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# Managing the Public Health Risks in the Time of COVID-19

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**Abstract**

Compliance with the public health authority guidelines is crucial to prevent the spread of COVID-19 successfully. By analyzing individual responses to a survey, we identify the weakest links, i.e., those who do not follow the guidelines as much as others do, and why they are failing. We find that individuals older than 60 are most enthusiastic in protecting their and others' health and that those younger than 30 are least enthusiastic. We categorize the factors possibly influencing the precautionary behavior into three groups: preference, belief, and constraint. It turns out that although beliefs on the effectiveness of protective measures do predict individual differences in their endeavors, they do not vary significantly across gender and age groups. On the other hand, risk, time, and social preferences explain individual differences well and significantly differ across gender and age groups. We also derive an implication for managing long-term risks due to fatigue and depression.

**JEL Classifications**: D01, D91, I12, I18

**Keywords**: Risk preference, Social preference, Health behavior, Life satisfaction, COVID-19

## 1 Introduction

In response to the COVID-19 pandemic, the public health authority provided citizens guidelines to slow down the disease's spread. Obviously, compliance with a policy is crucial for the policy

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to be effective. What makes everybody's compliance more important now than usual is the fact that even a small number of non-compliers without symptoms can spread the disease to many. Thus, it is of great importance to identify and secure the weakest links to successfully manage the risk.

In this paper, we identify who are not following the guidelines as much as others are and why they are failing by analyzing individual responses to an online survey of a representative sample of Koreans run in August 2020. For this purpose, we measured individual effort to protect their and others' health and life. More specifically, in the survey, we asked to report every precautionary measure that they were taking among ten items,[1] and for the main quantitative measure of individual effort, we employ the number of items checked. We also elicited risk, time, and social preferences by employing the method developed by Falk et al. (2018), and beliefs on the infection risk, and the effectiveness of precautionary measures. The survey design is discussed in Section 3, and the translated survey is in the appendix.

We find that individuals older than 60 are most enthusiastic in protecting their and others' health, and those younger than 30 are least enthusiastic. Because as Table 1 shows, COVID-19 is deadlier for the older than for the younger, our finding suggests that the risks of physical pain and death are rather well understood, which echoes Schmitz and Wübker (2011) who found that existing health conditions affect the health-protective behavior. This is in line with the growing body of evidence indicating that unhealthy behaviors often cluster in young individuals (Meng et al. (1999)), and gender and sociocultural factors are likely to influence health-related behavior (Deeks et al. (2009)).

Table 1: Fatality rate by age group in Korea

| Age group | Fatality rate |
|---|---|
| 30s | 0.05% |
| 40s | 0.10% |
| 50s | 0.42% |
| 60s | 1.27% |
| 70s | 6.68% |
| 80s + | 19.45% |

Source: Statista 2020

The optimal policy to secure the weakest links would depend on the reasons why they are putting less effort than others. For example, if non-compliers have misperceptions regarding

[1] The list of precautionary measures includes: "keeping 2m distance from others", "taking a 3-4 day break when feeling unwell", "canceling social gatherings," and "wearing a mask when going out."

the risks of COVID-19, providing the information would correct the bias. On the other hand, if preferences are the reason, then providing correct information would not do much good. Instead, more direct and coercive measures may be called for.

Thus, we investigate individual efforts further, focusing on the factors possibly influencing the precautionary behavior: preference, belief, and constraint. By *preference*, we mean risk, time, and social preferences as well as the aversion to physical and mental pains due to COVID-19. *Beliefs* are those on risks and the effectiveness of protections such as wearing a mask and social-distancing. Some people may have to bear a greater cost to follow the health authority guidelines because of their job requirements, where they live, disabilities, etc. Such factors are what we call *constraints*. Our focus is guided by the literature. For instance, Anderson and Mellor (2008) found that risk aversion increases the effort put in health-protective measures, and Hurley and Mentzakis (2013) reported that altruism is shown to affect similar decisions in the context of transmittable diseases.

Our results provide empirical evidence that (1) health-protective behaviors differ by age groups and gender, (2) they can be well explained by belief, preference, and cost as predicted, (3) different protective behaviors by age groups and gender can be explained by the difference in preference, and (4) those who put more effort in health protection suffer more than others in terms of life satisfaction. In other words, while beliefs on risks and the effectiveness of protective measures predict protective behaviors well, the differences in terms of belief are not significant across age groups. Why younger individuals are not putting great efforts in protective behaviors is due to the difference in risk, time, and social preferences, which differ significantly across age groups and gender.

On top of the aforementioned risk, we may also have to pay attention to fatigues and the negative effects on subjective well-being. Low life satisfaction is closely related to mental illness, depression, and high suicide rates (Bray and Gunnell (2006); Fergusson et al. (2015). In this sense, even if individuals (like people in their 60s) put great effort to follow the guidelines, they might suffer more in terms of mental health, which could cause another type of social risk in the long term. Therefore, together with the health policy promoting protective behaviors in the pandemic period, the authority should consider the long-term mental health with constant monitoring and social support for the vulnerable groups.

Since the outbreak, thousands of papers on the psychological, social, and economic effects of and responses to COVID-19 have been written. Among those, two most closely related studies are Campos-Mercade et al. (2020) and Sheth and Wright (2020). Campos-Mercade et al. (2020), studying the responses of Swedish people, find evidence that prosocial preferences

are predictive of taking precautionary measures. Sheth and Wright (2020), on the other hand, study the compliance to social distancing policy in the U.S., and find that neither preferences nor health conditions are predictive of compliance. The difference may be explained by the fact that in Campos-Mercade et al. (2020) the sample includes adults of all ages and educational achievement, whereas Sheth and Wright (2020) focus on college students. Our setup and findings are closer to those of Campos-Mercade et al. (2020) than Sheth and Wright (2020).

This study contributes to the literature on the responses to health policy during a pandemic (Bish and Michie (2010);Bults et al. (2011); Ibuka et al. (2010)). In the context of COVID-19, Wise et al. (2020) find that perceived personal risk is associated with preventative behaviors, but people are incompetent at assessing the actual risk. We also contribute to the broader literature on individual health-related decisions (Anderson and Mellor (2008); Hurley and Mentzakis (2013);Schmitz and Wübker (2011)).

## 2 Conceptual Framework

This section develops a simple model of health-protective behavior to organize ideas and present hypotheses formally. In particular, we focus on three groups of factors: *preference, belief*, and *constraint*. By *preference*, we mean risk, time, and social preferences as well as the aversion to physical and mental pains due to COVID-19. Of course, the *beliefs* on risks and the effectiveness of protections such as wearing a mask would affect individuals' behavior. Some people may have to bear a greater cost to follow the health authority guidelines because of their job requirements, where they live, disabilities, etc. Such factors are what we call *constraints*.

Let us consider an individual who puts effort to avoid getting infected by taking protective measures such as wearing a mask and refraining from social gatherings. The utility function of the individual is given by:

$$U_h - c(e) + \beta[U_h - p(e)\{\Delta U + q(e)G\}]$$

where $U_h$ is the utility level when healthy, $\Delta U(>0)$ is the change in utility due to infection, and $G(\geq 0)$ is the change in utility due to spreading the disease to others (namely, *guilt*). $\beta$ is the discount factor capturing the gap between now and the time suffering. $p(e)$ and $q(e)$ are the probabilities (that is, subjective beliefs) of getting infected and of spreading the disease to others, respectively, and $e$ is the effort level, which is a non-negative real number. We assume that the probabilities are decreasing, convex, and continuously differentiable, meaning that as

the individual puts more effort, the probabilities of infection decline, but the marginal effects are getting smaller. Notice that the individual may experience the *social pain* $G$ only if she gets infected first and then infects others. That is, without getting infected first, she cannot infect others. $c(e)$ is the effort cost assumed to be increasing, strictly convex, and continuously differentiable. To ensure the existence of an interior solution, we also assume that $c'(0) = 0$.

Note that $\Delta U$ is affected by a couple of factors. First, if an individual expects that suffering the disease would be physically and mentally painful, $\Delta U$ will be high. That is, if an individual is in a high-risk group (e.g., old and with chronic diseases), then such conditions will be captured by a high $\Delta U$ in this model. Also, $\Delta U$ is related to risk-aversion. A risk-averse individual would evaluate a downward utility change more greatly than an upward change. The more risk-averse an individual is, the greater the downward utility change would be. Thus, a greater risk-aversion would be captured by a greater $\Delta U$. On the other hand, $G$ captures the social preferences of an individual. If she cares for others, then she would feel guilty and regretful when infecting others. Also, if the individual lives with a child and/or an old member of her family, she would be more averse to getting infected than those who live alone.

The individual maximizes her utility by choosing $e$. The first-order condition is:

$$\beta[-p'(e^*)\{\Delta U + q(e^*)G\} - p(e^*)q'(e^*)G] = c'(e^*).$$

where $e^*$ is the optimal effort. A comparative static analysis is straightforward. Notice first that the marginal benefit of effort is on the left-hand side, and the marginal cost is on the right. Thus, any change that increases the left-hand-side would increase the optimal effort $e^*$, and any change that increases the right-hand-side would decrease it. Note also that since $p(e)$ and $q(e)$ are probabilities of *failures*, they are decreasing functions, which means that both $p'(e)$ and $q'(e)$ are negative.

Having these in mind, one can easily see that the optimal effort is increasing in $\Delta U$ and $G$, the expected utility changes in the events of infection, $\beta$, how much she cares for the future utility, and $p'(e)$ and $q'(e)$, the beliefs on the effectiveness of effort.[2] On the other hand, the optimal effort would decline as the marginal effort cost $c'(e)$ gets larger for any given $e$, that is, if she has constraints such as not being able to work from home and commuting by public transportation.

Moreover, the envelope theorem implies that the utility decrease will be larger for those who have greater $\Delta U$, $G$, $\beta$, $p(e)$, $q(e)$, and $c(e)$ (for any given $e$). Therefore, if we interpret

[2]For the probabilities which are functions of $e$, we must add "for any $e$" when doing a comparative static analysis. For example, if $p_1(e) > p_2(e)$ for any $e$, the optimal effort will be higher with $p_1(e)$.

the utility as *happiness* or subjective well-being, it means that those who expect to be hit by the shock more greatly would become *unhappier* than others. In other words, the subjective well-being of those who have greater $\Delta U$, $G$, $\beta$, $p(e)$, $q(e)$, and $c(e)$ would decline more, which roughly means that those who put greater effort in health-protective behavior would suffer more in times of pandemic.

The discussion thus far can be summarized as follows:

- An individual would try harder to avoid getting infected if the individual
  - is more averse to physical and mental pains,
  - is more risk-averse,
  - is more altruistic,
  - lives with a child or an elderly,
  - cares more for the future utility,
  - believes that the protective measures are effective,
  - and has fewer constraints.
- Roughly speaking, in times of pandemic, the subjective well-being of those who put greater effort in health protection would decline more than the subjective well-being of others.

# 3 Survey Design

Most people tend to be honest (or averse to lying) even when being honest is costly.[3] Nevertheless, responses to a morally loaded survey question may be biased because they may want to keep up a good image of themselves to themselves or to others.[4] Thus, instead of asking directly, "how well are you following the guideline?" we asked to report every precautionary measure that they were taking among ten items, most of which are from the guideline.[5] We

[3] There is a growing literature documenting people's lying aversion and preference for truth-telling. See, for example, Abeler et al. (2019), Gneezy et al. (2018), and the references therein.

[4] For studies on social image concern, see for instance Glazer and Konrad (1996), and Andreoni and Bernheim (2009). For those on self-image concern, see Bénabou and Tirole (2006), and Schram and Charness (2015).

[5] It is question #10 in Part C of the survey which can be found in the appendix. The precautionary measures include "keeping 2m distance from others", "taking a 3-4 day break when feeling unwell", "canceling social gatherings," and "wearing a mask when going out."

believe that people would respond more honestly in this setup because most of them were actually putting *some effort* as opposed to none, and it was challenging to do everything perfectly. So, this setup encouraged participants to be honest by allowing them to justify themselves for not being perfect easily. For the main quantitative measure of individual preventative effort, we employ the number of items checked.

As for beliefs, we directly asked the following questions: "Suppose an individual puts effort in precautionary measures exactly as you do. What do you think of the probability that the person gets infected within a week?" and "If the person got infected, what do you think of the probability that the person infects another person within a week?" Furthermore, we asked them to imagine the following hypothetical situations: they did not wear a mask at all in public places or go to social gatherings as before the outbreak. And then, we asked the same questions about the infection probabilities.[6] By subtracting the baseline probabilities from the hypothetical probabilities[7], we construct the measures for the effectiveness of wearing a mask and of avoiding social gatherings.

Our preference measures can be divided into two: the standard preferences and those regarding COVID-19. We follow Falk et al. (2018) to elicit the standard preferences such as risk, time, social preferences. Falk et al. (2018) identified non-incentivized questions that generate responses highly correlated with responses to incentivized questions and ran a world-wide survey to examine how risk, time, social preferences differ across and within nations. We employed their questions with minor modifications.[8] We also measure the aversion to COVID-19 by asking the following questions: "What do you think of the physical pain of Covid-19 in comparison with usual influenza?" (estimated physical pain), "Let's suppose you got infected, and infected others. What do you think of the mental pain of it in comparison with the physical pain?" (estimated mental pain), and "Let's suppose you got infected, and infected others. What do you think of the mental pain that you may suffer due to the social blame in comparison with the physical pain?" (estimated pain of infecting others)[9] On top of these, we also gathered demographic information.

[6] These are questions #2.1 and #2.2 of Part A.
[7] These are questions #3.1 and #3.2 (for masks), and #4.1 and #1.2 (for distancing) of Part A.
[8] These questions are in Part B of the survey.
[9] These are questions #5, #6, and #7 in Part A.

# 4 Results

## 4.1 Data

For this study, a private survey company[10] in South Korea ran an online survey in August 2020. 1,500 representative samples were collected within 3 weeks. Among this, 155 individuals who wore a mask less often or increased social activities after the COVID-19 outbreak were dropped for the analyses, which leaves us 1,345 observations in total.[11] Table 2 presents the summary statistics. Precautionary behavior is our main variable of interest, which is defined as the sum of all effort measures (e.g., wearing a mask, social distancing, etc.) each participant reported s/he followed to avoid the risk of COVID-19. There are ten effort measures they could choose in the question.[12] It turns out that Koreans take six health-protective measures on average. We further separate this effort measure into two categories: distancing (four effort measures) and sanitation (six effort measures).

Table 2: Summary Statistics

| | (1) | | | |
|---|---|---|---|---|
| | mean | sd | min | max |
| Female (=1) | 0.50 | 0.50 | 0.00 | 1.00 |
| Age | 44.63 | 13.09 | 20.00 | 69.00 |
| Monthly Income | 239.48 | 234.57 | 0.00 | 1000.00 |
| University (=1) | 0.77 | 0.42 | 0.00 | 1.00 |
| Having Children (=1) | 0.94 | 0.24 | 0.00 | 1.00 |
| Living with Elderly | 0.33 | 0.47 | 0.00 | 1.00 |
| Precautionary Measure | | | | |
| Total | 6.03 | 2.43 | 1.00 | 10.00 |
| Distancing | 3.15 | 1.73 | 0.00 | 6.00 |
| Sanitation | 2.89 | 1.04 | 0.00 | 4.00 |
| Observations | 1345 | | | |

[10] Macromill Embrain

[11] We further included these 155 participants for robustness checks, and qualitative results remain the same.

[12] There were 11 effort measures in the survey, but none checked the option "I still try to connect with people and friends even though I have to keep physical distance with them."

## 4.2 Health-Protective Behavior

Table 3 shows the heterogeneity in taking precautionary measures by gender and age groups. First of all, female participants tend to make more efforts (0.823 higher) than male participants (Deeks et al. (2009)). Having the participants aged in their 40s as the reference group, dummies for participants in their 20s, 30s, 50s, and 60s are considered. Younger participants make less effort, and older participants make more efforts (Deeks et al. (2009); Meng et al. (1999)). Especially participants in their 20s make on average 0.796 fewer efforts than those in their 40s, and participants in their 60s reported on average 0.649 more efforts. While females put consistently more efforts in both distancing and sanitation, age groups have different figures, depending on effort types. In terms of sanitation, the age differences are not so salient, whereas efforts related to social distancing has significant differences across age groups. Compared to the individuals in their 40s, those in their 20s significantly put fewer efforts in social distancing (and so do those in their 30s). Those in their 60s try to keep social distance significantly more.

Table 3: Precautionary Behavior by Gender and Age Group

| | (1) Total | (2) Distancing | (3) Sanitation |
|---|---|---|---|
| Female (=1) | 0.823*** | 0.444*** | 0.378*** |
| | (0.128) | (0.0915) | (0.0557) |
| Reference Group: Age 40s | | | |
| Age 20s | -0.796*** | -0.713*** | -0.0829 |
| | (0.203) | (0.145) | (0.0883) |
| Age 30s | -0.439** | -0.304** | -0.135 |
| | (0.204) | (0.146) | (0.0885) |
| Age 50s | -0.0141 | 0.0598 | -0.0739 |
| | (0.188) | (0.135) | (0.0818) |
| Age 60s | 0.649*** | 0.499*** | 0.151* |
| | (0.204) | (0.146) | (0.0885) |
| Constant | 5.726*** | 3.001*** | 2.725*** |
| | (0.150) | (0.107) | (0.0652) |
| Observations | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.062 | 0.063 | 0.038 |

Significant level: * 0.10 ** 0.05 *** 0.01

This behavioral difference across age groups and gender could be explained in several possible channels. As we described in the conceptual framework, this protective behavior towards COVID-19 can be explained by factors such as preferences, beliefs, and constraints. If these fac-

tors differ by gender and age systematically, the age and gender differences of the protective behavior can be well explained by these factors.

One might conjecture that younger/female individuals have different preferences, beliefs, or constraints than older/male ones. Referring to the appendix tables, we present the empirical evidence for that. Regarding disutilities and preferences, Table A1 shows that (1) younger individuals tend to estimate pains less severe than the older, while female individuals do estimate pains more severe than males, (2) younger individuals are generally more risk-taking, less patient[13], less altruistic, less reciprocal, and less trusting, while female individuals are more risk-averse, less reciprocal, and less trusting than males. Regarding the beliefs associated with the effectiveness of precautionary measures (Table A2), female individuals tend to estimate the effectiveness of wearing a mask and social distancing significantly higher than males. However, the effectiveness of these efforts does not seem to vary significantly with age. Interesting points are that younger people tend to underestimate the effectiveness of masks and social distancing than those in their 40s, and so do people in their 60s. Table A3 shows the differences in the cost of following the health guidelines (i.e., whether telecommuting is impossible), showing there is no difference across genders and age groups, except for the individuals in their 60s whose cost is significantly lower than others. This is quite intuitive that people in their 60s are likely to have been retired. Also, Table A4 presents that the concerns due to COVID-19 might be different across the gender and age groups. For example, older people tend to worry more about health, while individuals in their 40s tend to perceive it as financial risks than other age groups. Individuals in their 20s estimate the risk associated with social activities significantly higher than other age groups. Given all this empirical evidence, the age and gender differences in the protective behavior can be well explained by introducing these factors directly into the analyses as suggested in the model. In addition, age differences in preference factors are more salient than belief factors or cost factors, resulting in that the age differences in health-protective behaviors are caused mainly by differences in preference, rather than differences in belief.

Table 4 presents the factors that can directly explain individual protective behavior. Following our conceptual framework, we analyzed the health-protective behavior by estimated pains due to the infection, risk, time, and social preferences, belief (the effectiveness of wearing masks and social distancing on infection[14]), and constraints, as well as various socio-

[13]Individuals in their 60s also tend to be less time patient than those in their 40s.

[14]This is measured as the difference in the estimated infection probabilities between the current situation and the hypothetical situation of acting the opposite (wearing a mask to not wearing and social distancing to not distancing). The effectiveness of wearing a mask (social distancing, respectively) on self infection=#3.1(#4.1)-

Table 4: Determinants of Precautionary Bahavior

| | (1) Total | (2) Distancing | (3) Sanitation |
|---|---|---|---|
| $\Delta U$ | | | |
| Estimated Physical Pain | 0.353*** | 0.203*** | 0.150*** |
| | (0.0733) | (0.0530) | (0.0326) |
| Estimated Mental Pain | 0.111 | 0.0624 | 0.0488 |
| | (0.0737) | (0.0534) | (0.0328) |
| Risk Aversion | 0.447*** | 0.336*** | 0.111*** |
| | (0.0799) | (0.0578) | (0.0356) |
| $G$ | | | |
| Estimated Pain of Infecting others | 0.0870 | -0.00638 | 0.0934** |
| | (0.0839) | (0.0607) | (0.0373) |
| Altruism | 0.456*** | 0.276*** | 0.180*** |
| | (0.0759) | (0.0549) | (0.0338) |
| Having Children (=1) | 0.223 | 0.134 | 0.0892 |
| | (0.252) | (0.182) | (0.112) |
| Living with Elderly | 0.348*** | 0.200** | 0.147** |
| | (0.133) | (0.0959) | (0.0590) |
| $\beta$ | | | |
| Patience | 0.148** | 0.114** | 0.0338 |
| | (0.0753) | (0.0545) | (0.0335) |
| Belief | | | |
| Effectiveness of Mask on Self Infection | -0.00446 | -0.00452** | 0.0000553 |
| | (0.00284) | (0.00205) | (0.00126) |
| Effectiveness of Mask on Infecting Others | 0.00592** | 0.00430** | 0.00162 |
| | (0.00275) | (0.00199) | (0.00122) |
| Effectiveness of Distancing on Self Infection | 0.00570* | 0.00497** | 0.000732 |
| | (0.00313) | (0.00227) | (0.00140) |
| Effectiveness of Distancing on Infecting Others | 0.00607** | 0.00520** | 0.000866 |
| | (0.00282) | (0.00204) | (0.00125) |
| Cost | | | |
| Telecommuting Impossible (=1) | -0.439*** | -0.356*** | -0.0833 |
| | (0.126) | (0.0912) | (0.0561) |
| Socio-Demographic Characteristics | | | |
| Female (=1) | 0.616*** | 0.336*** | 0.281*** |
| | (0.125) | (0.0908) | (0.0558) |
| Age | 0.0222 | 0.0459* | -0.0237 |
| | (0.0365) | (0.0264) | (0.0162) |
| $Age^2$ | -0.0000463 | -0.000312 | 0.000265 |
| | (0.000412) | (0.000298) | (0.000183) |
| University (=1) | -0.432*** | -0.374*** | -0.0574 |
| | (0.151) | (0.110) | (0.0674) |
| Monthly Income | 0.000845*** | 0.000628*** | 0.000217* |
| | (0.000286) | (0.000207) | (0.000127) |
| Constant | 1.005 | -0.167 | 1.172*** |
| | (0.893) | (0.646) | (0.397) |
| Observations | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.205 | 0.183 | 0.142 |

Significant level: * 0.10 ** 0.05 *** 0.01.

Total: Level of Precautionary Behavior in total dimensions

Distancing: Level of Precautionary Behavior in terms of Social Distancing

Sanitation: Level of Precautionary Behavior in terms of Sanitation

demographic variables. Factors explaining disutilities such as estimated physical pain, estimated mental pain, and individual risk aversion all tend to increase the precautionary behavior: the more (especially physical) pain the participant estimates from the infection and the more risk-averse he is, the more precautionary measures he would take. Regarding social preferences, altruism, having children, and living with an elderly all are positively correlated with the protective behavior, while estimated pain of infecting others seems to be significantly and positively correlated with the protective behavior of sanitation only. Time preference is also an important factor increasing the protective behavior: the more patient the participant is, the more efforts (especially in terms of social distancing) he could exert. Estimating wearing masks and social distancing more effectively is generally increasing individual protective efforts. Note that, though, these effectiveness measures might be inter-related, causing a potential multicollinearity issue.[15] The cost of putting the protective behavior can be captured from the dummy variable of the impossibility of telecommuting. This constraint is strongly and negatively correlated with the distancing effort, but not with the sanitary effort. Apart from that, women tend to put more effort, those with more than a university degree put less effort, and the monthly income is positively correlated with the effort provision.

Table 5 shows the change in satisfaction due to the COVID-19 pandemic across gender and age groups. The dependent variable is defined by subtracting "Life satisfaction before the pandemic" from "Life satisfaction after the pandemic." Therefore, the lower the measure is, the unhappier s/he became by the COVID-19 situation. Basically, the satisfaction decreases due to the COVID-19 (negative constant values), showing that participants became unhappier. Female and younger (age 20s and 30s) individuals are hit harder by the COVID-19 shock than male and older participants. If we control for the protective effort measures, as expected, those who put greater effort in health-protective behavior are suffering more in times of pandemic (i.e., negative coefficients for protective behavior measures). Also, as discussed in Section 2, the envelope theorem implies that the satisfaction decrease will be larger for those who have greater $\Delta U$, $G$, $\beta$, $p(e)$, $q(e)$, and $c(e)$ would decline more. Table 6 confirms that estimated physical and mental pains, risk aversion, estimated pain of infecting others, and altruism all are the factors making more decreases in satisfaction due to the pandemic.[16]

#2.1, The effectiveness of wearing a mask (social distancing) on infecting others=#3.2(#4.2)-#2.2 in Part A.

[15]Regarding this, we perform the same analysis using a composite measure (PCA) of all these probabilities. The results remain the same qualitatively.

[16]If we believe that satisfaction and productivity are somewhat related(Oswald et al. (2015)), it is worth investigating the effect of COVID-19 on individual productivity. Tables A5 and A6 present the effect of COVID-19 on productivity change. We use question #9 in Part C (See the appendix), "How do you think the COVID-19 pandemic affects your productivity?" from very negatively to very positively. Similarly to the analyses on life satisfaction,

Table 5: COVID-19 on Life Satisfaction by Gender and Age Group

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Female (=1) | -0.443*** | -0.385*** | -0.364*** | -0.356*** |
| | (0.0802) | (0.0801) | (0.0808) | (0.0803) |
| Reference Group: Age 40s | | | | |
| Age 20s | -0.295** | -0.388*** | -0.312** | -0.379*** |
| | (0.127) | (0.127) | (0.126) | (0.126) |
| Age 30s | -0.342*** | -0.381*** | -0.370*** | -0.388*** |
| | (0.128) | (0.126) | (0.126) | (0.126) |
| Age 50s | 0.0633 | 0.0711 | 0.0479 | 0.0618 |
| | (0.118) | (0.117) | (0.117) | (0.116) |
| Age 60s | 0.00594 | 0.0709 | 0.0374 | 0.0746 |
| | (0.128) | (0.127) | (0.126) | (0.126) |
| Precautionary Behavior: Social Distancing | | -0.130*** | | |
| | | (0.0237) | | |
| Precautionary Behavior: Sanitation | | | -0.209*** | |
| | | | (0.0390) | |
| Precautionary Behavior | | | | -0.106*** |
| | | | | (0.0169) |
| Constant | -0.964*** | -0.574*** | -0.395*** | -0.359*** |
| | (0.0941) | (0.117) | (0.141) | (0.134) |
| Observations | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.031 | 0.051 | 0.050 | 0.058 |

Significant level: * 0.10 ** 0.05 *** 0.01

Table 6: COVID-19 on Life Satisfaction

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Estimated Physical Pain | -0.145*** | -0.123** | -0.123** | -0.116** |
| | (0.0480) | (0.0482) | (0.0483) | (0.0483) |
| Estimated Mental Pain | -0.0128 | -0.00656 | -0.00643 | -0.00420 |
| | (0.0490) | (0.0488) | (0.0489) | (0.0488) |
| Risk Aversion | -0.187*** | -0.154*** | -0.171*** | -0.152*** |
| | (0.0528) | (0.0533) | (0.0528) | (0.0532) |
| Estimated Pain of Infecting others | -0.115** | -0.114** | -0.101* | -0.107* |
| | (0.0556) | (0.0553) | (0.0555) | (0.0553) |
| Altruism | -0.0878* | -0.0620 | -0.0639 | -0.0535 |
| | (0.0506) | (0.0508) | (0.0509) | (0.0510) |
| Having Children (=1) | 0.176 | 0.188 | 0.188 | 0.192 |
| | (0.168) | (0.167) | (0.167) | (0.167) |
| Living with Elderly | 0.0322 | 0.0523 | 0.0523 | 0.0597 |
| | (0.0883) | (0.0880) | (0.0882) | (0.0880) |
| Patience | -0.0825 | -0.0721 | -0.0779 | -0.0715 |
| | (0.0502) | (0.0500) | (0.0500) | (0.0499) |
| Telecommuting Impossible (=1) | 0.0933 | 0.0629 | 0.0831 | 0.0629 |
| | (0.0837) | (0.0837) | (0.0834) | (0.0835) |
| Female (=1) | -0.351*** | -0.319*** | -0.313*** | -0.304*** |
| | (0.0836) | (0.0836) | (0.0841) | (0.0839) |
| Age | 0.0677*** | 0.0721*** | 0.0647*** | 0.0697*** |
| | (0.0243) | (0.0242) | (0.0242) | (0.0242) |
| $Age^2$ | -0.000608** | -0.000641** | -0.000576** | -0.000617** |
| | (0.000274) | (0.000273) | (0.000274) | (0.000273) |
| University (=1) | -0.0861 | -0.120 | -0.0936 | -0.118 |
| | (0.101) | (0.101) | (0.101) | (0.101) |
| Monthly Income | -0.000153 | -0.0000993 | -0.000126 | -0.0000942 |
| | (0.000190) | (0.000190) | (0.000190) | (0.000190) |
| Precautionary Behavior: Social Distancing | | -0.0896*** | | |
| | | (0.0248) | | |
| Precautionary Behavior: Sanitation | | | -0.131*** | |
| | | | (0.0409) | |
| Precautionary Behavior | | | | -0.0728*** |
| | | | | (0.0180) |
| Constant | -1.165** | -1.205** | -1.023* | -1.118* |
| | (0.591) | (0.589) | (0.591) | (0.588) |
| Observations | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.067 | 0.075 | 0.074 | 0.078 |

Significant level: * 0.10 ** 0.05 *** 0.01

# 5 Conclusion

This paper investigates what makes individuals comply with public health guidelines to prevent the spread of COVID-19. Running an online survey with 1,500 Korean representative samples, we partly explain the causes of non-compliant behavior. We find that individuals older than 60 are most active in protecting their and others' health and that those younger than 30 are the least compliant.

We categorize the factors possibly influencing the precautionary behavior into three groups: preference, belief, and constraint. Our results provide empirical evidence that while beliefs on risks and the effectiveness of protective measures predict protective behaviors well, there are no large differences in belief across age groups. Therefore, why younger individuals do not comply with the guidelines very actively is their different preferences over risk, time, and others' well-being compared to other groups than their belief on COVID-19 infection probabilities and estimated pains. This suggests that more direct and coercive measures could be more effective in order to increase the compliance of the health guidelines.

As well as preventing the spread of the virus, the great reduction of life satisfaction should be carefully emphasized. Negative shocks in life satisfaction may lead to mental illness, depression, and even suicide, which can be a serious potential risk to society. Therefore, the public health authority should not only focus on promoting protective behaviors, but also consider the long-term mental health with constant monitoring and social support for the vulnerable groups.

Of course, these results should be interpreted with extreme caution. A few variables that we use in our analyses might be inter-related to one another, and it is yet too early to make any conclusive causal relationship. However, our results can still shed light on understanding more on individual protective behaviors, which, in turn, could be of help to set a more effective communicable disease policy.

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we can conclude that the COVID-19 situation is negatively affecting individual productivity. This shock can be harsher for those who put greater effort in health-protective behavior or those who have greater $\Delta U$, $G$, $\beta$, $p(e)$, $q(e)$, and $c(e)$. From this, we could also infer that putting efforts in health-protective behavior can be considered as costs on satisfaction and productivity.

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# Appendix Table

Table A1: Disutility and Preference by Gender and Age Group

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Female (=1) | -0.0177 | 0.187*** | -0.0302 | 0.0681* | -0.208*** | -0.158*** | 0.313*** | 0.324*** | 0.286*** |
| | (0.0431) | (0.0416) | (0.0438) | (0.0402) | (0.0497) | (0.0530) | (0.0492) | (0.0600) | (0.0533) |
| Reference Group: Age 40s | | | | | | | | | |
| Age 20s | -0.334*** | -0.0777 | -0.208*** | -0.184*** | -0.202** | -0.132 | -0.164** | -0.289*** | -0.265*** |
| | (0.0684) | (0.0660) | (0.0695) | (0.0638) | (0.0788) | (0.0841) | (0.0780) | (0.0952) | (0.0845) |
| Age 30s | -0.0711 | -0.00368 | -0.266*** | -0.166*** | -0.170** | -0.0698 | 0.0428 | -0.0264 | -0.0322 |
| | (0.0685) | (0.0662) | (0.0696) | (0.0640) | (0.0790) | (0.0843) | (0.0782) | (0.0954) | (0.0847) |
| Age 50s | -0.111* | -0.0316 | 0.0929 | 0.0868 | 0.0517 | 0.376*** | -0.00444 | 0.0354 | -0.0743 |
| | (0.0634) | (0.0612) | (0.0644) | (0.0591) | (0.0730) | (0.0779) | (0.0723) | (0.0883) | (0.0784) |
| Age 60s | -0.193*** | 0.0474 | 0.323*** | 0.227*** | 0.00839 | 0.451*** | 0.0707 | -0.0902 | -0.179** |
| | (0.0685) | (0.0662) | (0.0696) | (0.0640) | (0.0790) | (0.0843) | (0.0782) | (0.0954) | (0.0847) |
| Constant | 0.146*** | -0.0740 | 0.0427 | -0.0149 | 0.171*** | -0.0558 | 6.301*** | 6.148*** | 6.381*** |
| | (0.0505) | (0.0488) | (0.0514) | (0.0472) | (0.0582) | (0.0621) | (0.0576) | (0.0704) | (0.0625) |
| Observations | 1345 | 1345 | 1345 | 1345 | 1345 | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.016 | 0.014 | 0.057 | 0.038 | 0.021 | 0.058 | 0.033 | 0.028 | 0.027 |

Significant level: * 0.10 ** 0.05 *** 0.01, (1) Patience (2) Risk Aversion (3) Altruism (4) Positive Reciprocity (5) Negative Reciprocity (6) Social Trust (7) Estimated Physical Pain (8) Estimated Mental Pain (9) Estimated Pain of Infecting Others

Table A2: Belief by Gender and Age Group

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Female (=1) | 4.220*** | 3.401** | 4.059*** | 5.292*** |
| | (1.446) | (1.534) | (1.330) | (1.518) |
| Reference Group: Age 40s | | | | |
| Age 20s | -4.493* | 1.356 | -3.997* | -1.963 |
| | (2.294) | (2.434) | (2.111) | (2.408) |
| Age 30s | 0.0611 | 1.359 | -0.341 | -2.371 |
| | (2.300) | (2.439) | (2.116) | (2.414) |
| Age 50s | -2.089 | -4.252* | 2.207 | -0.406 |
| | (2.127) | (2.256) | (1.956) | (2.232) |
| Age 60s | -4.773** | -6.518*** | 0.204 | -3.407 |
| | (2.300) | (2.440) | (2.116) | (2.414) |
| Constant | 23.76*** | 25.49*** | 13.60*** | 17.31*** |
| | (1.696) | (1.799) | (1.560) | (1.780) |
| Observations | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.008 | 0.012 | 0.010 | 0.007 |

Significant level: * 0.10 ** 0.05 *** 0.01

(1) Effectiveness of Mask on Self Infection

(2) Effectiveness of Mask on Infecting Others

(3) Effectiveness of Distancing on Self Infection

(4) Effectiveness of Distancing on Infecting Others

Significant level: * 0.10 ** 0.05 *** 0.01

Table A3: Cost (Constraints) by Gender and Age Group

| | Telecommuting Impossible (=1) |
|---|---|
| Female (=1) | 0.0228 |
| | (0.0259) |
| Age 20s | 0.00919 |
| | (0.0412) |
| Age 30s | -0.00883 |
| | (0.0412) |
| Age 50s | -0.0331 |
| | (0.0381) |
| Age 60s | -0.176*** |
| | (0.0412) |
| Constant | 0.385*** |
| | (0.0304) |
| Observations | 1345 |
| Adjusted $R^2$ | 0.015 |

Significant level: * 0.10 ** 0.05 *** 0.01

Table A4: COVID-19 Perceived Risk Type

| | (1) Health | (2) Financial | (3) Social |
|---|---|---|---|
| Female (=1) | 0.0427 | -0.0460* | 0.00342 |
| | (0.0269) | (0.0265) | (0.0169) |
| Reference Group: Age 40s | | | |
| Age 20s | -0.0389 | -0.0198 | 0.0597** |
| | (0.0427) | (0.0420) | (0.0268) |
| Age 30s | 0.0674 | -0.0774* | 0.00680 |
| | (0.0428) | (0.0421) | (0.0269) |
| Age 50s | 0.0662* | -0.0601 | -0.00197 |
| | (0.0396) | (0.0390) | (0.0249) |
| Age 60s | 0.213*** | -0.202*** | -0.00572 |
| | (0.0428) | (0.0421) | (0.0269) |
| Constant | 0.398*** | 0.493*** | 0.0956*** |
| | (0.0315) | (0.0311) | (0.0198) |
| Observations | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.026 | 0.018 | 0.002 |

Significant level: * 0.10 ** 0.05 *** 0.01

Table A5: COVID-19 on Productivity by Gender and Age Group

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Female (=1) | -0.238*** | -0.204*** | -0.185*** | -0.184*** |
| | (0.0666) | (0.0669) | (0.0673) | (0.0671) |
| Age 20s | 0.0589 | 0.00403 | 0.0472 | 0.00659 |
| | (0.106) | (0.106) | (0.105) | (0.106) |
| Age 30s | 0.00845 | -0.0149 | -0.0106 | -0.0204 |
| | (0.106) | (0.106) | (0.105) | (0.105) |
| Age 50s | -0.0549 | -0.0503 | -0.0653 | -0.0559 |
| | (0.0980) | (0.0975) | (0.0974) | (0.0973) |
| Age 60s | 0.114 | 0.152 | 0.135 | 0.156 |
| | (0.106) | (0.106) | (0.105) | (0.106) |
| Precautionary Behavior: Social Distancing | | -0.0769*** | | |
| | | (0.0198) | | |
| Precautionary Behavior: Sanitation | | | -0.140*** | |
| | | | (0.0325) | |
| Precautionary Behavior | | | | -0.0657*** |
| | | | | (0.0141) |
| Constant | 3.293*** | 3.524*** | 3.676*** | 3.669*** |
| | (0.0781) | (0.0978) | (0.118) | (0.112) |
| Observations | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.008 | 0.018 | 0.021 | 0.023 |

Significant level: * 0.10 ** 0.05 *** 0.01

Table A6: COVDI-19 on Productivity

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Estimated Physical Pain | -0.120*** | -0.108*** | -0.105*** | -0.102** |
| | (0.0397) | (0.0399) | (0.0399) | (0.0400) |
| Estimated Mental Pain | -0.0637 | -0.0600 | -0.0593 | -0.0583 |
| | (0.0404) | (0.0404) | (0.0404) | (0.0403) |
| Risk Aversion | -0.188*** | -0.168*** | -0.177*** | -0.165*** |
| | (0.0435) | (0.0441) | (0.0436) | (0.0440) |
| Estimated Pain of Infecting others | -0.0735 | -0.0729 | -0.0643 | -0.0684 |
| | (0.0459) | (0.0458) | (0.0459) | (0.0458) |
| Altruism | 0.0262 | 0.0412 | 0.0427 | 0.0474 |
| | (0.0417) | (0.0421) | (0.0421) | (0.0422) |
| Having Children (=1) | -0.0589 | -0.0522 | -0.0505 | -0.0489 |
| | (0.138) | (0.138) | (0.138) | (0.138) |
| Living with Elderly | 0.150** | 0.161** | 0.164** | 0.167** |
| | (0.0728) | (0.0728) | (0.0729) | (0.0728) |
| Patience | 0.0609 | 0.0670 | 0.0641 | 0.0678 |
| | (0.0414) | (0.0414) | (0.0413) | (0.0413) |
| Telecommuting Impossible (=1) | 0.0226 | 0.00488 | 0.0155 | 0.00372 |
| | (0.0691) | (0.0693) | (0.0689) | (0.0691) |
| Female (=1) | -0.0798 | -0.0616 | -0.0540 | -0.0512 |
| | (0.0690) | (0.0692) | (0.0695) | (0.0694) |
| Age | -0.0226 | -0.0200 | -0.0247 | -0.0214 |
| | (0.0200) | (0.0200) | (0.0200) | (0.0200) |
| $Age^2$ | 0.000245 | 0.000226 | 0.000268 | 0.000240 |
| | (0.000226) | (0.000226) | (0.000226) | (0.000226) |
| University (=1) | -0.106 | -0.125 | -0.111 | -0.125 |
| | (0.0833) | (0.0835) | (0.0831) | (0.0833) |
| Monthly Income | 0.000462*** | 0.000493*** | 0.000481*** | 0.000499*** |
| | (0.000157) | (0.000157) | (0.000157) | (0.000157) |
| Precautionary Behavior: Social Distancing | | -0.0522** | | |
| | | (0.0205) | | |
| Precautionary Behavior: Sanitation | | | -0.0907*** | |
| | | | (0.0338) | |
| Precautionary Behavior | | | | -0.0452*** |
| | | | | (0.0149) |
| Constant | 5.325*** | 5.302*** | 5.423*** | 5.354*** |
| | (0.488) | (0.487) | (0.488) | (0.487) |
| Observations | 1345 | 1345 | 1345 | 1345 |
| Adjusted $R^2$ | 0.057 | 0.061 | 0.062 | 0.063 |

Significant level: * 0.10 ** 0.05 *** 0.01

# Appendix: Survey questions

**Part A**

Below we ask how your everyday life has changed since the outbreak of COVID-19. Please reply as precisely as possible.

1.1. Do you wear a mask more often than before the outbreak? [ym]

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=strongly disagree | 2 | 3 | 4 | 5 | 6 | 7=strongly agree |

1.2. Do you refrain from going to social gatherings than before the outbreak? [yh]

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=strongly disagree | 2 | 3 | 4 | 5 | 6 | 7=strongly agree |

[The following sentences remain on the top of the screen during Part A.]

"Let us assume that all the others are behaving as they are now. On average, an adult catches a cold a couple of times a year. So during a week in the season, an individual catches a cold with about 10%.

Even if a question sounds vague, imagine as concretely as possible, and let us know what you are thinking. It will help our research a lot."

2.1. Suppose an individual puts effort in precautionary measures exactly as you do. What do you think of the probability that the person gets infected within a week?

| | | | | | | |
|---|---|---|---|---|---|---|
| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |

2.2. Suppose an individual puts effort in precautionary measures exactly as you do. If the person got infected, what do you think of the probability that the person infects another person within a week?

| | | | | | | |
|---|---|---|---|---|---|---|
| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |

[If ym<5]

3.1. Suppose an individual wears a mask all the time in public places. The person does everything else as you do now. What do you think of the probability that the person gets infected within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

3.2. Suppose an individual wears a mask all the time in public places. The person does everything else as you do now. If the person got infected, what do you think of the probability that the person infects another person within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

[If ym>4]

3.1. Suppose an individual does not wear a mask at all in public places. The person does everything else as you do now. What do you think of the probability that the person gets infected within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

3.2. Suppose an individual does not wear a mask at all in public places. The person does everything else as you do now. If the person got infected, what do you think of the probability that the person infects another person within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

[If yh<5]

4.1. Suppose an individual does not go to social gatherings at all. The person does everything else as you do now. What do you think of the probability that the person gets infected within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

4.2. Suppose an individual does not go to social gatherings at all. The person does everything else as you do now. If the person got infected, what do you think of the probability that the person infects another person within a week?

| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |
|---|---|---|---|---|---|---|

[yh>4]

4.1. Suppose an individual goes to social gatherings as before the outbreak. The person does everything else as you do now. What do you think of the probability that the person gets infected within a week?

| | | | | | | |
|---|---|---|---|---|---|---|
| 0% | lower than 0.1% | 0.1 1% | 1 5% | 5 10% | 10 20% | higher than 20% |

4.2. Suppose an individual goes to social gatherings as before the outbreak. The person does everything else as you do now. If the person got infected, what do you think of the probability that the person infects another person within a week?

| | | | | | | |
|---|---|---|---|---|---|---|
| 0% | lower than 0.1% | 0.1-1% | 1-5% | 5-10% | 10-20% | higher than 20% |

5. What do you think of the physical pain of Covid-19 in comparison with usual influenza?

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=much less painful | 2 | 3 | 4 | 5 | 6 | 7=much more painful |

6. Let's suppose you got infected and infected others. What do you think of the mental pain of it in comparison with the physical pain?

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=much less painful | 2 | 3 | 4 | 5 | 6 | 7=much more painful |

7. Let's suppose you got infected and infected others. What do you think of the mental pain that you may suffer due to the social blame in comparison with the physical pain?

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=much less painful | 2 | 3 | 4 | 5 | 6 | 7=much more painful |

**Part B**

1. In general, how willing or unwilling are you to take risks?

| | | | | | | |
|---|---|---|---|---|---|---|
| 1=completely unwilling | 2 | 3 | 4 | 5 | 6 | 7=completely willing |

2. You will be asked 5 questions in this section. Please imagine the following situation. You can choose between a sure payment of a particular amount of money, or a draw, where you would have an equal chance of getting amount x or getting nothing. What would you prefer: a draw with a 50 percent chance of receiving amount x, and the same 50 percent chance of receiving nothing or the amount of y as a sure payment?

[Please refer to Figure 1 for the logic]

| Question Number | Choices in Previous Questions | Option A | Option B |
|---|---|---|---|
| 1 | | 100% KRW 160,000 | 50% KRW 300,000 |
| 2 | A | 100% KRW 80,000 | 50% KRW 300,000 |
| 2 | B | 100% KRW 240,000 | 50% KRW 300,000 |
| 3 | A-A | 100% KRW 40,000 | 50% KRW 300,000 |
| 3 | A-B | 100% KRW 120,000 | 50% KRW 300,000 |
| 3 | B-A | 100% KRW 200,000 | 50% KRW 300,000 |
| 3 | B-B | 100% KRW 280,000 | 50% KRW 300,000 |
| 4 | A-A-A | 100% KRW 20,000 | 50% KRW 300,000 |
| 4 | A-A-B | 100% KRW 60,000 | 50% KRW 300,000 |
| 4 | A-B-A | 100% KRW 100,000 | 50% KRW 300,000 |
| 4 | A-B-B | 100% KRW 140,000 | 50% KRW 300,000 |
| 4 | B-A-A | 100% KRW 180,000 | 50% KRW 300,000 |
| 4 | B-A-B | 100% KRW 220,000 | 50% KRW 300,000 |
| 4 | B-B-A | 100% KRW 260,000 | 50% KRW 300,000 |
| 4 | B-B-B | 100% KRW 300,000 | 50% KRW 300,000 |
| 5 | A-A-A-A | 100% KRW 10,000 (risk=1) | 50% KRW 300,000 (risk=2) |
| 5 | A-A-A-B | 100% KRW 30,000 (risk=3) | 50% KRW 300,000 (risk=4) |
| 5 | A-A-B-A | 100% KRW 50,000 (risk=5) | 50% KRW 300,000 (risk=6) |
| 5 | A-A-B-B | 100% KRW 70,000 (risk=7) | 50% KRW 300,000 (risk=8) |
| 5 | A-B-A-A | 100% KRW 90,000 (risk=9) | 50% KRW 300,000 (risk=10) |
| 5 | A-B-A-B | 100% KRW 110,000 (risk=11) | 50% KRW 300,000 (risk=12) |
| 5 | A-B-B-A | 100% KRW 130,000(risk=13) | 50% KRW 300,000 (risk=14) |
| 5 | A-B-B-B | 100% KRW 150,000(risk=15) | 50% KRW 300,000 (risk=16) |
| 5 | B-A-A-A | 100% KRW 170,000(risk=17) | 50% KRW 300,000 (risk=18) |

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| Question Number | Choices in Previous Questions | Option A | Option B |
|---|---|---|---|
| 5 | B-A-A-B | 100% KRW 190,000(risk=19) | 50% KRW 300,000 (risk=20) |
| 5 | B-A-B-A | 100% KRW 210,000(risk=21) | 50% KRW 300,000 (risk=22) |
| 5 | B-A-B-B | 100% KRW 230,000(risk=23) | 50% KRW 300,000 (risk=24) |
| 5 | B-B-A-A | 100% KRW 250,000(risk=25) | 50% KRW 300,000 (risk=26) |
| 5 | B-B-A-B | : 100% KRW 270,000(risk=27) | 50% KRW 300,000 (risk=28) |
| 5 | B-B-B-A | 100% KRW 290,000(risk=29) | 50% KRW 300,000 (risk=30) |
| 5 | B-B-B-B | 100% KRW 310,000(risk=31) | 50% KRW 300,000 (risk=32) |

3. How willing are you to give up something that is beneficial for you today in order to benefit more from that in the future?

| 1=completely unwilling | 2 | 3 | 4 | 5 | 6 | 7=completely willing |
|---|---|---|---|---|---|---|

4. You will be asked 5 questions in this section. Suppose you were given a choice between receiving a payment today or a payment in 12 months. We will now present to you five situations. The payment today is the same in each of these situations, KRW 100,000. The payment in 12 months is different in every situation. For each of these situations, we would like to know which you would choose. Please assume there is no inflation, i.e., future prices are the same as today's prices. Would you rather receive KRW 100,000 today or KRW x in 12 months?

[Please refer to Figure 2 for the logic]

| Question Number | Choices in Previous Questions | Option A | Option B |
|---|---|---|---|
| 1 | | a year later 154,000 | today 100,000 |
| 2 | A | a year later 125,000 | today 100,000 |
| 2 | B | a year later 185,000 | today 100,000 |
| 3 | A-A | a year later 112,000 | today 100,000 |

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| Question Number | Choices in Previous Questions | Option A | Option B |
|---|---|---|---|
| 3 | A-B | a year later 139,000 | today 100,000 |
| 3 | B-A | a year later 169,000 | today 100,000 |
| 3 | B-B | a year later 202,000 | today 100,000 |
| 4 | A-A-A | a year later 106,000 | today 100,000 |
| 4 | A-A-B | a year later 119,000 | today 100,000 |
| 4 | A-B-A | a year later 132,000 | today 100,000 |
| 4 | A-B-B | a year later 146,000 | today 100,000 |
| 4 | B-A-A | a year later 161,000 | today 100,000 |
| 4 | B-A-B | a year later 177,000 | today 100,000 |
| 4 | B-B-A | a year later 193,000 | today 100,000 |
| 4 | B-B-B | a year later 210,000 | today 100,000 |
| 5 | A-A-A-A | a year later 103,000(time=32) | today 100,000(time=31) |
| 5 | A-A-A-B | a year later 109,000(time=30) | today 100,000(time=29) |
| 5 | A-A-B-A | a year later 116,000(time=28) | today 100,000(time=27) |
| 5 | A-A-B-B | a year later 122,000(time=26) | today 100,000(time=25) |
| 5 | A-B-A-A | a year later 129,000(time=24) | today 100,000(time=23) |
| 5 | A-B-A-B | a year later 136,000(time=22) | today 100,000(time=21) |
| 5 | A-B-B-A | a year later 143,000(time=20) | today 100,000(time=19) |
| 5 | A-B-B-B | a year later 150,000(time=18) | today 100,000(time=17) |
| 5 | B-A-A-A | a year later 158,000(time=16) | today 100,000(time=15) |
| 5 | B-A-A-B | a year later 165,000(time=14) | today 100,000(time=13) |
| 5 | B-A-B-A | a year later 173,000(time=12) | today 100,000(time=11) |
| 5 | B-A-B-B | a year later 181,000(time=10) | today 100,000(time=9) |
| 5 | B-B-A-A | a year later 189,000(time=8) | today 100,000(time=7) |
| 5 | B-B-A-B | a year later 197,000(time=6) | today 100,000(time=5) |
| 5 | B-B-B-A | a year later 206,000(time=4) | today 100,000(time=3) |
| 5 | B-B-B-B | a year later 215,000(time=2) | today 100,000(time=1) |

5. When someone does me a favor, I am willing to return it.

| 1=strongly disagree | 2 | 3 | 4 | 5 | 6 | 7=strongly agree |
|---|---|---|---|---|---|---|

6. Please think about what you would do in the following situation. You are in an area you are not familiar with, and you realize you lost your way. You ask a stranger for directions. The stranger offers to take you to your destination. Helping you costs the stranger about KRW 20,000 in total. However, the stranger says he or she does not want any money from you. You have six presents with you. The cheapest present costs KRW 5,000, the most expensive one costs KRW 30,000. Do you give one of the presents to the stranger as a "thank-you"-gift? If so, which present do you give to the stranger?

| No present | KRW 5,000 | 10,000 | 15,000 | 20,000 | 25,000 | 30,000 |
|---|---|---|---|---|---|---|

7. How willing are you to punish someone who treats you unfairly, even if there may be costs for you?

| 1=completely unwilling | 2 | 3 | 4 | 5 | 6 | 7=completely willing |
|---|---|---|---|---|---|---|

8. How willing are you to punish someone who treats others unfairly, even if there may be costs for you?

| 1=completely unwilling | 2 | 3 | 4 | 5 | 6 | 7=completely willing |
|---|---|---|---|---|---|---|

9. I assume that people have only the best intentions.

| 1=strongly disagree | 2 | 3 | 4 | 5 | 6 | 7=strongly agree |
|---|---|---|---|---|---|---|

10. Imagine the following situation: Today, you unexpectedly received KRW 1,000,000. How much of this amount would you donate to a good cause? (Values between 0 and 1,000,000 are allowed.)

11. How willing are you to give to good causes without expecting anything in return?

| 1=completely unwilling | 2 | 3 | 4 | 5 | 6 | 7=completely willing |
|---|---|---|---|---|---|---|

12. What do you think of the probability that you get infected COVID-19 in comparison to the average people in your age and gender?

| 1=far below | 2 | 3 | 4 | 5 | 6 | 7=far above |
|---|---|---|---|---|---|---|

13. How would you put yourself in terms of political orientation?

| 1=very progressive | 2 | 3 | 4 | 5 | 6 | 7=very conservative |
|---|---|---|---|---|---|---|

**Part C**

1. Which aspect of your life concerns you the most in case you get infected?

(1) health (2) financial (3) social (4) others

2. Regarding Covid-19, what concerns you the most?

(1) getting infected (2) spreading it to others (3) your and your family members' jobs being affected (4) your children's education being affected (5) being unable to meet family and friends (6) others

3. The infection probability is

(1) controllable by efforts. (2) uncontrollable because luck matters the most.

4. Can you work from home?

(1) can always (2) can sometimes (3) cannot

5. Do you go to public restaurants to have lunch or dinner?

(1) yes (2) only when unavoidable (3) no

6. Do you use public transportation?

(1) yes (2) only when unavoidable (3) no

7. How satisfied were you with your life before the outbreak?

| 1=very unsatisfied | 2 | 3 | 4 | 5 | 6 | 7=very satisfied |
|---|---|---|---|---|---|---|

8. How satisfied are you with your life after the outbreak?

| 1=very unsatisfied | 2 | 3 | 4 | 5 | 6 | 7=very satisfied |
|---|---|---|---|---|---|---|

9. How do you think the Covid 19 pandemic affects your productivity?

| 1=very negatively | 2 | 3 | 4 | 5 | 6 | 7=very positively |
|---|---|---|---|---|---|---|

10. Check everything that you do now:

☐ Keep 2 m distance from others.

☐ Try to connect with family and friends while keeping physical distance.

☐ Ventilate and sanitize things twice a day.

☐ Stay at home.

☐ Take a 3-4 day break when feeling unwell.

☐ Refrain from using public transportation.

☐ Refrain from going to public places such as bus terminals, libraries, and cafes.

☐ Cancel social gatherings and do not go to religious gatherings.

☐ Cough into sleeves, not hands.

☐ Wash your hands when coming back home and whenever necessary.

☐ Wear a mask when going out.

11. How has your job been affected by Covid-19?

(1) getting the same wage (2) not lost a job, but the wage got cut (3) lost a job (4) not lost a job, but been unpaid

12. Check everything that is the case to you:

☐ My wage got cut.

☐ It affects my physical health negatively.

☐ I feel depressed because of Covid-19.

☐ It affects my mental health negatively.

☐ It affects my financial condition negatively.

☐ I move physically less than before.

13. Do you know anyone close to you who was confirmed?

(1) yes (2) no

14. Do you live with anyone older than 60?

(1) yes (2) no

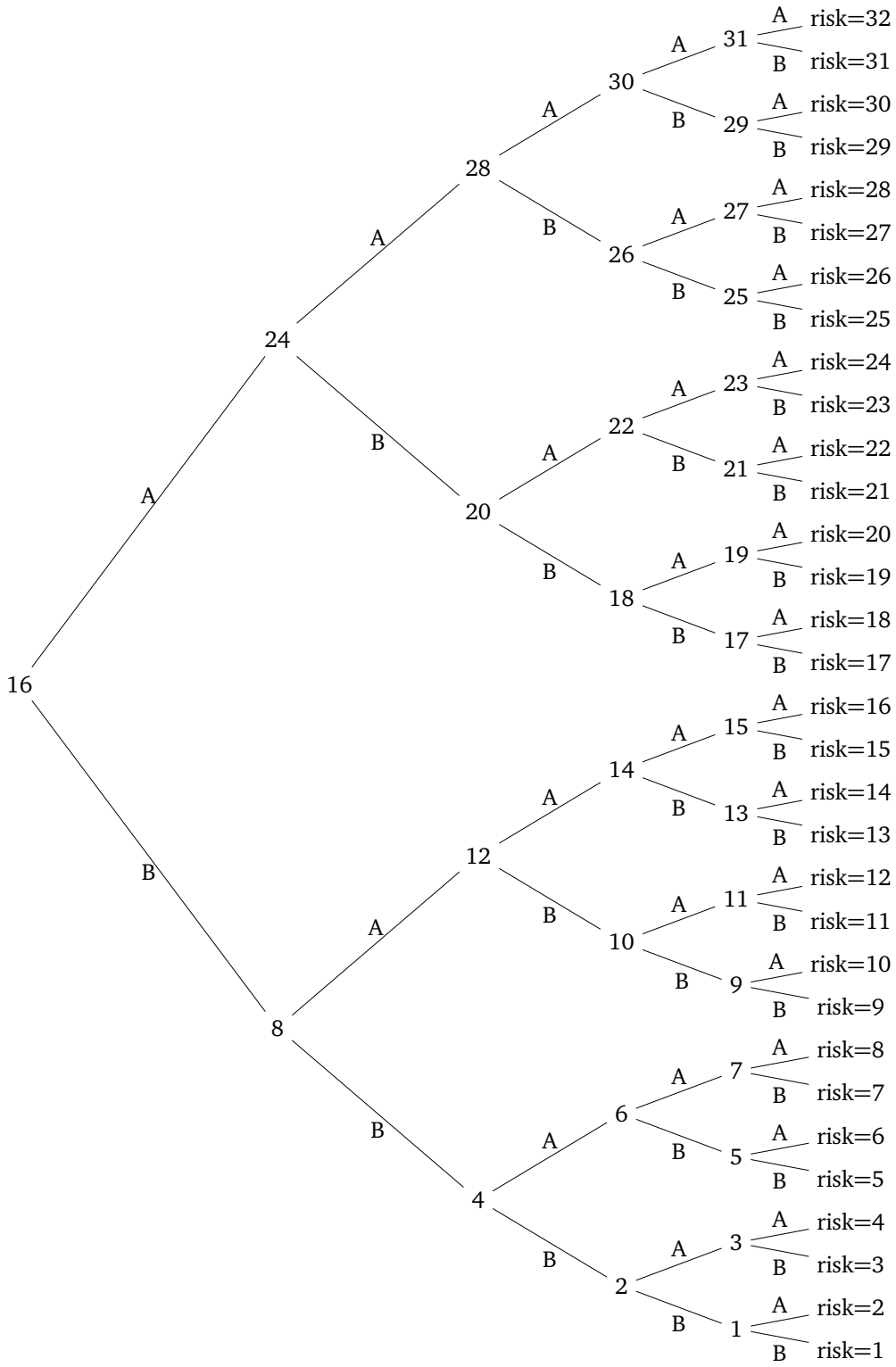


Figure 1: Tree for the Staircase Risk Task (Numbers: Sure Payment in KRW 10,000, A= Choice of Lottery, B= Choice of Sure Payment in KRW 10,000)

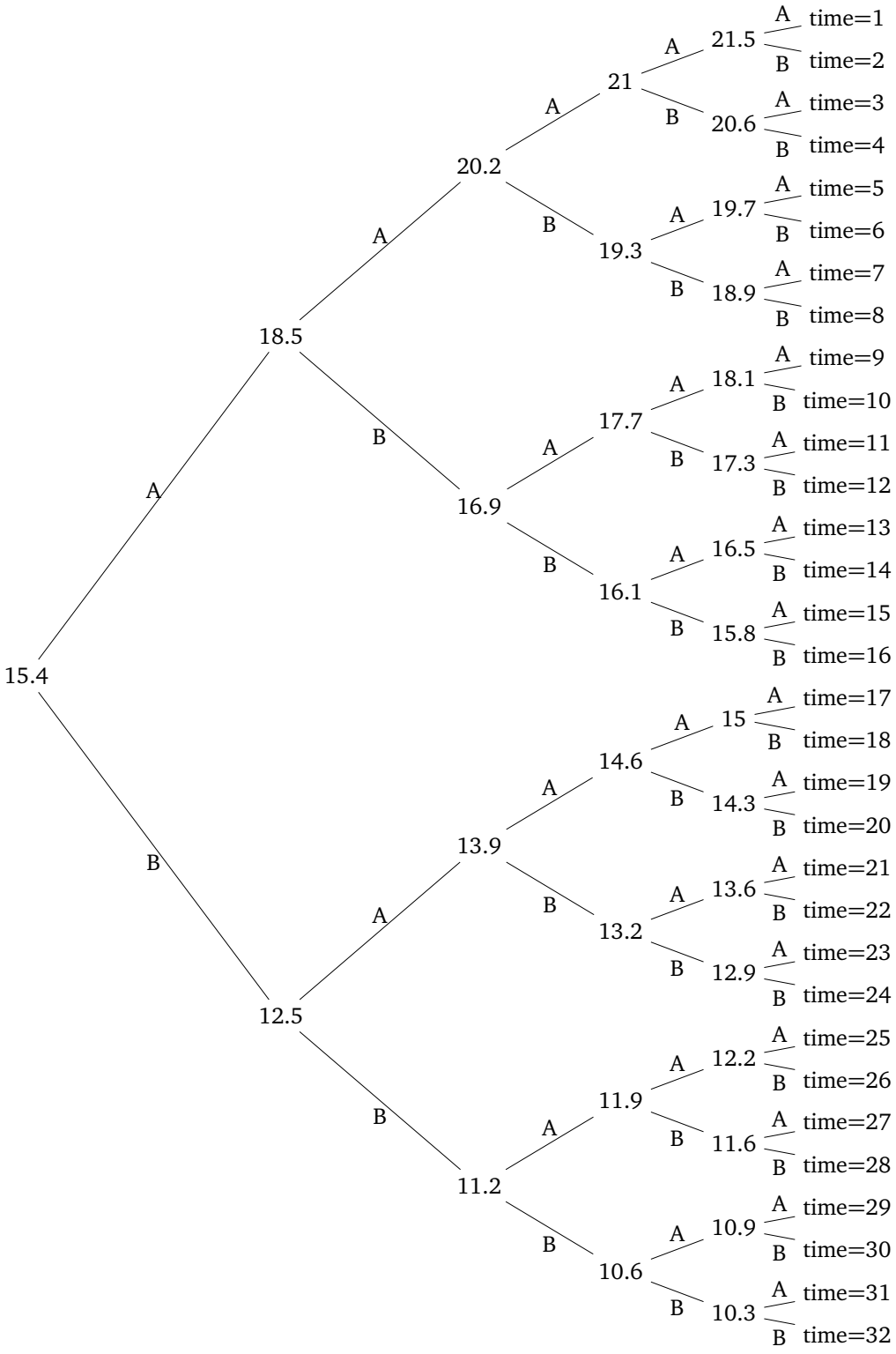


Figure 2: Tree for the Staircase Time Task (Numbers: Payment (in KRW 10,000) in 12 Months, A= Choice of KRW 100,000 Today, B= Choice of "X KRW 10,000 in 12 Months")