




The Psychological Costs of the COVID-19 Pandemic and Heterogeneous Effects in South Korea: Evidence from a Difference-in-Differences Analysis

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Abstract

This study estimates the effects of the COVID-19 pandemic on life satisfaction and stress and examines whether these effects vary across different sociodemographic groups using a nationally representative sample in South Korea. We estimate the causal effects of COVID-19 on psychological well-being by exploiting regional variation in the spread of the pandemic in South Korea. While the number of confirmed cases was very small in other provinces in the first half of 2020, the coronavirus spread rapidly in Daegu after an outbreak in one church. We employ a difference-in-differences approach that compares changes in people's life satisfaction and stress before-and-after the initial surge of COVID-19 cases in Daegu and other provinces. Our results show that the proportion of people who are dissatisfied with life increased by 2.8–6.5 percentage points more in Daegu than in other provinces after the COVID-19 outbreak. During the same period, the proportion of people who reported feeling stressed increased more in Daegu than in other provinces by 5.8–8.9 percentage points. Our results also suggest that the negative impact of the COVID-19 outbreak on psychological well-being is significantly greater for men, young adults, middle-aged adults, self-employed workers, and middle-income individuals. On the other hand, the proportion of people who report feeling stressed among the highest-educated (a master's degree or higher) and high-income individuals decreased after the onset of the COVID-19 outbreak.

Keywords COVID-19 · Life satisfaction · Stress · Heterogeneous effects · Sociodemographics

1 Introduction

The coronavirus (COVID-19) pandemic has substantially disrupted the lives of individuals around the world since its onset in 2019 (Ammar et al., 2020). The COVID-19 pandemic has threatened the physical and mental health of individuals. Because the pandemic has persisted for an extended period, the consequences that it has had on population well-being

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and health are gradually intensifying. A large body of literature documents that the pandemic lowers psychological well-being as well as quality of life (Ammar et al., 2020; Le & Nguyen, 2021; Zhang & Ma, 2020), and increases suicidal ideation (Gunnell et al., 2020; McIntyre & Lee, 2020) and suicide attempts (Tanaka & Okamoto, 2021). The pandemic may directly impact one's well-being due to fear and anxiety of contracting and/or transferring the virus (Xiong et al., 2020). Such concerns are driven in part by a rise in stigma and prejudice against people who have the virus (Carmassi et al., 2020; Fiorillo & Gorwood, 2020).

Beyond its direct impacts, the virus has indirect effects on psychological well-being. There have been significant changes to people's daily lives as governments around the world have issued public policies that encourage and/or directly enforce social distancing, self-quarantining, and lockdowns to slow the spread of the virus (Farkhad & Albarracín, 2021; Groeniger et al., 2021; Sobol et al., 2020). Disruptions in physical contact with family members, friends, and colleagues make individuals feel socially isolated, leading to an increase in depression, stress, and anxiety (Tang et al., 2020). In addition, the pandemic creates substantial psychological burdens for individuals with children, as parenting roles have intensified. The escalation of interpersonal conflict and stress at home has led to a considerable increase in domestic abuse and family violence around the world (Mazza et al., 2020; Usher et al., 2020). New realities of working from home and home-schooling of children increase stress and stress-related well-being problems, particularly among working couples with school-going children (Lee et al., 2021).

Another important pathway through which the pandemic impacts well-being is increased uncertainty about future employment, income, and wealth (Witteveen & Velthorst, 2020). The International Labour Organization (ILO) reported that about 74 percent of the global workforce were impacted severely by full or partial lockdowns in 2020 (Monitor, 2020). The pandemic has led to a sudden, extraordinary amount of job loss (del Rio-Chanona et al., 2020). Global unemployment rates have reached double digits, with millions applying for unemployment benefits, disaster payments, or other social safety net programs (for Economic Co-Operation & (OECD), 2020). Studies suggest that economic uncertainty during the pandemic negatively affects one's psychological well-being and health (Arthi & Parman, 2021).

This study estimates the effects of COVID-19 on people's life dissatisfaction and stress. Given the complexity and diversity of the mechanisms that underly the impact of the pandemic on psychological well-being, estimating the net impact of the pandemic is an important empirical issue. We conduct the analysis using the Social Survey, which includes a large nationally representative sample that allows for the estimation of heterogeneous effects across diverse sociodemographic groups. We estimate the effects in a causal manner by exploiting regional variation in the initial surge of COVID-19 cases. We employ a difference-in-differences approach that compares changes in life satisfaction and stress before-and-after the outbreak of COVID-19 between Daegu, a province where the coronavirus spread extensively, and other provinces with limited coronavirus cases. We argue that regional variation in the spread of COVID-19 is plausibly exogenous. This is a critical requirement for the identification of causal impacts using a difference-in-differences approach. This approach is based on the fact that the large number of infections in Daegu were caused by an unexpected group infection in a church. We believe that our approach is differentiated from previous studies using a type of time series analysis, which regards a change in psychological well-being before and after COVID-19 as a effect of COVID-19.

We also investigate whether the effects of COVID-19 on life satisfaction and stress differ by sociodemographic characteristics (gender, age, education, income, and employment

type). An individual's social location likely influences the extent to which they are affected by and the resources they have to respond to the aforementioned factors and circumstances that can affect psychological well-being. Thus, heterogeneous effects of the COVID-19 pandemic on psychological well-being are worth exploring. The investigation of heterogeneous effect by demographic group would also allow us to analyze whether and how the COVID-19 pandemic has deepened inequality in psychological well-being. In particular, we reveal that the differential economic impact of COVID-19 by socioeconomic group is an important cause of the differential effect on psychological well-being by socioeconomic group.

2 Theoretical Expectations on the Heterogeneous Effect of COVID-19 by Demographic Group

In this study, we focus on differential impacts of COVID-19 across gender, age, education, income, and employment type. As explained in section "[Introduction](#)", COVID-19 can affect people's life satisfaction and stress through multiple pathways. We discuss how the effects of COVID-19 on life satisfaction and stress can be different by demographic group by examining the possible pathways.

First, the pandemic's impact on psychological well-being may differ between men and women (Mooi-Reci & Risman, 2021). It is well-documented that women tend to have greater concerns about and fear of risk as well as uncertainty compared with men (Gustafson, 1998). Compared to men, women are more likely to be concerned about contracting the coronavirus and being unable to obtain medicine or medical treatment in case the need arises (Brooks & Saad, 2020). Moreover, women are more concerned than men about feeling isolated or being unable to reach family and friends in times of need (O'Connor et al., 2020). Women also bear disproportionate burdens that come with stay at home orders due to the closure of schools and daycares during the pandemic (Garnett et al., 2021). Women tend to do additional care work partly because of the persistence of traditional gender roles and partly because of the fact that women are more likely to be part-time workers, have more flexible work arrangements, and receive lower wages (Gustafson, 1998). While the majority of prior research shows that women are more likely to lose jobs during COVID-19 than men (Albanesi & Kim, 2021; Alon et al., 2021; Dang & Nguyen, 2021), some studies report contrasting patterns (Aum et al., 2020). Men might also be at higher risk of death due to COVID-19 (Rabin, 2020) and this would contract their outdoor activities.

Second, the pandemic's impact on psychological well-being may operate differently across age groups. Older adults tend to be less concerned about the threat of the pandemic and perceive a lower risk of the infection due to higher levels of coping efficacy (Klaiber et al., 2021). Other studies, however, suggest that older adults may be more psychologically vulnerable than their younger counterparts because disruptions to see, care for, and receive support from family, friends, and community members may particularly worsen the psychological health of older adults (Moreno et al., 2020). In addition, it was well known that the elderly are more susceptible to the coronavirus. It has been shared through various reports from the government and media since the early days of the pandemic that the elderly are at higher risk of developing more severe illness from COVID-19. This would promote anxiety and fear and further reduce social activities of the elderly, which can affect their psychological well-being. Conversely, young or middle-aged adults may feel more

stressed and depressed than older adults because of greater economic pressures caused by widespread unemployment and income loss brought on by the pandemic (Morrow-Howell et al., 2020; Pierce et al., 2020), though older adults also confront economic challenges due to declines in financial support from adult children (Li & Mutchler, 2020). It is also well known that young people who enter the labor market when economic conditions are bad have high unemployment rates and low wages and the effects are persistent (Bae & Kim, 2022; Kahn, 2010). It is likely that young people have a difficult time finding a job during the pandemic, and this would increase their stress level. Increased parenting stress may be another source of the pandemic-led threats to psychological well-being, particularly for younger married and cohabiting couples with children (van Ballegooijen et al., 2021).

Third, socioeconomic status (SES) factors, such as education and income, may moderate the impact of the pandemic on psychological well-being. Individuals with a higher SES may have ample social and financial resources to address both the physical and mental health risks associated with the pandemic (Bu et al., 2020; Kim, 2021; McLeod & Kessler, 1990). For example, the pandemic may pose a greater threat to lower SES individuals because they are less likely to receive timely medical care and treatment as well as social and material support from others in case of infection (Arthi & Parman, 2021). Moreover, low-SES individuals may be more concerned about their job insecurity during the pandemic and the accompanying economic downturn (Moreno et al., 2020). Therefore, low-SES individuals may have disproportionately poorer psychological well-being than their high-SES counterparts (Vieira et al., 2020). Alternatively, low-SES individuals may be less responsive or sensitive to economic and social disruption caused by the pandemic (Ronzani et al., 2018) because they may have already experienced and suffered similar disruptions due to their socioeconomically disadvantaged backgrounds. If this is the case, changes to daily routines at work and home may have a greater impact on high-SES individuals compared with low-SES individuals.

Fourth, the psychological impact of the pandemic may vary by a person's employment type. The well-being of the self-employed may be most severely affected by the pandemic for several reasons. Self-employed workers, mainly concentrated in the service industry in South Korea, may be psychologically vulnerable because they tend to be exposed to a greater risk of contracting the virus (e.g., high-risk working environments can increase risk of infection if they have decreased sanitation, are overcrowded, and have limited opportunities for workers to physically distance) (Cetrulo et al., 2020). Moreover, it is often the case that the self-employed are hardest hit by public health measures that encourage social distancing in local communities. Therefore, self-employed persons are more likely to face economic hardships compared with individuals who work for others (Hupkau & Petrongolo, 2020). For example, in the United States, the number of active small businesses plummeted by 3.3 million or 22% between February and April 2020, and this was the largest drop on record (Fairlie, 2020). The number of small establishments also declines substantially after the COVID-19 pandemic in South Korea (Kim & Kim, 2022). Therefore, economic uncertainty related to the pandemic presents unique challenges for self-employed workers, from revenue losses to temporary or permanent closures, which may harm their psychological well-being (Ruffolo et al., 2021; Vandoros et al., 2019).

In sum, the negative impacts of the COVID-19 pandemic on life satisfaction and stress are expected to be greater for people with low socioeconomic status, such as low-educated and low-income people. On the other hand, it is difficult to predict clearly the differential effect by gender and age because there are opposing factors. Estimating heterogeneous effects by demographic group is, therefore, an interesting empirical problem because the net effect of various mechanisms is ambiguous. It is also important to estimate the

magnitude of the effect and the difference in the effect by the group, even when the expectation is rather clear.

3 The COVID-19 Outbreak in South Korea

In South Korea, the widespread COVID-19 outbreak began in late February after the first COVID-19 case was confirmed on January 20, 2020. Prior to February 18, there had only been 31 total confirmed cases in South Korea. The situation changed in late February when an outbreak was brought on by a group infection in a church in Daegu. The number of confirmed cases began to surge after a large number of unspecified people had contact with and infected individuals in a church. The cumulative number of confirmed cases increased to 9786 on March 31, and most of them were in Daegu. From mid-April to the end of May, the spread of COVID-19 was greatly suppressed as the effects of social distancing began to appear. The number of new confirmed cases increased by 877 from April 15 to May 31.

Figure 1 presents trends of the number of confirmed cases per 1000 people separately by province from January 20 to May 31. This time frame captures the time in which the survey data used in this study was collected. South Korea has 17 provinces in administrative districts. Figure 1 shows that most confirmed cases in South Korea by the end of May occurred in Daegu. The province with the second-highest number of confirmed cases is Gyungbuk, which is adjacent to Daegu. The increase in the number of confirmed cases in Gyungbuk was influenced by the increase in neighboring Daegu. Even in Gyungbuk, however, the extent of the coronavirus spread was much lower than in Daegu. The fear and risk of having contact with an infected person may have also been much lower in Gyungbuk even though there were quite a few confirmed cases because the area of Gyeongbuk is the largest among 17 provinces in South Korea (population density in Daegu: 2757.64/km²; that in Gyungbuk: 144.24/km²). With the exception of these two provinces, the number of confirmed cases remained very small until the end of May. The cumulative number of

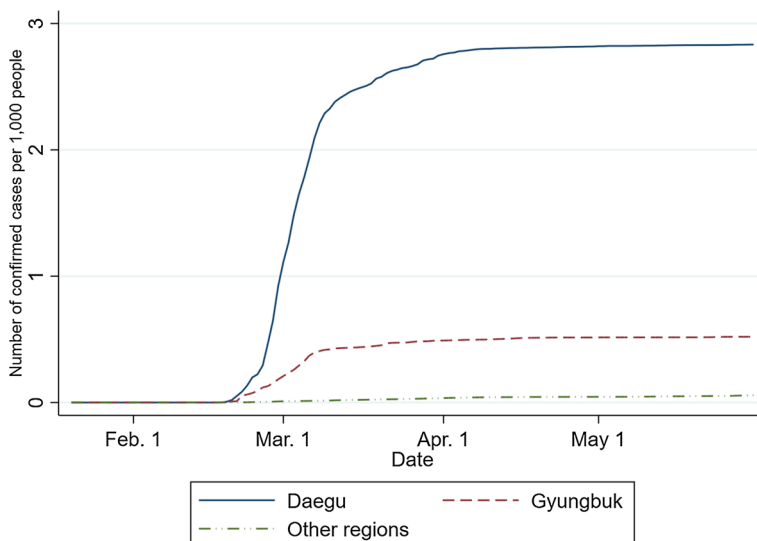


Fig. 1 Time trends of the number of confirmed cases per 1000 people by region: January 2020–May 2020

confirmed cases per 1000 people was 2.86 in Daegu on May 31. This is approximately 32 times higher than the average cumulative number of confirmed cases per 1000 people in other provinces. We exploit this huge difference in the spread of COVID-19 between Daegu and other provinces to estimate the impact of COVID-19 on people's psychological well-being.

We also would like to briefly explain the South Korean government's quarantine policies in response to the pandemic. The South Korean government did not implement different quarantine policies by region. The government did not also implement restrictions on movement or lockdown of regions. The government instead responded with a diagnostic kit that quickly finds the confirmed case, isolates the infected people, identified the movement of the confirmed people, traced the infection route, and tested people who had come into contact with the confirmed people. Schools were closed as face-to-face classes were switched to non-face-to-face classes. Although there were not many confirmed cases in regions other than Daegu, non-face-to-face classes were implemented at most schools across the country. The workplace was not closed, and only confirmed people did not go to work until they tested negative.

4 Data

This study relies on data from the Social Survey. The Social Survey is a cross-sectional data set that occurs every two years. We use data from 2010 to 2020. Each survey captures approximately 38,000 household members aged 13 or older in approximately 19,000 nationally representative sample households. The survey collection occurs from mid-May to late May. The Social Survey investigates individuals' subjective perceptions about health, education, crime, safety, family, and living conditions. The survey's purpose is to grasp the public's social interests and subjective perceptions related to their quality of life. The data gathered from this survey are suitable for this study because they contain psychological well-being measures and demographic characteristics of participants. We restricted our sample to participants who were between 19 to 70 years old. Because testing whether the labor market impact of the pandemic is a major pathway influencing people's psychological well-being is one of our main tasks, we exclude the elderly over 70 or those under the age of 19 from the sample.

We analyze two dependent variables: life dissatisfaction and stress. Regarding the first variable, the Social Survey asked how satisfied an individual is with his or her life. There were five response items to the question: (1) very satisfied, (2) slightly satisfied, (3) neutral, (4) slightly dissatisfied, and (5) very dissatisfied. If a respondent chooses item (4) or (5), we judged that the respondent is dissatisfied with life and made a dummy variable of life dissatisfaction. Regarding the second variable, the survey asked how stressed an individual was in his or her daily life over the past two weeks. The response items are: (1) I felt very stressed, (2) I felt stressed, (3) I did not feel stressed, (4) I did not feel stressed, (5) I did not feel stressed at all. If a respondent selects item (1) or (2), we judged that the respondent was stressed at some point over the past two weeks. We use these transformed binary variables as dependent variables for convenience in the interpretation of estimation results. We, however, make it clear that even if the Likert scale itself is used as the dependent variable, the result that COVID-19 worsened people's life satisfaction and stress is maintained.

The main explanatory variable is a measure of the spread of COVID-19. Considering the substantial difference in the number of confirmed cases in relation to population size

between Daegu and other provinces, we created a dichotomous variable equal to one if the province of residence is Daegu and the survey year is 2020 and zero if the province of residence is not Daegu or the survey year is not 2020. This measure was also used in a prior study that examined the effect of COVID-19 on employment in South Korea (Aum et al., 2020).

All models control for age, gender, 8 dummies of education level (no education, elementary school, middle school, high school, 2-year college, 4-year college, master's degree, doctor's degree), 3 dummies of employment type (wage worker, self-employed, non-worker), 4 dummies of marital status (single, married, divorced, bereavement), 3 dummies of household income (high income, middle income, low income), province fixed effects, and year fixed effects. The Social Survey divides household income into eight categories and asks individuals in which category the household income falls. We classify these categories into three groups (low, middle, and high income groups) and analyze trends by income group. In subgroup analyses, the sociodemographic characteristic on which the classification was based is not controlled for.

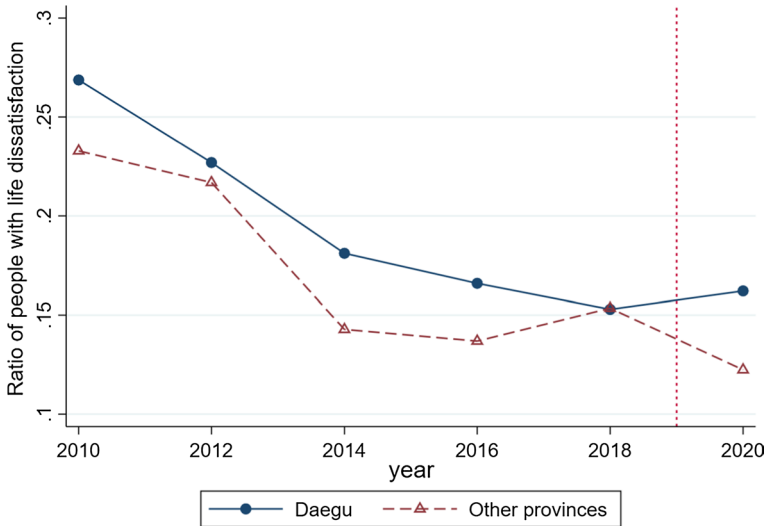
Table 1 shows summary statistics for all provinces, Daegu, and provinces other than Daegu. It also reports differences in the mean values between Daegu and other provinces and their t-test results. The cumulative number of confirmed cases per 1000 people on May 31 was 2.86 in Daegu and 0.09 in other provinces. This is a sizable difference. The psychological well-being measures, the proportion of individuals who are dissatisfied with life and feel stressed, are greater in Daegu than in other provinces both before and after COVID-19. However, the differences substantially increase after COVID-19.

Except for the psychological well-being measures, summary statistics are calculated for all periods. In terms of sociodemographic characteristics, the proportion of men is smaller in Daegu than in other provinces. The mean age and the proportion of married people are similar in Daegu and in other provinces. The share of individuals with high levels of education (with college or higher education levels) is higher in Daegu. The proportion of high income households is lower in Daegu than in other provinces, while the share of low and middle income households is greater in Daegu. With respect to employment, the proportion of individuals who do not work is higher in Daegu than in other provinces, while the share of wage workers and self-employed individuals is lower in Daegu.

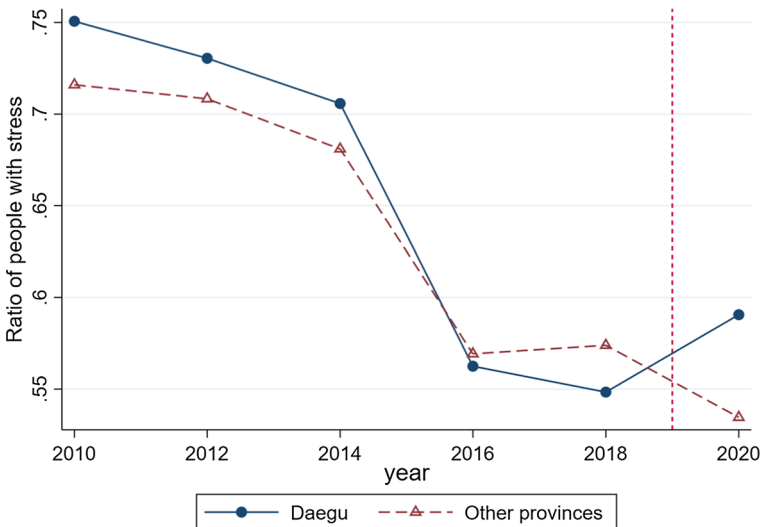
5 Graphical Analysis

In analyses that use the difference-in-differences approach, comparing trends of an outcome variable in treatment and control groups is important because the key identifying assumption of the difference-in-differences approach for causal inference is that the trends of the outcome variable before an event of interest are parallel. In this section, we graphically illustrate trends of the proportions of people with life dissatisfaction and stress in Daegu and other provinces. We also show trends of the proportions by sociodemographic characteristics in the treatment and control regions.

Figure 2 provides strong visual evidence that individuals in Daegu have worse psychological well-being after the COVID-19 outbreak than individuals in other provinces. Panel (a) of Fig. 2 depicts the time trends of the proportion of people who are dissatisfied with life in Daegu and other provinces. The vertical line separates the periods before and after the COVID-19 pandemic. While the proportion decreased more rapidly in Daegu than in other provinces from 2014 to 2018, it suddenly increased more



(a) Proportion of people with life dissatisfaction



(b) Proportion of people with stress

Fig. 2 Trend of psychological well-being by region: May 2010–May 2020

in Daegu in 2020. Panel (b) of Fig. 2 depicts the trends of the proportion of people who reported feeling stressed. The proportion of people who reported feeling stressed decreased more rapidly in Daegu than in other provinces from 2010 to 2018. In 2020, the proportion of individuals who reported feeling stressed declined in other regions, while the proportion substantially increased in Daegu. The time trends of the two psychological well-being outcomes measures consistently show that the psychological

well-being of individuals in other provinces did not deteriorate significantly, while the psychological well-being of individuals in Daegu significantly worsened in 2020. We infer that the disproportionately large spread of COVID-19 in Daegu after the end of February 2020 drove the worsened psychological well-being of people in Daegu. The trends of the psychological well-being outcomes before 2020 are not parallel, but tend to improve more in Daegu than in other provinces. Without taking into account the different trends across provinces, we may underestimate the impact of COVID-19 on psychological well-being. We allow for differential trends of psychological well-being outcomes, as shown in equation (1).

Another main objective of this study is to explore the heterogeneous impacts of COVID-19 on psychological well-being among individuals with different sociodemographic and socioeconomic backgrounds. To examine the heterogeneous impact of the spread of COVID-19 on psychological well-being across different subgroups, we first graphically compare the changes in the psychological well-being of people in Daegu and other provinces by sociodemographic characteristics. Panel (a) of Fig. 3 shows the time trend of the difference in the proportion of people who are dissatisfied with life between Daegu and other provinces by gender. The proportion of men and women who are dissatisfied with life increased significantly after the spread of COVID-19, but the magnitude of the increase is slightly larger for men. Panel (b) of Fig. 3 presents the time trend of the difference in the proportion of people who

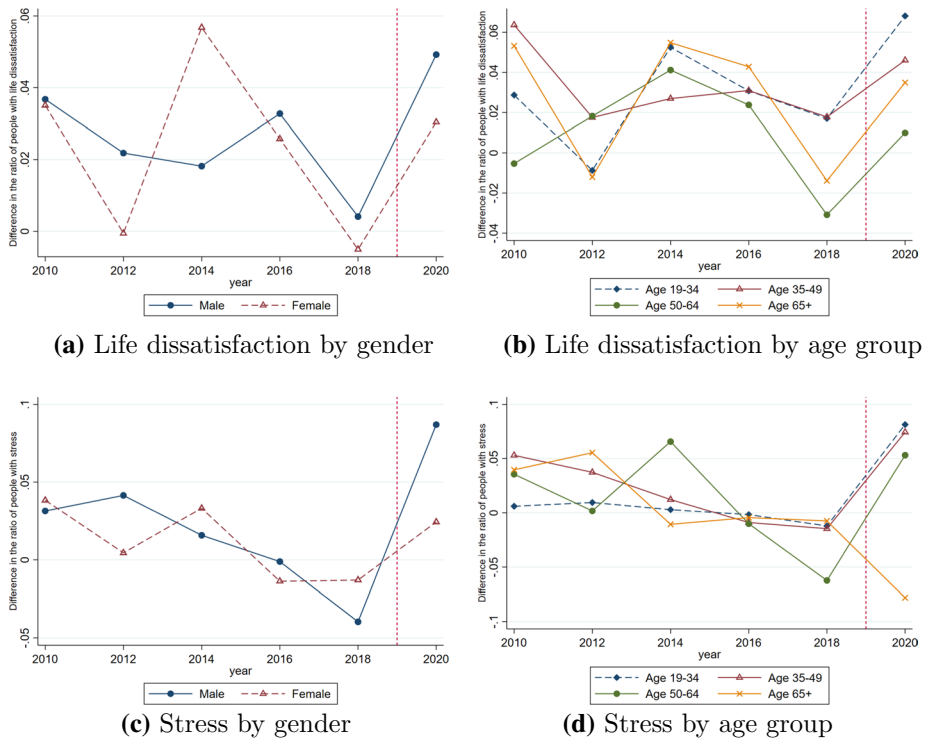


Fig. 3 Trend of the difference in psychological well-being between Daegu and Other Provinces by sociodemographic group: May 2010–May 2020

reported being dissatisfied with life between Daegu and other provinces by age group. It clearly shows that the proportion of people dissatisfied with life in Daegu increased significantly more than in other regions after COVID-19.

Panel (c) of Fig. 3 shows the time trend of the difference in the proportion of people reporting stress between Daegu and other provinces by gender. The increase in the proportion of people reporting feeling stressed after COVID-19 is significantly greater for men than women. The proportion of men and women feeling stressed decreased faster in Daegu, but this proportion increased significantly quicker in Daegu after the spread of COVID-19. This trend holds for all age groups. As shown in Panel (d), the proportion of people feeling stressed increased more in Daegu after the onset of COVID-19 across all ages, with the exception of individuals 65 years and older.

Figure 4 shows time trends of the difference in the psychological well-being measures between Daegu and other provinces by the following three socioeconomic status variables: education, household income, and employment type. Panels (a) and (d) of Fig. 4 present the time trends of the proportion of people who reported being dissatisfied with life and feeling stressed by education level. Notably, the psychological well-being of people with college or lower education in Daegu deteriorated more than that of individuals in other provinces. Psychological well-being improved more for people with a master’s degree or higher in Daegu than for similarly educated persons in other provinces.

Panels (b) and (e) depict time trends of the difference in the psychological well-being measures by household income. The most interesting results are that the deterioration of psychological well-being due to COVID-19 is greatest in the middle income group, while psychological well-being improves in the high income group. Psychological well-being worsens slightly in the low-income group.

Panel (c) shows the time trends of the difference in the proportion of people who are dissatisfied with life in Daegu and other provinces. Life dissatisfaction increased the most among self-employed individuals after the COVID-19 outbreak. It also increased for wage

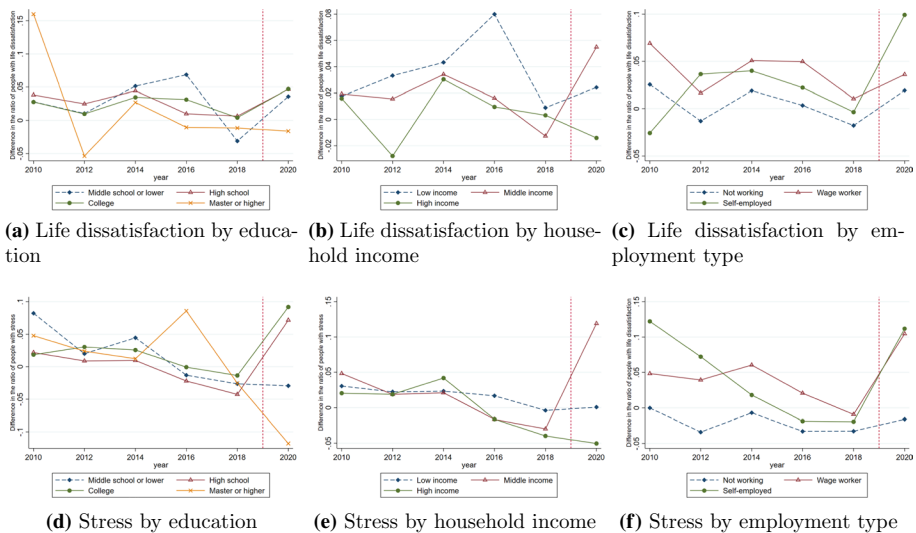


Fig. 4 Trend of the difference in psychological well-being between Daegu and Other Provinces by socioeconomic status: May 2010–May 2020

Table 1 Summary statistics

	(1) All	(2) Daegu (treatment)	(3) Other provinces (control)	(4) Difference
<i>Spread of COVID-19</i>				
The number of confirmed cases per 1000 people on May 31	0.22	2.86	0.09	2.77
<i>Mental health</i>				
Ratio of people with life dissatisfaction before COVID-19	0.168 (0.374)	0.185 (0.388)	0.167 (0.373)	0.017*** (0.004)
Ratio of people with life dissatisfaction after COVID-19	0.123 (0.329)	0.162 (0.369)	0.121 (0.327)	0.041*** (0.009)
Ratio of people with stress before COVID-19	0.619 (0.486)	0.626 (0.484)	0.618 (0.486)	0.008 (0.006)
Ratio of people with stress before COVID-19	0.534 (0.499)	0.586 (0.493)	0.531 (0.499)	0.055*** (0.014)
<i>Sociodemographics</i>				
Gender(Male=1)	0.497 (0.500)	0.484 (0.500)	0.498 (0.500)	-0.014** (0.005)
Age	44.6 (13.84)	44.70 (13.96)	44.62 (13.84)	0.083 (0.147)
Marriage(Married=1)	0.652 (0.476)	0.647 (0.478)	0.652 (0.476)	-0.006 (0.005)
<i>Education level</i>				
Middle school or lower	0.155 (0.361)	0.162 (0.368)	0.154 (0.361)	0.007 (0.004)
High school	0.324 (0.468)	0.300 (0.458)	0.325 (0.468)	-0.025*** (0.005)
College	0.469 (0.499)	0.489 (0.500)	0.467 (0.499)	0.022*** (0.005)
Master or higher	0.053 (0.225)	0.049 (0.216)	0.054 (0.225)	-0.005 (0.002)
<i>Household income</i>				
Low income	0.260 (0.438)	0.283 (0.451)	0.258 (0.438)	0.025*** (0.005)
Middle income	0.521 (0.500)	0.538 (0.499)	0.521 (0.500)	0.017** (0.005)
High income	0.219 (0.414)	0.179 (0.384)	0.221 (0.415)	-0.042*** (0.004)
<i>Employment type</i>				
Wage worker	0.475 (0.499)	0.449 (0.497)	0.476 (0.499)	-0.027*** (0.005)
Self-employed	0.177 (0.382)	0.154 (0.361)	0.178 (0.383)	-0.024*** (0.004)
Not working	0.348 (0.476)	0.397 (0.489)	0.346 (0.476)	0.051*** (0.005)
Observations	178,796	10,306	168,490	178,796

1. Standard deviations are in parenthesis. 2. *** $p < 0.001$; ** $p < 0.01$, * $p < 0.05$

workers and individuals who do not work albeit the magnitude of the increase is less in each of these groups compared with the self-employed. Panel (f) of Fig. 4 shows the time trends of the difference in the proportion of people with stress between Daegu and other provinces. The difference in the proportion also increased the most for self-employed people after the spread of COVID-19 in 2020. The difference in the proportion between Daegu and other provinces for wage workers increased the second greatest, and the gap for non-workers increased by the smallest amount.

Figures 3 and 4 show that individuals in most sociodemographic groups analyzed in this study who also lived in Daegu experienced greater deterioration in their psychological well-being after the outbreak of COVID-19 compared with individuals who lived in other provinces. On the other hand, the psychological well-being outcomes improve more in Daegu after the outbreak of COVID-19 for high socioeconomic groups, such as those with a master's degree or higher and those with a high-income. Figures 3 and 4 also show that men, prime working age groups, and self-employed people experienced heightened deterioration of their psychological well-being. We infer that part of the deterioration in psychological well-being after the onset of COVID-19 is related to economic damages and the shrinking economic activities due to COVID-19. Motivated by these figures, we quantitatively analyze how the extensive spread of COVID-19 in Daegu affects the psychological well-being of people in Daegu and how the effect differs across sociodemographic groups.

6 Empirical Strategy

We analyze the effect of the COVID-19 outbreak on life satisfaction and stress by estimating the following difference-in-differences model:

$$Y_{ist} = \beta_0 + \beta_1 \text{Treat}_s \text{Post}_t + X_{ist} \beta_2 + \delta_s + \lambda_t + \text{Trend}_{st} + \epsilon_{ist} \quad (1)$$

where Y_{ist} is an outcome variable (life satisfaction or stress) of individual i in province s in year t . Treat_s is a dummy variable that indicates residence in Daegu metropolitan city, and Post_t is a dummy variable that is equal to one if year t is 2020 and zero otherwise. X_{ist} is a vector of sociodemographic variables/characteristics of individual i . δ_s and λ_t represent province fixed effects and year fixed effects, respectively. Trend_{st} represents province-specific time trends. ϵ_{ist} is an error term.

The key parameter of interest in the model is β_1 , which is the effect of the COVID-19 outbreak on psychological well-being. In the difference-in-differences framework, this is estimated by comparing changes in life dissatisfaction and stress between persons in Daegu, where the coronavirus rapidly spread during the survey period, and persons in other provinces after controlling for individual characteristics. The key identifying assumption in the difference-in-differences estimation is that trends of the outcome variables in treatment and control groups are parallel. In models with province-specific times trends, it is required that trends of the outcome variables after partialling out the province-specific times trends are parallel. Our preferred model is a model with province-specific linear times trends because it may be more plausible to assume that time trends of the dependent variables are different across different provinces and quadratic trends may overfit in the data without long pre-periods. Since it is not known which model is the most appropriate, however, we report the estimation results for several models and analyze whether the results are robust to the models.

Another important objective of this study is to analyze the heterogeneous impacts of COVID-19 on psychological well-being across different sociodemographic groups. For this analysis, we estimate the following model:

$$Y_{ist} = \gamma_0 + \gamma_1 Treat_{s,Post_t} + \sum_{k=1}^m \gamma_{2k} Treat_{s,Post_t} Group_{ki} + X_{ist} \gamma_3 + \phi_s + \zeta_t + Trend_{st} + v_{ist} \tag{2}$$

Compared to equation (1), equation(2) adds on triple interaction terms, $Treat_{s,Post_t} Group_{ki}$. $Group_{ki}$ is a dummy variable that indicates a sociodemographic group k. If individual i belongs to sociodemographic group k, then $Group_{ki}$ is equal to one and zero otherwise. In the model, there are m+1 different groups based on sociodemographic characteristics. γ_1 represents the effect of COVID-19 on psychological well-being for the base group. γ_{2k} represents the additional effect of COVID-19 on psychological well-being for group k compared to the effect on the base group, which means $\gamma_1 + \gamma_{2k}$ is the effect of COVID-19 for group k.

7 Results

Table 2 provides difference-in-differences estimates of the impacts of COVID-19 on life dissatisfaction and stress. These are estimates of the coefficient β_1 in equation (1). Panel (a) shows that the proportion of people who are dissatisfied with life in Daegu increases by 2.8–6.5 percentage points more than in other provinces after COVID-19. It also shows that the proportion of people reporting feeling stressed in Daegu increases by 5.8–8.9 percentage points after COVID-19 compared to other provinces. All estimation results consistently show that the psychological well-being of individuals in Daegu worsened significantly more than the psychological well-being of individuals in other provinces after 2020.

Table 2 The effects of COVID-19 on psychological well-being

	(1)	(2)	(3)	Observations
<i>(a) Dichotomous variable</i>				
Life dissatisfaction	0.028*** (0.004)	0.040*** (0.006)	0.065*** (0.009)	178,796
Stress	0.058*** (0.009)	0.085*** (0.008)	0.089*** (0.012)	178,796
<i>(b) Likert scale values</i>				
Life dissatisfaction	0.080*** (0.019)	0.085*** (0.025)	0.144*** (0.027)	178,796
Stress	0.084*** (0.010)	0.127*** (0.011)	0.154*** (0.019)	178,796
Province-specific time trend	None	Linear	Quadratic	

1. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. 2. Standard errors are clustered at the province-level. 3. All models commonly control age, a dummy of gender, dummies of education level, dummies of job status, dummies of marital status, dummies of household income, province fixed effects, and year fixed effects

The cause of the deterioration of psychological well-being among people in Daegu is possibly due to the prevalence of COVID-19 in Daegu as other provinces had few cases.

Our preferred model, a model with province-specific linear time trends, shows that the ratios of people with life dissatisfaction and stress increase 4.0 and 8.5 percentage points more in Daegu after COVID-19, respectively. Considering the ratio of people with life dissatisfaction and stress were 15.3% and 57.0% in 2018 in the nation, the estimates can also be interpreted that COVID-19 increases the proportion of people with life dissatisfaction by 26.1% and that with stress by 14.9%. We believe that the magnitude of the effect is substantial.

Panel (b) of Table 2 shows the results for dependent variables with Likert scale points. Column (1) shows the estimation results from the model that does not control for province-specific time trends. Columns (2) and (3) present results from models that control for linear and quadratic provincial time trends, respectively. Panel (a) shows that the Likert scores of life satisfaction and stress increases more in Daegu than in other provinces after COVID-19. The relative increase in the Likert score in Daegu after COVID-19 are 0.080–0.144 points for life satisfaction and 0.084–0.154 points for stress. Again, these show that the results are maintained qualitatively even when the Likert scale scores are used as the dependent variables. From now on, only the results for the dummy dependent variables are reported due to space constraints.

Table 3 provides estimates of the impacts of COVID-19 on psychological well-being by gender and age. These are estimation results for equation (2). Columns (1)–(3) present results for life dissatisfaction by model specification and columns (4)–(6) show results for stress by specification. Panel (a) of Table 3 shows that the proportion of women who are dissatisfied with life increases 2.0–5.7 percentage points more in Daegu

Table 3 The effects of COVID-19 on psychological well-being by gender and age

	(1)	(2)	(3)	(4)	(5)	(6)
	Life dissatisfaction			Stress		
<i>(a) Gender</i>						
COVID-19	0.020***	0.032***	0.057***	0.047***	0.074***	0.078***
(Base=female)	(0.004)	(0.005)	(0.009)	(0.008)	(0.008)	(0.013)
COVID-19×Male	0.016***	0.016***	0.016***	0.021***	0.021***	0.021***
	(0.002)	(0.002)	(0.002)	(0.004)	(0.004)	(0.004)
<i>(b) Age</i>						
COVID-19	0.066***	0.078***	0.104***	0.052***	0.079***	0.085***
(Base=ages 19–34)	(0.005)	(0.006)	(0.009)	(0.010)	(0.009)	(0.010)
COVID-19×Ages 35–49	−0.038***	−0.038***	−0.038***	0.024***	0.024***	0.024***
	(0.001)	(0.001)	(0.001)	(0.006)	(0.006)	(0.006)
COVID-19×Ages 50–64	−0.061***	−0.062***	−0.062***	0.019	0.019	0.019
	(0.004)	(0.004)	(0.004)	(0.013)	(0.013)	(0.013)
COVID-19×Ages 65+	−0.070***	−0.070***	−0.070***	−0.092***	−0.092***	−0.092***
	(0.003)	(0.003)	(0.003)	(0.013)	(0.013)	(0.013)
Observations	178,796	178,796	178,796	178,796	178,796	178,796
Regional time trend	None	Linear	Quadratic	None	Linear	Quadratic

1. *** $p < 0.001$; ** $p < 0.01$; * $p < 0.05$. 2. Standard errors are clustered at the province-level. 3. All models commonly control age, a dummy of gender, dummies of education level, dummies of job status, dummies of marital status, dummies of household income, province fixed effects, and year fixed effects

than in other provinces after COVID-19. The estimated coefficient of the interaction between the COVID-19 dummy and the male dummy shows that the proportion of men in Daegu who are dissatisfied with life increases 1.6 percentage points more than the proportion of women with life dissatisfaction in Daegu after COVID-19. These estimates are statistically significant at 0.1%. Columns (4)–(6) show that the proportion of women feeling stressed in Daegu increases 4.7–7.8 percentage points more than in other provinces. The impact is 2.1 percentage points higher for men than women. Results in Panel (a) of Table 3 consistently show that men experience greater psychological well-being problems related to COVID-19 than women.

Panel (b) of Table 3 shows that the proportion of people aged 19–34 who report being dissatisfied with life increases 6.6–10.4 percentage points more than that in other provinces after COVID-19. The impact of COVID-19 on life dissatisfaction is smaller for older age groups. In addition, the extensive spread of COVID-19 in Daegu increases the proportion of people aged 19–34 who report being dissatisfied with life by 5.2–8.5 percentage points. The impact is 2.4 percentage points greater for people aged 35–49, and it is 9.2 percentage points smaller for people 65 years or older.

Results in Table 4 show estimates of the impact of COVID-19 on psychological well-being by education, household income, and employment type. Columns (1)–(3) in Panel (a) of Table 4 show that the proportion of people with middle school or lower education who are dissatisfied with life increases by 0.3–4.0 percentage points more in Daegu than in other provinces after COVID-19. The impact of COVID-19 on life dissatisfaction is statistically significant when regional time trends are controlled for. Compared to people with middle school or lower education, the magnitude of the increase is 2.7 percentage points greater for high school graduates and 3.1 percentage points greater for college graduates. There is no statistically significant difference in the magnitude of the increase between middle school graduates and people with master's degree or higher education. Columns (4)–(6) show that the proportion of people who report feeling stressed among those with middle school or lower education increases 0.7–3.8 percentage points more in Daegu than in other provinces. The impact of COVID-19 on the probability of feeling stressed is 7.1 percentage points higher for high school graduates and 7.2 percentage points higher for college graduates than people with middle school or lower education. On the other hand, the effect of COVID-19 is 11.6 percentage points lower for people with master's degree or higher education than people with middle school or lower education.

Panel (b) presents estimates of the impact of COVID-19 on psychological well-being by household income. The estimated impact of COVID-19 on the proportion of people with life dissatisfaction in low-income households ranges from –0.2 to 3.6 percentage points, as shown in columns (1)–(3). In the model without province-specific time trends and that with province-specific linear time trends, the estimated impact is not statistically significant. On the other hand, the spread of COVID-19 in Daegu increases the proportion of people who report being dissatisfied with life in middle-income households by 5.3–9.1 percentage points. These estimates are statistically significant at 0.1%. The impact of COVID-19 on the proportion of people who are dissatisfied with life in high-income households is not statistically significantly different from that in low-income households. Columns (4)–(6) show results for stress. The widespread diffusion of COVID-19 in Daegu increases the proportion of people with stress in low-income households by 3.4–6.7 percentage points. The magnitude of the impact is 8.3–8.4 percentage points for people in middle-income households. On the other hand, the proportion of people who report feeling stressed in high-income households decreases by 3.0–6.3 percentage points in Daegu after COVID-19.

Table 4 The effects of COVID-19 on psychological well-being by socioeconomic status

	(1)	(2)	(3)	(4)	(5)	(6)
	Life dissatisfaction			Stress		
<i>(a) Education</i>						
COVID-19	0.003	0.015**	0.040***	0.007	0.034**	0.038**
(Base=Middle school or lower)	(0.007)	(0.007)	(0.013)	(0.013)	(0.012)	(0.015)
COVID-19×High school	0.027***	0.027***	0.027***	0.071***	0.071***	0.071***
	(0.008)	(0.008)	(0.008)	(0.006)	(0.006)	(0.006)
COVID-19×College	0.031***	0.031***	0.031***	0.072***	0.072***	0.072***
	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)
COVID-19×Master or higher	0.008	0.008	0.008	-0.116***	-0.116***	-0.116***
	(0.013)	(0.013)	(0.013)	(0.009)	(0.009)	(0.009)
<i>(b) Household income</i>						
COVID-19	-0.002	0.010	0.036***	0.034**	0.062***	0.067***
(Base=low income)	(0.004)	(0.006)	(0.008)	(0.011)	(0.011)	(0.014)
COVID-19×Middle income	0.055***	0.055***	0.055***	0.084***	0.084***	0.083***
	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)
COVID-19×High income	0.002	0.002	0.002	-0.097***	-0.097***	-0.097***
	(0.005)	(0.005)	(0.005)	(0.010)	(0.010)	(0.010)
<i>(c) Employment type</i>						
COVID-19	0.004	0.016**	0.042***	0.008	0.035***	0.039***
(Base=Non-worker)	(0.004)	(0.006)	(0.008)	(0.009)	(0.009)	(0.013)
COVID-19×Wage worker	0.019***	0.019***	0.019***	0.077***	0.077***	0.077***
	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.007)
COVID-19×Self-employed	0.108***	0.108***	0.108***	0.109***	0.109***	0.109***
	(0.006)	(0.005)	(0.005)	(0.007)	(0.007)	(0.007)
Observations	178,796	178,796	178,796	178,796	178,796	178,796
Regional time trend	None	Linear	Quadratic	None	Linear	Quadratic

1. *** $p < 0.001$; ** $p < 0.01$, * $p < 0.05$. 2. Standard errors are clustered at the province-level. 3. All models commonly control age, a dummy of gender, dummies of education level, dummies of job status, dummies of marital status, dummies of household income, province fixed effects, and year fixed effects

Results of the pandemic’s impact of on psychological well-being by employment type are reported in Panel (c) of Table 4. Columns (1)–(3) show that the proportion of non-workers who are dissatisfied with life increases by 0.4–4.2 percentage points more in Daegu after the onset of the COVID-19 pandemic than in other provinces. The proportion of wage workers with life dissatisfaction increases by 2.3–6.1 percentage points more in Daegu than in other provinces. The impact of COVID-19 on life dissatisfaction is the greatest for the self-employed. The proportion of self-employed people who are dissatisfied with life increases by 11.2–15.0 percentage points more in Daegu than in other provinces. Columns (4)–(6) show the estimation results for stress. The proportion of non-workers who reported feeling stressed increases 0.8–3.9 percentage points more in Daegu than in other provinces after COVID-19. The amount of the increase is 7.7 percentage points greater for wage workers and 10.9 percentage points higher for self-employed people than non-workers. The estimation results consistently show that the psychological well-being of self-employed people in Daegu deteriorated the most after the COVID-19 outbreak.

8 Discussion and Conclusion

Although previous studies document that the COVID-19 pandemic has had psychological consequences worldwide (Rajkumar, 2020), less is known about whether the psychological impact of the pandemic has been even across sociodemographic groups. Because the pandemic has persisted for an extended period, examining the heterogeneous effects of the pandemic is critical to better understand the pandemic's consequences. This intersection of understanding can also inform policymakers about how to address the psychological well-being problems brought on by the pandemic more effectively. In this study, we investigated how the COVID-19 outbreak impacted life satisfaction and stress in South Korea, and whether these effects differ depending on sociodemographic characteristics including gender, age, education, income, and employment type.

This article found that the initial surge of COVID-19 cases negatively affected psychological well-being. We found that the proportion of people dissatisfied with life increased by 2.8–6.5 percentage points more in Daegu. Daegu is a place that experienced a more dramatic diffusion of COVID-19 compared with other provinces after the initial COVID-19 outbreak. Similarly, the proportion of people with stress increased more in Daegu than in other provinces by 5.8–8.9 percentage points. The negative impact on psychological well-being is significantly greater for men, young adults, middle-aged adults, self-employed people, and middle-income people. On the other hand, the highest-educated (a master's degree or higher) and high-income people reported feeling less stressed than other groups after the initial surge of the pandemic.

In this study, we found interesting patterns about the heterogeneous effects of the pandemic on psychological well-being. First, this study found that men got more stressed and dissatisfied with their lives. This is inconsistent with previous research that show that women's psychological well-being is more affected by the pandemic than men's psychological well-being (Mooi-Reci & Risman, 2021). These results in this study may indicate that the psychological well-being consequences of the pandemic may be largely driven by economic shock and insecurity. Unlike other countries, men's employment declined significantly more than women's in South Korea in the early days of COVID-19 (Aum et al., 2020). Despite an increase in the number of dual-earner families in Korea, men are traditionally expected to take primary responsibility of financially supporting their family (Park & Chesla, 2007). Thus, compared to women, men may perceive economic uncertainty as a more serious threat, and this may lead to lower psychological health among men.

We also found that pandemic most severely affected the psychological well-being of the youngest group (ages 19–34) in this study. Interestingly, while the pandemic's effect on life satisfaction is greater in the younger population, its impact on stress is greater in middle-aged individuals, especially those between 35–49 years old. These contrasting results provide support for potentially heterogeneous pathways through which the pandemic shapes psychological well-being for different age groups. During the pandemic, young people may perceive the future more pessimistically, resulting in lower levels of life satisfaction. Given that life satisfaction captures how one feels about their future directions and options (rather than an assessment of current feelings), it is possible that concerns about the future such as concerns about romantic relationships or marriage as well as employment may negatively affect life satisfaction among young people (Kim & Kim, 2021; Pierce et al., 2020). Among middle aged persons, the increased burden of childcare during the pandemic, a family stressor, may be more salient for their mental wellbeing

(Buecker et al., 2020). Interestingly, the pandemic has no or little discernable impact on the psychological well-being of older adults (aged 65+) in this study. This is consistent with a previous study that found that, compared to younger and middle-aged adults, older adults' mental health is more resilient as they are less concerned with harm to their physical health and safety as well as emotional well-being due possibly to higher levels of coping efficacy (Klaiber et al., 2021).

Our findings on the heterogeneous effects of COVID-19 across different SES groups suggest that the pandemic has the strongest impact on the psychological well-being of high school-/college-educated and middle-income individuals. While the pandemic appears to have a negative impact on life satisfaction for all SES groups, it negatively affects stress for low and middle-SES groups, but not the highest SES group (i.e., master's degree or higher and high-income group). Since the onset of the COVID-19 pandemic, working from home has increased due to the risk of infection. Considering that the jobs in which working from home is possible are typically high-paying jobs (Dingel & Neiman, 2020), high-income individuals may have lower stress related to work. The highest-SES groups have a lower risk of losing jobs (Aum et al., 2020). They may also be able to utilize their social and financial resources to successfully mitigate stress, an acute threat to psychological well-being during the pandemic (Daly et al., 2020). That said, when it comes to life satisfaction, the pandemic appears to change one's fundamental attitudes towards one's life, regardless of SES.

Findings of this study also indicate that the pandemic most severely negatively affects the psychological well-being of self-employed workers, followed by wage workers and then unemployed individuals. Results lend support to the claim that economic hardships and uncertainty led by the pandemic may be the major driver of heterogeneous effects of the pandemic by employment type. Although both unemployed individuals and wage workers have been affected by the pandemic-related economic downturn and are worried about future economic ramifications of the pandemic (Monitor, 2020), self-employed workers have been hardest hit by the pandemic (Fana et al., 2020; Wolfe & Patel, 2021). In particular, despite their effectiveness, social distancing measures that forced night curfews and business suspensions play a major role in business disruptions (Koren & Pető 2020). Their downstream consequences in turn negatively affect the psychological well-being of self-employed individuals.

This study contributes to a growing body of literature about how the COVID-19 pandemic affects psychological wellbeing. This study estimates the causal effect of COVID-19 on psychological well-being by taking advantage of the fact that the transmission of the virus was concentrated only in one area at the beginning of the COVID-19 pandemic in South Korea. Our study provides a comprehensive account of the heterogeneous effects of the pandemic on life satisfaction and stress with a focus on differences by gender, age, education, income, and employment type. To the authors' knowledge, this is the first study to investigate multiple sources of heterogeneous impacts in a single study.

Our findings have important policy implications. Despite the creation and implementation of several interventions designed and implemented to improve people's psychological well-being during the pandemic, policymakers did not consider potential heterogeneity in the psychological costs of the pandemic when developing such interventions. Our findings may guide policymakers and practitioners to tailor intervention programs to help relieve psychological distress for individuals in different sociodemographic groups. For example, given the prolonged pandemic and potential habituation of social distancing, long-term and practical policies are needed to promote the psychological well-being of self-employed individuals. Providing self-employed

individuals with temporary financial support as a means to compensate for income loss may not be a long-term solution for their recovery from psychological downturns. Moreover, despite evidence of heterogeneous effects, our findings document that the pandemic has adversely affected the psychological well-being of everyone. Therefore, policymakers should continue to consider policy interventions that benefit the psychological well-being of all individuals, irrespective of their sociodemographic characteristics.

This study has limitations. First, we only investigate the short-term effects of the COVID-19 pandemic in the early stages of it due to data limitation. It may be meaningful for subsequent research to analyze the longer-term effects of COVID-19 on life satisfaction and stress and how the effects dynamically change during the pandemic. Second, we did not quantitatively evaluate relative importance of each mechanism through which COVID-19 affects life satisfaction and stress, while we estimate the net effect of COVID-19. Future research that quantitatively evaluates the relative importance of each mechanism, such as mediation analysis, needs to be performed. Third, our measures of psychological well-being are limited. It may be necessary for future research to conduct a more detailed analysis using multidimensional measures of well-being.

Declarations

Conflicts of interest The authors declare that they have no conflict of interest.

Informed Consent This research did not involve human participants.

Human or Animal Rights This research did not involve human or participants or animals, and did not require research ethics approval.

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