collected the questionnaires online and sent the results. All the data were anonymized. This study was approved by the Ethics Committee of Aichi Toho University. Online written informed consent was obtained from all potential participants.

Our final sample consisted of 2,573 compensated Japanese-speaking adults aged 20 years and residing in Japan. The sample was collected according to the prefectural population and age distribution.

### 2.2 Survey items

The questionnaire items collected the following data:

Demographic information: age, gender (male or female), residential area (Hokkaido, Tohoku, Kanto, Chubu, Kansai, Chugoku, Shikoku, and Kyushu),

marital status, living condition (alone/with children/with adults/with elderly aged 65 years or older/with a medical worker), education (high school or less/college, university, graduate university), job (agriculture, forestry, fisheries/service industry/administrative position/employee (full-time)/civil servant/medical workers/students/part-time job/unemployed, housewife/others), income before the COVID-19 pandemic (million yen; < 1.99, 2.00-3.99, 4.00-5.99, 6.00-7.99, 8.00-9.99, 10.00-11.99, > 12.00), decrease in income after the COVID-19 pandemic (yes/no: y/n), having a specific political party affiliation (y/n), gathering information from the traditional media such as newspaper, television (y/n), good sleep for the past one month (y/n), pre-existing diseases (pulmonary diseases, heart diseases, diabetes, severe obesity, chronic renal failure, liver disease, and immunodeficiency diseases) (y/n), currently smoking (y/n), and currently pregnant (y/n).

In addition to these were the subjective status changes before and after the COVID-19 expansion: sleep (improved/no change/worsened), physical condition (improved/no change/worsened), and mental health state (improved/no change/worsened).

The respondents were requested to answer all the above-mentioned items and indicate how that condition had changed after the COVID-19 pandemic.

### 2.3 Statistical analyses

First, we conducted a descriptive analysis to report the demographic characteristics. Second, we calculated the proportion of the people who answered "worsened" regarding their subjective sleep, physical, and mental state. Third, we performed a logistic regression analysis. In terms of the modifications in the three areas, each was divided into two groups: "worsened" and "improved/no change", which were employed as dependent variables. A chi-square test was utilized to assess the associations between "worsened" and each independent variable ( $\chi^2$ ). The variables with  $p < 0.2$  in the  $\chi^2$  test were used as covariates for binominal logistic regression analysis. A logistic regression analysis using the variable increase method with the likelihood ratio was

performed.

In addition, a logistic regression analysis was performed to examine not only the stand-alone worsening factors for sleep, physical condition, and mental status, but also for those who had multiple deteriorating physical and mental conditions due to COVID-19. All the data were analyzed using SPSS version 25. The significance level was  $\alpha < 0.05$ .

### 3. Results

#### 3.1 Demographic characteristics

The participants' characteristics are shown in **Table 1**. Of the 2,573 participants, 1,203 (46.8%) and 1,370 (53.2%) were males and females, respectively. The mean age ( $\pm$  standard deviation) was  $52.2 \pm 16.8$  years.

**Table 1.** Sample characteristics. (n = 2,573).

Characteristics		N (mean)	% (SD)
Female		1370	53.2
Male		1203	46.8
Age (in years)	20-29	323	12.6
	30-39	379	14.7
	40-49	456	17.7
	50-59	398	15.5
	60-69	436	16.9
	70-79	581	22.6
Japan Region	Hokkaido (North Island)	98	3.8
	Tohoku (North of Honshu*)	215	8.4
	Kanto (Mideast of Honshu*)	770	29.9
	Chubu (Mid of Honshu*)	447	17.4
	Kansai (Midwest of Honshu*)	437	17.0
	Chugoku (West of Honshu*)	167	6.5
	Shikoku (Southwest Island)	111	4.3
	Kyusyu (South Island)	328	12.7
Married		1552	60.3
Living	Alone	420	16.3
	With children	464	18.0
	With adults	1295	50.3
	With elderly people (aged > 65 years)	1059	41.2
	With a medical worker	82	3.2
Education	High school or less	905	35.2
	College/University/Graduate university	1668	64.8

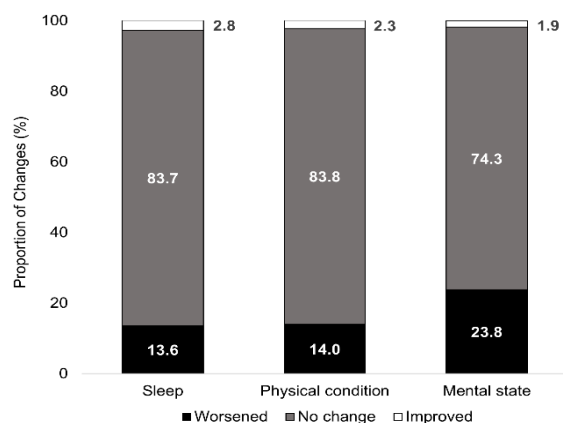
Table 1 continued

Characteristics		N (mean)	% (SD)
Job	Agriculture, Forestry, Fisheries	19	0.7
	Service industry	128	5.0
	Freelance	91	3.5
	Administrative position	125	4.9
	Employee (full-time)	507	19.7
	Civil servant	49	1.9
	Medical workers	51	2.0
	Students	57	2.2
	Part-time job	312	12.1
	Unemployed/housewife	1072	41.7
	Others	162	6.3
Income before the COVID-19 pandemic (million yen)	< 1.99	251	9.8
	2.00-3.99	668	26.0
	4.00-5.99	573	22.3
	6.00-7.99	340	13.2
	8.00-9.99	204	7.9
	10.00-11.99	89	3.5
	> 12.00	113	4.4
	Declined to answer	155	6.0
	Unknown	180	7.0
Decrease in income after the COVID-19 pandemic		118	4.6
Having a specific political party affiliation		1028	40.0
Intention of the COVID-19 vaccine	Yes	1809	70.3
	No	377	14.7
	Undecided/unknown	387	15.0
Getting vaccinated against influenza annually (almost)		1144	44.5
Number of information collecting ways about COVID-19		(2.9)	(1.34)
Gathering information from the old media: newspaper and television		1919	74.6
Good sleep for the past one month		1643	63.9
Pre-existing diseases (pulmonary diseases, heart diseases, diabetes, severe obesity, chronic renal failure, liver disease, and immunodeficiency diseases)		415	16.1
Smoking		377	14.7
Pregnant		33	1.3

Note: Abbreviation: SD, standard deviation.

\*Honshu: Main and Biggest Island of Japan.

### 3.2 The proportion of the samples worsened in the subjective sleep, physical, and mental state



**Figure 1** shows the proportion of the participants who answered “worsened” regarding their sleep, physical condition, and mental state before and after the COVID-19 outbreak. Specifically, 349 (13.6%), 359 (14.0%), and 612 (23.8%) individuals reported deterioration in their sleep, physical condition, and mental state, respectively.

**Figure 1.** The proportion of the participants who answered “worsened”, “no change”, or “improved”.

Among the 2,573 participants, the proportion who answered “worsened” before and after the COVID-19 (black bar) were 13.6% ( $n = 349$ ) for sleep quality, 14.0% ( $n = 359$ ) for physical condition, and 23.8% ( $n = 612$ ) for mental state. The proportion who answered “no change” (gray bar) was 83.7% ( $n = 2153$ ) for sleep quality, 83.8% ( $n = 2155$ ) for physical condition, and 74.3% ( $n = 1912$ ) for mental state. The proportion who answered “improved” (white bar) were 2.8% ( $n = 71$ ) for sleep quality, 2.3% ( $n = 59$ ) for physical condition, and 1.9% ( $n = 49$ ) for mental state.

### 3.3 Factors related to the subjective sleep, physical condition, and mental state after the COVID-19 outbreak

The association of the potential factors and the subjective sleep, physical condition, and mental state has been displayed in **Table 2**. In the logistic regression model comparing the “worsened” and “improved/no change” groups regarding subjective sleep, the following independent variables were

found to be significantly associated: age (OR = 0.987; 95% CI 0.977-0.997), not vaccinated against influenza annually (OR = 0.58; 95% CI 0.41-0.80), income decreased after the COVID-19 outbreak (OR = 2.85; 95% CI 1.55-5.22), poor sleep quality in the past month (OR = 6.04; 95% CI 4.27-8.54), worsened physical condition due to the COVID-19 outbreak (OR = 10.56; 95% CI 7.32-15.23), and deteriorated mental state (OR = 4.82; 95% CI 3.38-6.88) ( $p < 0.05$ ).

On comparing the “worsened” and the “improved/no change” groups for physical condition, the following independent variables were found to be significantly associated: living alone (OR = 1.56; 95% CI 1.03-2.36), poor sleep quality in the past month (OR = 1.53; 95% CI 1.08-2.16), pre-existing diseases (OR = 1.86; 95% CI 1.24-2.79), worsened subjective sleep after the COVID-19 outbreak (OR = 10.35; 95% CI 7.19-14.91), and deteriorated mental state after the COVID-19 outbreak (OR = 11.94; 95% CI 8.49-16.80) ( $p < 0.05$ ).

Similarly, regarding the mental state after the COVID-19 pandemic, the following independent variables were significantly associated with the “worsened” group ( $p < 0.05$ ): age (OR = 0.990; 95% CI 0.983-0.997), female (OR = 1.67; 95% CI 1.30-2.13), number of information collection methods regarding COVID-19 (OR = 1.23; 95% CI 1.13-1.35), poor sleep quality in the past month (OR = 1.31; 95% CI 1.01-1.70), worsened sleep after the COVID-19 outbreak (OR = 4.46; 95% CI 3.12-6.37), and poorer physical condition after the COVID-19 outbreak (OR = 10.86; 95% CI 7.72-15.28).

Regarding the group with the worsening of either sleep, physical condition, or mental health in Additional Analysis 1 (**Table 3**), the following groups were also included: younger (OR = 0.99; 95% CI 0.98-0.99), female (OR = 1.54; 95% CI 1.26-1.88), decreased income after the COVID-19 outbreak (OR = 1.94; 95% CI 1.27-2.96), poor sleep quality in the past month (OR = 3.25; 95% CI 2.66-3.96), possible pregnancy (OR = 2.58; 95% CI 1.21-5.50), and the number of information sources on COVID-19 (OR = 1.34; 95% CI 1.24-1.44) ( $p < 0.05$ ). For the

group with deteriorated sleep, physical health status, and mental health in Additional Analysis 2 (Table 3), the following groups were affected: younger (OR = 0.98; 95% CI 0.97-0.99), female (OR = 1.54; 95% CI 1.08-2.20), decreased income after the COVID-19

outbreak (OR = 3.40; 95% CI 1.73-6.70), poor sleep quality in the past month (OR = 10.10; 95% CI 6.74-15.14), and more means of gathering information about COVID-19 (OR = 1.43; 95% CI 1.26-1.61) (p < 0.05).

**Table 2.** Logistic regression analysis of the change in the subjective sleep, physical condition, and mental state. (n=2,573).

Variables	B	OR (95%CI)	p-value
<b>Change in the subjective sleep †</b>			
Age	-0.01	0.987 (0.977-0.997)	0.009
Not taking influenza vaccine annually	-0.55	0.58 (0.41-0.80)	0.001
Decreased income during the pandemic	1.05	2.85 (1.55-5.22)	< 0.001
Deterioration in the quality of sleep in the past month	1.80	6.03 (4.26-8.53)	< 0.001
Deterioration of the physical condition	2.36	10.56 (7.32-15.23)	< 0.001
Deterioration of the mental state	1.57	4.82 (3.38-6.88)	< 0.001
<b>Change in the subjective physical condition ††</b>			
Living alone	0.44	1.56 (1.03-2.36)	0.035
Deterioration in the quality of sleep in the past month	0.42	1.53 (1.08-2.16)	0.017
Deterioration of the subjective sleep condition	2.34	10.35 (7.19-14.91)	< 0.001
Deterioration of the mental state	2.48	11.94 (8.49-16.80)	< 0.001
Pre-existing diseases	0.62	1.86 (1.24-2.79)	0.003
<b>Change in the subjective mental state †††</b>			
Age	-0.01	0.990 (0.983-0.997)	0.009
Female	0.51	1.67 (1.30-2.13)	< 0.001
Number of information collection methods regarding COVID-19	0.21	1.23 (1.13-1.35)	< 0.001
Deterioration in the quality of sleep in the past month	0.27	1.31 (1.01-1.70)	0.041
Deterioration of the subjective sleep condition	1.49	4.46 (3.12-6.37)	< 0.001
Deterioration of the physical condition	2.39	10.86 (7.72-15.28)	< 0.001

Note: Other variables were not significant in the model.

† female, married, intention of taking the COVID-19 vaccine, income before the COVID-19 pandemic, old media, number of information methods, pre-existing diseases, pregnant;

†† age, female, married, COVID-19 vaccine, influenza, income before COVID-19, decrease in the income after the COVID-19 outbreak, number of methods of collecting information;

††† married, income before the COVID-19 pandemic, decrease in the income after the COVID-19 outbreak, old media, pregnant;

Abbreviation: OR, odds ratio; CI, confidence interval.

**Table 3.** Logistic regression analysis of the groups in which all as well as any one of the three conditions, namely, sleep, physical condition, and mental health, worsened.

Variables	B	OR (95%CI)	p-value
<b>Change in the subjective sleep, physical condition, and mental state †</b>			
Age	-0.02	0.98 (0.97-0.99)	0.001
Female	0.43	1.54 (1.08-2.20)	0.018
Decreased income during the pandemic	1.23	3.40 (1.73-6.70)	< 0.001
Deterioration in the quality of sleep in the past month	2.31	10.10 (6.74-15.14)	< 0.001
Number of information collecting methods about COVID-19	0.36	1.43 (1.26-1.61)	< 0.001

Table 3 continued

Variables	B	OR (95%CI)	p-value
<i>Change in any one of the following: subjective sleep, physical condition, and mental state††</i>			
Age	-0.01	0.99 (0.98-0.99)	< 0.001
Female	0.43	1.54 (1.26-1.98)	< 0.001
Decreased income during pandemic	0.66	1.94 (1.27-2.96)	0.002
Deterioration in the quality of sleep in the past month	1.18	3.25 (2.66-3.96)	< 0.001
Pregnant	0.95	2.58 (1.21-5.50)	0.01
Number of information collecting methods about COVID-19	0.29	1.34 (1.24-1.44)	< 0.001

Note: Other variables were not significant in the model.

† living with children, married, education, income before the COVID-19 pandemic, old media, pre-existing diseases;

†† living with children, married, COVID-19 vaccine, getting vaccinated against influenza annually (almost), income before COVID-19;

Abbreviation: OR, odds ratio; CI, confidence interval.

## 4. Discussion

This study was conducted in Japan when the COVID-19 vaccination had just begun, and most people had not been vaccinated. It was assumed that many people were both concerned about the continuing pandemic and hopeful regarding the vaccine at the time. After the COVID-19 outbreak, our results demonstrated a deterioration of subjective sleep, physical condition, and mental health perceptions by 13.6%, 14.0%, and 23.8%, respectively. The number of COVID-19-infected people in Japan was limited compared to the other OECD countries. Nevertheless, it was found that a limited number of people experienced physical and mental deterioration in an unstable situation.

Each group indicated an association with the background factors, confirming that subjective sleep, physical condition, and mental state affected each other. As for the relationship between sleep with the COVID-19 pandemic, a dose-response relationship was found between anxiety, depression, and sleep<sup>[19]</sup>; moreover, sleep timing was delayed and the quality of sleep deteriorated during the lockdown<sup>[20]</sup>. Our findings reported that younger people whose physical and mental states deteriorated after the pandemic experienced poorer sleep.

As for physical condition, people who lived alone and those with pre-existing medical diseases were more likely to experience health deterioration. A reason for this was that many of them refrained from

seeing a doctor or seeking consultation with someone during the COVID-19 pandemic. An online survey of 1,879 participants by Michael et al. also showed that those with poor physical health states during the COVID-19 disaster experienced significantly more stress, anxiety, and depression symptoms than those who did not<sup>[21]</sup>.

Several reports have been on the relationship between the COVID-19 pandemic and mental health. A study in the U.S. reported that mental distress and isolation increased with the former<sup>[22]</sup>. Moreover, there were international reports of anxiety, depression, PTSD, and stress regarding the coronavirus<sup>[23-25]</sup>. Risk factors associated with mental distress, mental health, anxiety, and depression during the COVID-19 pandemic were found to be more prevalent among women, young people, chronically/mentally ill individuals, unemployed people, students, and those with high exposure to COVID information<sup>[23-25]</sup>. In our research, females, young people, and those with more sources of information on COVID-19 had poorer mental health, which is consistent with the aforementioned international reports.

By 2020, an increase in suicides among women and young people was noted (Ministry of Health, Labor, and Welfare, Japan)<sup>[26]</sup>. Furthermore, Horita et al. also demonstrated a surge in suicides in Japan, especially among young women, during the COVID-19 pandemic<sup>[27]</sup>. These circumstances necessitate urgent measures to be implemented for vulnerable populations.



We found that the more sources of information people had about COVID-19, the poorer their mental health. In Japan, Internet traffic has increased sharply from the previous year after 2020 (COVID-19 pandemic) [28]. This has been believed to be due to a rise in stay-at-home hours. Trust in televisions (TV), newspapers, and other media has been declining [29,30]. In particular, it has become clear that there is considerable misinformation on the social networking service (SNS) [31]. Prior research has shown that exposure to misinformation is detrimental to mental and physical health [12-18]. During the COVID-19 pandemic, it was found that the reasons for the health effects of the SNS were that its users skipped lunch and had fewer conversations [32]. It is possible that information-gathering while staying at home is not merely limited to the SNS and the Internet. Given these findings, it is probable that in this study's results, those who used various information-gathering methods to collect data about COVID-19 were affected by these factors and their mental and physical health worsened. Furthermore, in addition to the SNS, a study in Japan showed that people who received information about the COVID-19 infections from TV news and Internet articles tended to have higher levels of coronavirus anxiety [33]. The study also reported that reducing the amount of time spent watching TV and reading Internet articles may have a positive impact on mental health. Specifically, seeking more information to reduce anxiety may increase exposure to false, misleading, or negative information, consequently increasing anxiety. A study by Machida et al. including Japanese participants also indicated that those who were more diligent in gathering information about the COVID-19 vaccination were more likely to refrain from receiving it [34].

Furthermore, this study's analyses suggested the possibility that a careful approach to pregnant women is needed from a preventive perspective concerning the deterioration of mental and physical conditions caused by the COVID-19 disaster.

Reports from Belgium, China, and Canada have presented elevated depressive and anxiety symptoms among pregnant women during the COVID-19

pandemic [35-37]. Among Japan, Matsushima and Horiguchi showed that the percentage of mothers with depressive symptoms was remarkably higher than that found in normal circumstances in Japan. They reported that given that the experience of pregnancy/becoming a mother can itself be considered a stressful event, the risk of postpartum depression was intensified with additional stressors caused by the COVID-19 pandemic, including voluntary social isolation and economic uncertainty [38]. Furthermore, Davenport et al. found that one in seven women in the perinatal period were affected by depression and anxiety and that these were associated with an increased risk of preterm delivery, a decreased maternal-child bonding, and a delayed cognitive aptitude and emotional development in infants, effects that may continue into childhood [39]. Therefore, similar to previous studies, this research's results indicated that support and care may be essential for those who are pregnant and of childbearing potential, as they are likely to present some kind of disorder. However, this study's results alone should be interpreted with caution since it is not possible to mention whether sleep or physical discomfort was exacerbated by pregnancy or whether COVID-19 had an effect.

Based on this research's findings, we believed that the variables (i.e., younger, female, decreased income after the COVID-19 outbreak, poor sleep quality in the past month, possible pregnancy, and the number of information sources on COVID-19) that were suggested to have an impact on the deterioration of all or any of the psychosomatic state variables (i.e., sleep, physical condition, and mental state) are especially important for the prevention of the physical health. According to an article, the COVID-19 pandemic has spurred the development of health monitoring through wearable devices [40]. The article also reported that the pandemic requires not only individual but also collective behavior change in the community. Therefore, we believe that it is crucial to recognize physical and mental health problems earlier by monitoring health through wearable devices and to approach not only individuals but the whole community. In particular, the odds ratio of

sleep quality was more extensive in the model with the group in which any one of the physical and mental conditions worsened as the dependent variable, as compared to that in which all physical and mental conditions deteriorated as the dependent variable. Thus, it is suggested that sleep quality may have a greater critical impact on the widespread worsening of the psychosomatic states due to COVID-19. A meta-analysis by Alimoradi et al. also showed an association between sleep and psychological distress (depressive and anxiety symptoms) [9]. The limitations of their study included that most papers employed in the meta-analysis were Chinese and Italian and were conducted only among young people. This study's results provided new evidence of an association between sleep and physical and psychological complaints among diverse ages in Japan. From a preventive perspective, treatment and intervention for sleep disorders may be meaningful in improving the deterioration of mental and physical conditions. By using wearable devices, sleep quality can be easily monitored, making it possible to recognize sleep disorders earlier. The early recognition of sleep disturbances can lead to their early treatment and intervention which may eventually help address the deterioration in mental and physical conditions. However, this research's analyses also suggested that various aspects other than sleep may be confounding factors in this deterioration. Therefore, it is essential to note that sleep treatment alone may not be beneficial.

## 5. Conclusions

In this study, it became clear that the COVID-19 pandemic and the self-restraint lifestyle affected both body and mind; furthermore, sleep, physical condition, and mental state affected each other. Additionally, it was evident that socially vulnerable groups such as women, young people, and those with underlying diseases were more susceptible to the pandemic. Based on these findings, it is necessary to consider appropriate intervention support methods.

The limitations of this study are as follows. It was a web-based survey; hence, those who did not have

access to Internet devices were excluded. And people with poor Internet access may be equally affected causing bias. Such people cannot receive appropriate information and support. In addition, this study is a small sample size. Furthermore, all the questionnaires employed in this study were not objective indexes; however, subjective and not validated ones. Nevertheless, health itself is an inherently subjective concept; thus, this survey is certainly meaningful.

## Author Contributions

T.F., M.K., and M.Y. designed the study. All authors conducted the survey, analyzed the data, and wrote the paper. All authors read and approved the final manuscript.

## Conflict of Interest

The authors declare that they have no conflicts of interest to report regarding the present study.

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## Appendix A

**Table A1.** Comparison of the demographic characteristics of the participants included and excluded in the analysis.

Characteristics	Model 1					Model 2				
	Deterioration in the subjective sleep, physical condition, and mental state group		All unchanged/ good group		p value	Deterioration in any one of the following group: Subjective sleep, physical condition, or mental state		All unchanged/ good group		p value
	n = 192		n = 1831			n = 741		n = 1831		
	Mean (n)	SD (%)	Mean (n)	SD (%)	Mean (n)	SD (%)	Mean (n)	SD (%)		
Age (in years)	48.7	15.4	53.1	16.7	< 0.001	49.8	16.7	53.1	16.7	<0.001
Number of information collecting ways about COVID-19	3.3	1.5	2.8	1.3	< 0.001	3.2	1.3	2.8	1.3	<0.001
Sex										
Man	71	37	919	50.2	< 0.001**	284	38.3	919	50.2	<0.001**
Female	121	63	912	49.8		457	61.7	912	49.8	
Age group (in years)										
20-29	30	15.6	215	11.7	0.003**	107	14.4	215	11.7	<0.001**
30-39	31	16.1	243	13.3		136	18.4	243	13.3	
40-49	34	17.7	326	17.8		130	17.5	326	17.8	
50-59	42	21.9	279	15.2		119	16.1	279	15.2	
60-69	31	16.1	330	18		106	14.3	330	18	
70-79	24	12.5	438	23.9		143	19.3	438	23.9	

Table A1 continued

Japan Region										
Hokkaido (North)	8	4.2	66	3.6	0.09	32	4.3	66	3.6	0.236
Tohoku (Northeast)	11	5.7	161	8.8		54	7.3	161	8.8	
Kanto (Mideast, including Tokyo)	57	29.7	551	30.1		219	29.6	551	30.1	
Chubu (Mideast)	24	12.5	336	18.4		111	15	336	18.4	
Kansai (Mid)	32	16.7	305	16.7		132	17.8	305	16.7	
Chugoku (Midwest)	18	9.4	114	6.2		53	7.2	114	6.2	
Shikoku (Southwest)	13	6.8	73	4		38	5.1	73	4	
Kyusyu (Southwest)	29	15.1	225	12.3		102	13.8	225	12.3	
Married	106	55.2	1136	62	0.064	416	56.1	1136	62	0.006**
Living										
Alone	32	16.7	299	16.3	0.904	120	16.2	299	16.3	0.933
With children	41	21.4	317	17.3	0.163	147	19.8	317	17.3	0.131
With adults	101	52.6	921	50.3	0.544	374	50.5	921	50.3	0.937
With elderly people (>65 years old)	76	39.6	745	40.7	0.767	314	42.4	745	40.7	0.431
With a medical worker	7	3.6	62	3.4	0.85	20	2.7	62	3.4	0.369
Education										
High school or less	58	30.2	651	35.6	0.14	253	34.1	651	35.6	0.497
College/University/Graduate university	134	69.8	1180	64.4		488	65.9	1180	64.4	
Job										
Agriculture, Forestry, Fisheries	3	1.6	11	0.6	0.11	8	1.1	11	0.6	0.035*
Service industry	7	3.6	102	5.6		26	3.5	102	5.6	
Freelance	9	4.7	62	3.4		29	3.9	62	3.4	
Administrative position	10	5.2	97	5.3		28	3.8	97	5.3	
Employee (full-time)	36	18.8	361	19.7		146	19.7	361	19.7	
Civil servant	3	1.6	38	2.1		11	1.5	38	2.1	
Medical workers	3	1.6	44	2.4		7	0.9	44	2.4	
Students	1	0.5	35	1.9	21	2.8	35	1.9	0.035*	
Part-time job	26	13.5	214	11.7	98	13.2	214	11.7		
Unemployed/housewife	72	37.5	755	41.2	317	42.8	755	41.2		
Others	22	11.5	112	6.1	50	6.7	112	6.1		
Income before the COVID-19 pandemic (million yen)										
<1.99	29	17.7	171	10.7	0.13	79	12.4	171	10.7	0.093
2.00-3.99	44	26.8	500	31.2		168	26.4	500	31.2	
4.00-5.99	36	22	392	24.5		181	28.5	392	24.5	
6.00-7.99	21	12.8	248	15.5		92	14.5	248	15.5	
8.00-9.99	15	9.1	138	8.6		66	10.4	138	8.6	
10.00-11.99	10	6.1	66	4.1		23	3.6	66	4.1	
12.00<	9	5.5	86	5.4		27	4.2	86	5.4	
Decrease of income after the COVID-19 pandemic	17	8.9	68	3.7	< 0.001**	50	6.7	68	3.7	<0.001**

Table A1 continued

Having a specific political party affiliation	77	40.1	733	40	0.985	295	39.8	733	40	0.917
Intention of the COVID-19 vaccine										
Yes	139	72.4	1263	69	0.238	546	73.7	1263	69	0.033*
No	22	11.5	295	16.1		92	12.4	295	16.1	
Undecided/unknown	31	16.1	273	14.9		103	13.9	273	14.9	
Having the annual influenza vaccine (almost)	90	46.9	788	43	0.307	355	47.9	788	43	0.024*
Gathering information from old media: newspaper and television	134	69.8	1373	75	0.116	546	73.7	1373	75	0.492
Good sleep for the past one month	40	20.8	1325	72.4	<0.001**	318	42.9	1325	72.4	<0.001**
Pre-existing diseases (pulmonary diseases, heart diseases, diabetes, severe obesity, chronic renal failure, liver disease, and immunodeficiency)	39	20.3	289	15.8	0.105	126	17	289	15.8	0.446
Smoking	31	16.1	266	14.5	0.547	111	15	266	14.5	0.769
Pregnant	3	1.6	17	0.9	0.398	16	2.2	17	0.9	0.012*

Note: Abbreviation: SD, standard deviation.

\*Honshu: Main and Biggest Island of Japan.