Age-related differences in depressive symptoms and coping strategies during the COVID-19 pandemic in Japan: A longitudinal study

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A B S T R A C T

Objective: The coronavirus 2019 (COVID-19) pandemic has particularly influenced the mental health of younger adults; accordingly, this study investigated age-related factors related to mental health and provided suggestions related to mental health recovery.
Methods: A web-based longitudinal survey was conducted from 2020 to 2021 in Japan. The survey consisted of the Patient Health Questionnaire-9 (PHQ-9), used to measure depressive symptoms as a response variable, and an anger questionnaire and coping strategy scale to assess explanatory variables.
Results: A total of 1468 participants were analyzed (valid response rate = 54.2%); 368 were younger adults (age range = 20–39), 667 were middle-aged adults (age range = 40–64), and 433 were aged adults (age range = 65–79). The PHQ-9 scores in the younger adults worsened over the three survey timepoints. State anger was strongly related to PHQ-9 scores in all age groups (standardized beta = 0.39–0.47), and state anger in the younger group was highest at all survey times, In the younger group, only nonadaptive coping strategies were related to PHQ-9 scores. Emotional support, venting, and humor adaptive strategies used by middle-aged and aged adults were most commonly used by younger adults; however, there were no significant relationships of these strategies with PHQ-9 scores in the younger group.
Conclusion: The level of depressive symptoms among the younger adults might be considerably worse than the middle-aged and aged adult. The younger adults might not make use of strategies, hence, they might need advice and skill training of strategies.

1. Introduction

Social changes and inconveniences because of the coronavirus disease 2019 (COVID-19) pandemic have worsened the mental health of the general population worldwide, and many studies on this topic have pointed out that the mental health of younger individuals might be particularly worse than that of middle-aged and aged individuals [1–9]. It has been suggested that younger adults might not be handling this exceptional situation as well as older adults [10]. Both adaptive and nonadaptive coping strategies for dealing with the pandemic have already been suggested: problem-focused coping, active coping, use of emotional support, and humor might be adaptive strategies [5,11], whereas self-distraction, substance use, behavioral disengagement, venting, planning, and self-blame might be nonadaptive strategies [11]. However, the benefits of various coping strategies for mental health have been shown to differ based on age [12–14]. It is necessary to

investigate coping strategies that differ depending on age, with a particular focus on younger individuals.

Additionally, we need to realize that the pandemic has extended for a long period of time. COVID-19 infection was first discovered in December 2019, and the World Health Organization (WHO) declared a pandemic in March 2020. From that point, COVID-19 has spread, and lockdown or mild lockdown was conducted in countries around the world. COVID-19 vaccines were supplied in December 2020; however, the supply was not yet sufficient around the world, and the patterns of an infection period and a stable period were repeated. There was a possibility that mental health among the general population would improve because people might become accustomed to the situation, but there was also a possibility that mental health would worsen because there were no signs that the situation was being brought under control. Additionally, some research has implied that mental health might improve in the stable period of the pandemic [15,16]; accordingly, there was another

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possibility that mental health had improved during only the stable period of the pandemic.

The present study conducted surveys during the COVID-19 pandemic in Japan. In Japan, the first infected patient was identified in January 2020, the cycle of an infection period and a stable period have been repeated, and there were three waves of the COVID-19 pandemic through February 2021 (Fig. 1). The general population was strongly encouraged to restrict activities since March 2020, such as avoiding nonessential outings, participating in events, and eating out. Previous research from Japan showed that the mental health of the Japanese population was worse during the pandemic [9,17–19], similar to any other country.

In the present study, we conducted longitudinal surveys during the COVID-19 pandemic in Japan. We aimed to reveal changes in mental health, examine related factors that differ depending on age, and suggest age-appropriate beneficial strategies, especially among younger individuals because their mental health has shown a marked deterioration. Regardless of the pattern of an infection period and stable period changes, it should be clarified whether mental health has been affected by the long duration of the pandemic.

2. Material and method

2.1. Study design and participants

We conducted a longitudinal survey that consisted of 3 web-based surveys (Fig. 1) with an online research company, Macromill, Inc. Japan. From a pool of approximately 10 million registered individuals residing in Macromill, Inc. and companies with which Macromill has partnerships., we recruited participants who were 20 to 69 years old and lived in the prefectures under special precautions related to the first wave of the COVID-19 pandemic in Japan: Tokyo, Saitama, Chiba, Kanagawa, Osaka, Hyogo, Fukuoka, Hokkaido, Ibaraki, Ishikawa, Gifu, Aichi, and Kyoto. A quota sampling method was used to compare equal-sized age groups (20s, 30s, 40s, 50s, 60s, and 70s), participants of both sexes (male and female), and participants with different employment statuses (full-time worker; no regular employment; and unemployed, including homemaker, retired, and jobless). The present study did not

have exclusion criteria aside from the above selection criteria; however, participants were limited to those who could use mobile phones or computers because participants had to answer the web-based surveys on their mobile phones or computers.

The first survey was conducted from 17 to 22 July 2020. We planned to recruit 2700 participants based on the sample size calculation for the first study [17]. A second survey was conducted from 18 to 23 September 2020, and a third survey was conducted from 22 to 27 January 2021 for participants who answered the 1st survey. Participants had to answer within the period for the second survey and the third survey.

The present study analyzed participants who answered all 3 surveys and had no missing values. We categorized participants who were 20 to 39 years old as the younger adult group, 40 to 64 years old as the middle-aged adult group, and 65 to 79 years old as the aged adult group based on previous studies [8,20]. All the participants received Macromill points for their participation; Macromill points are used in the original point service of Macromill, Inc., and participants can trade these points for prizes or cash.

2.2. Measurements

Participants were required to provide information regarding their age, sex, residential area, underlying disease, presence or absence of an underlying disease that was associated with a higher risk of a more severe SARS-CoV-2 infection, marital status, presence or absence of children, household income, employment status, and economic impact of the COVID-19 pandemic. Household income was the only question that was not mandatory, which was based on the online research company policy. The average household income in Japan was 5.52 million JPY [21].

The web-survey questionnaire contained the three scales described below. The Patient Health Questionnaire-9 (PHQ-9) was used to assess depressive symptoms. The PHQ-9 is composed of 9 items scored on a four-point scale (0 to 3), and the score can range from 0 to 27, with higher scores indicating more depressive symptoms [22,23]. The mean PHQ-9 scores prepandemic in Japan were 2.9 ± 4.3 among healthy workers [24], 4.1 ± 4.2 in adults [25] and 3.2 ± 3.1 among university
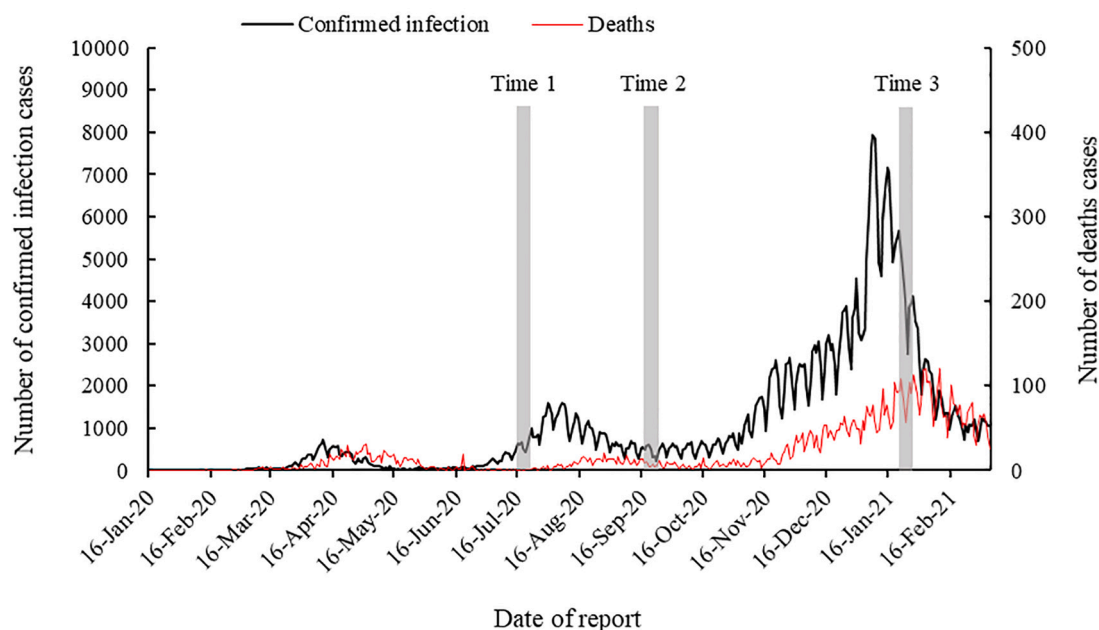

Fig. 1. Number of confirmed COVID-19 cases (the first axis) and deaths (the second axis) in Japan and the survey periods in the present study. Data on the COVID-19 cases were obtained from Japan Broadcasting Corporation (NIPPON HOSO KYOKAI (NHK) in Japanese). https://www3.nhk.or.jp/news/special/coronavirus/data-widget/#mokuji0.

students [26].

To assess anger, the state anger scale and anger control scale, which are subscales of the State-Trait Anger Expression Inventory (STAXI), were used [27,28]. The state anger scale consists of 10 items scored on a four-point scale (0 to 3), and the score can range from 0 to 30, with higher scores indicating higher state anger. The anger control scale consists of 7 items scored on a four-point scale (0 to 3), and the score can range from 0 to 21, with higher scores indicating that the participant makes a greater attempt to keep calm and restrain one's behavior.

To assess coping strategies, the Japanese version of the Brief Coping Orientation to Problems Experienced (Brief COPE) [29], which is the Brief Coping Orientation to Problems Experienced inventory [30] translated into Japanese, was used. The scale comprises 28 items and assesses 14 coping styles. Each coping style is evaluated by two items scored on a four-point scale (1 to 4), and the scores for each coping style could range from 2 to 8. Higher scores indicated higher levels of coping styles.

2.3. Statistical analysis

First, we compared the participants who completed all 3 surveys and had no missing values and those who dropped out of the surveys and had missing values. The sociodemographic characteristics and mean PHS-9, STAXI, and Brief COPE scores at time 1 among the participants and missing group were compared with the chi-square test and two-sample *t*-test.

The participants were categorized into a younger adult group (aged 20 to 39), a middle-aged adult group (aged 40 to 64), and an aged adult group (aged 65 to 79). To compare sociodemographic characteristics between the age groups, chi-square tests were performed for the sociodemographic characteristics at time 1. To examine the PHQ-9, STAXI, and Brief COPE scores by survey time and age group, two-way analyses of variance (ANOVAs) for the scores were conducted.

Finally, to investigate the influences of sociodemographic characteristics and measures on depressive symptoms depending on age group, multiple linear regression by age group was conducted: the PHQ-9 at time 3 was the dependent variable, and the sociodemographic characteristics at time 1 and the STAXI and Brief COPE scores at time 3 were the predictor variables.

The statistical significance level was set at $p < .05$, and a

corresponding 95% confidence interval (CI) was calculated by multiple linear regression. Phi (φ) and Cramer's V (V) were used for the effect size for the chi-square test, Cohen's D (d) was used for the *t*-test, partial η^2 was used for ANOVAs, and R^2 was used for multiple linear regression. All statistical analyses were carried out using IBM SPSS Statistics (Version 28).

3. Results

A detailed description of study participant inclusion is shown in Fig. 2. The first survey was completed by 2708 participants; 2113 participants participated in the time 2 survey, and 1819 participants participated in the time 3 survey. The response rate was 78.0% between time 1 and time 2 and 86.1% between time 2 and time 3. In addition, 189 participants had missing values; accordingly, a total of 1468 participants were analyzed, and 1240 data points were missing (total response rate = 54.2%).

Sociodemographic characteristics and mean scores of the measures among the total participants ($N = 1468$) and missing group ($N = 1240$) at time 1 are shown in Table 1. The missing group was younger than the participants ($t = 12.23$, $p < .001$, d = 0.47). There were significant differences in sex, presence or absence of an underlying disease, marital status, presence or absence of children, household income, PHQ-9 score, self-distraction, denial, emotional support, instrumental support, behavioral disengagement, and venting; however, these effect sizes were small (φ and Cramer's V = 0.06–0.11, d = 0.03–0.14).

Among the 1468 participants, 368 (25.1%) were categorized into the younger adult group, 667 (45.4%) into the middle-aged adult group, and 433 (29.5%) into the aged adult group. The mean age among the younger adult group was 30.92 ± 5.18, middle aged group was 52.64 ± 7.10, and aged group was 70.95 ± 3.32. sociodemographic characteristics among the participants are shown in Table 2.

The results of two-way ANOVA for PHQ-9, STAXI, and Brief COPE scores are shown in Table 3. Regarding the PHQ-9, the main effect of age group was significant (F = 79.72, $p < .001$, partial $\eta^2 = 0.10$); the scores were highest for younger adults, followed by middle-aged adults and then aged adults (all $p < .001$). Some interactions and main effects between groups and within subjects were significant; for example, the state anger scores at time 2 in the middle-aged and aged groups were significantly lower than those at time 1 and time 3. On the other hand,
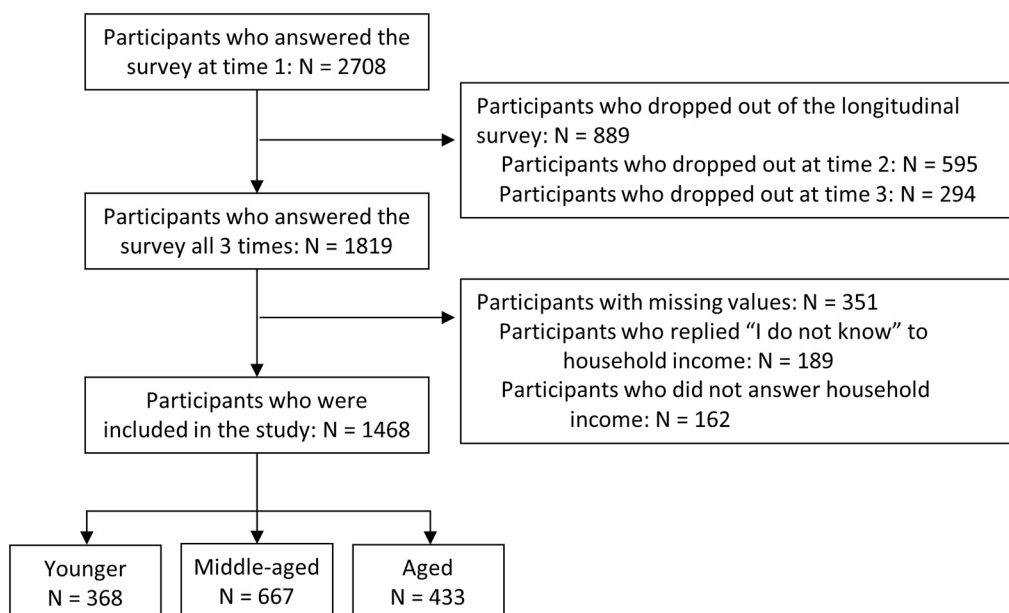

Fig. 2. Flow chart of this study showing participant inclusion.

Table 1

Sociodemographic characteristics and measures among the total participants and the missing group at time 1.

	Total participants		Missing group		Statistical analysis		
	N = 1468		N = 1240				
	N/Mean	%/SD	N/Mean	%/SD	χ^2/t	p	φ/d
Age (Mean ± SD, t-test, d)	52.60	± 15.82	45.10	± 15.98	12.23	< 0.001	0.47
Sex							
Male	805	54.8	549	44.3	30.00	< 0.001	0.11
Female	663	45.2	691	55.7			
Residential areas							
Not under mild lockdown	740	50.4	639	51.5	0.34	0.56	0.01
Under mild lockdown	728	49.6	601	48.5			
Underlying disease							
Without	1270	86.5	1119	90.2	9.00	0.003	0.06
With	198	13.5	121	9.8			
Marital status							
Single	615	41.9	601	48.5	11.74	< 0.001	0.07
Married	853	58.1	639	51.5			
Children							
Without	636	43.3	667	53.8	29.50	< 0.001	0.10
With	832	56.7	573	46.2			
Household income							
< 2 million JPY	211	14.4	88	13.5	11.92	0.02	0.07
2–4 million JPY	427	29.1	202	30.9			
4–6 million JPY	337	23.0	165	25.2			
6–8 million JPY	198	13.5	105	16.1			
> 8 million JPY	295	20.1	94	14.4			
Employment status							
Full-time worker	536	36.5	420	33.9	3.48	0.32	0.04
No regular employment	468	31.9	408	32.9			
Homemaker	199	13.6	193	15.6			
Not working	265	18.1	219	17.7			
Economically impacted							
Unimpacted	807	55.0	664	53.5	1.38	0.50	0.02
Negative impact	616	42.0	544	43.9			
Positive impact	45	3.1	32	2.6			
PHQ-9 (Mean ± SD, t-test, d)	5.0	5.3	5.7	5. 6	3.6	< 0.001	0.14
STAXI (Mean ± SD, *t*-test, d)							
State Anger	15.09	5.42	15.28	5.33	0.92	0.36	0.04
Anger Control	19.12	3.94	19.06	4.14	0.39	0.69	0.02
Brief COPE (Mean ± SD, t-test, d)							
Self-distraction	4.64	1.36	4.77	1.37	2.51	0.01	0.10
Active coping	5.27	1.32	5.24	1.28	0.66	0.51	0.03
Denial	3.21	1.24	3.06	1.23	3.17	0.002	0.12
Substance use	3.25	1.55	3.14	1.52	1.91	0.06	0.07
Emotional support	4.01	1.43	4.14	1.47	2.36	0.02	0.09
Instrumental support	3.98	1.47	4.16	1.49	3.14	0.002	0.12
Behavioral disengagement	3.83	1.30	3.93	1.33	2.06	0.04	0.08
Venting	3.99	1.31	4.14	1.38	3.00	0.003	0.12
Positive reframing	4.75	1.43	4.75	1.41	0.01	0.99	0.00
Planning	5.09	1.41	5.04	1.37	1.05	0.30	0.04
Humor	3.70	1.36	3.66	1.35	0.78	0.43	0.03
Acceptance	5.95	1.36	6.01	1.27	1.22	0.22	0.05
Religion	3.28	1.41	3.21	1.35	1.46	0.14	0.06
Self-blame	3.48	1.37	3.57	1.44	1.60	0.11	0.06

the state anger scores in the younger group were not significantly different across the 3 time points; however, the partial η² values were small.

Multiple regression analyses dependent on age group were conducted (Table 4): the dependent variable was the PHQ-9 score at time 3, and the predictor variables were risk factors at time 1 and the STAXI and Brief COPE scores at time 3. State anger and self-blame were significantly related to PHQ-9 scores in all age groups, and other factors and strategies showed different relationships that were dependent on age group. In the younger group, not working was a risk factor, and substance use was a nonadaptive strategy, while being married was an adaptive factor. In the middle-aged group, having underlying disease, being a homemaker, and experiencing a negative impact because of the pandemic were risk factors; substance use, behavioral disengagement, and acceptance were nonadaptive strategies; and being married, having emotional support, venting, planning, and using humor were adaptive factors and strategies. In the aged group, having underlying disease was

a risk factor, and venting and positive reframing were adaptive strategies.

4. Discussion

The present study investigated mental health and related factors throughout the COVID-19 pandemic and aimed to suggest beneficial strategies, especially for younger individuals. The results showed that depressive symptoms in the younger group were worse than those in the middle-aged and aged groups, which was consistent with previous studies. In general, negative emotions such as depression, anger, and anxiety decrease with age [31–36] and, consequently, the result that the difference of depressive levels differ by age groups might be partially influenced by it. Additionally, for comparison, PHQ-9 scores before the COVID-19 pandemic [24–26] among the general population were similar to the scores obtained in the middle-aged and aged groups in the present study. Accordingly, the level of depressive symptoms among

Table 2
Sociodemographic characteristics of the participants by age group (*N* = 1468).

	Younger adult		Middle-aged adult		Aged adult		Statistical analysis		
	N = 368		*N* = 667		*N* = 433				
	N	%	N	%	N	%	χ^2	p	φ
Sex									
Male	219	59.5	346	51.9	240	55.4	5.67	0.06	0.06
Female	149	40.5	321	48.1	193	44.6			
Residential areas									
Not under mild lockdown	201	54.6	340	51.0	199	46.0	6.13	0.047	0.07
Under mild lockdown	167	45.4	327	49.0	234	54.0			
Underlying disease									
Without	349	94.8	580	87.0	341	78.8	44.31	< 0.001	0.17
With	19	5.2	87	13.0	92	21.2			
Marital status									
Single	233	63.3	296	44.4	86	19.9	157.41	< 0.001	0.33
Married	135	36.7	371	55.6	347	80.1			
Children									
Without	260	70.7	310	46.5	66	15.2	253.69	< 0.001	0.42
With	108	29.3	357	53.5	367	84.8			
Household income									
< 2 million JPY	50	13.6	116	17.4	45	10.4	39.83	< 0.001	0.12[a]
2–4 million JPY	100	27.2	164	24.6	163	37.6			
4–6 million JPY	95	25.8	144	21.6	98	22.6			
6–8 million JPY	63	17.1	86	12.9	49	11.3			
> 8 million JPY	60	16.3	157	23.5	78	18.0			
Employment status									
Full-time worker	127	34.5	278	41.7	131	30.3	18.04	0.006	0.08[a]
No regular employment	123	33.4	198	29.7	147	33.9			
Homemaker	49	13.3	89	13.3	61	14.1			
Not working	69	18.8	102	15.3	94	21.7			
Economically impacted									
Unimpacted	195	53.0	335	50.2	277	64.0	21.46	< 0.001	0.09[a]
Negative impact	159	43.2	311	46.6	146	33.7			
Positive impact	14	3.8	21	3.1	10	2.3			

[a] Cramer's V.

those in the middle-aged and aged groups might be the same or slightly worse than those in the general population before the COVID-19 pandemic; on the other hand, the younger group might have worse mental health because of the pandemic.

Some research has implied that mental health might have improved during the stable period of the pandemic [15,16]; however, PHQ-9 scores in the present study did not improve among those in the younger group at the 2nd survey when the pandemic was temporarily settling in Japan. In addition, state anger, which was strongly related to depressive symptoms, remained at high levels among those in the younger group at the 2nd survey, even though state anger among those in the middle-aged and aged groups had decreased during a stable time of the pandemic. The state anger in the younger group was higher than that in the middle-aged and aged groups through the 3 surveys. Hence, state anger might be an important factor for depression, especially in younger individuals. Younger ages have been associated with higher levels of anger before the pandemic [32–36]. As an explanation for this finding, Brown [37] suggested that older adults were more adept at avoiding social stressors [38,39] and were more likely to utilize coping strategies that are most beneficial to them [40,41]. To support this suggestion, previous studies pointed out that risk factors and coping strategies differed depending on age [12–14].

Regarding the coping strategies used by the younger individuals in the present study, there were no adaptive strategies, but there were nonadaptive strategies, namely, self-blame and substance use. Younger individuals used self-blame and substance use more frequently than middle-aged and aged individuals. Although the individuals in the middle-aged and aged groups had some risk factors and used nonadaptive coping strategies, they also had some adaptive strategies, that is, venting, emotional support, humor, and positive reframing. In addition, emotional support, venting, and humor were most often used by the younger group, even though these coping strategies were not

significantly related to depressive symptoms individuals in the younger group.

Therefore, it is suggested that the younger adults used some coping strategies with some frequency and attempted to deal with the stress resulting from the COVID-19 pandemic; however, they either did not select adaptive strategies, or if they did select potential adaptive strategies, they did not make use of the strategies as well as the middle-aged and aged adults. As a result, the younger adults did not control their anger, and their depressive level continued to worsen; in contrast, when the pandemic was temporarily under control, the middle-aged and aged individuals maintained their mental health. There is a possibility that younger people need advice and skill training to adaptively use these strategies to control their anger and improve their mental health.

4.1. Limitation

We recruited participants who satisfied particular criteria, such as living in certain residential areas and being capable of using a mobile phone or personal computer to answer the web-based survey, and we used a quota sampling method based on age, sex, and employment status. In addition, 45.8% of participants who participated in the 1st survey dropped out of the longitudinal survey, accordingly, these results cannot reflect the entire Japanese population. Although the difference in PHQ-9 scores between the participants and missing group was small, the missing group was younger than the participants. There is a possibility that the results would have differed between the missing group and the participants in the present study.

As responses to the survey were self-reported, the depressive symptoms, emotions, and behaviors of the participants were not observed. In particular, the present study cannot explicitly determine whether depression was actually present.

Finally, some research has pointed out that students experience

Table 3
Scores on the PHQ-9, STAXI, and Brief COPE.

		Younger adult		Middle-aged adult		Aged adult		Statistical analysis								
								Interaction			Survey time (within)			Age group (between)		
		Mean	SD	Mean	SD	Mean	SD	F	p	partial η^2	F	p	partial η^2	F	p	partial η^2
PHQ-9	Time 1	6.9	5.9	5.2	5.3	0.8	3.6	2.92	0.02	0.00	0.75	0.47	0.00	79.72	< 0.001	0.10
	Time 2	6.8	6.0	5.3	5.4	2.7	3.4									
	Time 3	7.2	6.3	5.0	5.6	2.8	3.9									
State Anger	Time 1	15.75	6.26	15.14	5.50	11.73	4.38	4.58	0.001	0.01	11.73	< 0.001	0.01	14.86	< 0.001	0.02
	Time 2	15.92	6.93	14.07	5.38	13.52	4.42									
	Time 3	16.01	6.94	14.58	5.71	14.15	4.97									
Anger Control	Time 1	18.56	4.58	19.26	3.76	23.40	3.55	1.56	0.18	0.00	23.40	< 0.001	0.02	5.43	0.004	0.01
	Time 2	18.03	5.08	18.03	4.60	18.65	4.15									
	Time 3	17.85	5.16	18.44	4.34	18.72	4.51									
Self-distraction	Time 1	4.73	1.56	4.63	1.30	23.72	1.25	0.85	0.50	0.00	23.72	< 0.001	0.02	4.58	0.01	0.01
	Time 2	4.59	1.57	4.30	1.43	4.29	1.39									
	Time 3	4.52	1.54	4.36	1.49	4.31	1.41									
Active coping	Time 1	5.09	1.48	5.28	1.28	31.60	1.21	1.03	0.39	0.00	31.60	< 0.001	0.02	8.73	< 0.001	0.01
	Time 2	4.86	1.55	4.88	1.45	5.14	1.38									
	Time 3	4.82	1.56	4.99	1.44	5.16	1.36									
Denial	Time 1	3.19	1.39	3.18	1.20	2.34	1.15	2.94	0.02	0.00	2.34	0.10	0.00	3.75	0.02	0.01
	Time 2	3.34	1.49	3.07	1.21	3.24	1.29									
	Time 3	3.25	1.46	3.04	1.24	3.17	1.20									
Substance use	Time 1	3.39	1.69	3.31	1.59	1.29	1.35	0.64	0.63	0.00	1.29	0.28	0.00	7.75	< 0.001	0.01
	Time 2	3.30	1.68	3.24	1.57	3.04	1.40									
	Time 3	3.35	1.67	3.27	1.56	2.95	1.36									
Emotional support	Time 1	4.27	1.68	4.07	1.37	13.44	1.24	0.88	0.48	0.00	13.44	< 0.001	0.01	22.50	< 0.001	0.03
	Time 2	4.16	1.71	3.81	1.46	3.55	1.30									
	Time 3	4.09	1.64	3.86	1.48	3.57	1.35									
Instrumental support	Time 1	4.19	1.71	4.04	1.41	8.89	1.29	1.03	0.39	0.00	8.89	< 0.001	0.01	17.66	< 0.001	0.02
	Time 2	4.11	1.67	3.88	1.48	3.51	1.31									
	Time 3	4.01	1.68	3.86	1.49	3.61	1.37									
Behavioral disengagement	Time 1	4.12	1.49	3.84	1.26	5.78	1.11	0.53	0.71	0.00	5.78	0.003	0.00	30.53	< 0.001	0.04
	Time 2	4.10	1.54	3.71	1.41	3.50	1.23									
	Time 3	4.01	1.54	3.71	1.37	3.41	1.22									
Venting	Time 1	4.11	1.51	4.03	1.29	9.10	1.14	0.35	0.84	0.00	9.10	< 0.001	0.01	9.97	< 0.001	0.01
	Time 2	4.00	1.63	3.81	1.37	3.64	1.23									
	Time 3	4.03	1.59	3.91	1.32	3.71	1.21									
Positive reframing	Time 1	4.55	1.59	4.77	1.40	16.56	1.32	1.89	0.11	0.00	16.56	< 0.001	0.01	2.76	0.06	0.00
	Time 2	4.40	1.62	4.53	1.56	4.64	1.44									
	Time 3	4.49	1.68	4.53	1.56	4.52	1.47									
Planning	Time 1	4.90	1.58	5.10	1.35	32.54	1.32	1.11	0.35	0.00	32.54	< 0.001	0.02	4.21	0.015	0.01
	Time 2	4.73	1.58	4.77	1.49	4.86	1.46									
	Time 3	4.67	1.57	4.85	1.52	4.93	1.44									
Humor	Time 1	3.90	1.56	3.73	1.35	5.68	1.14	1.42	0.22	0.00	5.68	0.003	0.00	11.36	< 0.001	0.02
	Time 2	3.79	1.52	3.67	1.48	3.51	1.28									
	Time 3	3.83	1.58	3.53	1.46	3.37	1.21									
Acceptance	Time 1	5.67	1.63	6.01	1.30	20.27	1.15	0.02	> 0.99	0.00	20.27	< 0.001	0.01	13.47	< 0.001	0.02
	Time 2	5.43	1.74	5.77	1.52	5.83	1.40									
	Time 3	5.44	1.72	5.77	1.60	5.85	1.37									
Religion	Time 1	3.36	1.52	3.28	1.40	0.93	1.33	0.66	0.62	0.00	0.93	0.39	0.00	2.609	0.07	0.00
	Time 2	3.38	1.52	3.18	1.42	3.19	1.32									
	Time 3	3.43	1.61	3.22	1.42	3.24	1.36									
Self-blame	Time 1	3.76	1.62	3.47	1.32	3.88	1.14	2.15	0.07	0.00	3.88	0.02	0.00	26.89	< 0.001	0.04
	Time 2	3.81	1.73	3.35	1.42	3.11	1.15									
	Time 3	3.73	1.77	3.26	1.39	3.18	1.26									

greater mental disruption than workers [42]; however, the present study could not selectively investigate students and university students. Additionally, even though the present study was conducted in only one country, further study using international comparison might be required to discuss mental health, especially among young adults, during the COVID-19 pandemic and to elucidate the particular populations who need professional care.

5. Conclusion

The present study showed that the level of depressive symptoms among the younger adult population might be considerably worse than the relatively stable or slightly worse levels observed in the middle-aged and aged adult, although, many studies pointed out that the mental health of the general population worsened during the COVID-19 pandemic [2,7,10,43–47]. State anger might hold the key to the deterioration in mental health among the younger individuals. State anger among middle-aged and aged individuals decreased when the pandemic was in a stable phase; in contrast, state anger among the younger individuals was not alleviated, and these high levels of state anger were strongly related to depressive symptoms. Before the pandemic, younger people were shown to have higher levels of anger than older people, which might be related to coping strategies [32–41]. The results of the present study suggested that some coping strategies were used more frequently by the younger group; however, these coping strategies either were nonadaptive strategies or were adaptive strategies only in the middle-aged and aged groups. On the other hand, middle-aged and aged adults had some risk factors and used nonadaptive coping strategies;

Table 4

Multiple linear regression of risk factors at time 1 and the STAXI and Brief COPE scores at time 3 associated with the PHQ-9 score at time 3.

		Younger adult			Middle-aged adult			Aged adult		
		β	(95% CI)	p value	β	(95% CI)	p value	β	(95% CI)	p value
Sex	Male	Ref		0.08	Ref		0.91	Ref		0.79
	Female	0.09	(− 0.15, 2.38)		0.00	(− 0.74, 0.83)		0.01	(− 0.69, 0.91)	
Residential areas	Not under mild lockdown	Ref		0.48	Ref		0.82	Ref		0.85
	Under lockdown	0.03	(− 0.65, 1.39)		- 0.01	(− 0.75, 0.59)		- 0.01	(− 0.70, 0.58)	
Underlying disease[a]	Without	Ref		0.40	Ref		0.003	Ref		0.03
	With	0.03	(− 1.25, 3.16)		0.09	(0.53, 2.50)		0.09	(0.10, 1.66)	
Marital status	Single	Ref		0.005	Ref		< 0.001	Ref		0.06
	Married	- 0.19	(− 4.22, − 0.76)		- 0.15	(− 2.73, − 0.70)		- 0.09	(− 1.85, 0.03)	
Children	Without	Ref		0.78	Ref		0.91	Ref		0.60
	With	0.02	(− 1.47, 1.95)		0.00	(− 0.91, 0.81)		- 0.02	(− 1.20, 0.69)	
Household income	< 2 million JPY	Ref			Ref			Ref		
	2–4 million JPY	- 0.04	(− 2.28, 1.13)	0.51	- 0.02	(− 1.35, 0.92)	0.71	- 0.06	(− 1.59, 0.71)	0.45
	4–6 million JPY	- 0.07	(− 2.77, 0.72)	0.25	- 0.04	(− 1.85, 0.72)	0.39	- 0.13	(− 2.43, 0.10)	0.07
	6–8 million JPY	- 0.02	(− 2.30, 1.54)	0.70	0.00	(− 1.61, 1.46)	0.92	- 0.03	(− 1.74, 1.13)	0.67
	> 8 million JPY	- 0.06	(− 2.99, 0.95)	0.31	0.01	(− 1.37, 1.57)	0.90	- 0.06	(− 2.01, 0.72)	0.36
Employment status	Full-time worker	Ref			Ref			Ref		
	No regular employment	0.06	(− 0.46, 2.10)	0.21	0.00	(− 0.91, 0.87)	0.96	- 0.01	(− 0.89, 0.79)	0.91
	Homemaker	0.09	(− 0.27, 3.61)	0.09	0.07	(0.07, 2.37)	0.04	0.03	(− 0.84, 1.54)	0.56
	Not working	0.15	(0.76, 3.93)	0.004	0.04	(− 0.57, 1.90)	0.29	0.00	(− 0.97, 1.01)	0.97
Economic impact	Unimpacted	Ref			Ref			Ref		
	Negative impact	0.04	(− 0.53, 1.58)	0.33	0.12	(0.64, 2.02)	< 0.001	0.05	(− 0.26, 1.10)	0.23
	Positive impact	0.01	(− 2.34, 2.94)	0.82	- 0.02	(− 2.64, 1.22)	0.47	0.08	(− 0.09, 4.20)	0.06

		Younger adults			Middle-aged adults			Aged adults		
		β	(95% CI)	p value	β	(95% CI)	p value	β	(95% CI)	p value
STAXI	State Anger	0.47	(0.33, 0.52)	< 0.001	0.39	(0.31, 0.45)	< 0.001	0.44	(0.27, 0.41)	< 0.001
	Anger Control	0.04	(− 0.06, 0.17)	0.37	0.03	(− 0.06, 0.14)	0.40	0.07	(− 0.02, 0.14)	0.17
Brief COPE	Self-distraction	0.06	(− 0.21, 0.69)	0.30	0.08	(− 0.04, 0.60)	0.09	0.06	(− 0.16, 0.48)	0.32
	Active coping	- 0.06	(− 0.70, 0.25)	0.35	- 0.08	(− 0.68, 0.05)	0.09	- 0.05	(− 0.48, 0.20)	0.42
	Denial	- 0.12	(− 1.03, 0.02)	0.06	- 0.04	(− 0.56, 0.18)	0.32	0.02	(− 0.29, 0.42)	0.73
	Substance use	0.10	(0.01, 0.76)	0.045	0.07	(0.00, 0.51)	0.048	- 0.07	(− 0.47, 0.10)	0.20
	Emotional support	- 0.11	(− 0.94, 0.13)	0.14	- 0.11	(− 0.80, − 0.01)	0.047	0.08	(− 0.17, 0.64)	0.25
	Instrumental support	0.01	(− 0.46, 0.55)	0.86	0.08	(− 0.05, 0.66)	0.10	0.02	(− 0.35, 0.43)	0.83
	Behavioral disengagement	0.10	(− 0.02, 0.83)	0.06	0.16	(0.32, 0.95)	< 0.001	0.05	(− 0.16, 0.50)	0.30
	Venting	- 0.12	(− 0.96, 0.00)	0.05	- 0.09	(− 0.75, − 0.04)	0.03	- 0.15	(− 0.84, − 0.14)	0.006
	Positive reframing	0.07	(− 0.16, 0.66)	0.24	- 0.04	(− 0.45, 0.19)	0.43	- 0.16	(− 0.75, − 0.09)	0.01
	Planning	- 0.05	(− 0.70, 0.27)	0.38	- 0.11	(− 0.75, − 0.04)	0.03	0.04	(− 0.24, 0.43)	0.57
	Humor	- 0.05	(− 0.60, 0.22)	0.36	- 0.08	(− 0.6, − 0.04)	0.03	- 0.02	(− 0.39, 0.24)	0.64
	Acceptance	0.10	(− 0.03, 0.73)	0.07	0.11	(0.10, 0.67)	0.007	- 0.01	(− 0.32, 0.27)	0.85
	Religion	0.00	(− 0.42, 0.44)	0.96	- 0.04	(− 0.44, 0.13)	0.29	0.02	(− 0.26, 0.36)	0.75
	Self-blame	0.25	(0.50, 1.26)	< 0.001	0.24	(0.63, 1.27)	< 0.001	0.23	(0.37, 1.08)	< 0.001
	R^2	0.45		< 0.001	0.42		< 0.001	0.30		< 0.001

[a] Underlying disease that could easily be exacerbated by coronavirus; CI: confidence interval.

CI: confidence interval.

however, they might have maintained their mental health because they could adaptively use particular coping strategies. Hence, younger individuals might not make use of the strategies as well as the middle-aged and aged individuals, even though they might have been attempting to deal with the stress resulting from the COVID-19 pandemic. To improve their depressive symptoms, advice and skill training for making good use of these strategies might be needed for younger adults.

Ethics approval

The Research Ethics Review Committee of Kitasato University School of Allied Health Sciences approved this study (approval numbers were 2020–011 and 2020–023). All participants were informed of the purposes of the present study and their right to quit the survey before they participated. The participants checking the box "I agree to participate in the study" was considered an indication of participant consent, and informed consent was obtained from all participants. This study was conducted in accordance with the 1964 Helsinki Declaration and its later amendments.

Author contributions

Yuko Fukase, Kanako Ichikura, and Hirokuni Tagaya designed the study and performed the statistical analyses. Yuko Fukase collected the data and drafted the manuscript. Yuko Fukase, Kanako Ichikura, and Hanako Murase contributed to the scientific discussion of the data. All authors have read and approved the manuscript.

Competing interest statement

Yuko Fukase had received research grants from the Murata Science Foundation. Kanako Ichikura is an advisor of a personal health care services by Clinical Study Support, Inc. Hirokuni Tagaya is an advisor of a clinical trial by Taisho Pharmaceutical Holdings and a committee member of a Medical Research Ethics Committee of Nikon Corporation and Japan Aerospace Exploration Agency. Hanako Murase has no competing interests to report.

Data availability statement

The datasets generated during the current study are available in the openICPSR database, https://doi.org/10.3886/E143321V1

Clinical trial registration

None.

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References

[1] H. Wang, Q. Xia, Z. Xiong, Z. Li, W. Xiang, Y. Yuan, Y. Liu, Z. Li, The psychological distress and coping styles in the early stages of the 2019 coronavirus disease (COVID-19) epidemic in the general mainland Chinese population: a web-based survey, PLoS One 15 (2020), e0233410, https://doi.org/10.1371/journal.pone.0233410.

[2] L.Y. Lin, J. Wang, X.Y. Ou-Yang, Q. Miao, R. Chen, F.X. Liang, Y.P. Zhang, Q. Tang, T. Wang, The immediate impact of the 2019 novel coronavirus (COVID-19) outbreak on subjective sleep status, Sleep Med. 77 (2020) 348–354, https://doi.org/10.1016/j.sleep.2020.05.018.

[3] K.M. Fitzpatrick, C. Harris, G. Drawve, How bad is it? Suicidality in the middle of the COVID-19 pandemic, Suicide Life Threat. Behav. 50 (2020) 1241–1249, https://doi.org/10.1111/sltb.12655.

[4] M. Varshney, J.T. Parel, N. Raizada, S.K. Sarin, Initial psychological impact of COVID-19 and its correlates in Indian Community: an online (FEEL-COVID) survey, PLoS One 15 (2020), e0233874, https://doi.org/10.1371/journal.pone.0233874.

[5] M. Shechory Bitton, A. Laufer, Mental health and coping in the shadow of the COVID-19 pandemic: the israeli case, Front. Public Health 8 (2020), 568016, https://doi.org/10.3389/fpubh.2020.568016.

[6] R. Rodríguez-Rey, H. Garrido-Hernansaiz, S. Collado, Psychological impact and associated factors during the initial stage of the coronavirus (COVID-19) pandemic among the general population in Spain, Front. Psychol. 11 (2020) 1540, https://doi.org/10.3389/fpsyg.2020.01540.

[7] I. Solomou, F. Constantinidou, Prevalence and predictors of anxiety and depression symptoms during the COVID-19 pandemic and compliance with precautionary measures: age and sex matter, Int. J. Environ. Res. Public Health 17 (2020) 4924, https://doi.org/10.3390/ijerph17144924.

[8] M.M. Hossain, S. Tasnim, A. Sultana, F. Faizah, H. Mazumder, L. Zou, E.L. J. McKyer, H.U. Ahmed, P. Ma, Epidemiology of mental health problems in COVID-19: a review, F1000Res. 9 (2020) 636, https://doi.org/10.12688/f1000research.24457.1.

[9] T. Yamamoto, C. Uchiumi, N. Suzuki, J. Yoshimoto, E. Murillo-Rodriguez, The psychological impact of 'Mild Lockdown' in Japan during the COVID-19 pandemic: a nationwide survey under a declared state of emergency, Int. J. Environ. Res. Public Health 17 (2020) 9382, https://doi.org/10.3390/ijerph17249382.

[10] C. Pieh, S. Budimir, T. Probst, The effect of age, gender, income, work, and physical activity on mental health during coronavirus disease (COVID-19) lockdown in Austria, J. Psychosom. Res. 136 (2020), 110186, https://doi.org/10.1016/j.jpsychores.2020.110186.

[11] E. Umucu, B. Lee, Examining the impact of COVID-19 on stress and coping strategies in individuals with disabilities and chronic conditions, Rehab. Psychol. 65 (2020) 193–198, https://doi.org/10.1037/rep0000328.

[12] O. Braun-Lewensohn, S. Abu-Kaf, K. Al-Said, E. Huss, Analysis of the differential relationship between the perception of one's life and coping resources among three generations of bedouin women, Int. J. Environ. Res. Public Health 16 (2019) 804, https://doi.org/10.3390/ijerph16050804.

[13] L. Rubio, C. Dumitrache, E. Cordon-Pozo, R. Rubio-Herrera, Coping: impact of gender and stressful life events in middle and in old age, Clin. Gerontol. 39 (2016) 468–488, https://doi.org/10.1080/07317115.2015.1132290.

[14] M. Oh, J.W. Kim, N.H. Yoon, S.A. Lee, S.M. Lee, W.S. Kang, Differences in personality, defense styles, and coping strategies in individuals with depressive disorder according to age groups across the lifespan, Psychiatry Investig. 16 (2019) 911–918, https://doi.org/10.30773/pi.2019.0160.

[15] Z. Cai, Q. Cui, Z. Liu, J. Li, X. Gong, J. Liu, Z. Wan, X. Yuan, X. Li, C. Chen, G. Wang, Nurses endured high risks of psychological problems under the epidemic of COVID-19 in a longitudinal study in Wuhan China, J. Psychiatr. Res. 131 (2020) 132–137, https://doi.org/10.1016/j.jpsychires.2020.09.007.

[16] Z. Zhu, Q. Liu, X. Jiang, U. Manandhar, Z. Luo, X. Zheng, Y. Li, J. Xie, B. Zhang, The psychological status of people affected by the COVID-19 outbreak in China, J. Psychiatr. Res. 129 (2020) 1–7, https://doi.org/10.1016/j.jpsychires.2020.05.026.

[17] Y. Fukase, K. Ichikura, H. Murase, H. Tagaya, Depression, risk factors, and coping strategies in the context of social dislocations resulting from the second wave of COVID-19 in Japan, BMC Psychiatry 21 (2021) 33, https://doi.org/10.1186/s12888-021-03047-y.

[18] M. Ueda, A. Stickley, H. Sueki, T. Matsubayashi, Mental health status of the general population in Japan during the COVID-19 pandemic, Psychiatry Clin. Neurosci. 74 (2020) 505–506, https://doi.org/10.1111/pcn.13105.

[19] H. Kikuchi, M. Machida, I. Nakamura, R. Saito, Y. Odagiri, T. Kojima, H. Watanabe, K. Fukui, S. Inoue, Changes in psychological distress during the COVID-19 pandemic in Japan: a longitudinal study, J. Epidemiol. 30 (2020) 522–528, https://doi.org/10.2188/jea.JE20200271.

[20] E. Hoshino, S. Ohde, M. Rahman, O. Takahashi, T. Fukui, G.A. Deshpande, Variation in somatic symptoms by patient health questionnaire-9 depression scores in a representative Japanese sample, BMC Public Health 18 (2018) 1406, https://doi.org/10.1186/s12889-018-6327-3.

[21] Ministry of Health, Labor and Welfare, Comprehensive Survey of Living Conditions in 2019. https://www.mhlw.go.jp/toukei/saikin/hw/k-tyosa/k-tyosa19/index.html, 2020.

[22] K. Muramatsu, H. Miyaoka, K. Kamijima, Y. Muramatsu, Y. Tanaka, M. Hosaka, Y. Miwa, K. Fuse, F. Yoshimine, I. Mashima, N. Shimizu, H. Ito, E. Shimizu, Performance of the Japanese version of the patient health questionnaire-9 (J-PHQ-9) for depression in primary care, Gen. Hosp. Psychiatry 52 (2018) 64–69, https://doi.org/10.1016/j.genhosppsych.2018.03.007.

[23] K. Kroenke, R.L. Spitzer, J.B. Williams, The PHQ-9: validity of a brief depression severity measure, J. Gen. Intern. Med. 16 (2001) 606–613, https://doi.org/10.1046/j.1525-1497.2001.016009606.x.

[24] K. Nakata, T. Tsuji, J. Vietri, D.H. Jaffe, Work impairment, osteoarthritis, and health-related quality of life among employees in Japan, Health Qual. Life Outcomes 16 (2018) 64, https://doi.org/10.1186/s12955-018-0896-9.

[25] K. Toyoshima, T. Inoue, J. Masuya, Y. Fujimura, S. Higashi, I. Kusumi, Affective temperaments moderate the effect of insomnia on depressive symptoms in adult community volunteers, J. Affect. Disord. 282 (2021) 726–731, https://doi.org/10.1016/j.jad.2020.12.138.

[26] N. Mitsui, S. Asakura, K. Takanobu, S. Watanabe, K. Toyoshima, Y. Kako, Y.M. Ito, I. Kusumi, Prediction of major depressive episodes and suicide-related ideation over a 3-year interval among Japanese undergraduates, PLoS One 13 (2018), e0201047, https://doi.org/10.1371/journal.pone.0201047.

[27] C.D. Spielberger, Manual for the State-Trait Anger Expression Scale (STAXI), Psychological Assessment Resources, Odessa, FL, 1988.

[28] T. Suzuki, Y. Haruki, The relationship between anger and circulatory disease, Jpn. J. Health Psychol. 7 (1994) 1–13, https://doi.org/10.11560/jahp.7.1_1.

[29] Y. Otsuka, T. Sasaki, K. Iwasaki, I. Mori, Working hours, coping skills, and psychological health in Japanese daytime workers, Ind. Health 47 (2009) 22–32, https://doi.org/10.2486/indhealth.47.22.

[30] C.S. Carver, You want to measure coping but your protocol's too long: consider the brief COPE, Int. J. Behav. Med. 4 (1997) 92–100, https://doi.org/10.1207/s15327558ijbm0401_6.

[31] American Psychiatric Association, Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5), American Psychiatric Publication, Washington, DC, 2013.

[32] S. Schieman, Age and anger, J. Health Soc. Behav. 40 (1999) 273–289, https://doi.org/10.2307/2676352.

[33] L.H. Phillips, J.D. Henry, J.A. Hosie, A.B. Milne, Age, anger regulation and well-being, Aging Ment. Health 10 (2006) 250–256, https://doi.org/10.1080/13607860500310385.

[34] L.B. Fan, J.A. Blumenthal, L.L. Watkins, A. Sherwood, Work and home stress: associations with anxiety and depression symptoms, Occup. Med. (Lond.) 65 (2015) 110–116, https://doi.org/10.1093/occmed/kqu181.

[35] F. Blanchard-Fields, A.H. Coats, The experience of anger and sadness in everyday problems impacts age differences in emotion regulation, Dev. Psychol. 44 (2008) 1547–1556, https://doi.org/10.1037/a0013915.

[36] K.S. Birditt, K.L. Fingerman, Age and gender differences in adults' descriptions of emotional reactions to interpersonal problems, J. Gerontol. B Psychol. Sci. Soc. Sci. 58 (2003) P237–P245, https://doi.org/10.1093/geronb/58.4.p237.

[37] R.L. Brown, The influence of stressor exposure and psychosocial resources on the age-anger relationship, J. Aging Health 28 (2016) 1465–1487, https://doi.org/10.1177/0898264315624900.

[38] S.D. Neupert, D.M. Almeida, S.T. Charles, Age differences in reactivity to daily stressors: the role of personal control, J. Gerontol. B Psychol. Sci. Soc. Sci. 62 (2007) P216–P225, https://doi.org/10.1093/geronb/62.4.p216.

[39] S.T. Charles, J.R. Piazza, G. Luong, D.M. Almeida, Now you see it, now you don't: age differences in affective reactivity to social tensions, Psychol. Aging 24 (2009) 645–653, https://doi.org/10.1037/a0016673.

[40] L.L. Carstensen, H.H. Fung, S.T. Charles, Socioemotional selectivity theory and the regulation of emotion in the second half of life, Motiv. Emot. 27 (2003) 103–123, https://doi.org/10.1023/A:1024569803230.

[41] L.L. Carstensen, M. Pasupathi, U. Mayr, J.R. Nesselroade, Emotional experience in everyday life across the adult life span, J. Pers. Soc. Psychol. 79 (2000) 644–655, https://doi.org/10.1037//0022-3514.79.4.644.

[42] S. Marelli, A. Castelnuovo, A. Somma, V. Castronovo, S. Mombelli, D. Bottoni, C. Leitner, A. Fossati, L. Ferini-Strambi, Impact of COVID-19 lockdown on sleep quality in university students and administration staff, J. Neurol. 268 (2020) 8–15, https://doi.org/10.1007/s00415-020-10056-6.

[43] L. Wright, A. Steptoe, D. Fancourt, Does thinking make it so? Differential associations between adversity worries and experiences and mental health during the COVID-19 pandemic, J. Epidemiol. Community Health (2021), https://doi.org/10.1136/jech-2020-215598 jech–2020–215598.

[44] A. Sommerlad, L. Marston, J. Huntley, G. Livingston, G. Lewis, A. Steptoe, D. Fancourt, Social relationships and depression during the COVID-19 lockdown: longitudinal analysis of the COVID-19 social study, Psychol. Med. (2021) 1–10, https://doi.org/10.1017/S0033291721000039.

[45] O. Megalakaki, C.K. Kokou-Kpolou, J. Vaude, S. Park, S.K. Iorfa, J.M. Cenat, D. Derivois, Does peritraumatic distress predict PTSD, depression and anxiety symptoms during and after COVID-19 lockdown in France? A prospective longitudinal study, J. Psychiatr. Res. 137 (2021) 81–88, https://doi.org/10.1016/j.jpsychires.2021.02.035.

[46] E.P.H. Choi, B.P.H. Hui, E.Y.F. Wan, Depression and anxiety in Hong Kong during COVID-19, Int. J. Environ. Res. Public Health 17 (2020) 3740, https://doi.org/10.3390/ijerph17103740.

[47] C.J. Bryan, A.O. Bryan, J.C. Baker, Associations among state-level physical distancing measures and suicidal thoughts and behaviors among U.S. adults during the early COVID-19 pandemic, Suicide Life Threat. Behav. 50 (2020) 1223–1229, https://doi.org/10.1111/sltb.12653.