COVID-19 risk perceptions and attitudes toward the environment: Evidence from longitudinal data

by

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Masters project submitted in partial fulfillment of the requirements for the International Master of Environmental Policy degree at Duke Kunshan University, a degree awarded by the Nicholas School of the Environment and the Sanford School of Public Policy of Duke University

April 27, 2023

Executive Summary

The COVID-19 pandemic is a global health crisis that has had far-reaching consequences. It brought health concerns and an economic recession due to measures such as social distancing to avoid the spread of the virus, causing individuals to feel the dual risks of infection and financial loss. The COVID-19 pandemic is also considered a significant turning point that profoundly influences public environmental protection considerations (Zebardast & Radaei, 2022). Hence, this study seeks to understand the relationships between COVID-19 risk perceptions, environmental attitude change, and pro-environmental behavioral intentions, with the aim of providing insights for policymakers to foster sustainable lifestyle transitions.

The COVID-19 pandemic has triggered two primary risk perceptions: health risk and economic risk. On the one hand, given that human activities are believed to have contributed to the emergence of the pandemic (Admin, 2021), the perception of infection with the Covid-19 virus can serve as an indicator of the potential dangers associated with environmental changes that may occur in the future (Di Baldassarre et al., 2021). Consequently, this increased awareness of environmental risks can potentially promote environmentally responsible behaviors within society (Zebardast & Radaei, 2022). On the other hand, the pandemic has also caused significant economic risks due to lockdowns and social isolation, triggering a global economic shock. As a result, people have placed increased value on economic recovery and growth, which may downplay environmental problems.

The environmental attitude change and political attitude change due to the COVID-19 pandemic are both important outcomes and potential mediators of the relationship between risk perceptions and pro-environmental future intentions. The environmental attitude has been shown to be a significant psychological factor in the manifestation of pro-environmental behaviors (Botetzagias et al., 2015), with individuals having more positive environmental attitudes being more willing to engage in pro-environmental behaviors (Davison et al., 2014). Meanwhile, research on political attitude change has revealed that individuals who identify as liberals tend to exhibit greater levels of concern with respect to environmental issues and are more inclined to engage in pro-environmental behavior (Taniguchi & Marshall, 2018). Additionally, recent studies suggest that the COVID-19 pandemic has played a role in shaping and polarizing the political attitudes of individuals (Daniele et al., 2020).

Based on previous research introduced in the background, I formulated four groups of hypotheses:
H1: Health risk perceptions positively predict environmental attitude change and pro-environmental behavioral intentions.
H2: Economic risk perceptions negatively predict environmental attitude change and pro-environmental behavioral intentions.
H3: Environmental attitude change positively predicts pro-environmental behavioral intentions and mediates the relationship between health and economic risk perceptions and pro-environmental behavioral intentions.
H4: Political attitude change positively predicts pro-environmental behavioral intentions and

mediates the relationship between health and economic risk perceptions and pro-environmental behavioral intentions.

To verify the hypothesis, I used the data from the PsyCorona survey, a cross-national longitudinal study with a baseline cross-sectional survey conducted in March 2020 and follow-up longitudinal surveys until August 2021. The sample comprised 4,100 participants from 74 countries and was diversely distributed in different genders, ages, and educational backgrounds.

I conducted multilevel regressions to examine the interactions between individual and country factors, using health risk perception and economic risk perception as the main predictors. I nested the individual-level variables (gender, age, education degree) within country-level variables (health, economic and environmental situations in different countries). I also conducted mediation analyses by using environmental attitude change and political attitude change as mediating variables.

The key findings of the study are as follows:
1）Multilevel regressions results
Health risk perception positively predicted environmental attitude change.
Health risk perception positively predicted pro-environmental behavioral intentions.
Environmental attitude change positively predicted pro-environmental behavioral intentions.

Economic risk perception positively predicted political attitude change.
Political attitude change positively predicted pro-environmental behavioral intentions.

2）Mediation analyses results
Environmental attitude change mediates the relationship between health risk perception and pro-environmental behavioral intention.

Political attitude change mediates the relationship between economic risk perception and only the intention of reducing driving cars.

Notably, health risk perception emerged as the most consistent and influential predictor, with a larger effect size compared to economic risk perception.

These results suggest that when individuals perceive a higher risk of virus infection, they tend to become more aware of the threats posed by environmental changes and the environmental damage caused by human activities. This heightened awareness can be attributed to the fact that pandemic outbreaks, like COVID-19, are often considered to result from negative human impacts on natural systems. Consequently, people may be more inclined to agree with environmental measures and regulations and increase their pro-environmental behavioral intentions to avoid similar crises in the future due to environmental damage.

On the other hand, when individuals perceive higher economic risks, their political attitudes tend to become more liberal. This shift is noteworthy because liberals generally demonstrate stronger support for environmentalism and exhibit more pro-environmental tendencies. This

finding implies that concerns about the economic downturn causing people to downplay environmental issues can be mitigated through appropriate government policies and interventions.

There are some limitations of this study, such as the data on attitude change were not measured by pre-post differences. Ideally, environmental and political attitudes should have been surveyed separately before and after the COVID-19 pandemic and use the differences as attitude change. Moreover, attitude change may not be the only mediating variable explaining the relationship between risk perceptions and pro-environmental behavioral intentions. Other variables, such as subjective norms, may also contribute to the observed relationships and warrant further exploration in future research.

In conclusion, the study provides valuable insights into the complex relationships between COVID-19 risk perceptions, environmental attitude change, and pro-environmental behavioral intentions, which can help guide the design of policies and interventions that balance economic recovery and environmental sustainability. By capitalizing on this "window of opportunity," policymakers can foster a greener future where individuals are more aware of environmental threats and actively engage in sustainable practices.

Contents

1. Introduction

The COVID-19 outbreak is a global health crisis that has caused serious health concerns and has challenged people's livelihoods worldwide. To slow down the spread of the virus and protect life, mitigating and restrictive measures such as lockdowns and social isolation have been implemented in most countries (Benke et al., 2020). However, this preventive approach also strongly reduced civil liberties and challenged economic security (Fetzer et al., 2020). It has brought major economic disruption with consequences for employment and financial stability (Adrian & Natalucci, 2020). Thus, due to the pandemic, citizens have dually experienced the risk of contracting the coronavirus and the risk of consequential economic loss due to the virus mitigating approaches.

Understanding both health and economic risk perceptions prompted by pandemics is crucial because the environmental crisis and infectious outbreak crises can become recurrent intertwined public health challenges, largely depending on how the post-COVID recovery will deal with environmental issues (Manzanedo & Manning, 2020). The COVID-19 pandemic has both driven negative and positive environmental externalities in society and organizations (Chowdhury et al., 2021). On the negative side, the inappropriate disposal of plastic generated by the excessive consumption of single-use plastics due to the COVID-19 pandemic, such as masks and gloves, has exacerbated worldwide plastic pollution (Benson et al., 2021). In addition, the quarantine measures during the pandemic have led to a significant surge in online purchases, resulting in an increase in household waste due to the packaging used for delivery. Wrappers and boxes were commonly used to deliver household items purchased online, further contributing to the accumulation of waste (Somani et al., 2020).

At the same time, the pandemic also ushered positive effects on the environment. The lockdown policies have limited industrial and transportation activities, showing considerable reductions in pollution and noise levels and improvements in air quality (Hoang et al., 2021; Facciolà et al., 2021; Cho, 2020; Zambrano-Monserrate et al., 2020). Although these environmental impacts caused by COVID-19 may be temporary, they can provide a "window of opportunity" to positively influence the environmental attitude and promote sustainable lifestyle transitions in the post-pandemic era (Sarkis et al., 2020). However, to what extent the mammoth disruption generated by the COVID-19 pandemic - both in healthcare and economic domains - may have influenced support for policies to protect planetary health remains unclear.

This study utilized the longitudinal data from an 18-month survey conducted in 74 countries during the COVID-19 pandemic (March 2020 to August 2021) to determine how the perceptions of health and economic risk experienced during 2020 due to the coronavirus are related to a) change in environmental and political attitudes during the pandemic; b) and future pro-environmental behavioral intentions, including reducing the consumption in meat and dairy products, and reducing driving and flying behaviors. Attitude change (both environmental attitude and political attitude) will also be examined as mediators to analyze the pathways by which perceived risks are associated with environmental behavior intentions.

2. Literature review

2.1 Prolonged Covid-19 risk perceptions as predictors of attitude change

The COVID-19 pandemic may have changed behavior toward and the relationship with risks (Vieira et al., 2021) and contributed to developing positive social transformations (Slovic & Weber., 2001; Aerts et al., 2018; Buchecker et al., 2013; Dryhurst et al., 2020).

Previous research has shown that individual risk perceptions are subjective and depend largely on emotional, cognitive, and cultural factors (van der Linden, 2017), individual knowledge (Mondino et al., 2020), the levels of media coverage (Kasperson et al., 1998), and experience (Wachinger et al., 2012). Hazards and their associated events can affect psychological, social, institutional, and cultural processes in ways that influence risk perception and shape risk behavior. These processes can amplify or reduce risk at both individual and societal levels, resulting in social amplification of risk. (Kasperson et al., 1988). Research in Italy and Sweden shows that the COVID-19 crisis impacted risk perception through an availability heuristic, which means people assess the frequency or probability of an event by how easily they can bring the instances or occurrences to mind (Tversky & Kahneman, 1974). The COVID-19 risk perceptions, as experienced events, could provide an indication of the threat of future environmental change risks. People could internalize the perception of COVID-19 risks and thus consider similar risks (i.e., environmental risks) as more likely to occur in the future and more impactful (Di Baldassarre et al., 2021). The COVID-19 risks may be strengthening the notion that if humankind continues to ignore the environment, recurring disasters, and pandemics will continue to occur, thereby changing the environmental attitude and supporting participation in pro-environmental behaviors (Lucarelli et al., 2020; Zebardast & Radaei, 2022).

On the one hand, support for pro-environmental action may have increased due to COVID-19 because the pandemic has drawn attention to the close links between planetary health and human health. The COVID-19 crisis was viewed as a rapid "trial run" about handling future environmental problems (Galbraith & Otto., 2020; Kassam. & Yim, 2020). As an experienced event, its health risk perceptions could provide an indication of the threat of future environmental change risks, and this realization may encourage the increase of environmentally responsible behaviors within society. (Zebardast & Radaei, 2022).

The COVID-19 epidemic gives a sharp warning that people are a component of the ecosystem. Anthropogenic changes, like the intrusion on animal habitats, the exploitation of wildlife, the environment, and deforestation, produce negative effects in the ecosphere, resulting in a substantial rise in pathogen activity and the emergence of lethal diseases (Admin, 2021) and ultimately transfer to humans with severe health consequences. Previously, fatal illnesses caused by the zoonotic virus were Zika, Ebola, SARS, and currently, Monkeypox and COVID-19 (Admin, 2021). The WHO Report on the origins of COVID-19 suggests that the most likely culprit was the zoonotic transfer; 75% of newly emerging infectious diseases are zoonotic. The interaction between humans and wildlife can facilitate the evolution, mutation, and

transmission of viruses from animals to humans, leading to the appearance of novel viruses. (Admin, 2021). Climate change has also been found to have a positive relationship with the expansion of rising contagious illnesses (EIDs) (e.g., COVID-19, HIV, SARS-COV) (Patz et al., 2004; Allen et al., 2017), people with respiratory conditions brought by air pollution are more vulnerable to COVID-19. Yet, the ecological basis of COVID-19 does not appear to have been widely acknowledged and discussed outside environmental communities. If the human impact on nature as having been the cause of COVID-19 is salient in individuals' minds, a plausible hypothesis would be that people who are perceived to be at higher health risk or who have experienced personally or in close others illness may feel more concerned over environmental problems, and become more supportive of increased environmental protection to minimize the risk of future similar pandemics.

On the other hand, support for pro-environmental action may have decreased due to COVID-19. This is also a valid possibility because the COVID-19 pandemic has triggered a worldwide economic shock and conveyed sharp recessions for many of the world's economies. Due to the travel restrictions and strict measures for quarantine, economic and social activities were slowed down, which caused high social and economic costs, leading to business bankruptcies and rising unemployment (Aktar et al., 2022). This may have increased the value placed on economic recovery and growth above other priorities. Psychological studies about system justification indicated that when facing threats, people are motivated to defend, reinforce, and rationalize the current societal status quo (Jost, 2020). Hence, when economic stability is threatened, people are unlikely to prioritize sustainability initiatives but are more likely to minimize environmental issues in order to safeguard and uphold the existing status quo. (Hennes et al., 2016). Lower support for investment in environmental protection may be expected from individuals who perceived/ experienced a higher economic risk or who have experienced financial hardship. Research in Australia suggested that arguments prioritizing economic recovery and dismissing climate change as a secondary concern reduced support for pro-environmental actions (Ecker et al., 2020).

Given these two conceptually plausible scenarios, we propose the test of competing hypotheses (Lemeshko et al., 2009):

H1a: COVID-19 pandemic health risk perception predicts a more positive environmental attitude.
H1b: COVID-19 pandemic health risk perception predicts more pro-environmental behavioral intentions.
H2a: COVID-19 pandemic economic risk perception predicts a more negative environmental attitude.
H2b: COVID-19 pandemic economic risk perception predicts less pro-environmental behavioral intentions.

2.2 Attitude change as the mediator of pro-environmental behavior intentions

I will examine the environmental and political attitude change due to the COVID-19 pandemic as important outcomes in their own right but also as potential mediators of the relationship between risk perceptions and pro-environmental future intentions – a proxy measure of pro-environmental behavior. Pro-environmental behavior can be identified as the action that "consciously seeks to minimize the negative impact of one's actions on the natural and built world" (Kollmuss & Agyeman, 2002, p. 240). Research has found that psychological factors play a crucial role in motivating pro-environmental behaviors(Botetzagias et al., 2015), and environmental attitude is a significant factor among psychological variables (Eagly & Chaiken, 2010). The environmental attitude can be understood as a form of enduring inclination in an individual to assist people, the environment, and the world (Sultan, 2013). This desire results in a positive feeling about caring for the environment, which motivates the person to take an active role in the preservation of nature (Mitchener & Jackson, 2012). The environmental attitude reveals the extent to which people are committed to and supportive of environmental issues (Abdollahzadehgan et al., 2013). People who possess a favorable attitude toward the environment are more inclined to engage in pro-environmental behaviors (Davison et al., 2014; Vlahakis et al., 2014).

Previous research illustrated that disastrous events impact environmental behavior through cognitive, emotional, and other mediating factors (Mazzocchi & Montini, 2001). People would be more ready to encourage pro-environmental behaviors after they are aware of the COVID-19 implications and understand the significance of environmental protection. Environmental attitude is regarded as a potential factor that could influence the connection between COVID-19 and the occurrence of environmental behavior. The following hypothesis number three (H3) is put out to examine the effect of this mediating variable:

H3a: Environmental attitude change has a positive impact on pro-environmental behavioral intentions.
H3b: Environmental attitude change mediates the relationship between health risk and pro-environmental behavioral intentions.
H3c: Environmental attitude change mediates the relationship between economic risk and pro-environmental behavioral intentions.

Pro-environmental behavior has substantial polarization according to political ideology and political party affiliation (Neumayer, 2004; Dalton, 2015; Wolsko et al., 2016). Liberals tend to show greater concern about environmental problems, engage more in environmentally friendly behavior, and display stronger support for environmental legislation and regulation. (Feygina, Jost, & Goldsmith, 2010; Gromet, Kunreuther, & Larrick, 2013; Guber, 2013; McCright & Dunlap, 2011). Individuals with liberal ideology also identify more with environmentalism (Taniguchi & Marshall, 2018); for example, they tend to hold stronger concerns about global warming (McCright et al., 2016; Tranter & Booth, 2015), and they report

higher rates of pro-environmental actions than their conservative counterparts (Dunlap, 1975). In this study, participants were asked whether the COVID-19 pandemic has changed their perceptions of government provision of social protection in old age, unemployment, and illness as an overall measure of political attitude. The more participants believed that the government should provide social protection for vulnerable groups, the more their political attitudes were identified as liberal.

Previous evidence has shown that the COVID-19 pandemic could change individuals' political attitudes (Daniele et al., 2020; Bertrand et al., 2020; Bernacer et al., 2021)) and lead to political polarization (Jungkunz, 2021), but the associations between these changes in political views and pro-environmental behavior intentions also remain unclear. We propose the political attitude as another mediator that can possibly affect the relationship between COVID-19 and environmental and behavioral intentions. Hence following hypothesis number four (H4) is proposed:

H4a: Political attitude change has a positive impact on pro-environmental behavioral intentions.
H4b: Political attitude change mediates the relationship between health risk and pro-environmental behavioral intentions.
H4c: Political attitude change mediates the relationship between economic risk and pro-environmental behavioral intentions.

Figure 1 shows the Conceptual Model of our theoretical framework that the effect of health versus economic risk perceptions may be mediated by environmental and political attitude change.

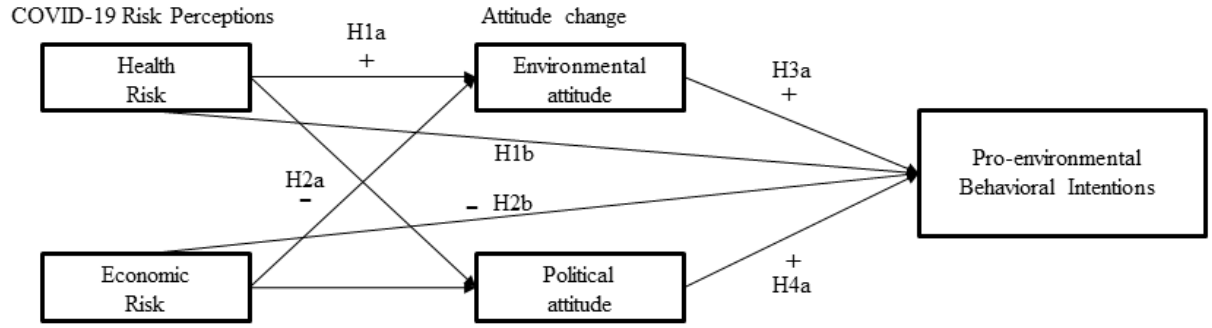

Figure 1. Conceptual Model

3. Materials and methods

3.1 Study design and data collection

This study was based on data from the global Psycorona project, a cross-national longitudinal study focused on how people perceive and consider the COVID-19 pandemic and its economic repercussions. This project initiated a baseline cross-sectional phase in March 2020; respondents could then voluntarily participate in a longitudinal phase involving follow-up

surveys throughout the pandemic (until August 2021). Participants were recruited using a combination of convenience and representative sampling strategies, and they were able to complete the survey in one of the 30 languages provided. PsyCorona Survey received ethical approval from the Ethical Committee of the University of Groningen (study code: PSY-1920-S-0390) and New York University Abu Dhabi (study code: HRPP-2020-42). Prior to participating in the survey, all respondents provided informed consent, and directly identifiable personal data were removed.

This paper used the data collected from participants who completed at least one wave between March and December 2020 (waves 0 to 16), measuring predictors and at least one follow-up survey measuring outcomes on February 2021 (wave 18) or August 2021 (wave 22).

Data were reported from 74 countries: Canada; USA; Venezuela; Peru; Mexico; El Salvador; Colombia; Chile; Brazil; Argentina; Trinidad and Tobago; Panama; Ecuador; Costa Rica; Uruguay; Trinidad and Tobago; UK; Spain; Netherlands; Italy; Greece; Germany; France; Belgium; Sweden; Switzerland; Luxembourg; Ireland; Finland; Cyprus; Austria; Ukraine; Turkey; Russia; Romania; Serbia; Poland; Lithuania; Kosovo; Kazakhstan; Hungary; Estonia; Czech Republic; Croatia; Bulgaria; Bosnia and Herzegovina; Slovakia; Georgia; UAE; South Africa; Saudi Arabia; Lebanon; Jordan; Israel; Iran; Algeria; Iraq; Egypt; Vietnam; Thailand; Singapore; Philippines; Malaysia; Japan; Indonesia; India; Bangladesh; Australia; Taiwan; South Korea; New Zealand; Hong Kong; China; Cambodia. *Two measures were taken to ensure data quality: (1) checking IP addresses to identify potential duplicate responders and (2) removing participants whose responses were deemed random from the database. These nations encompassed a range of the COVID-19 pandemic temporal phases and economic development levels, indicating the necessity for country-level variables.*

3.2 Measures

3.2.1 Predictors

PsyCorona Survey measured the risk perception of COVID-19 at multiple points in 16 waves from March to December 2020 in two separate items, with an 8-point Likert scale: a) Risk health perception: “How likely is it that you will get infected with coronavirus”; b) Risk perception about the economy: “How likely is it that your personal situation will get worse due to economic consequences of coronavirus” (from 1= Exceptionally unlikely to 8= already happened).

3.2.2 Outcomes and mediators

Pro-environmental behavioral intentions outcomes were measured in February 2021 and August 2021 waves. The results from August 2021 were used. Participants were measured whether they would change their intentions regarding pro-environmental behaviors due to the influence of the COVID-19 pandemic. They were asked to indicate their intentions in the future with two questions (four items) individually. "Research suggests that COVID-19 spread to humans at animal markets. Moving forward, what do you intend to do? a) Consume meat; b)

Consume dairy products (e.g., milk or cheese)" and "Research suggests that during the COVID-19 pandemic, pollution and carbon emissions decreased (e.g., from lower industrial activity; less car and air travel). Moving forward, what do you intend to do? a) Drive; b) Fly" (from -3=much less to 3= much more).

The environmental and political attitude change were measured in 2 waves in February 2021 (wave 18) and August 2021 (wave 22). The results from the two waves did not exhibit any significant statistical difference. Hence the results from February 2021 were used to allow for a time difference between the mediators and outcome variables (T-test p=0.507).

Whether the participants have changed their views about the environmental threats and regulations due to the pandemic was examined through three items. The participants answered the questions "Has the pandemic changed your views on these topics? (from -3=disagree much more now to 3=agree much more now)" about "a) Many of the claims about environmental threats are exaggerated; b) People worry too much about human progress harming the environment; c) Environmental laws and regulations cost too many jobs and hurt the economy." The three items of the question were combined as an overall measure of the environmental attitude change (Cronbach's = 0.847). The scores were reversed to keep consistent with the political attitude change; a higher score represents a more positive environmental attitude change.

Similarly, participants were asked whether the pandemic had changed their views about the social protection measures provided by the government by the question, "Has the pandemic changed your views on these topics? (from -3=disagree much more now to 3=agree much more now)" about "a) The Government should provide a decent standard of living for the old; b) The Government should provide a decent standard of living for the unemployed; c) The Government should provide healthcare for the sick." Three items of the question were combined respectively to interpret the changes (revealing a good internal consistency Cronbach's a= 0.880).

3.2.3 Covariates

In this study, two groups of covariates were considered in the multilevel regression models. The first group is individual-level variables: basic socio-demographic factors, including age, gender, and education levels. The second group is country-level variables, including a) country-level health covariates (health expenditure, out-of-pocket payment, hospital beds, case-fatality rate), b) country-level economic covariates (total population, GDP per capita, unemployment rate), and c) country-level environmental covariates (CO_2 emissions, PM 2.5 air pollution, renewable energy consumption). The Case-Fatality Rate was collected from World in Data, and the other variables were obtained from the World Bank's country indicators database.

3.3 Statistical analyses

To explore the differences in risk perceptions between countries, we conducted descriptive analyses using post hoc tests for analysis of variance (ANOVA) and paired samples t-tests. Additionally, we computed the Intraclass Correlation Coefficient (ICC) to assess the level of association between observations within countries. The (ICC) can also be interpreted as the variance partition coefficient, which indicates the proportion of variation attributable to between-country differences (Austin & Merlo, 2017).

The data used in this study have a hierarchical structure; individuals are nested within countries. Subjects within the same cluster are often more similar than two randomly picked subjects, as they will likely have some correlation on important variables (Austin et al., 2001). For our data, participants in the same countries are in the same cluster and share the country-level variables. The correlation of outcomes within clusters is not considered in traditional statistical methods, so they tend to underestimate standard errors. Significance tests ignoring the multilevel structure of the data would artificially increase the significance of hypothesis tests and lead to spuriously significant effects (Austin et al., 2001). Thus, we employed hierarchical models to comprehend the impact of adjusting for person-level variables while accounting for the random differences between countries.

The multilevel models used in this study are defined below. Model 0: Model 0, or the empty model, provided unadjusted rates for the attitude change and behavioral intentions (outcomes) that accounted for clustering. Model 1: included the individual-level variables as fixed effects, perception of health, and economic risk as random intercept within the country. Model 2: same as model 1 but included the individual-level country-level covariates as fixed effects.

It was found in social psychology theory that attitudes cause intentions, which then cause behavior (Fishbein & Ajzen, 1975). The mediation effect is a process in which the effect of one or more predictors is transmitted by a mediating variable(s) to a dependent variable(s). Thus we employed mediation analysis to study the mechanisms through which risk perceptions (independent variable) have an effect on pro-environmental behavioral intentions (dependent variable). The environmental and political attitude change are used as mediator variables in this paper. The models were implemented using the bootstrapping method, which is a non-parametric method based on multiple data resampling with a replacement multiple times. In each resampled data set, the indirect effect is estimated, and an empirically generated sample distribution is used to estimate the confidence intervals of the indirect effect (Özdil & Kutlu, 2019).

4. Results

4.1 Descriptive statistics

4.1.1 Sample

The final sample of this study consisted of 4,100 participants from 74 countries. At the aggregate level, about two-thirds (68.2%) were female. The age distribution was approximately balanced among the age groups between 25-74 (16.3%, 16.0%, 18.4%, 20.5%, and 18.0%) with an age span of ten years old, adding 8.0% under 24 and 3.3% were older than 75 (range 18–85). The education level of most participants was high school degree (20.2%), undergraduate degree (25.9%), or postgraduate degree (22.7%), and of the remaining participants, 22.8% were educated less than high school, and 8.9% had a doctorate degree.

4.1.2 Attitude change

The average score of environmental attitude change is M= 0.292 (SD = 1.144), revealing a slight increase in the awareness and concern regarding environmental issues of participants. Meanwhile, the global average score of political attitude change is M=1.022（SD=1.214, higher than the score of environmental attitude change (T-test $p<0.01$), so the pandemic seems to have influenced participants' political attitudes in a more pronounced way.

Gender, age, and education socio-demographic subgroup analyses were conducted for attitude change. The gender subgroup analysis exposed that the pandemic has changed the environmental attitude of females more (T-test $p<0.1$). The results from the age subgroup suggest that increasing age is negatively related to the scores in both kinds of attitude change. The older the participants are, their attitudes are less likely to be influenced by the pandemic. (Environmental attitude change B=-0.10. se=0.02, $p<0.01$; Political attitude change: B=-0.03. se=0.01, $p<0.05$). Education subgroup analysis revealed that education level could positively predict the scores of environmental attitude change. The group with higher degrees expressed more positive changes in environmental attitude (B= 0.03. se=0.01, $p<0.05$). In all subgroups, the political attitude changed to a greater extent than the environmental attitude, corresponding to the overall results.

4.1.3 Pro-environmental behavioral intentions

The behavioral intentions result from the survey in August 2021 are used for analysis. All the results are negative, revealing that impacted by COVID-19, participants intend to conduct more pro-environmental actions in the future, including reducing their intentions to consume meat (M = -0.435, SD = 0.967) or dairy (M = -0.152, SD = 0.800), and driving cars (M = -0.496, SD = 1.097) or taking planes (M = -0.784, SD = 0.967). The pro-environmental behavioral intentions results are consistent with environmental attitude change results. All the reductions were moderate as the absolute reduction values of intentions are smaller than 1, among which the willingness to fly decreased the most, and the willingness to buy dairy products had the smallest change (ANOVA and Post Hoc Test compared with all other behavioral intentions

p<0.01).

Socio-demographic subgroups analysis of pro-environmental behavioral intentions was also conducted. We found significant gender differences in the willingness to buy meat and dairy products and drive (T-test p<0.01), with a more pronounced decrease for women. Age significantly influences the intention to dairy consumption and take flights, but in inverse directions; older groups have more willingness reductions to fly (B=0.04. se=0.01, p<0.01) but hardly reduce their intentions to buy dairy (B=-0.14, se=0.02, p<0.01). Education level is weakly associated with meat (B=-0.03, se=0.01, p<0.05) and dairy consumption (B=-0.02, se=0.01, p<0.1), and driving (B=-0.04, se=0.02, p<0.01).

4.1.4 Risk perceptions about health and economy

The global average perceived risk of getting infected by COVID-19 is 3.754 (SD=1.13), slightly lower than the global average perceived risk of facing economic consequences, 3.974 (SD=1.59). Figure 2 illustrates the changing trends of health and economic risk perceptions. The perceived economic risk is generally scored higher than the perceived health risk (Paired T-test p<0.01). Both risk perceptions reduce in the first four waves after the baseline survey and then stabilize, but the health risk perceptions start to increase slightly after July 2020 and exceed the economic risk perceptions (The difference become significant after September 2020, Paired T-test p<0.01).

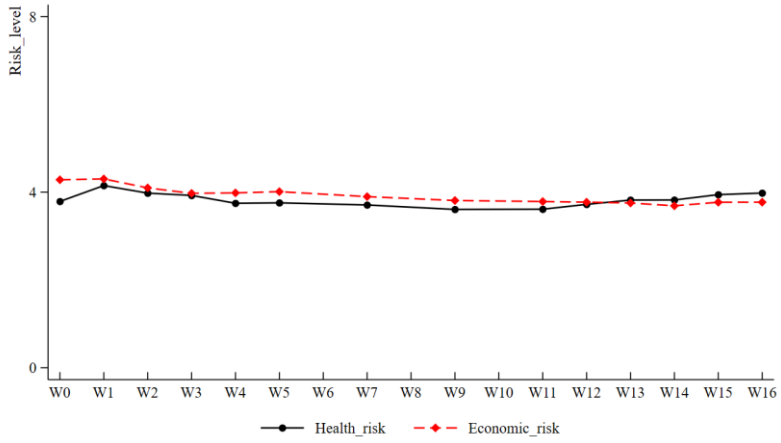

Figure 2. Perceived health risk versus perceived economic risk.

According to the education, age, and education socio-demographic subgroups analysis, participants also report receiving a higher risk of suffering from economic consequences than getting infected by COVID-19 in different population groups, while the risk perceptions are different among groups. Females report significantly higher health perceptions compared to males (Females: M = 3.824 SD = 1.106; males: M = 3.593 SD = 1.106; T-test p<0.01). The perceived economic and health risk decrease as the age group increases (Health risk: B=-0.13. se=0.01, p<0.01; Economic risk: B=-0.13. se=0.02, p<0.01), and people over 85 years old perceive higher health risk than economic consequences. For education subgroups, participants with higher degrees perceived lower risk of getting infected (B=0.06. se=0.01, p<0.01).

However, there is no noteworthy discrepancy in economic risk perceptions among individuals with different levels of education.

4.2 Association between risk perceptions, attitude change, and behavioral intentions

Multilevel regression models were conducted to examine the associations between risk perception and attitude change, risk perception and behavioral intentions, as well as attitude change and behavioral intentions. A step-by-step analysis was applied, and individuals were nested within countries since the data is hierarchical. Demographics and socioeconomic covariates were adjusted in Model 1, and a full set of potential individual and country-level covariates (including country-level health covariates, country-level economic covariates, and country-level environmental covariates) were adjusted in Model 2.

4.2.1 Risk perceptions and attitude change

The relationships between risk perceptions and environmental and political attitude change are demonstrated in Table 1. in a multilevel regression hierarchy. Higher health risk perceptions were positively associated with greater environmental attitude change (B=0.085***, se=0.020, p<0.01). When people perceive a higher risk of contracting the virus, they shift to a more positive environmental attitude. This is reflected in their greater concern about environmental threats and human impacts. They also support environmental measures and laws rather than seeing them as harmful to the economy and jobs. However, economic risk perceptions do not significantly predict environmental attitude change. Based on the results, hypothesis 1a was supported based on the influence of health risk perception, while hypothesis 2a is not effectively supported by the influence of economic risk perception.

At the same time, higher economic risk perceptions are positively associated with political attitude change. As more economic consequences of the COVID-19 pandemic are perceived, people's political attitude shift toward being more liberal and becoming more emphatic about government responsibility (B=0.085***, se=0.015, p<0.01). This implies that individuals may be more amenable to the government providing assistance to the elderly and unemployed. People would also be more supportive of government intervention in healthcare to support the sick. In addition, health risk perceptions did not significantly predict political attitude change. The ICCs are very small (-) in all models for calculating attitude change results, revealing that the country differences can only explain a very small proportion of the results.

Table 1. The relationship between risk perceptions and attitude change

Attitude change	Environmental			Political		
	0	1	2	0	1	2
Intercept	-0.071 (0.084)	-0.262** (0.131)	0.264 (0.277)	0.583*** (0.103)	0.758*** (0.146)	0.664** (0.282)
Health risk	0.086*** (0.019)	0.085*** (0.020)	0.085*** (0.020)	-0.001 (0.020)	0.006 (0.021)	0.006 (0.020)
Economic risk	0.021	0.022	0.018	0.133***	0.130***	0.085***

	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.015)
Gender		0.061 (0.045)	0.058 (0.045)		0.046 (0.047)	0.045 (0.045)
Age		0.014 (0.013)	0.019 (0.013)		-0.005 (0.014)	0.015 (0.013)
Education		0.020 (0.014)	0.020 (0.014)		-0.044*** (0.015)	-0.054*** (0.014)
Health Expenditure			0.014 (0.016)			-0.059*** (0.016)
Out-of-pocket payment			-0.004 (0.003)			0.013*** (0.003)
Hospital Beds			-0.058*** (0.013)			-0.042*** (0.014)
Case-Fatality Rate			-2.632*** (0.947)			-1.228 (0.965)
Total population			0.000 (0.000)			0.000*** (0.000)
GDP per capita			-0.000 (0.000)			0.000* (0.000)
Unemployment Rate			-0.011** (0.005)			0.028*** (0.006)
CO2 emissions			-0.018* (0.011)			-0.003 (0.011)
PM 2.5 Air pollution			0.000 (0.004)			0.005 (0.004)
Renewable energy consumption			0.007** (0.003)			0.012*** (0.003)
ICC	0.004	0.004	5.33e-21	0.02	0.01	4.20e-22

4.2.2 Attitude Change and behavioral intentions

Table 2. displays the coefficients between attitude change and behavioral intentions. When the environmental attitude of participants changes more towards pro-environment due to the Covid-19 pandemic, they will lower their intentions to engage in all the behaviors harmful to the environment (Meat consumption: B=-0.161***, se=0.021, p<0.1; Dairy consumption: B=-0.088***, se=0.017, p<0.01; Driving: B=-0.130***, se=0.024, p<0.01; Flying: B=-0.126***, se=0.029, p<0.01). Meanwhile, for the political attitude, being more liberal can only predict a reduced willingness to drive cars (B=-0.046**, se=0.024, p<0.05). Hence the environmental attitude change better predicts the reduction results in behavioral intentions. The results supported hypotheses H3a and H4a.

Table 2. The relationship between attitude change and behavioral intentions

	Consume Meat			Consume Dairy product		
	0	1	2	0	1	2
Intercept	-0.336*** (0.059)	-0.053 (0.128)	-0.236 (0.350)	-0.139*** (0.026)	-0.137 (0.097)	-0.298 (0.255)
Environmental attitude change	-0.165*** (0.021)	-0.164*** (0.021)	-0.161*** (0.021)	-0.091*** (0.017)	-0.090*** (0.017)	-0.088*** (0.017)
Political attitude change	0.016 (0.020)	0.015 (0.020)	-0.003 (0.020)	0.032** (0.016)	0.035** (0.016)	0.021 (0.017)
Gender		-0.163*** (0.049)	-0.155*** (0.049)		-0.099** (0.041)	-0.089** (0.041)
Age		0.008 (0.015)	0.014 (0.015)		0.034*** (0.012)	0.040*** (0.012)
Education		-0.044*** (0.016)	-0.048*** (0.016)		-0.015 (0.013)	-0.020 (0.013)

Health Expenditure			0.009 (0.020)			-0.029** (0.015)
Out-of-pocket payment			0.006 (0.004)			0.001 (0.003)
Hospital Beds			0.006 (0.017)			0.019 (0.012)
Case-Fatality Rate			0.429 (1.187)			1.486* (0.845)
Total population			-0.000 (0.000)			0.000*** (0.000)
GDP per capita			-0.000 (0.000)			-0.000 (0.000)
Unemployment Rate			0.017** (0.007)			0.009* (0.005)
CO2 emissions			0.005 (0.014)			0.015 (0.009)
PM 2.5 Air pollution			-0.008 (0.005)			0.002 (0.004)
Renewable energy consumption			-0.003 (0.004)			0.000 (0.003)
ICC	0.01	0.02	0.02	0.0003	0.003	1.34e-22
	Drive			Fly		
	0	1	2	0	1	2
Intercept	-0.357*** (0.061)	0.027 (0.145)	-0.278 (0.355)	-0.690*** (0.086)	-0.012 (0.175)	0.142 (0.484)
Environmental attitude change	-0.132*** (0.024)	-0.131*** (0.024)	-0.130*** (0.024)	-0.132*** (0.030)	-0.132*** (0.029)	-0.126*** (0.029)
Political attitude change	-0.035 (0.023)	-0.039* (0.023)	-0.046** (0.024)	0.012 (0.028)	0.004 (0.028)	-0.035 (0.029)
Gender		-0.181*** (0.057)	-0.170*** (0.057)		-0.120* (0.069)	-0.114* (0.069)
Age		-0.013 (0.017)	-0.012 (0.017)		-0.152*** (0.020)	-0.139*** (0.020)
Education		-0.044** (0.018)	-0.044** (0.019)		0.005 (0.022)	0.002 (0.022)
Health Expenditure			0.001 (0.021)			-0.021 (0.027)
Out-of-pocket payment			-0.001 (0.004)			0.003 (0.005)
Hospital Beds			0.027 (0.017)			-0.021 (0.024)
Case-Fatality Rate			0.844 (1.192)			-1.380 (1.649)
Total population			0.000 (0.000)			0.000 (0.000)
GDP per capita			-0.000** (0.000)			-0.000 (0.000)
Unemployment Rate			0.003 (0.007)			0.028*** (0.009)
CO2 emissions			0.028** (0.014)			0.008 (0.020)
PM 2.5 Air pollution			0.006 (0.005)			-0.005 (0.007)
Renewable energy consumption			-0.001 (0.004)			-0.006 (0.005)
ICC	0.01	0.01	4.20e-16	0.02	0.01	0.03

4.2.3 Risk perceptions and behavioral intentions

The results of the multilevel regression models, which utilized risk perceptions to forecast

behavioral intentions, are presented in Table 3. The higher perceived health risk is associated with significant intention reductions. The more health threats people felt from getting infected, the more they are willing to reduce consuming meat (B=-0.045**. se=0.019, p<0.05) and dairy products (B=-0.029*, se=0.015, p<0.1), and traveling by airplanes (B=-0.056**. se=0.026, p<0.05). The economic risk perception cannot predict any of the intentions in pro-environmental actions in model 2, although, for meat and dairy consumption, higher perceiving economic risk can predict the reduction of these behaviors in the model not adjusting any covariates, the results become insignificant after adjusting the individual covariates and the country level covariates for the two actions, respectively. The results support hypothesis H1b but do not provide valid evidence for hypothesis H2b.

Table 3. The relationship between risk perceptions and behavioral intentions

	Consume Meat			Consume Dairy product		
	0	1	2	0	1	2
Intercept	-0.264*** (0.087)	-0.065 (0.133)	-0.401 (0.296)	-0.078 (0.061)	-0.148 (0.102)	-0.154 (0.211)
Health risk	-0.056*** (0.018)	-0.041** (0.019)	-0.045** (0.019)	-0.051*** (0.015)	-0.027* (0.015)	-0.029* (0.015)
Economic risk	0.022* (0.013)	0.020 (0.013)	0.002 (0.013)	0.032*** (0.011)	0.032*** (0.011)	0.016 (0.011)
Gender		-0.151*** (0.041)	-0.143*** (0.041)		-0.114*** (0.034)	-0.103*** (0.034)
Age		0.008 (0.012)	0.008 (0.013)		0.042*** (0.010)	0.045*** (0.010)
Education		-0.037*** (0.013)	-0.040*** (0.013)		-0.022** (0.011)	-0.024** (0.011)
Health Expenditure			0.007 (0.017)			-0.035*** (0.012)
Out-of-pocket payment			0.007** (0.003)			0.001 (0.002)
Hospital Beds			0.013 (0.014)			0.022** (0.010)
Case-Fatality Rate			0.497 (0.978)			0.779 (0.682)
Total population			0.000 (0.000)			0.000*** (0.000)
GDP per capita			-0.000 (0.000)			-0.000 (0.000)
Unemployment Rate			0.021*** (0.006)			0.014*** (0.004)
CO2 emissions			0.010 (0.011)			0.015** (0.007)
PM 2.5 Air pollution			-0.006* (0.003)			-0.003 (0.003)
Renewable energy consumption			-0.003 (0.003)			-0.001 (0.002)
ICC	0.01	0.02	0.02	0.002	0.006	5.02e-18
	Drive			Fly		
	0	1	2	0	1	2
Intercept	-0.293*** (0.095)	0.132 (0.151)	-0.000 (0.304)	-0.847*** (0.120)	-0.103 (0.176)	-0.226 (0.434)
Health risk	-0.038* (0.021)	-0.030 (0.022)	-0.032 (0.022)	0.000 (0.025)	-0.052** (0.026)	-0.056** (0.026)
Economic risk	-0.009 (0.015)	-0.014 (0.015)	-0.020 (0.016)	0.027 (0.018)	0.027 (0.018)	-0.003 (0.018)
Gender		-0.154*** (0.049)	-0.151*** (0.049)		-0.089 (0.057)	-0.070 (0.057)

Age		-0.024 (0.015)	-0.028* (0.015)		-0.142*** (0.017)	-0.136*** (0.017)
Education		-0.049*** (0.016)	-0.046*** (0.016)		0.015 (0.018)	0.016 (0.018)
Health Expenditure			0.008 (0.018)			-0.026 (0.023)
Out-of-pocket payment			-0.002 (0.003)			0.000 (0.005)
Hospital Beds			0.029** (0.014)			0.004 (0.020)
Case-Fatality Rate			-0.117 (1.000)			-0.166 (1.380)
Total population			0.000 (0.000)			0.000 (0.000)
GDP per capita			-0.000* (0.000)			-0.000 (0.000)
Unemployment Rate			0.004 (0.006)			0.040*** (0.008)
CO2 emissions			0.026** (0.011)			0.024 (0.016)
PM 2.5 Air pollution			0.001 (0.004)			0.002 (0.005)
Renewable energy consumption			-0.005 (0.003)			-0.011*** (0.004)
ICC	0.007	0.009	7.95e-18	0.01	0.01	0.07

In conclusion, the multilevel regression results are shown in Figure 3. Health risk perception positively predicted environmental attitude change and pro-environmental behavioral intentions. And environmental attitude change positively predicted pro-environmental behavioral intentions. Meanwhile, economic risk perception positively predicted a liberal-oriented political attitude change, and the political attitude change positively predicted pro-environmental behavioral intentions.

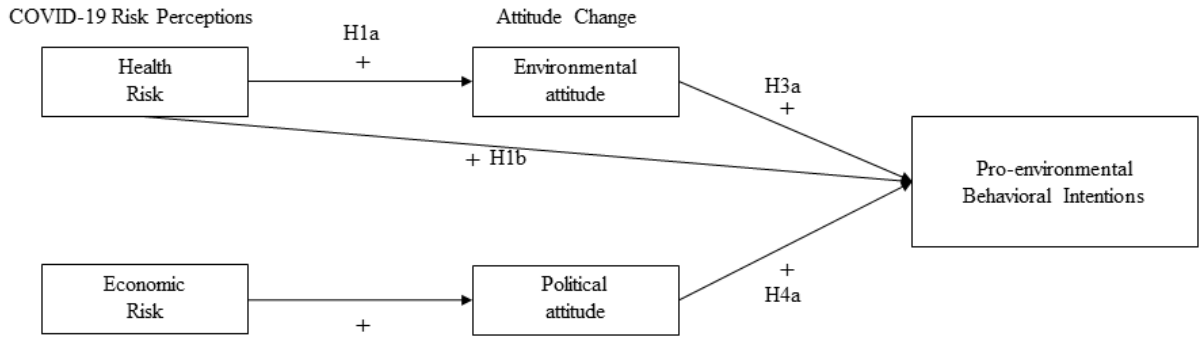

Figure 3. The multilevel regression results.

4.3 Mediation analyses

We conducted a multilevel mediation analysis to estimate whether the association between risk perceptions and behavioral intentions was mediated by attitude change. Following the model shown in Figure 1., environmental attitude change and political attitude change were examined as mediators by 1000 bootstrap samples.

Table 4. illustrates the bootstrapping analysis results of using the environmental and political attitude change as mediators. According to the table, in the four separate bootstrapping analyses of pro-environmental behavioral intentions, all results demonstrated a mediation effect, showing that the environmental attitude change mediated the relationship between health risk perception and the reduction in meat and dairy consumption, driving, and flying. However, environmental attitude change did not mediate the association between economic risk perceptions and pro-environmental behavioral intentions. According to the mediation analysis results, our hypothesis H3a is supported, and H3b is rejected.

Mediation analysis results for the other mediator variable, political attitude change, are also shown in Table 4. The results showed that political attitude change mediated the association between higher perceptions of economic risk during the pandemic and lower intentions of traveling by car and air. However, according to the multilevel regression results, the effects of political attitude change on reduced intentions to fly were insignificant. Thus, the political attitude change can only mediate the relationship between higher perceptions of economic risk and reduced intentions to drive. Meanwhile, the political attitude change did not mediate the relationship between health risk perception and any pro-environmental behavioral intentions. Hence our hypothesis H4a is rejected, and H4b is supported.

Table 4. The results of the mediation analysis

Environmental attitude change	Direct Effect: Health risk to behavior intentions			Indirect Effect: Health risk to behavioral intentions through environmental attitude change		
	β	se	CI	β	se	CI
Meat consumption	-0.015	0.022	-0.068, 0.027	-0.013	0.005	-0.028, -0.007
Dairy consumption	-0.027	0.020	-0.070, 0.010	-0.007	0.003	-0.018, -0.004
Driving	-0.040	0.026	-0.095, 0.008	-0.011	0.005	-0.031, -0.006
Flying	-0.062	0.032	-0.124, -0.001	-0.012	0.005	-0.025, -0.004
Environmental attitude change	Direct Effect: Economic risk to behavior intentions			Indirect Effect: Economic risk to behavioral intentions through environmental attitude change		
	β	se	CI	β	se	CI
Meat consumption	0.002	0.016	-0.028, 0.037	-0.005	0.003	-0.012, 0.0007
Dairy consumption	0.014	0.013	-0.013, 0.039	-0.003	0.002	-0.007, 0.0002
Driving	-0.011	0.019	-0.046, 0,029	-0.004	0.003	-0.011, 0.0002
Flying	-0.013	0.022	-0.060, 0.029	-0.004	0.003	-0.010, 0.002
Political attitude change	Direct Effect: Health risk to behavior intentions			Indirect Effect: Health risk to behavioral intentions through political attitude change		
	β	se	CI	β	se	CI
Meat consumption	-0.025	0.023	-0.069, 0.020	-0.002	0.002	-0.005, 0.0005
Dairy consumption	-0.032	0.021	-0.074, 0.010	-0.0001	0.001	-0.003, 0.002
Driving	-0.047	0.028	-0.101, 0.006	-0.003	0.003	-0.007, 0.002

Flying	-0.070	0.033	-0.130.-0.001	-0.003	0.003	-0.006, 0.002
Political attitude change	Direct Effect: Economic risk to behavior intentions			Indirect Effect: Economic risk to behavioral intentions through political attitude change		
	β	se	CI	β	se	CI
Meat consumption	−0.0009	0.017	-0.037, 0.032	-0.004	0.002	-0.007, 0.0002
Dairy consumption	0.012	0.013	-0.017, 0,036	-0.0005	0.001	-0.003, 0.002
Driving	-0.011	0.020	-0.048, 0.029	-0.006	0.002	-0.013,-0.003
Flying	-0.015	0.022	-0.056, 0.031	-0.006	0.002	-0.017, -0.003

Figure 4 summarizes the mediation analysis results and demonstrates parts of our hypothesis. The effect of health risk perceptions on pro-environmental behavioral intentions is mediated by the environmental attitude change, and the effect of economic risk perceptions on pro-environmental behavioral intentions is mediated by the political attitude change.

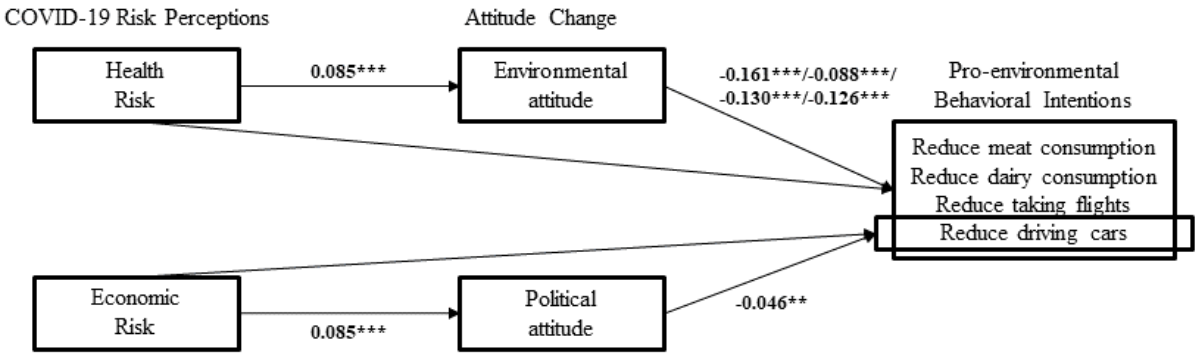

Figure 4. The mediation analyses results.

5. Discussion

Using longitudinal data from a large-scale cross-national survey across 74 countries, I examined global perceptions of the risk of being infected by the virus and the economic consequences faced owing to the COVID-19 pandemic and their relationship with the environmental attitude change and intentions to engage in pro-environmental actions. I predicted and found that participants worldwide showed positive environmental attitude change, which was positively associated with their health risk perception posed by the COVID-19 pandemic. At the same time, the political attitude of participants changed toward more liberal views, which were significantly and positively associated with the perceived risk of economic loss from the COVID-19 pandemic. People have also demonstrated pro-environmental behavioral intentions for environmentally sustainable consumption, mediated by the environmental and political attitude change as mediating variables, positively correlated with health and economic risk perceptions, respectively.

First, of the two perceived risks focused on in this study, the most consistent factor predicting

the environmental attitude change and the pro-environmental behavioral intentions was the perceived health risk, and their effects are positive. The more individuals perceived a high risk of virus infection, the more aware they were of the threats posed by the environment and the damage to it by human progress, and the more they agreed that environmental measures and laws were necessary rather than having a negative impact on the economy and employment. At the same time, the perceived health risk also positively predicted the pro-environmental behavioral intentions of participants, and the effects were partially mediated by environmental attitude change as a mediating variable. The higher the perceived health risk and the larger the environmental attitude change to positive, the more participants report they would likely reduce their future intentions to consume meat and dairy products, and the more they would likely reduce their future intentions to travel by car and by air. The results of the environmental attitude change and behavioral intentions together support previous research that the COVID-19 pandemic has positively influenced the support of people to protect the environment (Rousseau & Deschacht, 2020; Daryanto et al., 2022; Shreedhar & Mourato, 2020).

The environmental attitude change as a mediating variable was only partially mediated, possibly because when investigating pro-environmental behavioral intentions, participants were told that the COVID-19 virus originated in animal markets and that people may choose to reduce their meat and dairy consumption intentions out of fear of contracting the virus from food rather than fear of causing environmental damage. Similarly, people may have the intention to reduce air travel for reasons of reducing contact with crowds and reducing the risk of being infected. Thus, the health risk perception during the COVID-19 pandemic can directly and positively influence the pro-environmental behavioral intentions of participants, and it is these behaviors that can also reduce the risk of infection.

Second, another consistent predictor of the pro-environmental behavioral intentions of individuals was the economic risk posed by the COVID-19 pandemic, moderated by the political attitude change as a mediating variable. I found that the economic risk perception from the pandemic is a positive predictor of political attitude change. When people perceive that they will suffer greater economic losses due to the pandemic, their political attitudes become more liberal, which means they are more supportive of government care and protection for the elderly, unemployed, and sick. Political attitude change further positively predicted pro-environmental behavioral intentions. Participants who become more liberal exhibit more pro-environmental behavioral intentions, and they will reduce their intentions of traveling by fossil fuel transportation. Here, economic risk perceptions were not a direct predictor of pro-environmental behavioral intentions, and their relationship was fully mediated by political attitude change as a mediating factor. This precludes the speculation that people reduced their intention to use fossil fuel transportation for reasons of saving or unaffordability due to their exposure to the economic decline caused by the COVID-19 pandemic. However, political attitude change did not affect the behavioral intentions toward sustainable food consumption of participants.

Furthermore, I did not find that economic risk perception from the COVID-19 pandemic was predictive of the environmental attitude change of individuals. Consider together with the

results of full mediation effects, the findings do not support the previous speculation that people are likely to downplay environmental issues and prioritize economic recovery when economic stability is affected by the COVID-19 pandemic (Temple, 2020; Ecker et al., 2020). This may be due to the fact that liberals are more inclined to subscribe to environmentalism and engage in more environmentally friendly behaviors, as has been verified in previous studies (Guber, 2013; Taniguchi & Marshall, 2018). Here I only consider support for government provision of livelihood security for the elderly and unemployed and health care coverage for the sick as a measure of freedom of the political attitude, which may also bias the results. Whereas the perception of providing livelihood security seems to be more biased towards addressing the economic consequences of the covid-19 pandemic, providing health care coverage seems to be more biased towards addressing the health consequences. Regardless, the results illustrate that concerns about COVID-19 causing an economic downturn that makes people consider environmental issues as a backseat issue can be addressed with some simple government policy or advocacy. However, the question of how to make the pro-environmental behavioral intentions actually materialize, especially in the context of the economic losses caused by COVID-19 and the potential costs that some pro-environmental behaviors may add, is more the question that needs to be addressed to achieve a green recovery in the post-epidemic era.

Finally, I found that when comparing these two predictive mechanisms, health risk perceptions were the more dominant predictor. According to our results, only perceived health risk positively predicted all outcomes, even though economic risk perceptions from the COVID-19 pandemic were perceived to be higher at the global level. This result differs from previous studies showing that perceived economic risk better predicts viral prevention behavior and supports stricter health regulations to restrict viruses (Nisa et al., 2021). However, our study also supports that the economic risk perception posed by the COVID-19 pandemic is a more significant predictor of political attitude change, as I did not find that the health risk perceptions were predictive of the political attitude change in individuals. This is consistent with the previous study in which the economic risk perception was a stronger predictor of policy support.

Take together; these results suggest that when pandemic outbreaks are attributed to be derived from the detrimental effects of human activities on natural systems, including environmental pollution and ecosystem degradation, leading to the origin and accelerated spread of the virus to humans (Zebardast & Radaei, 2022), and people perceive a health risk of contracting virus infections, they associate this risk with environmental issues. To avoid similar health crises (and perhaps other crises such as acute infectious diseases or natural disasters) that may arise in the future due to environmental damage, people increase their environmental attitudes and pro-environmental behavioral intentions. At the same time, the perceived economic consequences of the COVID-19 pandemic shifted the political attitude shifts toward a more liberal direction, and such an attitude can cause people to exhibit more pro-environmental tendencies. Our findings suggest that the COVID-19 pandemic may have been a potential turning point for the global public to increase environmental attitudes and shift to environmentally sustainable consumption.

6. Limitations and recommendations

One limitation of the study is that our results on attitude change were not measured as pre-and-post differences. Ideally, attitudes toward the environment and politics should have been surveyed separately before and after the COVID-19 pandemic, and the differences should be treated as pre versus post attitude change. However, due to data limitations, no survey data on people's environmental attitudes, political attitudes, and pro-environmental behavioral intentions were collected before the pandemic. I was only able to distinguish attitude change based on the self-reported of participants, assessed in 2021, on the extent to which the risk perceptions in the pandemic have changed their perceptions of different topics. To mitigate the effects of this limitation, I collected and compared two data points in 2021 to ensure the reliability of the results. Despite this limitation, I focused primarily on the average attitude change rather than the attitude per se, so the lack of baseline points data of participants may be of lesser importance.

Another limitation is that this is a longitudinal cross-national study spanning 18 months, and despite the large total sample size (N=4100), the adoption of a country-level approach is limited. The sample size was uneven at the country level, with some countries having only one or two participants. In addition, our samples are not fully representative country samples that would allow for greater generalizability but convenience and snowball samples. Nevertheless, our multi-country data was maintained for 18 months, covering the key period of the pandemic, with survey participants representing a wide range of ages and education levels. Moreover, I adopt multilevel methods in regression and mediation analysis to account for the correlation of results within countries. Future studies could conduct further exploration of cross-national analyses to examine the influence of national/cultural characteristics on predicting pro-environmental attitudes and behavioral intentions by health and economic risk perceptions during the pandemic.

For future studies, the environmental attitude change may not be the only mediating variable that explains the direct relationship between the perceived health risk and pro-environmental behavioral intentions. As per the theory of planned behavior (Ajzen, 1991), behaviors are influenced by intentions, which are shaped by three factors: attitudes, subjective norms, and perceived behavioral control. The subjective norms and perceived behavioral control of individuals may also be explored as mediating variables in future studies. In addition, when investigating pro-environmental behavioral intentions, survey questions provided brief contextual information that allowed participants to associate these pro-environmental behaviors with the pandemic. For example, participants were informed that COVID-19 originated from animal markets and suggested that due to social isolation during the COVID-19 pandemic, human activity was reduced, so pollution and carbon emissions were reduced. These cue messages may influence the pro-environmental behavioral choices of participants by evoking negative or positive environmental and emotional responses (Mi et al., 2021). Our study mainly focused on the influence of individual psychological motivations on goal-directed behavior and did not consider emotional response factors. The possible presence of environmental affective reactions may have confounding effects on the results I obtained.

However, this may be a potential direction for future research. Furthermore, in the current study, I measured pro-environmental behavioral intentions rather than actual actions. Therefore, future research should address this issue by considering true pro-environmental behaviors.

It remains to be determined whether the trend toward positive public environmental attitudes associated with the perceived health and economic risks of the COVID-19 pandemic is temporary or can be sustained over time. The results of this study can help provide recommendations for policymakers to find opportunities in the aftermath of the pandemic, to increase public environmental attitudes, promote public pro-environmental behavioral intentions and translate them into actual pro-environmental actions, and transfer the temporary positive improvements in the environmental attitudes of citizens brought about by the pandemic as a turning point into long-term effects.

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