Impact of COVID-19 on mental health according to prior depression status: A mental health survey of community prospective cohort data

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ABSTRACT

Objective: We aimed to investigate the mental health impact of COVID-19 on a demographically well-characterized population cohort by gender and previous depression status.

Methods: Among people who participated in a community cohort study between 2013 and 2018 with previous depression measurement, a total of 1928 people without quarantine experience (680 men and 1249 women) were included after responding to an online survey in March 2020. In the 2020 survey, people were queried about daily needs supply, social support, risk perception, change during the COVID-19 pandemic, as well as mental health indices measuring loneliness, anxiety symptoms, post-traumatic stress disorder (PTSD), and depression. Separate analyses by gender were conducted to assess the association between COVID-19-related experiences and each mental health index, using multivariable logistic regressions with additional adjustment and stratification with pre-existing depression status.

Results: We could not observe significant gender differences for depression, anxiety, PTSD, and loneliness at 55 days after the start of the COVID-19 outbreak. Most external support, including daily needs supply and social support, protected men and women from experiencing severe anxiety (for life supply, OR = 0.92 (95%CI 0.88–0.97) (men) and OR = 0.95 (95% CI 0.91–0.99) (women); for social support, OR = 0.92(both for men and women, $p < 0.01$)). The results were similar for depression and PTSD. External support showed a larger reduction in the likelihoods for anxiety and depression during the COVID-19 pandemic among people with pre-existing depression compared to previously healthy people, and it was more prominent in men.

Conclusion: COVID-19 significantly affected the mental health of both men and women in the early period of the pandemic. Having enough supply of daily needs and social support seems important, especially for people with previous depression.

1. Introduction

Measures to control the 2019 novel coronavirus (SARS-CoV-2, COVID-19) pandemic have caused a public mental health crisis, wherein rigorous social distancing, followed by depletion of social support and interpersonal communication, has led to worsened depression, fear, insomnia, and anxiety symptoms [1,2]. Meanwhile, the interruption of supply chains has elicited shortages of general goods and sanitary products, increasing the risk of adverse mental health outcomes [3]: in face of new infectious diseases, people are more prone to panic buying, hoarding essential goods, and obsessing over personal hygiene measures, all of which are related to aggravated anxiety [4]. Disruptions to one's life attributable to a pandemic are large-scale traumatic events that can increase the mental health burden on a population [5]. Along with these external factors, an individual's perception of risk and their behaviors in response to a pandemic can also influence his or her mental

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health [6]. Also, in accordance with sex differences in psychiatric disorders [7], several reports have suggested disproportionate effects of COVID-19 on mental health according to sex: most studies have indicated a higher level of depression, anxiety, and posttraumatic stress disorder (PTSD) in women [8,9], suggesting that women may be more concerned with the virus's harmful potential, especially in regards to pregnancy [10]. Meanwhile, aggravation of a pre-existing mental disorder during the COVID-19 pandemic has been documented [11]. Adjusting to changes in one's life due to this new pandemic can be stressful, leading to abnormal modulation of the cortisol system and provoking recurrence of a prior depressive disorder and new psychiatric disorders, such as PTSD.

Most available data on mental health outcomes associated with the COVID-19 pandemic are from studies conducted in the form of a case study or a cross-sectional design, which do not allow for direct comparisons of adverse mental health outcomes before and after the outbreak. From a systematic review of the mental health consequences of the COVID-19 pandemic, researchers have suggested that evidence regarding the impact of COVID-19 on pre-existing psychiatric disorders, including depression, is limited, and that further investigations are needed.

Meanwhile, the COVID-19 pandemic has constantly been reported to affect people disproportionately depending on their sex, and the impact thereof on mental health is expected differ between the sexes, since women comprise higher percentages of caregivers and frontline healthcare professionals [12]. We hypothesized that upon being exposed to stress factors related to the COVID-19 pandemic, men and women would show different mental health responses, and that mental health responses would differ according to previous mental health status. We assumed that women will exhibit more prevalent mental health issues, and people with previous mental health issues may respond poorly to social intervention. Additionally, we aimed to explore the associations between COVID-19-related exposures and mental health outcomes based on baseline socio-demographic factors, including age, income, and education level. Therefore, we investigated the association between COVID-19-related situations and mental health assessments considering sex and pre-existing mental health status.

2. Methods

2.1. Participant selection

We utilized data from a previous community-based prospective cohort study known as the Cardiovascular and Metabolic Etiology Research Center (CMERC) study, which initially aimed to evaluate cardiovascular and metabolic risk factors among a community and high-risk population [13]. The baseline survey was conducted from 2013 to 2018, and the assessments included a questionnaire survey on the demographic, lifestyle, medical history, and psychological factors. The population comprised three groups (two community samples and one hospital-based sample). We used a community sample ($N = 4060$) consisting mostly of urban region residents near Seoul. We approached the 3940 participants from the CMERC study between March 11 and March 12, 2020 by postal mail with an invitation to participate in a COVID-19 mental health survey. We excluded 120 individuals who lacked valid contact information in March 2020. We also excluded 27 additional participants who withdrew consent during the invitation process. Participants were informed that they may withdraw from the study at any time.

After the exclusions above, a total of 3913 participants received the URL address to an online survey through mobile messages (SMS), and were informed that they could opt out. The mobile message was sent twice: on March 14 (55 days after the first COVID-19 case in S. Korea) and March 18. All items were self-reported through an online survey queried mostly by multiple-choice questions. Among the contacted people, 1970 responded to the online COVID-19 mental health survey

items with a response rate of 50.3%. Compared to the people who did not respond, the respondents were younger and had relatively higher Mini-mental Status Examination scores. The respondents also had higher proportions of wealthy and highly educated individuals (Supplementary Table 1). Also, the respondents tended to have healthier lifestyles, including less alcohol consumption and less cigarette smoking. Among the respondents, we selected 1929 general participants who had not contracted COVID-19 or undergone quarantine. Among the 1970 respondents, two confirmed cases and 39 quarantined cases were excluded. Also, one person lacking Beck Depression Inventory-II values was excluded. Finally, 1928 participants were included in the final analysis.

2.2. Assessments of mental health indices

In the baseline survey conducted from 2013 to 2018, depression was assessed via antidepressant use and the Beck Depression Inventory-II (BDI-II). We used the previously suggested cut-off of 0–13 (none), 14–19 (mild), and 20+ (moderated to severe) to categorize the participants with pre-existing depression severity [14].

In the novel March 2020 survey, each participant was asked to respond to the following assessments: Generalized Anxiety Disorder-7 (GAD-7) [15], Post-Traumatic Stress Disorder checklist for the DSM-5 (PCL-5) [16], and Patient Health Questionnaire-9 (PHQ-9) [17]. All of these have previously been validated for use in the Korean population.

2.3. Assessment of COVID-19-related situations

In the 2020 survey, participants were asked to rate their experiences during the COVID-19 pandemic on a scale of 0 (not at all) to 5 (very much) for the following 11 items: having their daily needs met, including food and water, goods related to personal hygiene, daily necessities, and quarantine supplies (i.e., facemasks and hand-sanitizers); receiving social support, including material support (i.e., food, face masks, and sanitizers), mental and psychiatric help, and other support related to daily living (i.e., childcare or nursing sick family members); subjective satisfaction about available information; and subjective thoughts on topics, including perceived seriousness of COVID-19, fear of their physical health when infected with COVID-19, and satisfaction with government action. Additionally, one item assessed the time spent searching for information relevant to COVID-19.

With the information from item-level analysis, we performed an explorative factor analysis and chose four factors to conduct confirmative factor analysis. After varimax rotation, we identified four clusters of COVID-19 experiences: 1) life needs supply (four items), 2) social support (three items), 3) fear of illness (one item), and 4) attitudes toward government actions (one item). For factors with multiple items, the scores of each item were summed up into single categories (Supplementary Table 2).

2.4. Covariates

In the baseline survey during 2013–2018, demographic factors, such as the date of birth, gender, final education, family income, and marital status, were queried. We categorized educational level according to years and levels achieved: 0–6 years, 7–9 years, 10–12 years, and 13+ years. The average household income was obtained as the total family yearly income divided by the number of family members. Marital status was to be marked as "never married," "married, living together with a partner," "divorced," or "widowed." Comorbidity was assessed using the question, "Have you ever been diagnosed with any of the listed conditions by a physician?" Comorbidity was coded as the number of the following conditions present: stroke, transient ischemic stroke, myocardial infarct, angina, heart failure, chronic renal failure, hypertension, dyslipidaemia, diabetes, thyroid disorders, fatty liver disease, chronic hepatitis, liver cirrhosis, asthma and chronic obstructive

pulmonary disease, osteoporosis, arthritis, autoimmune disease, and cancer.

2.5. Statistical analysis

2.5.1. Demographic and mental health characteristics

Demographic and COVID-19 experience-related characteristics were compared separately in men and women according to the categories of pre-existing depression severity (Table 1). To assess the association between external factors (life needs supply and social support) and internal factors (risk perception and behavior change) related to COVID-19 experience and mental health indices, we first categorized the mental health indices as follows: GAD-7 was used with a cut-off of 10 or greater to represent moderate and severe anxiety [15]; a score of 33 or higher in the PCL-5 was considered indicative of PTSD [18]; and a PHQ-9 score of 10 or greater indicated depression [17]. Overall analysis was repeated with the same outcomes as in the continuous forms. To capture the baseline distribution of these categories by demographic characteristics, these proportions were plotted by age group (30s, 40s, 50s, 60+), family income (in quartile), and educational level (≤9 years, 9–12 years, and 12+ years) in both men and women (Fig. 2 and

Supplementary Fig. 1). Additionally, these proportions were plotted according to previous depression status separately for men and women (Fig. 1).

Associations between the four factors driven from factor analysis regarding COVID-19-related situations and mental health indices in the general population were tested using multivariate logistic regression adjusted for age, sex, education, income, marital status, and comorbidities. A second model was developed for additional adjustment according to previous BDI-II scores at 2013–2018 separately for both sexes (Table 2 and Supplementary Table 3). To test the difference by both sexes, we performed heterogeneity test for each exposure category [19]. For comparisons according to previous depression status, the same analysis was repeated after stratification by previous depression status, and the estimates were compared. We did not apply additional adjustment for the multiple comparison initially, since the aim of the analysis was to explore different patterns in the overall COVID-19-related experiences and mental health responses. However, we additionally set the alpha level at 0.01 instead of 0.05 to correct for inflated type I errors without improperly inflating for type II errors with a more rigorous correction, such as Bonferroni correction.

Analyses were repeated with individual items queried in the original

Table 1

Demographic and COVID-19 experience characteristics of the general participants by pre-existing depression status in 2020 COVID-19 survey(D + 55 from initial outbreak in Korea) in men and women (N = 1928).

	Pre-existing depression (men, *N* = 680)						Pre-existing depression (women, *N* = 1248)					
	None (BDI-II 0–13)		Mild (BDI-II 14–19)		Moderate-Severe (BDI-II 20+)		None (BDI-II 0–13)		Mild (BDI-II 14–19)		Moderate-Severe (BDI-II 20+)	
	N, Mean	(%, SD)	N, Mean	(%, SD)	N, Mean	(%, SD)	N, Mean	(%, SD)	N, Mean	(%, SD)	N, Mean	(%, SD)
Baseline characteristics (2013–2018)												
Age (baseline)	50.57	(10.0)	49.50	(10.1)	51.83	(10.2)	50.87	(8.8)	51.08	(9.5)	51.66	(9.2)
Income (baseline)												
Q1(<36,000\/yr)	73	(13.0)	22	(28.2)	6	(15.0)	210	(22.4)	51	(24.9)	32	(30.5)
Q2(36000–60,000\/yr)	186	(33.1)	25	(32.1)	13	(32.5)	293	(31.2)	65	(31.7)	43	(41.0)
Q3(60000–84,000\/yr)	112	(19.9)	18	(23.1)	12	(30.0)	177	(18.9)	33	(16.1)	15	(14.3)
Q4(≥84,000\/yr)	191	(34.0)	13	(16.7)	9	(22.5)	258	(27.5)	56	(27.3)	15	(14.3)
Education (baseline)												
<9 years	27	(4.8)	4	(5.1)	3	(7.5)	94	(10.0)	23	(11.2)	19	(18.1)
9–12 years	144	(25.6)	29	(37.2)	15	(37.5)	373	(39.8)	80	(39.0)	41	(39.1)
12+ years	391	(69.6)	45	(57.7)	22	(55.0)	471	(50.2)	102	(49.8)	45	(42.9)
Comorbidity (baseline)												
None	317	(56.4)	48	(61.5)	12	(30.0)	541	(57.7)	119	(58.1)	59	(56.2)
1+	245	(43.6)	30	(38.5)	28	(70.0)	397	(42.3)	86	(42.0)	46	(43.8)
Physical activity (baseline)												
MPVA<150	283	(50.4)	53	(68.0)	20	(50.0)	571	(60.9)	141	(68.8)	72	(68.6)
MVPA≥150	279	(49.6)	25	(32.1)	20	(50.0)	367	(39.1)	64	(31.2)	33	(31.4)
Alcohol consumption (baseline)												
Never	51	(9.1)	5	(6.4)	2	(5.0)	264	(28.1)	55	(26.8)	25	(23.8)
Ever	511	(90.9)	73	(93.6)	38	(95.0)	674	(71.9)	150	(73.2)	80	(76.2)
Cigarette smoking (baseline)												
Never	161	(28.7)	14	(18.0)	7	(17.5)	892	(95.1)	188	(91.7)	90	(85.7)
Ever	401	(71.4)	64	(82.1)	33	(82.5)	46	(4.9)	17	(8.3)	15	(14.3)
COVID-19 related experience (2020, D + 55)												
Subjective severity of COVID-19												
Very severe	274	(45.4)	29	(37.7)	18	(45.0)	350	(38.5)	80	(40.4)	40	(39.2)
Severe	189	(34.7)	34	(44.2)	12	(30.0)	357	(39.3)	78	(39.4)	42	(41.2)
Moderate	98	(18.0)	11	(14.3)	5	(12.5)	172	(18.9)	37	(18.7)	19	(18.6)
Minimal	8	(1.5)	3	(3.9)	5	(12.5)	21	(2.3)	3	(1.5)	0	(0.0)
Not harmful to minimal	2	(0.4)	0	(0.0)	0	(0.0)	9	(1.0)	0	(0.0)	1	(1.0)
Hours spent searching for COVID-19 information(h)	2.04	(2.3)	1.53	(1.3)	1.65	(1.3)	2.03	(2.3)	1.72	(1.5)	1.98	(1.9)
Subjective sufficiency of information (0-Not sufficient to 5-over sufficient)	3.41	(1.0)	3.34	(1.0)	3.18	(1.2)	3.38	(1.0)	3.3	(1.0)	3.1	(1.0)
Satisfaction to government action												
Very much satisfied	92	(16.9)	10	(13.0)	2	(5.0)	142	(15.7)	20	(10.2)	16	(15.8)
Satisfied	267	(49.2)	42	(54.6)	23	(57.5)	466	(51.4)	100	(51.0)	55	(54.5)
Insufficient	130	(23.9)	18	(23.4)	7	(17.5)	210	(23.2)	52	(26.5)	23	(22.8)
Very much insufficient	54	(9.9)	7	(9.1)	8	(20.0)	88	(9.7)	24	(12.2)	7	(6.9)

Abbreviation: MVPA = Moderate-Vigorous Physical Activity; BDI=Beck Depression Inventory; GAD-7 = General Anxiety Disorder-7; PLC-5 = PTSD Checklist for DSM-5; PHQ-9 = Patient Health Quationnaire-9; UCLA Loneliness Scale Short-Form; CD-RISC-10 = Connor-Davidson Resilience Scale Short-Form.
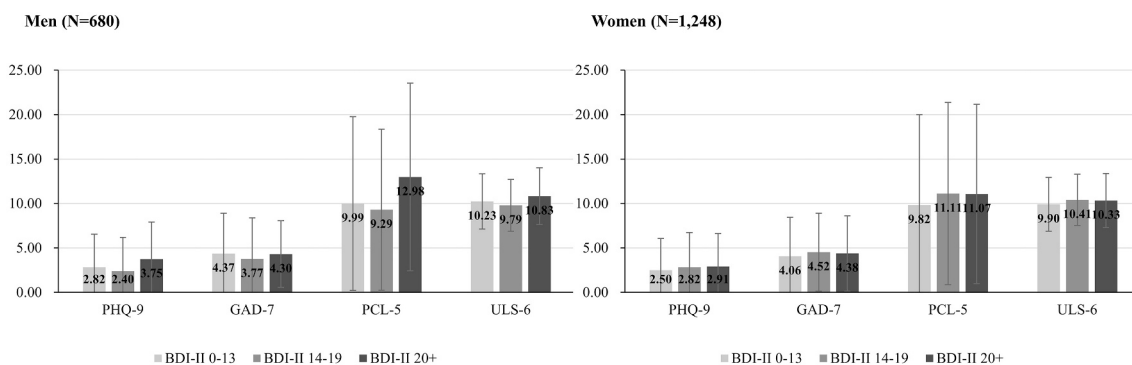
Fig. 1. Distribution of mental health measurements at 55 days after the start of COVID-19 outbreak in South Korea according to pre-existing depression status.

questionnaire regarding the COVID-19-related situation and mental health indices. Finally, the baseline characteristics between the included and excluded participants of this study were compared using a chi-square test and *t*-test (Supplementary Table 1). All analyses were performed using SAS 9.4.

2.6. Ethics

All participants agreed to participate the study and provided written consents before evaluation of the survey. The baseline and online follow-up surveys and protocols were approved by the Institutional Review Boards of Yonsei University Health System, Seoul, Korea (Baseline evaluation: 4–2013-0661; COVID-19 mental health online survey: Y-2020-0066). All procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration.

3. Results

3.1. Mental health during COVID-19 pandemic according to demographic characteristics

Overall, internal consistencies of the mental health measurement tools were relatively high in our sample population (BDI-II = 0.99, GAD-7 = 0.90, PCL-5 = 0.93, PHQ-9 = 0.85). Mostly, men and women showed similar distribution of mental health indices and COVID-19-related experiences (Supplementary Table 4). As shown in Fig. 2, relatively young participants reported having a higher level of anxiety according to GAD-7 compared to other age groups. About 21% of the youngest men (in their 30s) and 16% of the youngest women (also in their 30s) had GAD-7 scores of 10 or higher, which corresponds to moderate-to-severe anxiety. The overall proportion with significant anxiety tended to decrease with older age for both sexes. Regarding depressive symptoms, the lowest proportion was seen in men in their 40s and in women older than 60 years. The proportion of women having PCL-5 scores of 33 and higher as the potential PTSD group was 7.1% in the youngest group, and the proportion thereof decreased as age increased.

Regarding family income, the third quartile (35.0–49.5 million won, approximately £23,100–£32,670/year) reported the highest anxiety among both men (16%) and women (14.4%). Depression was also highest in the third income quartile in men only (10.6%). We were unable to identify a significant linear trend for any mental health index according to income categories. On the other hand, education level showed a significant linear trend in anxiety, especially for women: one-step higher education (i.e., elementary vs. middle school graduates, middle school vs. high school graduates) showed about a 1.42 times higher likelihood (95% CI 1.08–1.87) of having a clinically relevant anxiety disorder (GAD-7 ≥ 10) in women. Although not statistically significant, men also showed a 1.12 times higher likelihood for anxiety.

Overall, 13.7% of men and 14.2% of women with a college education or greater had anxiety. Depression showed a similar linear trend in men (OR = 1.33, 95% CI 0.76–2.33), but not in women. Women showed a linearly increasing proportion of PTSD with one-step higher education (OR = 1.65, 95% CI 1.04–5.60).

3.2. Mental health status according to pre-existing depression severity

Fig. 1 outlines the depression (PHQ-9), anxiety (GAD-7), and PTSD (PCL-5) rates after the start of COVID-19 outbreak according to sex and previous depression status. In men, most of the indices were plotted as a U-shape: men with a BDI-II score of 14–19 showed the lowest rates of depression, anxiety, PTSD, and loneliness. However, in women, adverse mental health severity, except for anxiety, linearly increased as the previous depression severity increased.

3.3. Association between COVID-19 experiences and mental health

Table 2 outlines the associations between one's experience with COVID-19 and mental health assessment in the general population after adjusting for demographic factors, comorbidity, and pre-existing depression status. External support, including life needs supply and social support, was associated with a lower prevalence of severe anxiety, PTSD, and depression in both men and women. In Table 2, where we summarized the clusters regarding life supply and social support from each original item after factor analysis, we could observe significantly negative associations for both summarized factors and anxiety symptoms (life supply for men: OR = 0.92 (95% CI 0.88–0.97) and for women: OR = 0.95 (95% CI 0.91–0.99); social support for men: OR = 0.92 (95% CI 0.88–0.96) and for women: OR = 0.92(95% CI 0.89–0.96)). The results were similar for depressive symptoms (life supply for men: OR = 0.92 (95% CI 0.87–0.97) and for women: OR = 0.91 (95% CI 0.86–0.95); social support for men: OR = 0.93 (95% CI 0.87–0.99) and for women: OR = 0.89 (95% CI 0.84–0.93)). These directions were not changed after additionally adjusting for previous depression. In contrast, most of the negative internal perception increased the likelihood of anxiety, PTSD, and depressive symptoms. For example, subjective perception of excessive amount of COVID-19-related information increased the likelihood of PTSD by about 2.55 times in men (95% CI 1.70–3.83) and 3.73 times (95% CI 2.62–5.29) in women. Likewise, dissatisfaction of government action increased the likelihood of PTSD with OR of 2.22 (95% CI 1.42–3.46) in men and 1.52 (95% CI 1.10–2.09) in women. Although we could observe different magnitude of association by sexes, there was no statistically significant difference (Table 2). When we repeated the same analysis with single-item questions from the original questionnaire, we found similar patterns with those in the initial analysis (Supplementary Table 3).

Table 2

Association between COVID-19 related situations and mental health measurements in general population at 55 days after the initial outbreak in Korea. (N = 1928).

	Men (N = 680)				Women (N = 1248)			
	(1) Demographic factors adjusted[b]		(2) (1) + pre-existing depression status (BDI-II) adjusted[c]		(1) Demographic factors adjusted[b]		(2) (1) + pre-existing depression status (BDI-II) adjusted[c]	
Experience during COVID-19 outbreak (0 to +55D)	Anxiety(GAD-7 = 10+: Case N = 76)[a]				Anxiety(GAD-7 = 10+: Case N = 108)[a]			
	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Life needs: "Did you have enough…?" (each: 0 = "Not at all" to 5 = "Very much") (p-heterogeneity by sex = 0.329)								
Food and water to drink	**0.92**	**(0.88–0.97)**	**0.92**	**(0.88–0.96)**	**0.95**	**(0.91–0.99)**	**0.95**	**(0.91–0.99)**
Personal hygiene condition (i.e. bath)								
Daily necessities								
Quarantine supplies (i.e. mask, hand sanitizer)								
Social Support from others (0 = "None" to 5 = "Very much") (p-heterogeneity by sex = 1.000)								
Material support (i.e. food, masks, sanitizers)	**0.92**	**(0.88–0.96)**	0.91	**(0.88–0.96)**	0.92	**(0.89–0.96)**	0.92	**(0.89–0.96)**
Mental/ Psychiatric support								
Daily living (i.e. childcare)								
Subjective thoughts								
Subjective satisfaction about the amount of information (0 = Extremely lacking to 5 = Too much)	(p-heterogeneity by sex = 0.282)							
	2.85	(2.22–3.66)	2.85	(2.22–3.67)	2.41	(2.02–2.87)	2.41	(2.02–2.87)
Dissatisfaction to government action (1 = Very much satisfied to 4 = Not satisfied at all)	(p-heterogeneity by sex = 0.209)							
	1.75	(1.34–2.28)	1.75	(1.34–2.28)	1.41	(1.15–1.74)	1.41	(1.15–1.74)
Experience during COVID-19 outbreak	PTSD (PCL-5 = 33+: Case N = 24)[a]				PTSD (PCL-5 = 33+: Case N = 48)[a]			
(0 to +55D)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)	OR	(95% CI)
Life needs: "Did you have enough…?" (each: 0 = "Not at all" to 5 = "Very much") (p-heterogeneity by sex = 1.000)								
Food and water to drink	**0.92**	**(0.86–0.98)**	0.91	**(0.85–0.98)**	0.92	**(0.87–0.97)**	0.92	**(0.87–0.97)**
Personal hygiene condition (i.e. bath)								
Daily necessities								
Quarantine supplies (i.e. mask, hand sanitizer)								
Social Support from others (each: 0 = "None" to 5 = "Very much") (p-heterogeneity by sex = 0.818)								
Material support (i.e. food, masks, sanitizers)	**0.90**	**(0.84–0.98)**	0.91	**(0.84–0.98)**	0.89	**(0.84–0.94)**	0.89	**(0.84–0.94)**
Mental/ Psychiatric support								
Daily living (i.e. childcare)								
Subjective thoughts								
Subjective satisfaction about the amount of information (0 = Extremely lacking to 5 = Too much)	(p-heterogeneity by sex = 0.165)							
	2.55	(1.70–3.83)	2.52	(1.68–3.79)	3.73	(2.62–5.29)	3.74	(2.63–5.32)
Dissatisfaction to government action (1 = Very much satisfied to 4 = Not satisfied at all)	(p-heterogeneity by sex = 0.176)							
	2.22	(1.42–3.46)	2.18	(1.40–3.40)	1.52	(1.10–2.09)	1.52	(1.11–2.09)
Experience during COVID-19 outbreak	Depression (PHQ-9 = 10+: Case N = 35)[a]				Depression (PHQ-9 = 10+: Case N = 52)[a]			
(0 to +55D)	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Life needs: "Did you have enough…?" (each: 0 = "Not at all" to 5 = "Very much") (p-heterogeneity by sex = 0.771)								
Food and water to drink	**0.92**	**(0.87–0.97)**	0.91	(0.86–0.96)	0.91	(0.86–0.95)	0.91	(0.87–0.95)
Personal hygiene condition (i.e. bath)								
Daily necessities								
Quarantine supplies (i.e. mask, hand sanitizer)								
Social Support from others (each: 0 = "None" to 5 = "Very much") (p-heterogeneity by sex = 0.295)								
Material support (i.e. food, masks, sanitizers)	**0.93**	**(0.87–0.99)**	0.93	**(0.87–0.99)**	0.89	**(0.84–0.93)**	0.89	**(0.84–0.93)**
Mental/ Psychiatric support								
Daily living (i.e. childcare)								
Subjective thoughts								
Subjective satisfaction about the amount of information (0 = Extremely lacking to 5 = Too much)	(p-heterogeneity by sex = 0.119)							
	1.65	(1.29–2.11)	1.64	(1.28–2.10)	2.16	(1.71–2.72)	2.15	(1.71–2.72)
Dissatisfaction to government action (1 = Very much satisfied to 4 = Not satisfied at all)	(p-heterogeneity by sex = 0.458)							
	1.16	(0.82–1.64)	1.14	(0.81–1.62)	**1.36**	**(1.12–1.80)**	1.36	(1.02–1.81)

Abbreviation: PTED=Post-traumatic embitterment disorder; GAD-7 = General Anxiety Disorder-7; PLC-5 = PTSD Checklist for DSM-5; PHQ-9 = Patient Health Quationnaire-9; UCLA Loneliness Scale Short-Form; CD-RISC-10 = Connor-Davidson Resilience Scale Short-Form; PTSD=Post-traumatic Stress Disorder.

Bold indicate the estimate is statiscally significant with p-value<0.05

[a] Higher score indicates higher level of anxiety, PTSD, and depression.
[b] Adjusted for age, gender, education, income, marital status, and comorbidity.
[c] Adjusted for age, gender, education, income, marital status, comorbidity, and BDI-II score before COVID-19.

3.4. Associations between COVID-19 experiences and anxiety according to pre-COVID-19 depression status

In Fig. 3, the magnitude of associations between COVID-19 experiences and mental health indices is presented according to pre-existing depression status. Among men who were mildly depressed before the COVID-19 outbreak, external support, such as life needs supply and social support, seemed to significantly decrease anxiety and PTSD. This result was similar when all of the item related to life needs supply and social support were summarized as single factors after factor analysis
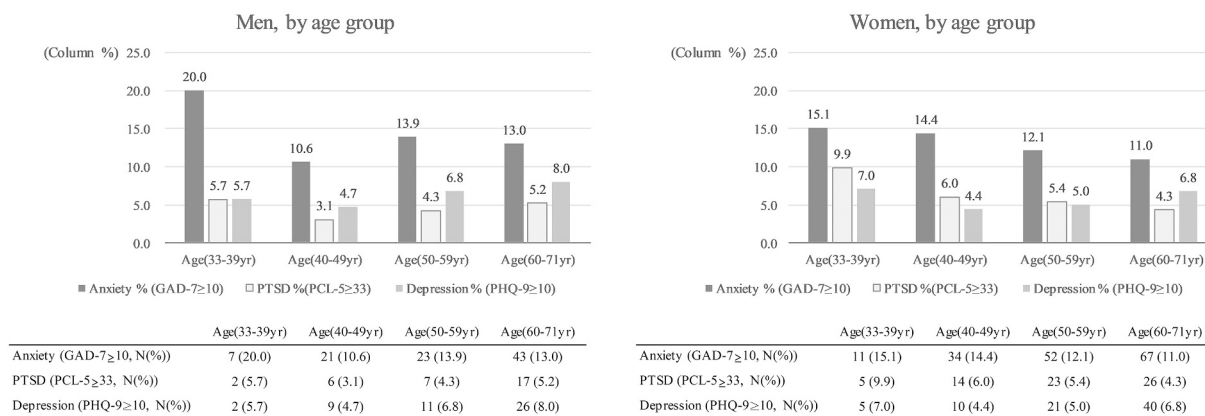
Fig. 2. Anxiety, posttraumatic stress disorder (PTSD), and depressive symptoms during the COVID-19 outbreak (D + 55) in South Korea according to age (N = 1928).

(Supplementary Fig. 2). Also, moderately-to-severely depressed men before COVID-19 showed a relatively greater reduction in PTSD and depression symptoms when they received positive social support. In women, social support seemed to be a greater benefit to women with more severe depressive symptoms before the COVID-19 outbreak. Fear of health due to COVID-19 elicited a statistically significant increase in the likelihood of severe anxiety in both men and women. Meanwhile, men with prior "mild" depression showed the highest likelihood of having severe anxiety (OR 11.72, 95% CI 1.99–69.21), exhibiting a reverse U-shape pattern, whereas both women without depressive symptom and those with the most severe pre-exiting depression showed elevated ORs for severe anxiety (OR 2.64, 95% CI 2.16–3.32; OR = 3.48, 95% CI 1.32–9.17).

4. Discussion

Infectious disease epidemics have been found to affect social mental health; these include the SARS outbreak in 2013, Ebola in 2014, and MERS in 2015. As such, several surveys have been conducted to explore the impact of COVID-19 on mental health in different populations, including China [20,21] and Italy [22], These reports showed that adverse mental health outcomes increased with the outbreak of COVID-19. Consistent with previous studies, the participants in this study exhibited relatively higher adverse mental health index scores (GAD-7 [12.2%], PCL-5 [4.3%], and PHQ-9 [6.1%]) than those before the COVID-19 outbreak. For example, about 12.2% of the participants in this survey were suspected of generalized anxiety disorder, scoring 10 or higher in GAD-7. This was much higher than the usual proportion of 2.4% based on a lifetime prevalence reported in a previous national survey. The proportion of PTSD increased from a lifetime prevalence of 1.5% to approximately four times higher. Similarly, the prevalence of depressive symptoms (PHQ-9 with a cut-off of 10 or higher) increased from 5.1% to 6.1% compared to the previous national statistics in 2016 [23].

There are numerous reports suggesting gender differences in reaction to COVID-19. More adverse mental health issues, including increased anxiety and depressive symptoms, were observed in young women in a Caucasian population [24], and elevated anxiety levels were related to higher compliance with precautionary quarantine measures in another study [25]. In people residing in Wuhan and surrounding areas in China, the mean PCL-5 score was higher in women (men = 12.0, women = 16.4) at 1 month after the initial COVID-19 outbreak [26]. Unexpectedly, however, we found very few sex differences across most of the mental health indices (Fig. 1), which was similar to previous reports from China [21] and India [27]. Usually, mental health problems, such as depression and anxiety, are more prevalent in women in instances of social stress. During the Great Recession in the U.S., women showed higher anxiety levels than men among 80,000 citizens aged 18 to 64

years [28]. However, several studies have reported that when facing social stress during the relatively early period of a pandemic or a massive social change, there are no gender differences in reactions toward acute stress or cortisol changes [29–31]. It is possible that our results could be interpreted as reflecting the effects from a chronic stressor, since we observed the population's mental health indices at 55 days after the first outbreak of COVID-19 in South Korea. However, within this period, acute events would be distributed throughout, such as unexpected separations from close people and potential conflicts with individuals with which one is quarantined, which could yield exposure to interpersonal or social stressors [32]. Additionally, sex differences regarding the population's age range should also be considered. For instance, a recent meta-analyses examining sex differences in depression [33] revealed that sex differences are most pronounced in younger populations, namely adolescents, but they tend to decline into adulthood. Considering the age range of the current study sample, with a mean age about 50 years, this could partially explain the lack of expected sex differences. Further assessment of long-term psychological effects is warranted, considering that there were large gaps between sexes, including the employment rates of men and women in South Korea (men = 70.7% vs. women = 51.6%).

Overall, external support, such as life needs supply and social support, showed a robust negative association with most of the adverse mental health outcomes in this study. In previous reports, adverse health effects from natural disasters, such as hurricanes, were attenuated by social support [34]. This protective effect was similar in both sexes. However, when considering previous depression status, men with previous depression tended to have a lower prevalence of depression and severe anxiety when there was external support. Thus, during a nationwide acute stressful event, it could be helpful prioritize mentally vulnerable groups for social support and material supply. We also found that a longer time spent searching for information was positively associated with increased adverse mental health outcomes. This was in line with previous reports that reviewed the global mental health impact of COVID-19, in which heavy social media use was shown to increase high acute stress [35].

From the initial cohort survey, we could obtain reliable 21-item BDI-II values, since it was performed through face-to-face examinations with a relatively long survey time permitted for each participant to respond. However, later surveys were administered online via each participant's mobile phone, and there was a limitation to the overall survey time at 5–10 min as a maximum, which necessitated a faster tool (PHQ-9) with which to measure depressive symptoms. When comparing the measuring capabilities of BDI-II and PHQ-9, two randomized controlled trials of 172 depressed participants showed both adequate convergent/discriminant validity, internal consistence/reliability, with similar responsiveness to changes [36]. BDI-II comprises a two-factor model; however, in this population, PHQ-9 failed to give the same factor

Association[b] between COVID-19 experience and Mental Health Indices at COVID-19 (D+55)		Men Pre-existing depression[a]			Women Pre-existing depression[a]		
		None (n=562)	Mild (n=78)	Moderate-Severe (n=40)	None (n=938)	Mild (n=205)	Moderate-Severe (n=105)
OR* for Anxiety (GAD-7=10+)							
Life needs supply[c]: "Do you had enough…?"	Food and water to drink	**0.93**	0.84	1.09	**0.95**	0.97	1.05
	Personal hygiene condition (i.e. bath)						
	Daily necessities						
	Quarantine supplies(i..e. mask, hand sanitizer)						
Social Support from others	Material support (i.e. food, masks, sanitizers)	**0.95**	**0.74**	N/A	**0.93**	**0.91**	0.83
	Mental/ Psychiatric support						
	Support related with daily living (i.e. childcare)						
Fear of illness during COVID-19		2.81	11.72	5.43	2.68	1.61	3.48
Satisfaction to government action		1.88	0.88	2.58	1.34	1.86	1.81
OR* for Depression(PHQ-9=10+)							
Life needs supply[c]: "Do you had enough…?"	Food and water to drink	**0.93**	0.26	0.70	**0.90**	0.91	0.95
	Personal hygiene condition (i.e. bath)						
	Daily necessities						
	Quarantine supplies(i..e. mask, hand sanitizer)						
Social Support from others	Material support (i.e. food, masks, sanitizers)	0.96	0.19	N/A	**0.88**	**0.87**	0.86
	Mental/ Psychiatric support						
	Support related with daily living (i.e. childcare)						
Fear of illness during COVID-19		**1.55**	N/A	3.28	**2.80**	1.34	2.10
Satisfaction to government action		1.12	N/A	1.39	1.16	**2.03**	1.33
OR for PTSD (PCL-5=33+)							
Life needs supply[c]: "Do you had enough…?"	Food and water to drink	**0.92**	0.43	0.98	**0.92**	0.92	1.01
	Personal hygiene condition (i.e. bath)						
	Daily necessities						
	Quarantine supplies(i..e. mask, hand sanitizer)						
Social Support from others	Material support (i.e. food, masks, sanitizers)	0.92	0.79	N/A	**0.91**	**0.74**	0.83
	Mental/ Psychiatric support						
	Support related with daily living (i.e. childcare)						
Fear of illness during COVID-19		2.34	N/A	1.30	**3.86**	**3.15**	N/A
Satisfaction to government action		2.11	11.46	1.33	1.43	2.03	1.91

Bold numbers indicate statistical significance of p<0.05 and * denotes statistical significance of p<0.01. [a] BDI-II was categorized as None=0-13, Mild=14-19, Moderate-to-severe=20+, following Beck, et al. 1996; [b] Numbers in the cells denote the association between COVID-19 experience and anxiety measured with GAD-7 by generalized linear model adjusted for age, education, marital status, income, and comorbidity. Items in the same subcategory were measured with same Likert scales. ; [c] Life supply was replied as 0="Not at all" to 5="Very much"; d Each social suppoart item was answered as 0="None" to 5="Very much". ; [d] Subjective satisfaction about the amount of information was responded as 0="Extremely lacking" to 5="Too much"; [e] Subjective seriousness of COVID-19 was responded as 1="Not severe" to 5="Very severe".

Fig. 3. Patterns of association between COVID-19-related factors (external support [life needs supply and social support] and internal cognitive/behavioral factors) and mental health indices for pre-existing depression status. Red denotes positive linear associations (i.e., risk factors), whereas blue denotes negative linear associations (i.e., protective factor).

structure. In our previous study, we confirmed a two-factor structure for PHQ-9 in the Korean population [37]. Moreover, BDI-II tends to assign more participants with severe depression compared to PHQ-9 [36]. As a result, we might have underestimated depression outcomes relative to those prior to COVID-19.

This study had some limitations that warrant consideration. From the entire cohort, we were only able to obtain responses from 53% of the study population; therefore, selection bias may be a concern. Also, as

COVID-19 status was self-reported, there might be a possibility that true COVID-19 cases were included in our analysis sample, which might cause overestimation of outcome variables. Comparing the included and excluded participants, we noted that people who were included in this survey were more likely to be younger, have higher income, be more well-educated, and had higher cognitive functions (Supplementary Table 1). Therefore, our results may reflect an underestimation of adverse mental health states during the COVID-19 pandemic. Moreover,

our study participants were from a relatively fair socioeconomic background, and were physically healthy [13]. A responder bias may also be possible, wherein more people who are interested in their psychiatric conditions tend to participate in related surveys. Also, a general characteristic of participants in the baseline survey of the CMERC cohort is that they were relatively healthy, since the recruited people had no history of cancer, myocardial infarction, stroke, and heart failure. Finally, since the participant of this study were mostly residents of an urban region near Seoul, it was impossible to compare regional differences, which would make it hard to generalize our results for the entire population of South Korea. Urban environments could be considered to be more protective against epidemics, since they provide people with better supply of materials, better sanitary conditions, and abundant educational resources.

Notwithstanding, this study also had several strengths. First, we surveyed a well-characterized large community prospective cohort population, which enabled us to assess pre-outbreak data on family income, comorbidity, and depression. Second, we were able to categorize the participants according to the severity of their pre-existing depression states, which made it possible to check for dose-response relationships. Third, a thorough assessment of multiple mental health indices was conducted simultaneously to facilitate interpretation. Fourth, not only mental health status, but also other various factors including attitude, behavior, and social support, during the COVID-19 pandemic were assessed in order to possibly devise future directions in mental health protection during outbreaks of infectious diseases. Finally, since this study was conducted in a longitudinal cohort, prior mental health conditions were also considered when investigating the relationship between COVID-19-related experiences and mental health outcomes.

In conclusion, although we could not observe a significant difference in mental health indices between the sexes at 55 days after the start of COVID-19 outbreak, effect modifications were observed according to pre-existing depression status when assessing the association between COVID-19 experience and indices of mental health, including depression, anxiety, and PTSD symptoms, during the pandemic. Herein, as the time searching for information regarding COVID-19 increased, most adverse mental health outcomes also increased. Men who had mild depressive symptoms in the pre-COVID-19 period tended to show the largest negative associations between supply/support and anxiety/depression during the COVID-19 outbreak. Based on our results, we suggest that we need to consider people's previous mental health status when providing them with daily necessities and social support. Further study is needed to assess different trajectories of mental health status according to sex in reaction to the COVID-19 pandemic and potential social changes as a result thereof that can affect men and women differently.

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Declaration of Competing Interests

The authors have no competing interests to report.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2021.110552.

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