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** This working paper is a preliminary version that only includes a part of the analysis of our project.

Abstract

The COVID-19 pandemic and the lockdown policy have negatively affected mental health. People have begun to spend more time on online communication, including via video games, as a part of their stress-coping behavior. Thus, video games have become an essential platform for online communication. However, people are also concerned about whether playing video games for a long time is really good for mental health. To this interest, the previous studies show negative correlations between video games and mental health under the COVID-19 pandemic through cross-sectional analysis. In this paper, using a causal inference approach, we examine whether video games negatively affect mental health under COVID-19. We exploit a natural experiment where people joined the lottery to purchase video games (Play Station 5) and find no significant negative impact on mental health. We also employ the Inverse Probability Weighting method to adjust for self-selection into joining a lottery, of which the estimates stay insignificant. These findings provide a better understanding of the relationship between video games and mental health, thus helping policymakers to form more effective policies against the psychological distress of the people under and post the COVID-19 pandemic.

Keywords: mental health, video game, lottery, COVID-19

1. Introduction

The Coronavirus 2019 (COVID-19) pandemic in 2020 has dramatically changed the lifestyle. People have been required to stay at home and forced to shift their communication styles from an offline basis to an online basis due to the lockdown policy implemented by the government (Clark-Ginsberg and Petrun Sayers 2020; Gioia et al. 2021). The pandemic and the sudden change of lifestyle increased stress (Holmes et al. 2020; Yamamoto et al. 2020) and caused psychological distress, which led to addictive behaviors (i.e., alcoholism) for some people (Bonny-Noach and Gold 2020).

As a part of their stress-coping behavior, people have begun to spend more time online, including gaming. Video games have become an important platform for online communication for the users, which ranks as one of the major leisure activities under the containment policy (Barr and Copeland-Stewart 2021; Washington Post 2021). Combined with phone calls, texts, and chat tools, video games are giving people a way to share the fun with each other. However, people also concern whether spending time for playing video games longer time is really good—or at least not harmful—for mental health, though at first glance, it seems to be helpful for battling isolation (ABC News 2020).

Do video games negatively affect mental health under the COVID-19 containment policies? Numerous studies of the medical and psychological fields have examined the effect of playing video games on mental health and argue that video games are potentially harmful to mental health (Granic, Lobel, and Engels 2014). Some recent studies examining the effect of video games on mental health under the COVID-19 containment policies conclude that playing video games is associated with an increased risk of mental problems (Giardina et al. 2021; Kato, Shinfuku, and Tateno 2020; Oka et al. 2021). The World Health Organization (WHO) and New York Times have warned that during the COVID-19 pandemic, the increased screen time and games-playing time may lead to internet and gaming addiction (The New York Times 2021). A local government in Japan reported the negative impact of video games on mental health

through their survey (Hyogo Prefecture 2020). Such information would consolidate the negative image about video games on mental health, thus may lead to the policy based on this image.

The empirical evidence of associations between video games and mental health is, however, not conclusive. Recent review papers highlight the methodological limitations of the previous studies (Ferguson, 2015). Firstly, many studies are cross-sectional and the causal inference is not carefully conducted.[1] Especially, whether playing video games induce stress or people with higher stress prefer playing video games is less than clear. Secondly, studies based on laboratory experiments heavily rely on college students as their target population rather than the child, adolescent, or elderly population. Thirdly, laboratory experiments examine short-term emotional effects right after playing video games and do not measure mental health measures in real situations. Considering those limitations, the review papers argue that policy implications based on correlations between video games and mental health may be misleading and making policies that discourage playing video games would be too simplistic (Ferguson 2015; Granic, Lobel, and Engels 2014; Greitemeyer and Mügge 2014). Further, a review study (Granic, Lobel, and Engels 2014) stresses that contrary to stereotypes, video gamers are not isolated because recent video games have an aspect of an online communication tool. This aspect was not (or could not have been) considered in the previous studies, though online communication is shown to be beneficial for maintaining mental health (Morgan and Cotten 2003).

This study aims to fill the gap by exploiting a natural experiment that created a plausibly exogenous random variation of ownership of a new video game. We focus on a lottery for winning the right to purchase Play Station 5 (PS5), newly released in October 2020. Due to the supply limitation, people in Japan are required to join the lottery to purchase PS5.[2] To the best of

[1] The most recent papers listed above (Giardina et al. 2021; Kato, Shinfuku, and Tateno 2020; Oka et al. 2021) are not exceptions.
[2] People can purchase PS5 in the secondhand market, but in our data, most of the people answered that they got PS5 through lotteries.

our knowledge, no study employs a natural experiment approach to estimate video games' effects on mental health.

Our data of 18,189 samples, composed of people aged 10~69 from all the 47 prefectures in Japan, is collected through an internet survey in February 2021. Among them, 1,481 people joined the PS5 lottery, and 254 people won the lottery.[3] Our major target population is the people who joined the lottery. We also attempt to conduct statistical inferences that adjust for self-selection into the lottery by using the inverse probability weighting (IPW) approach.

In our main analysis, we conduct a regression analysis by assuming that the chance of winning the PS5 lottery is quasi-random. As a pre-analysis, we first show that a cross-sectional estimation based on our data indicates that playing video games (PS5) is negatively associated with mental health; this is consistent with the previous studies. In contrast, our main analysis finds that the results obtained from a regression analysis exploiting the natural experiment indicate no significant negative impact of PS5 on mental health. This result differs from recent related studies, which show negative impacts of video games on mental health under the COVID-19 pandemic (Giardina et al. 2021; Kato, Shinfuku, and Tateno 2020; Oka et al. 2021). A possible explanation is that the estimates of the previous studies relying on cross-sectional analysis are contaminated with selection bias. At the same time, there are some other possible explanations, including a loss of precision due to a smaller sample.

This study contributes to several strands of literature. Firstly, numerous medical field studies examine the impact of playing video games on mental disorders such as depression (Granic, Lobel, and Engels 2014).[4] The majority of them find that high exposure to video games is related to symptoms of depression. For example, Wang, Sheng, & Wang (2019) shows that students with mobile game addiction tend to feel social anxiety, depression, and loneliness.

[3] Some people have not received the results of the lottery yet. Those people are excluded from the sample of the lottery analysis.

[4] Some exceptions include Giardina et al. (2021) and Roy and Ferguson (2016). Those find a positive impact of video games on stress, though they have limitations within the rigorousness of their methodologies.

However, the methods of most studies are cross-sectional, thus failing to eliminate the effects of unobservable characteristics such as personality and family backgrounds.[5] Moreover, the medical researchers mainly focus on problematic gaming behavior ("gaming addiction"); studies that examine the effect of video games on light players (or ordinary players) are scarce (Ferguson 2015). This study aims to fill these gaps by exploiting a natural experiment.

Secondly, this study is related to the literature of psychology that examines the psychological effects of playing video games. The studies show that while playing violent video games induces stress and aggressive behavior, playing non-violent video games induces positive emotion and relieves stress (Bowman and Tamborini 2012; Rieger et al. 2014). However, evidence from these studies is likely to have limited external validity because most studies employ laboratory experiments. Typically, university students are invited to play video games for a few hours, and after that, immediately their emotional change is measured (e.g. Reinecke 2009). Thus, there are unanswered questions regarding the consequences of playing video games—and communicating online with friends—in the actual situation, especially for the population other than university students (Granic, Lobel, and Engels 2014). In contrast, this study utilizes the data collected through a large-scale online survey for a wide range of age groups—between the ages of 10 and 69, joined from all 47 prefectures, ranging from light users (or non-users) to heavy game users.

Thirdly, this study contributes to the literature of the medical studies and leisure studies that examines whether sedentary behavior (i.e., watching TV, using a computer, online communications, and playing video games) affects mental health (Teychenne et al. 2019; Teychenne, Ball, and Salmon 2010). Many cross-sectional studies find that sedentary behavior is

[5] Some recent medical studies (Ferguson 2015; Stenseng, Hygen, and Wichstrøm 2020) argue that the existing medical studies' causal inferences are not likely to be free from endogeneity problems. Notably, Ferguson (2015) shows that the magnitude of the negative effect of video games is substantially reduced by including control variables such as gender and family environment. Though the concern of endogeneity is mentioned in these papers, there are no further studies—examining the video game effect—which conduct causal inference rigorously, to our knowledge.

associated with a higher risk of depression (for example, Rezende, Rodrigues Lopes, Rey-López, Matsudo, & Luiz, 2014). Meanwhile, several studies examining the effect of using a computer find positive effects of online communication on mental health. For example, Shaw & Gant (2002) employ a laboratory experiment and show that internet chatting reduced depression symptoms. Therefore, it is less than clear whether playing PS5, which is a sedentary behavior but also facilitates online communication—online chatting, battle, and cooperative play—negatively affects mental health or not. This study utilizes a natural experiment—neither cross-sectional studies nor laboratory experiments—and examines the effect of video games which are counted as a tool for online communication, on mental health.

The rest of the paper is organized as follows. Section 2 reviews study setting about how PS5 represents the videogame by which people can enjoy online communication, and the reason why there is a scarce supply of PS5 that leads to the lottery, followed both by the outline of the survey conducted by the internet survey company and by the explanation of K6 to capture psychological distress. Section 2 also describes the identification strategy. Section 3 presents the empirical results to check whether video games have an impact on mental health. Finally, section 4 starts with a conclusion, followed by the policy implication and the limitations of our study.

2. Data and Study Design

2.1. Study setting

In October 2020, SONY corporation, a well-known electric company, released PlayStation 5 or PS5, the newest console of the PlayStation series, which is a worldwide well-known video game. In this study, we select PS5 as our primary target video game console because of the increase in the number of people who communicate online through PS5 software such as "Monster-hunter" and "Final Fantasy" under the lockdown policy COVID-19 pandemic.

After its first debut in 1994, the PlayStation series has been widespread. As of June 2021, the sales of PS4 reached 114 million in the world, and more than 100 million people actively play Play Station Network, a digital entertainment service associated with PlayStation for online communication.

However, due to the limited supply of semiconductors for PS5, people can rarely purchase PS5 by a standard method such as online shopping or shopping on-site; hence the main way for people to get PS5 is to join the lottery provided by dealers. Otherwise, they need to pay extra costs to get PS5. For example, if someone wants to purchase PS5 online at Amazon Japan, he/she needs to pay more than 1,000 dollars as of July 2021 (the regular price of PS5 is about 400 dollars).

If people want to join the lottery, they usually need to register their information such as name and email address at the dealer's website. After entering the lottery, they waited for several weeks for the result of dealers that randomly decide the winner. After the announcement of the result, people purchased it if they win the lottery. These conditions for the natural experiment differentiate this paper from previous studies.

2.2.Data

For this study, we work with the Gameage Research and Institution (GRI) in Japan to conduct a survey. GRI hired an Internet survey company called Cross Marketing, Inc. and employed random sampling from about 55,000 people across the nation who had pre-registered as potential survey participants. The survey was implemented on February 2, 2021, under a state of emergency in Japan. GRI sent out our survey to pre-registered 55,000 people in the actual implementation, and 18,189 people responded. Among them, 1,481 people joined the lottery and got the result, and 254 people won the lottery.

Next, we use the Japanese version of K6 as a scale of psychological distress to measure mental health. K6 is composed of 6-item questions that measure the scale of nonspecific

psychological distress in the past 30 days and score the degree of the psychological distress from 0 (the lowest) to 24(the highest) following the methodology used in the previous paper(Yamamoto et al. 2020). In this measure, each question is rated on a scale of 0 (none of the time) to 4 (all of the time). Given its brevity and high accuracy, the K6 is an ideal scale for screening for mental disorders in population-based health surveys in Japan(Furukawa et al. 2003).

We included a question asking about the degree of psychological distress scored on the scale from 0 to 24 measured by K6 and asking if people join the lottery. We specifically focused on the psychological distress of the people who joined the lottery to purchase PS5.

Table 1 shows the descriptive statistics of our sample, including the following variables: age, gender, the degree of the preferences of the games, marital status, job status. This table shows that our sample consists of wide ranges of age and various socio-economic groups. In addition, our sample consists of various characteristics. About half of the respondents were male, married, or have children regarding the distribution of samples. For example, the age structure ranges from children, adolescents[6] to adults, while the sample in the previous experimental studies is typically university students. Besides, the mean of our target variable, K6, is 5.91. Appendix Table A-1 describes the distribution of K6, which shows that 53.2% of scores are below 5, a similar result to the previous study (Yamamoto et al. 2020).

In addition, we include the degree of people's preference on games measured by five scales, ranging from 1(the most frequent user/ heavy user) to 5(non-user), defining it as "Gaming preference.". GRI annually captured this variable through the different questionnaires asking about the frequency of playing the video games and uses it as a significant indicator of

[6] In our survey, parents or guardians sometimes respond on behalf of their children between 15 and 19 years old.

GRI. The mean of "Gaming Preference" was distributed relatively equally in each preference (1: 22%, 2:24%, 3:24%, 4:23%, and 5:7%).[7]

[7] This measure is created and calculated by Gameage Research and Institute. The gaming preference is calculated based on some factors such as frequency of playing the video games, collected by surveys.

Table 1. Descriptive Statistics of the people in our survey

Variables	Mean	SD
Outcome variables		
Kessler Psychological Distress Scale (K6): 0-24	5.91	6.41
Basic characteristics		
Age	36.53	15.61
Gender(Male=1)	0.50	0.50
Married (=1)	0.55	0.50
Have child(ren) (=1)	0.47	0.50
Divorced (=1)	0.06	0.23
Student (=1)	0.04	0.20
Self-employed (=1)	0.08	0.27
Full-time employee (=1)	0.50	0.50
Part-time employee (=1)	0.15	0.35
No job (=1)	0.10	0.30
Gaming preference (Heavy player=1 ~ No gamer=5) = 1	0.22	0.42
Gaming preference (Heavy player=1 ~ No gamer=5) = 2	0.24	0.43
Gaming preference (Heavy player=1 ~ No gamer=5) = 3	0.24	0.43
Gaming preference (Heavy player=1 ~ No gamer=5) = 4	0.23	0.42
Gaming preference (Heavy player=1 ~ No gamer=5) = 5	0.07	0.25
No. of observation	18,189	

Notes: K6 is a scale of psychological distress, where there are 6-item questions in the questionnaire that measures the scale of nonspecific psychological stress in the past 30 days and scores the degree of the psychological distress from 0 (the lowest) to 24(the highest). Gaming Preference is created and calculated by Gameage Research institute and calculated based on some factors such as frequency of playing the video games, collected by surveys. The survey was conducted in February 2021.

2.3.Identification Strategy

In this research, we use the following regression equations to examine the impact of video games on mental health. First, we examine the relationship between video games and mental health by cross-sectional analysis, following the previous studies examining whether video games negatively affect mental health. We use equation (1) to see the correlation between video games and mental health (n = 18,189).

$$(1)\ Y_{pi} = \beta Haveps5 + \xi X_{pi} + \alpha_p + \varepsilon_{pi}$$

where Y_{pi} is the psychological distress measure (K6) for individual *i* in prefecture *p*. *Haveps5* is a dummy taking 1 if an individual has PS5 and 0 otherwise. X is a set of control variables consisting of individual characteristics, including age, gender, marital status, job status, whether having children or not. We also include the gaming preference as control variables: dummies of each scale (1~5). We also include prefecture fixed effects to control for the correlation between the psychological distress measure (K6), whether having PS5, and geographical characteristics.

Note that the method above only leads to correlation, not a causal relationship, while it uses all samples (n=18,189). In other words, the method above has a problem of endogeneity. For example, people who have PS5 would have various characteristics that make people decide to play PS5, which could create a selection bias.

Second, based on this result, we employ a natural experiment based on the lottery to purchase PS5. Here, the target population of our analysis is the people who joined and got the result of the PS5 lottery (n = 1,334).[8] [9] If a lottery is conducted randomly, comparing the psychological distress measure of people who win and lose the lottery would reduce the selection bias caused by the difference between people who have PS5 and people who do not. Hence, we view whether people win the lottery or not as the treatment in our paper and employ the following equation to measure the impact of video games:

$$(2)\ Y_{pi} = \beta lotterywin_{pi} + \phi jointotal_{pi} + \psi X_{pi} + \alpha_p + \varepsilon_{pi}$$

[8] The target population of this analysis is the people who had the will to play PS5, not all the people who joined our survey. The leisure literature stresses the importance of autonomy of choosing leisure (Caldwell 2005) by oneself considering one's personality differences or one's mood ("self-determination hypotheses"). If one does not choose the leisure by oneself, the stress-coping effect of the leisure is expected to be reduced. The psychology literature also argue that this point should be considered in the future research (Granic, Lobel, and Engels 2014). In that sense, limiting our target population to the people who joined the PS5 could be reasonable.

[9] Among 1,481 people who joined the lottery, 147 people had not received the result yet. We use the rest of the participants (1,334) as the target population.

where dependent variable Y_{pi} is k6 for individual *i* in prefecture *p*, *lotterywin* is a dummy taking 1 if an individual wins the lottery and 0 if an individual loses the lottery, and $jointotal$ is the total number of times that people joined the lottery for individual *i* in prefecture *p*,. X_{pi} is a set of control variables that are the same as those used in equation (1); α_p are prefecture dummies. Our main interest lies in the coefficients β, which could capture the causal effect of video games.

As mentioned earlier, using a dummy indicating whether people have PS5 or not (*HavePS5*)—as a variable of interest—causes endogeneity. So instead, as our main analysis, we adopt the Intention to Treat (ITT) approach, using the PS5 lottery result (*lotterywin*) as a variable of interest to mitigate endogeneity problems. In the later part, we also examine the causal effect of *HavePS5* on mental health with the instrumental variable method.

Note that we need to deal with two challenges even in ITT approach: selection about joining the lottery and randomness of the lottery. To begin, one may concern the non-random selection of joining the PS5 lottery. Indeed, the characteristics of the people who joined the PS5 lottery are different from those who did not join the lottery. In Appendix Table A-2, we display the comparison of the observable characteristics. If one wants to apply our estimates to the people who do not join the PS5 lottery, the estimates of our main analysis based on regression (2) could be biased. To adjust for selection into the lottery, we adopt the inverse probability weighting (IPW) method and conduct additional analysis to conjecture what happens if all participants are assumed to join the lottery. In our IPW regressions, the data is weighted by the inverse of the probability of joining the lottery.[10] Probit model estimates are shown in Appendix Table A-3. We predict the probability for each person to join the lottery through the probit model.

[10] The data of the people who joined the lottery—used for estimating equation (2)—is weighted by $\frac{1}{\pi}$ where π denotes the probability of joining the lottery. This is analogous to the way the IPW method is used for dealing with attrition problems (Wooldridge 2011). In our case, for the people who did not join the lottery, whether they won the lottery or not and the subsequent outcomes such as k6 (if they joined the lottery) are not available—attrited.

Next, one would also concern whether the lottery is conducted randomly. Table 2 shows a balance table that is used for verifying the validity of the natural experiment. As explained in the Data and Study setting section, our underlying assumption for the internal validity is that there is no systematic difference in predetermined characteristics between the control group (people who did not win the lottery) and the treatment group (people who win the lottery). Column (1) and Column (2) show the mean of various characteristics for the control group and the treatment group, respectively. Column (3) shows the results of the t-tests and the joint F-test.

One can find that two variables (full-time employment dummy and gaming preference = 5 dummy) show significant correlations with the result of the lottery in columns (2). It is puzzling that the statistically positive estimate of the coefficient of the dummy of gaming preference = 5 (a non-gamer) because this result implies that a non-gamer is more likely to win PS5 than a heavy gamer. Unfortunately, we do not have a clear explanation of this at this stage.

Though the t-stats for some variables indicate statistically significant relationships, the result of the joint F-test (1.557) is not statistically significant. The result of the balance test is not perfect, but at least, it does not strongly reject the validity of the natural experiment. In our regressions, we control for the observed characteristics to address the potential selection bias.

Nevertheless, we still need to admit that other factors may contaminate the randomness of the PS5 lotteries—our estimation is not free from endogeneity problems, including omitted variable bias. For example, one can join the PS5 lotteries multiple times to increase the probability of winning the lottery. We show the comparison of the total number of joining the lottery in the lower part of Table 2. As expected, it is significantly different between people who win the lottery and not (-0.893), which explains that the more times the people join the lottery, the more likely they win the lottery. Moreover, the PS5 lotteries are implemented by stores, and the probability of winning is likely to be different between stores. One might find stores where one can win PS5 at a higher likelihood, though such information is not available online to our knowledge

To mitigate the potential selection bias in estimating the coefficient of interest (β), we additionally control for the number of times of joining the lottery. However, the variable itself is potentially endogenous. To address the problem, we run the regression of equation (2) with and without the number of times of joining the lottery. If the estimated relationship changes with the inclusion of this variable, it would indicate that such variables are potentially driving part of the observed relationship between being a PS5-lottery winner and the psychological distress scale. As it turns out, the data do not indicate that to be the case.

Table 2 Randomness check of lottery

Variable	N	(1) Did not win PS5 lottery Mean/SE	N	(2) Won PS5 lottery Mean/SE	(3) t-test Difference (1)-(2)
Age	1080	35.017	254	35.618	-0.601
		[0.299]		[1.187]	
Gender (Male=1)	1080	0.619	254	0.571	0.049
		[0.016]		[0.032]	
Married (=1)	1080	0.544	254	0.551	-0.008
		[0.014]		[0.041]	
Have child(ren) (=1)	1080	0.470	254	0.472	-0.002
		[0.016]		[0.039]	
Age	1080	0.050	254	0.047	0.003
		[0.007]		[0.015]	
Gender (Male=1)	1080	0.044	254	0.067	-0.023
		[0.006]		[0.016]	
Stay-at-home wife/husband (=1)	1080	0.076	254	0.091	-0.015
		[0.007]		[0.016]	
Full-time employee (=1)	1080	0.655	254	0.547	0.107***
		[0.016]		[0.030]	
Self-employed (=1)	1080	0.073	254	0.102	-0.029
		[0.009]		[0.020]	
Part-time employee (=1)	1080	0.089	254	0.098	-0.010
		[0.010]		[0.016]	
No job (=1)	1080	0.064	254	0.094	-0.031
		[0.007]		[0.020]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 1	1080	0.491	254	0.488	0.003
		[0.015]		[0.034]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 2	1080	0.252	254	0.240	0.012
		[0.014]		[0.025]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 3	1080	0.144	254	0.122	0.022
		[0.011]		[0.030]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 4	1080	0.100	254	0.106	-0.006
		[0.010]		[0.014]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 5	1080	0.013	254	0.043	-0.030**
		[0.003]		[0.010]	
F-test of joint significance (F-stat)					1.557
F-test, number of observations					1334
# of times joined lottery	1080	3.276	254	4.169	-0.893***
		[0.110]		[0.312]	

Notes: Gaming preference is created and calculated by Gameage Research institute and calculated based on some factors such as frequency of playing the video games, collected by surveys. The number of times of joining lotteries is censored at 99 percentiles to deal with extreme values. Regressions include prefecture fixed effects. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

Finally, to estimate the causal effect of having PS5 on mental health, we use the PS5 lottery result (win or not) as an instrument, focusing on the situation where the lottery result influences mental health only through having PS5. Thus, the endogenous variable used in the IV regression is a dummy of having PS5. This setting allows us to compare the estimates of the OLS and the IV regressions. With the IV regression, the estimation of local average treatment effects (LATE; Lousdal 2018)) is of interest to evaluate the impact of video games on mental health.

3. Empirical Results

3.1. Estimates by cross-sectional analysis

First, we examine the relationship between PS5 ownership and psychological distress measure (K6) by equation (1). In our data, 319 samples have PS5, and the result in each Column in Table 3 indicates a positive correlation between *haveps5* and psychological distress (*k6)*, which aligns with the findings of the previous studies. Column (1) shows the results of regression (1) without control variables, which describes that the people are feeling higher stress by 1.59 in K6 scale when they have PS5. Column (2) displays the results of regression (1) with control variables except for gaming preference with the anticipation that gaming preference has a strong correlation with stress based on the previous studies. The point estimate of the coefficient of the having PS5 dummy is 1.84, meaning people is still under higher stress when they have PS5. Finally, Table 3 Column (3) shows regression (1) results with control variables, including gaming preference, which reports people feeling higher stress by 1.17 in the K6 scale when they have ps5. Indeed, as argued by Ferguson (2015), including control variables reduces the magnitude of the negative impact. Particularly, we find that the magnitude of the impact drops when we include gaming preference. In sum, the results of our cross-sectional analysis successfully traced the results of the previous studies.

Table 3. The relationship between Psychological Distress (K6) and Having PS5

VARIABLES	(1) Kessler Psychological Distress Scale: 0-24	(2) Kessler Psychological Distress Scale: 0-24	(3) Kessler Psychological Distress Scale: 0-24
1 if having PS5	1.59***	1.84***	1.17**
	(.539)	(.515)	(.495)
Observations	18,189	18,189	18,189
R-squared	.00607	.0595	.077
Controls	No	Yes	Yes
Gaming preference dummies	No	No	Yes
Prefecture FE	Yes	Yes	Yes

Notes: Results show the correlation between the psychological distress measure (K6) and the having PS5 dummy from equation (1). Control variables include age, gender, marriage dummy, dummy indicating having child(ren), dummy indicating divorced, dummy indicating student, dummy indicating stay-at-home wife/husband, dummy indicating self-employed, dummy indicating part-time employed, and dummy indicating jobless. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

However, this method to measure the impact of video games on mental health has one challenge: selection bias. People who have PS5 are likely to be different from those who do not have PS5 in terms of individual characteristics, family background (as shown in Appendix Table A-2), or other ways that are unobservable. Indeed, Table 3 shows that the coefficient of β in equation (1) varies depending on the control variable, especially on the existence of gaming preference. Therefore, we need to find a way to differentiate the causal impact of video games on mental health, even though there are positive correlations between *K6* and *Haveps5*.

3.2.Estimates based on natural experiment

In response to the challenge, we examine the impact of video games (PS5) on the mental health measured by K6 in equation (2), exploiting the natural experiment. The results in Table 4 indicate statistically insignificant relationships between the result of the lottery and mental distress, which is different from the previous studies and the results in Table 3, while we admit that the decrease of the sample size would reduce the precision of the estimation. Firstly, Column (1) describes the results of equation (2) without control variables, which was statistically insignificant. Secondly, in Column (2), we run the regression with control variables

except *jointotal* to check how it affects the results because of potential endogeneity between the result of the lottery and the number of joining the lottery, as seen in section 2.3. Thirdly, Column (3) describes the results of the regression, including *jointotal*.

Notably, the results in Table 4 Columns (2) and (3) show a statistically insignificant relationship between winning PS5 and psychological distress. We do not see a huge difference in the estimates of coefficient β between with (0.462) and without (0.474) the number of joining the lottery. Thus, the estimates of the coefficient of the variable of interest (1 if won PS5 lottery) do not change significantly despite the inclusion of the potentially endogenous variable, *jointotal*.

Table 4. The impact of video games on mental health estimated by exploiting lottery

	(1)	(2)	(3)
VARIABLES	Kessler Psychological Distress Scale (k6): 0~24		
1 if won PS5 lottery	.546	.474	.462
	(.448)	(.421)	(.437)
# of times joined lottery			.0145
			(.0623)
Observations	1,334	1,334	1,334
R-squared	.0455	.103	.103
Controls	No	Yes	Yes
Prefecture FE	Yes	Yes	Yes
Mean	5.86	5.86	5.86

Notes: Results show the ITT estimates from equation (2). Control variables include age, gender, marriage dummy, dummy indicating having child(ren), dummy indicating divorced, dummy indicating student, dummy indicating stay-at-home wife/husband, dummy indicating self-employed, dummy indicating part-time employed, dummy indicating jobless, and gaming preference dummies of scale 1~5 for each. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

There are some possible explanations for the insignificant estimates. Firstly, the previous studies have overestimated the impact of video games due to bias such as selection bias. Secondly, an important motivation for people to purchase PS5 is to play games online to spend time with friends under the COVID-19 lockdown policy. Such a social connection generated through PS5 might mitigate the negative impact of video games on psychological distress (Shaw and Gant 2002). Thirdly, the number of samples for this analysis (n = 1,334) is

smaller than that of the samples for our OLS (n = 18,189). Smaller sample size would increase standard errors, thus may cause insignificant results.

We also admit that our study design targets a limited population. The main target population is those who joined and got the result of the lottery (n = 1,334). It does not include those who did not join the survey (n = 16,708). Indeed, there are significantly different baseline characteristics between people who joined the lottery and people who had never joined the lottery in Appendix Table A-2. For example, we see a significant difference in some variables such as K6 (-2.068) and gaming preference.

To adjust for the selection into the PS5 lottery, we employ the IPW method. Table 5 shows the results of our IPW regressions. Columns (1), (2), and (3) indicate no significant impact of video games on mental health, consistent with the results in Table 4. The structure of Table 5 is analogous to that of Table 4. First, Column (1) describes the results without control variables, which were statistically insignificant. Then, in columns (2) and (3), we run the regression with control variables. The difference between Columns (2) and (3) is whether the results include variable *jointotal*. The results in Table 5 Columns (2) and (3) show a statistically insignificant relationship between the result of the lottery and stress again.

Table 5. The impact of video games on stress through the lottery adjusted by IPW

VARIABLES	(1)	(2)	(3)
	Kessler Psychological Distress Scale (k6): 0~24		
1 if won PS5 lottery	.594	.433	.431
	(.58)	(.48)	(.499)
# of times joined lottery			.00348
			(.0783)
Observations	1,334	1,334	1,334
R-squared	.0572	.139	.139
Controls	No	Yes	Yes
Prefecture FE	Yes	Yes	Yes
Mean	5.86	5.86	5.86

Notes: Results show the ITT estimates adjusted by inverse probability weighting. Control variables include age, gender, marriage dummy, dummy indicating having child(ren), dummy indicating divorced, dummy indicating student, dummy indicating stay-at home wife/husband, dummy indicating self-employed, dummy indicating part-time employed, dummy indicating jobless, and gaming preference dummies of scale 1~5 for each. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

To estimate the causal effect of having PS5 on mental health, we run the instrumental variable (IV) regression, using the dummy indicating winning the lottery as an instrumental variable. In this setting, our main explanatory variable is whether people have PS5 (*havePS5*)—same as equation (1). Table 6 shows the results of the IV analysis. Specifically, we run the regression without the IPW method in Columns (1) and (2) while the results based on the IPW method are shown in Columns (3) and (4). Columns (1) and (3) describes the results without control variables, while Columns (2) and (4) show the results with control variables.

Columns (1) through (4) of Table 6 indicate no significant impact of video games on mental health, still consistent with the results in Tables 4 and 5. The magnitude of the point estimates is smaller than those from OLS shown in Table 3. Note that the IV method provides less efficient estimates than OLS, which might affect our results. Still, we find the coherency of the results through the reduced form, the IPW, and the IV methodology.

The first stage regression results are shown in Appendix A-4. The F-stats for the weak IV test, which is shown in Table 6, is high enough. Thus, the weak IV problem is not a big concern for our IV analysis.

Table 6. IV results

	(1)	(2)	(3)	(4)
VARIABLES	Kessler Psychological Distress Scale (k6): 0-24			
1 if having PS5	.91	.777	1.02	.721
	(.764)	(.749)	(1.02)	(.848)
Observations	1,334	1,334	1,334	1,334
Controls	No	Yes	No	Yes
Prefecture FE	Yes	Yes	Yes	Yes
IPW	No	No	Yes	Yes
Mean	7.776	7.776	7.776	7.776
Kleibergen-Paap rk Wald F statistic	524	498.3	199.6	303

Notes: Results show the IV estimates with and without inverse probability weighting. Control variables include age, gender, marriage dummy, dummy indicating having child(ren), dummy indicating divorced, dummy indicating student, dummy indicating stay-at-home wife/husband, dummy indicating self-employed, dummy indicating part-time employed, dummy indicating jobless, and gaming preference dummies of scale 1~5 for each. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

4. Conclusion

The objectives of the present study were to investigate whether video games negatively affect mental health under COVID-19 containment policies. The present study focuses on a lottery to purchase PS5—a well-known console for online communication through its software—and uses it as a natural experiment to measure the impact of video games on mental health. Based on previous findings from observational studies within the existing literature (Giardina et al. 2021; Kato, Shinfuku, and Tateno 2020; Oka et al. 2021), we hypothesized that our sample would show a negative impact of video games on mental health.

Contrary to our hypothesis, the results of our study indicated that video games have no significant negative effects on people's mental health. One of the possible explanations is that the previous studies have overestimated the impact due to bias such as selection bias. We also adjust for the selection into the lottery by applying the IPW method; the results are consistent with our primary results. Our IV estimation for robustness checks also supports these results.

The effectiveness of our finding would probably not be limited under the COVID-19 pandemic situation where people are forced to communicate online under the lockdown policies. Some of the changes in people's lifestyle would not return to the past. If so, finding stressors under the new lifestyle would stay a field of academic or public interest. Thus, our results could potentially be the key to understanding the relationship between video games and mental health for future studies.

4.1.Policy Implication

As concisely discussed in section 1, how to deal with stress has been one of the core interests among policymakers, especially after the COVID-19 pandemic, because the magnitude of psychological distress (k6) increases under the lockdown policy. For example, the government provides hotline services for people who suffered from mental health. For policymakers to form proper measures to tackle this issue, it is essential to understand the mechanism that induces stress among people. If policymakers misunderstand the mechanism, they will spend valueless money to improve the problem.

This paper contributes to policymakers having a proper understanding of the relationship between video games and mental health. Without this paper, policymakers would imagine that video games increase stress based on previous studies' findings. This misunderstanding would encourage them to regulate the activity regarding video games. For example, Kagawa prefecture in Japan places an obligation on parents to make rules at home and make efforts to have their children comply with the guideline that those under 18 should use video games for no more than 60 minutes a day (90 minutes on school holidays) and stop using smartphones by 9 p.m. for junior high school students and younger and by 10 p.m. for all others to avoid the addiction on video games (IT media news 2020). Our findings would assist the government to make wiser policy decisions on regulating people's activities of gaming.

In addition, video games play a significant role as a tool for online communication. Indeed, some local governments in Japan and the U.S. employ video games in education such as e-Sports, where students play video games as a part of sports (Impress Watch 2020; New York State 2019). Therefore, it is essential to have a proper view of video games on mental health when the authorities account for the value of the programs to stakeholders such as parents. Thus, the results of the present study help policymakers formulate good educational policies based on a less biased idea about the impact of video games on mental health.

4.2.Limitations

Despite the results that we find in this study, we need to acknowledge some limitations in our research. First, due to a limitation of the survey method, we could not capture the duration of the playing game. Instead, we focus on the condition that people have PS5. As discussed in some of the previous research, addiction to video games occurs depending on the duration of play. We can solve this issue by including the question asking about the duration of the play in the future survey so that the result shows the impact of the duration of playing video games on mental health.

Second, this study focuses on the impact of PS5 on mental health, whereas many consoles such as Nintendo Switch also provide a platform for online communication. While focusing on PS5 because people need to join the lottery to purchase PS5, we need to find a way to estimate other consoles' impact.

Third, this study uses cross-sectional data and cannot conclude the long-term effects of video games on mental health. Therefore, we cannot infer how playing games over time could contribute to a change of stress. Repetition of the survey over time is a solution to this challenge.

Fourth, our approach of exploiting the natural experiment can only utilize a smaller number of samples compared to an approach using the full sample. This leads to less precise

estimates by its design. This can be a reason for obtaining insignificant estimates. At least, we attempt to adjust the selection into a smaller number of samples by using the IPW method.

Finally, the randomness of the natural experiment is far from perfect. One can join the lottery multiple times, and many different stores conduct the lottery. This mechanism of the lottery would create room for finding a better opportunity to win the lottery. A field experiment of exogenously creating variation in playing video games in a sample population would generate more reliable data.

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Appendix

Table A-1. Distribution of K6 in our sample

K6 score	# of Observation	Percent	Cumulative(%)	K6 score	# of Observation	Percent	Cumulative(%)
0	5641	31.01	31.01	13	419	2.3	86.01
1	1201	6.6	37.62	14	366	2.01	88.02
2	1120	6.16	43.77	15	328	1.8	89.82
3	877	4.82	48.6	16	301	1.65	91.48
4	844	4.64	53.24	17	257	1.41	92.89
5	777	4.27	57.51	18	330	1.81	94.71
6	942	5.18	62.69	19	201	1.11	95.81
7	630	3.46	66.15	20	173	0.95	96.76
8	604	3.32	69.47	21	112	0.62	97.38
9	548	3.01	72.48	22	95	0.52	97.9
10	506	2.78	75.27	23	75	0.41	98.31
11	501	2.75	78.02	24	307	1.69	100
12	1034	5.68	83.7				

Note: K6 is a scale of psychological distress, where there are 6-item questions in the questionnaire that measures the scale of nonspecific psychological stress in the past 30 days and scores the degree of the stress from 0 (the lowest) to 24(the highest). Detailed information is provided by National Commodity Survey (https://www.hcp.med.harvard.edu/ncs/k6_scales.php).

Table A-2. Characteristics of people who join the lottery and people who do not join.

Variable	N	(1) Not joined lottery Mean/SE	N	(2) Joined lottery Mean/SE	t-test Difference (1)-(2)
Outcome variables					
Kessler Psychological Distress Scale (k6): 0-24	16708	5.707	1334	7.776	-2.068***
		[0.048]		[0.197]	
Measure of happiness: 5-35	16708	17.046	1334	16.468	0.578***
		[0.050]		[0.183]	
Basic characteristics					
Age	16708	36.669	1334	35.131	1.538***
		[0.122]		[0.392]	
Gender (Male = 1)	16708	0.493	1334	0.610	-0.117***
		[0.004]		[0.013]	
Married (=1)	16708	0.546	1334	0.545	0.001
		[0.004]		[0.014]	
Have child(ren) (=1)	16708	0.472	1334	0.471	0.001
		[0.004]		[0.014]	
Divorced (=1)	16708	0.059	1334	0.049	0.009
		[0.002]		[0.006]	
Student (=1)	16708	0.039	1334	0.048	-0.009
		[0.001]		[0.006]	
Stay-at-home wife/husband (=1)	16708	0.133	1334	0.079	0.054***
		[0.003]		[0.007]	
Full-time employee (=1)	16708	0.493	1334	0.634	-0.141***
		[0.004]		[0.013]	
Self-employed (=1)	16708	0.078	1334	0.079	-0.001
		[0.002]		[0.007]	
Part-time employee (=1)	16708	0.151	1334	0.091	0.061***
		[0.003]		[0.008]	
No job (=1)	16708	0.105	1334	0.070	0.036***
		[0.002]		[0.007]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 1	16708	0.197	1334	0.490	-0.294***
		[0.003]		[0.014]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 2	16708	0.241	1334	0.250	-0.008
		[0.003]		[0.012]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 3	16708	0.246	1334	0.140	0.106***
		[0.003]		[0.010]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 4	16708	0.245	1334	0.101	0.143***
		[0.003]		[0.008]	
Gaming preference (Heavy player=1 ~ No gamer=5) = 5	16708	0.071	1334	0.019	0.053***
		[0.002]		[0.004]	
F-test of joint significance (F-stat)					60.602***
F-test, number of observations					18042

***, **, and * indicate significance at the 1, 5, and 10 percent critical level.

Table A-3. Estimation results for the non-lottery-joining probit model.

VARIABLES	(1)
Age	-.0016
	(.000998)
Gender (Male=1)	.166***
	(.0315)
Student (=1)	.000136
	(.0726)
Stay-at-home wife/husband (=1)	-.247***
	(.0536)
Self-employed (=1)	-.121**
	(.0555)
Part-time employee (=1)	-.315***
	(.049)
No job (=1)	-.316***
	(.0549)
Gaming preference (Heavy player=1 ~ No gamer=5) = 2	-.445***
	(.0371)
Gaming preference (Heavy player=1 ~ No gamer=5) = 3	-.732***
	(.0417)
Gaming preference (Heavy player=1 ~ No gamer=5) = 4	-.878***
	(.0451)
Gaming preference (Heavy player=1 ~ No gamer=5) = 5	-1.06***
	(.0864)
Constant	-.907***
	(.0469)
Observations	18,042

Notes: Standard errors are in parentheses. ***p < 0.01, **p < 0.05, *p < 0.1.

Table A-4. First stage regression results.

VARIABLES	(1) 1 if having PS5	(2) 1 if having PS5	(3) 1 if having PS5	(4) 1 if having PS5
1 if won PS5 lottery	.599***	.594***	.585***	.598***
	(.0262)	(.0266)	(.0414)	(.0344)
Observations	1,334	1,334	1,334	1,334
Controls	No	Yes	No	Yes
Prefecture FE	Yes	Yes	Yes	Yes
IPW	No	No	Yes	Yes
Mean	.16	.16	.16	.16

Notes: First stage regression results for the IV analysis with and without inverse probability weighting are shown. Control variables include age, gender, marriage dummy, dummy indicating having child(ren), dummy indicating divorced, dummy indicating student, dummy indicating stay-at-home wife/husband, dummy indicating self-employed, dummy indicating part-time employed, dummy indicating jobless, and gaming preference dummies of scale 1~5 for each. Standard errors are clustered by prefectures. ***p < 0.01, **p < 0.05, *p < 0.1.

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