The Replication Report of Risk-taking with Age-related Measures

1.Introduction

COVID-19 is a disease that can cause people to have mild to moderate respiratory syndrome. On January 2020, the World Health Organization (WHO) declared the outbreak a Public Health Emergency of International Concern. Shortly after, WHO announced that covid-19 is a global pandemic on 11 March 2020. According to the World Health Organization, the cumulative cases were over 253 million and cumulative deaths were over 5 million. This paper will focus on investigating how age differences in risk-taking during the pandemic are related to objective risk, risk attitude and numerical ability by replicating Wolfe, K., Sirota, M., & Clarke, A. D. F. (2021)'s paper, "Age differences in COVID-19 risk-taking, and the relationship with risk attitude and numerical ability".

Wolfe, K., Sirota, M., & Clarke, A. D. F. (2021)'s paper, "Age differences in COVID-19 risk-taking, and the relationship with risk attitude and numerical ability", discovers the relationship between age and COVID-19 risk taking as well as the relationship with risk attitude and numerical ability. They conducted an online survey via Prolific Academic to collect data from different age groups on how they react to COVID-19 risk-taking as well as information regarding COVID-19 pandemic including participants' numerical abilities. They use mediation analysis to investigate the relationship between age differences in COVID-19 risk-taking, and the relationship with risk attitude and numerical ability. Details on the survey can be found in the

appendix.

This paper replicates the results from Wolfe, K., Sirota, M., & Clarke, A. D. F. (2021)'s original analysis. First, Wolfe, K., Sirota, M., & Clarke, A. D. F. (2021)'s measures and scale are introduced. Second, the methods are discussed. Third, the replication results are shown. Lastly, limitations to the study are discussed. The result from the original paper shows that older adults would be less likely to take risks than younger adults during the pandemic, participants with higher objective risk would be less likely to take risks than those with lower objective risks. Both younger and older adults in the survey are risk adverse.

1.1 Literature Review

The coronavirus disease (COVID-19) is an infectious disease caused by SARS-CoV-2. Most people who get infected by the disease will have mild to moderate respiratory syndrome and recover without requiring special treatment. However, some will have serious syndromes and require ventilators and ICU services. Elder age group and those with pre-existing conditions such as cardiovascular disease and diabetes are more exposed to the risks of getting COVID-19. It is believed that the coronavirus is spread through drops and infection particles delivered into the air when a contaminated individual inhales, talks or sneezes. Since the announcement of global pandemic by WHO, the UK government declared a nationwide lock down with implementations of preventive measures. Measures such as social distancing, limiting social interaction, avoiding non-essential travel and washing hands often with

antibacterial soap were carried out to prevent the spread of disease. The similar actions were also done in Canada. Canadian government restricted all non-essential travel across the border in March 2020. Shortly after the travel restrictions, governments announced lockdowns in the middle of March. Schools and business were forced to shut down, and a series of measures that designed to prevent the spread of disease were legalized. It has been proven by many studies that following the government-mandated preventive measures such as wearing masks and washing hands are crucial and necessary to prevent the disease from spreading. However, some groups of people during the pandemic had protested against the use of face masks and refuse to take these measures. According to several Statistics Canada surveys, most Canadians were following the recommendations to limit the spread of COVID-19. In addition to the survey, the examination of whether Canadians will continue to adhere to these mandated preventive measures shows that most of Canadians expect to continue following these public health guidelines such as social distancing and limiting social interactions, but some groups will be less likely to follow these measures than others. In the study conducted in previous SARS epidemic in Canada in 2003, the results show that younger adults are less likely to follow public health guidelines (Blendon et al., 2004). Josef et al. (2016) shows that people's willingness to take risk become less and less when they age. In addition, when it comes to safety and health, Rolison et al. (2013) find that younger adult are more likely to take risks than older adults. It is important to understand the relationship between age differences and risk-taking because the pandemic is far from over yet. It is important

to understand peoples' behaviors during the pandemic as it is a crucial thing to limit the spread.

2. Data

The replication uses the dataset collected from the survey conducted in the report (Wolfe et al., 2021). The dataset consists of a total 489 participants with 20 of them failing to meet the eligibility requirements. The total number of participants including into the analysis is 469, with 232 younger adults and 237 older adults. Participants, materials, and procedure can be checked in the original paper as the main objective is to replicate the study.

2.1 Data description:

Risk-taking is measured through the survey that includes a set of questions on numbers of activities and behaviors. (Full questions displayed in the appendix) There are five sacles to some of the questions, 1 = never, 2 = mostly not, 3 = sometimes, 4 = mostly yes, 5 = always. 1 indicates the lowest level of risk-taking and 5 indicates the highest level of risk-taking

Objective risk for COVID-19 is measured with the objective risk stratification tool (Development of an Objective Risk Stratification Tool to facilitate workplace assessments of healthcare workers when dealing with the CoViD-19 pandemic)

Risk attitude is measured by the COVID-19 risk perception scale. (Risk perceptions of COVID-19 around the world)

Full details on the survey are given in the appendix.

Dependent variable: COVID-19 risk-taking

Independent variable: Age group.

Mediator variables: Objective risk, Risk attitude, Numeracy

Descriptive variables such as trust in UK government and COVID-19 numbers usage are exclude from the replication because both items are not included in the original planned analyses.

2.2 Descriptive Statistics

Table 1: Descriptive statistics of age group

Measures	Number of participants	Mean and standard deviation	
		Younger adults	Older adults
Age (in years)	469participants in total 232 younger adults 237 older adults	26.52 (5.16)	69.38(3.85)

Details of surveys are given in the appendix. (Gender, education, infected COVID-19 or not etc.)

Table 2. Descriptive statistics of risk-taking, objective risk and risk attitude in younger and older adults.

Measures	Mean and standard deviation		
	Overall	Younger adults	Older adults
COVID-19 risk-taking	1.92 (0.49)	2.01 (0.51)	1.84 (0.46)
Objective risk	2.54 (2.05)	1.04 (0.94)	4.00 (1.76)
Risk attitude	−0.47 (0.71)	−0.50 (0.72)	−0.43 (0.70)

Table 3. Zero-order correlations between COVID-19 risk-taking, age group, objective risk, numeracy (single item) and risk attitude

measure	1	2	3	4	5
1. COVID 19 risk-taking					
2. age group	r = -0.17				
	p<0.001				
3.objective risk	r = -0.1	r = 0.72			
	p = 0.019	p < 0.001			
4. risk attitude		r = 0.05	r = 0.05		
		p = 0.284	p = 0.331		
5. numeracy		r = -0.13	r =-0.05	r = -0.05	
		p = 0.007	p = 0.382	p = 0.268	

3.Methodology

3.1 Participants

Before the data collection begins, Wolfe et al. conduct a power analysis to estimate the sample size required to detect the effects. The direct effect of the age group and on risk-taking is set to -0.3; the direct effect of the age group and on risk attitude and numeracy is set to -0.3; the effect of age group on objective risk is set to 0.3. The estimated sample size of N=400 with α = 0.05 and 1-β = 0.95 is found out to be sufficient to carry out the analysis.

The replication used the exact dataset collected from the survey conducted in the report (Wolfe et al., 2021). The dataset consists of a total 489 participants with 20 of

them failing to meet the eligibility requirements. The total number of participants including into the analysis is 469, with 232 younger adults and 237 older adults.

3.2 Mediation Model

For the mediation model to work, we first need to test whether age is significantly correlated with COVID risk-taking. Then simple linear regression models are used for the primary hypothesis (relationship between the mediators and dependent variables). Primary hypotheses must be tested first, and then once all those hypotheses are satisfied; we can carry on the mediation analysis.

Testing H1: age

(1) H1: age. Age is significantly correlated with COVID risk-taking.

Primary hypotheses:

(2) H1: objective risk. People who are more exposed to the risk of coronavirus will be more likely to follow public health guidelines.

(3) H1: risk attitude. People who are more risk averse toward coronavirus will be more likely to follow public health guidelines.

(4) H1: numeracy. People with higher numeracy skill will be more likely to follow public health guidelines.

Those four primary hypotheses must be tested before conducting the mediation analysis.

Mediation analysis:

Note: For any of the H2 to be tested, the (1) H1: age must be confirmed first along

with the corresponding H1 to H2.

(2) H2: objective risk. Objective risk will mediate the relationship between age and coronavirus risk-taking.

(3) H2: risk attitude. Risk attitude will mediate the relationship between age and coronavirus risk-taking

(4) H2: numeracy. Numeracy will mediate the relationship between age and coronavirus risk-taking
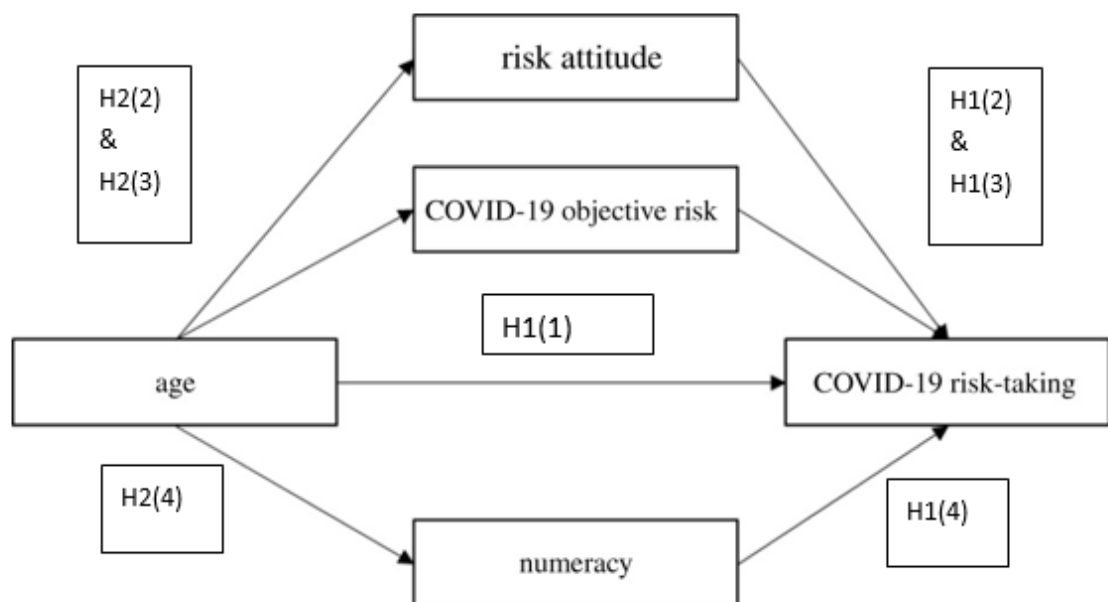

Figure 1. Visual representation of the mediation model

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4. Replication Results and Discussion:

Table 4: Regression results for H1: age.

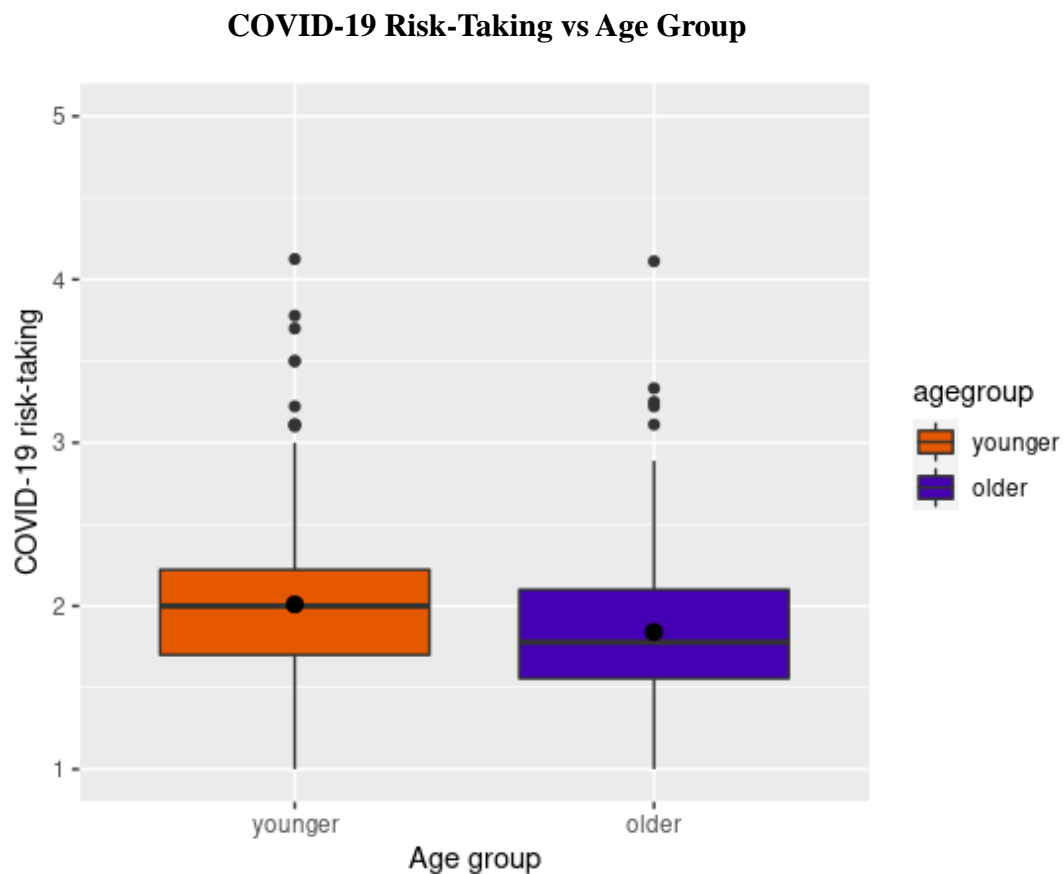|	Risk-taking			
Predictors	*Estimates*	*CI*	*Statistic*	*p*
Intercept	2.01	1.95 – 2.07	62.82	<0.001
Age Group	-0.17	-0.26 – -0.08	-3.77	<0.001
Observations	469			
R^2 / R^2 adjusted	0.030 / 0.027			

COVID-19 Risk-Taking vs Age Group

Figure 2: Box plot illustrating age differences of COVID-19 risk-taking

First, we can see that older adults are less likely to take risks than younger adults from table 2. To test the (1) H1: age. Age is correlated with COVID risk-taking., simple linear regression is used. We found that age group is a significant correlated with COVID risk-taking. Thus, we can continue our analysis. In addition, from Figure 2, both age groups are risk averse as they have small risk-taking scale, the mean of older adults taking risk is smaller than younger adults. This suggests that younger adults are less likely to take preventive measures.

Table 5: Regression results for H1: objective risk.

Predictors	Estimates	CI	Statistic	p
		Risk-taking		
Intercept	1.99	1.92 – 2.06	55.05	<0.001
Objective risk	-0.03	-0.05 – -0.00	-2.36	**0.019**
Observations	469			
R^2 / R^2 adjusted	0.012 / 0.010			

To test (2) H1: objective risk. People who are more exposed to the risk of coronavirus will be more likely to follow public health guidelines. Linear regression is used, and the results show that objective risk does associate with COVID risk-taking behaviors. In addition, objective risk is negatively correlated with risk-taking. Therefore, we can continue the mediation analysis.

Table 6: Regression results for H1: risk attitude.

	Risk-taking			
Predictors	Estimates	CI	Statistic	p
Intercept	1.94	1.89 – 2.00	69.43	<0.001
Risk attitude	-0.01	-0.07 – 0.06	-0.17	0.864
Observations	441			
R^2 / R^2 adjusted	0.000 / -0.002			

To test (3) H1: risk attitude. People who are more risk averse toward coronavirus will be more likely to follow public health guidelines. The results show that risk attitude is not significantly correlated with COVID risky behavior. Thus, risk attitude is excluded from the mediation model.

Table 7: Regression results for H1: numeracy.

	Risk-taking			
Predictors	Estimates	CI	Statistic	p
Intercept	1.79	1.72 – 1.86	49.10	<0.001
Numeracy	0.22	0.13 – 0.31	4.69	<0.001
Observations	469			
R^2 / R^2 adjusted	0.045 / 0.043			

To test (4) H1: numeracy. People with higher numeracy skill will be more likely to follow public health guidelines. From the results, numeracy is significantly correlated with COVID risk-taking. This suggests that numeracy should be included in the mediation analysis.

Conclusion of Primary hypotheses:

From the results of primary hypotheses, we first confirm that age is significantly

correlated with COVID-19 risk-taking. Then we confirm that there are significant relationships between risk-taking and objective risk [H1:(2)], and numeracy [H1:(4)]. Thus, we can constitute our analysis and test the relationship between the independent variable(age) and those two variables (mediators) to see whether the results are significant, and then once those are confirmed, we can continue with the hypothesis (H2).

Table 8: Regression results for Objective risk and age

	Objective			
Predictors	Estimates	CI	Statistic	p
Intercept	4.00	3.81 – 4.18	43.35	<0.001
Age	-2.95	-3.21 – -2.70	-22.53	<0.001
Observations	469			
R^2 / R^2 adjusted	0.521 / 0.520			

From the results of table 8, we can see that age and objective risk are significantly correlated to each other; then we can continue testing H2(2).

Table 9: Regression results for Numeracy and age

	Numeracy			
Predictors	Estimates	CI	Statistic	p
Intercept	0.57	0.50 – 0.63	18.08	<0.001
Age	0.12	0.03 – 0.21	2.70	0.007
Observations	469			
R^2 / R^2 adjusted	0.015 / 0.013			

From the results shown in table 9, we can see that the relationship between age and numeracy is significant. In addition, we can see that older adults have a lower
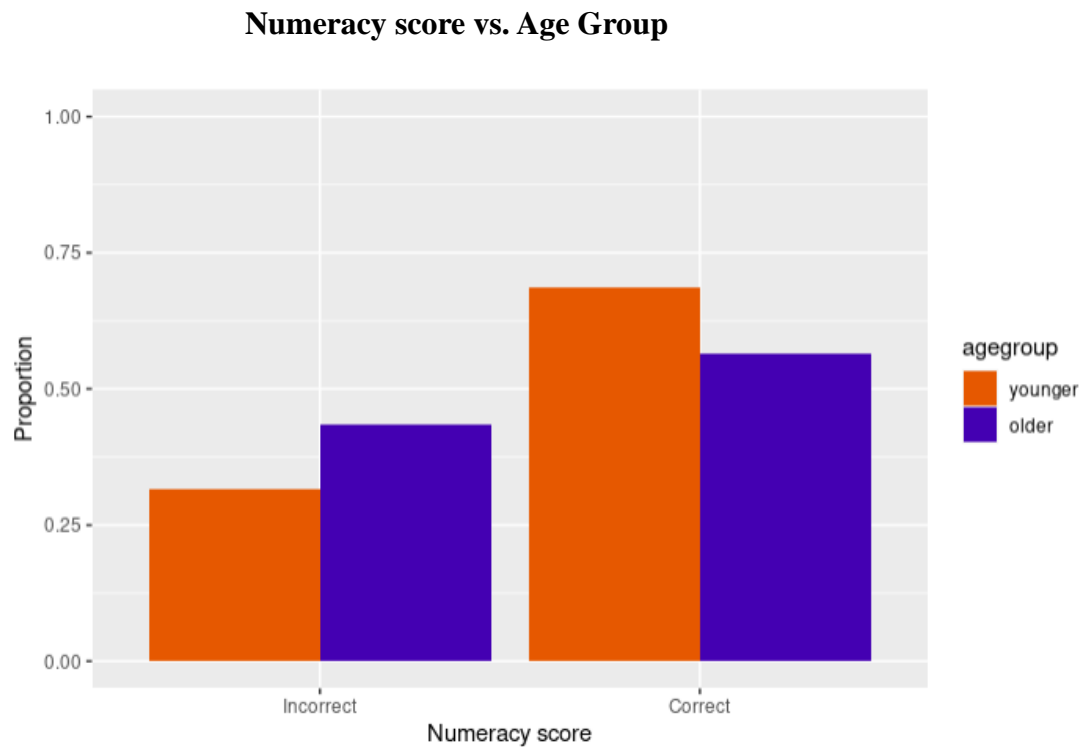
numeracy score than younger adults. (Figure 3)

Numeracy score vs. Age Group

Figure 3: Numeracy score vs. Age group

Conclusion:

Since there are significant relationships between risk-taking and objective risk [H1:(2)], and numeracy [H1:(4)]. Then we can proceed with the mediation model to test H2 hypotheses [H2:(2) and H2:(4)].

Mediation model:

The mediation model includes age differences in objective risk, numeracy and their mediation of age differences in risk-taking. We want to find whether the relationship between age group and risk-taking can be mediated by objective risk and numeracy. The results are summarized in the figure below:

$ab_{\text{objective risk}} = 0.01, 95\% \text{ CI } (-0.08, 0.09)$

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                        ┌──────────────────────────┐
                        │  COVID-19 objective risk │
                        └──────────────────────────┘
a₁ = 2.95                                              b₁ = 0
p < 0.001                                              p < 0.843

┌──────────────┐    c = -0.17      ┌────────────────────┐
│  age group   │    p < 0.001      │ COVID-19 risk-taking│
└──────────────┘    c' = -0.16     └────────────────────┘
                    p < .017
a₂ = -0.12                                             b₂ = 0.20
p < 0.007              ┌──────────────┐                p < 0.001
                       │   numeracy   │
                       └──────────────┘
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$a_1 = 2.95$, $p < 0.001$

$b_1 = 0$, $p < 0.843$

$c = -0.17$, $p < 0.001$

$c' = -0.16$, $p < .017$

$a_2 = -0.12$, $p < 0.007$

$b_2 = 0.20$, $p < 0.001$

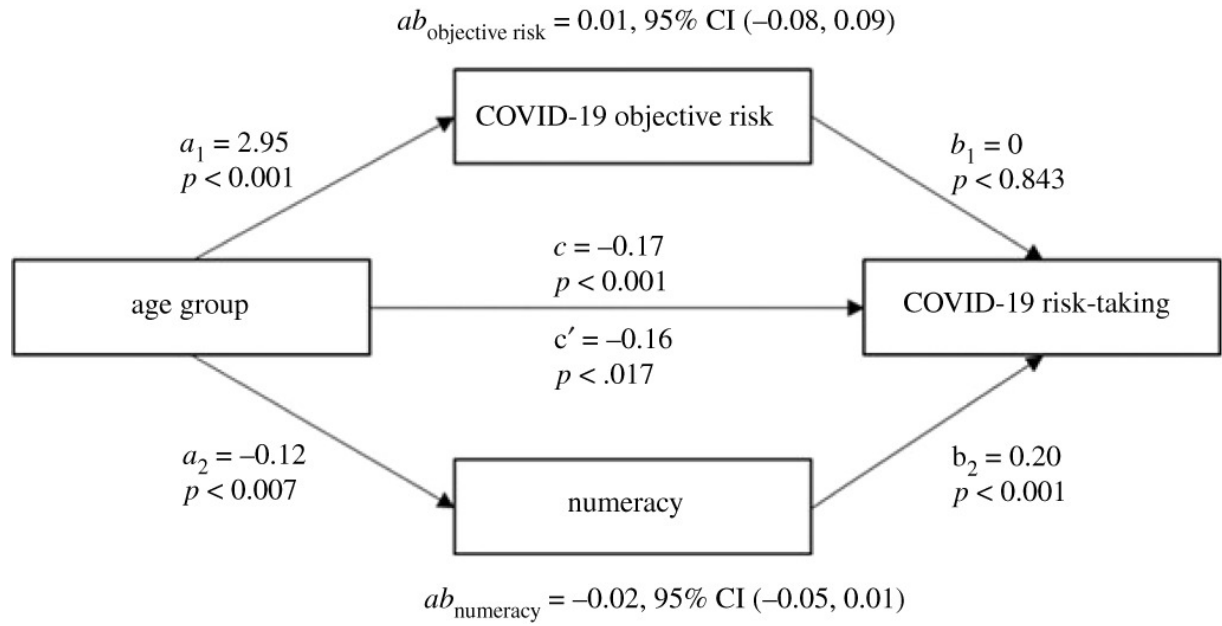$ab_{\text{numeracy}} = -0.02, 95\% \text{ CI } (-0.05, 0.01)$

Figure 4: Visual Summary of the mediation model

From the results, we can see that objective risk is no longer significantly associated with COVID-19 risk-taking, numeracy still significantly associated with COVID-19 risk-taking. Then the mediation model is used to test the indirect effect with those two mediators. The results show that objective risk is not a significant mediator, but numeracy is. The indirect effect of numeracy as the mediator is -0.02.

5. Limitation of the results:

The limitations are due to the validity of the data. The data in the original paper were collected based on the self-reported surveys. The measures are not accurate, and they can be biased. In addition, there are omitted variable bias existing in the study. The study uses simple linear regression to test the correlation between age and other variables, the results are potentially biased due to some variables omitted in the model that are both related to independent variables and dependent variables.

6. Conclusion:

First, this replication study yields the same results as in the original paper. The results show younger adults are more willing to take risk than older adults, which suggests that younger adults are less likely to follow preventive measures The results also show that numeracy abilities are significantly correlated with COVID-19 risk-taking, and this correlation is negative which suggests that people with higher numeracy ability are less likely to take preventive measures. This result seems contradict with common sense, as in the paper, the authors propose that people with low numeracy is relayed to poor health and decision-making. Nevertheless, the pandemic has shown the importance of being able to publish rapidly and disseminate research widely. This open assess paper on Royal Open Science Society provides us with open data and code which enables us to replicate the study. This replication helps me develop skills in statistics, R, and R packages, that will enable me to further disaggregate the dataset in other areas.

Appendix:

1. Survey:

Original paper link: https://osf.io/u6exb/.

Github link:

https://github.com/DD-

Daniel/STA496/blob/f8d48689cb38c8258d09dc89d4e699c68e7f1719/replication%20

of%20the%20paper/Survey.pdf

2. Variable name and variable values:

Complete list of key measures:

-younger and older adult participants / factor, younger & older

-younger and older adult participants / integer, 0 = younger, 1 = older

- statement on regularly checking numbers of COVID infection, hospitalizations &deaths / 1 (Strongly agree) - 6 (strongly disagree)

- PoliciesUK / statement on how dissatisfied with UK government COVID policies / 1 (Extremely dissatisfied) - 6   (Extremely satisfied)

- Normalized scores on COVID risk perception / 0 (low risk perception) - 1 (high risk perception)

- Risk attitude scores / negative scores indicate risk averse, positive scores indicate risk seeking.

- Objective risk for COVID-19 serious illness or death / Higher scores indicating higher risk.

- Scores on the Lipkus Numeracy Scale / 0 (no correct answers) - 11 (all correct

answers)

- Third item of numeracy scale, best predictor / 0 = incorrect, 1 = correct

- mean scores on COVID-19 risk-taking items / 0 (no risk-taking) - 5 (high risk-taking)

- subset of guidelines enforced by government / 0 (no risk-taking) - 5 (high risk-taking)

- subset of guidelines unenforced by government / 0 (no risk-taking) - 5 (high risk-taking)

- mean scores for personal risk perception items only / 0 (low risk perception) - 1 (high risk perception)

- mean scores for perception of others' risk items only / 0 (low risk perception) - 1 (high risk perception)

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