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Influenza risk perception and travel-related health protection behavior in the US: Insights for the aftermath of the COVID-19 outbreak

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ABSTRACT
Influenza is a contagious virus affecting both one's health and economic productivity. This study evaluates uses a survey of 2168 individuals across the U.S. Ordered logit regressions are used to model risk mitigation travel-related decisions. Models are estimated for three influenza outbreak scenarios, specifically an individual's travel-related: 1) risk perceptions, 2) risk mitigation decisions when infected and the individual wants to prevent spreading it, and may want treatment, and 3) risk mitigation decisions when not infected and the individual wants to reduce exposure. Risk perception results show that a recent personal experience with influenza-like symptoms and being female significantly increased risk perception at mandatory and medical trip locations. Risk mitigation model results show that males are less likely to alter their travel patterns in response to the possible spreading of the virus or increasing exposure. Knowing the difference between influenza and the stomach flu is more influential in reducing travel than a recent influenza experience in one's household. Individuals proactive with their health (i.e., receive the vaccine, have health insurance) are also proactive in seeking medical attention and reducing influenza spread. Lastly, aligned with the Protection Motivation Theory, individuals reduce travel to locations in which they perceived medium or high risk. However, increased risk perceived at one's work location did not significantly reduce travel. The findings provide insight into the risk perception and mitigation behavior of the American public during the COVID-19 pandemic and after restrictions are lifted.

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1. Introduction

Within the United States, influenza affects an estimated 25–50 million people per year, with 150,000 hospitalizations and 30,000–40,000 deaths (Rau et al., 2015), resulting in an annual economic impact in the billions of dollars (Schoenbaum, 1987). Three types of influenza affect human health: seasonal, Zoonotic or variant, and pandemic influenza (WHO, 2014). Seasonal influenza can affect individuals multiple times in their lifetimes and is predominant during winter months, in regions with a temperate climate. Zoonotic or variant forms of influenza are spread by the interaction between humans and animals and have been recorded several times in the past century (WHO, 2014). Whereas, a virus is pandemic when it has not previously circulated amongst humans and creates significant epidemics, for example, the H1N1 influenza (2009) pandemic (WHO, 2014) and the Coronavirus disease (COVID-19) pandemic (Chappell, 2020). Pandemics can lead to much higher death tolls worldwide if not contained quickly through social distancing measures and vaccines.

Influenza spreads from person to person through sneezing, coughing (Stelzer-Braud et al., 2009), or touching contaminated surfaces (Jones, 2011). COVID-19 can live on surfaces for several days (Gray, 2020) and be airborne for up to three hours (Harvard Medical School, 2020). Individuals can be exposed to the virus at a variety of locations based on their daily activities, such as work, school, restaurants, libraries, hospitals, and doctor's offices. Seasonal influenza vaccinations are developed based on predictions of which virus strains will be prevalent in a given year, but the effectiveness varies, meaning those who are vaccinated can become ill after exposure to a strain that is not well matched by the vaccine or if the individuals are unable to develop a protective immune response.

Chances of contracting or spreading the infection can be reduced if a person alters their behavior effectively when they perceive high influenza risk during their daily activities. For the purposes of this paper, risk is a combination of consequences and likelihood. The consequences are contracting influenza and the severity of the symptoms, which are a function of individual health and mitigation measures. The likelihood can be considered a function of exposure and susceptibility. The influenza virus is a threat to an individual's health if he/she is not immune.

Previous studies have linked the preventative health measures an individual takes with the risk perceived (Marathe et al., 2011; Chen et al., 2012).
2. Data and methodology

The data for this study came from a survey that was developed by researchers at Virginia Tech. It was distributed by the GfK Group (formerly Knowledge Networks) using a sample from GfK’s KnowledgePanel®, a probability-based web panel designed to be representative of the United States. GfK recruits panel members by using address-based sampling methods. Once household members are recruited for the panel and assigned to a study sample, they are notified by email for survey taking and panelists can visit their online member page. The sample for this study consisted of participants who spoke English, were at least 18 years old, and resided in the United States. From the 3604 fielded participants in March 2016, a total of 2168 participants (close to 60%) completed the survey. The majority of the respondents were based in California (11.2%), followed by Texas (7.3%), Florida (6.7%) and New York (5.9%).

Survey participants were provided the following text prompt for the symptoms of influenza: “The purpose of this survey is to learn about your experience with influenza. Influenza is an illness that has symptoms such as fever, cough, sore throat, muscle aches, runny or stuffy nose, headaches, and fatigue. Influenza is not what people refer to as the stomach flu. When completing this survey, please consider only influenza and not the stomach flu as you answer the questions.”

Table 1 outlines the information collected from respondents that were used to build the models for the three scenarios, including both the independent and dependent variables. Scenario 1 contains models that estimate factors that influence a person’s risk perception at work, school, restaurant, library, hospital, and doctor office locations. Scenario 2 contains travel-related behaviors for four locations when a person is sick with influenza and possibly trying to prevent spreading the virus or to seek medical attention. Scenario 3 contains three models for when someone is not sick, but possibly wants to reduce exposure.

Additional questions regarding each respondent’s demographics and home provided information that could be used to predict their risk perceptions and their risk mitigation actions in the three scenarios. Respondents selected their household income range and, for this study, the income ranges were converted to a continuous format by averaging the minimum and maximum bounds of each range. The housing type (apartment/mobile) and race/ethnicity (race white, non-Hispanic) variables, respectively, were grouped to increase variable significance in the models. For example, with the race/ethnicity variable, all combinations were tested, such as Black/non-Hispanic and White/non-Hispanic vs Any/Hispanic and Other, non-Hispanic, Any/Hispanic and Black/non-Hispanic vs White/non-Hispanic and Other/non-Hispanic, Black/non-Hispanic vs all other races, White/non-Hispanic vs all other races, etc. Other race and housing type groupings reduced variable significance and, at times, the reduction resulted in variable insignificance. When significant, the risk perception ratings were included as independent variables in the Scenario 2 and 3 models.

The dependent variables for all models were indicated on three-factor scales (low, medium, high or never, sometimes, always). These responses have an intuitive order but no mathematical equivalent representation. An ordered logit model is most commonly used to account for this property in the dependent variable, and the ordered logit was used for Scenario 1. However, the difference in the transition from never to sometimes and the difference from sometimes to always is not always equal. Many variables in the Scenario 2 and 3 models had relationships that violated the parallel regression assumption of the ordered logit. This was indicated through the results of the Brant Test, which significantly rejected the null hypothesis that the parallel regression assumption holds (Williams, 2006). This means there was not a single uniform trend across the three responses. For example, in this study, a large number of respondents with past influenza experience answered ‘sometimes’ to avoiding public places when sick while very few answered ‘never’ or ‘always.’ This relationship violates the parallel regression assumption. The ordered logit cannot be used because a single coefficient cannot pick up this changing effect across the three ordered responses. Therefore, the generalized ordered logit used in Scenarios 2 and 3...
gives more than one coefficient to parameters violating the assumption to overcome the ordered logit’s shortcomings (Williams, 2006).

The generalized ordered logit model has a similar probability equation to the ordered logit. However, since the generalized ordered logit model gives one coefficient to parameters meeting the parallel regression assumption and more than one coefficient to those violating the assumption, the equation is adjusted to meet this specification. Eq. (1) gives the generalized logit probability equation (for individual i selecting an option with a coding greater than j) for a model where both $X_{1i}$ and $X_{2i}$ meet the parallel regression assumption and therefore $\beta_1$ and $\beta_2$ can be used across all $J$s. The $X_{3i}$ variable did not meet the assumption, therefore $\beta_3$ varies across the $J$ alternatives. Eqs. (2)-(4) are used in conjunction with Eq. (1) to get the separate probabilities of individual i choosing each of the M ordinal responses (Williams, 2006).

Variables in the ordered logit models.

| Scenario 1: risk perception of contracting influenza |
|----------------------------------------------------|
| Doctor's office risk rating | Three-factor response scale: low, medium, high |
| Hospital's risk rating | |
| Library risk rating | |
| Restaurants risk rating | |
| School risk rating | |
| Work risk rating | |

| Scenario 2: actions when sick with influenza |
|---------------------------------------------|
| Visit doctor's office | Three-factor response scale: never, sometimes, always |
| Avoid public places | |
| Avoid public transit | |
| Stay at home | |

| Scenario 3: actions to reduce exposure |
|---------------------------------------|
| Avoid public places | Three-factor response scale: never, sometimes, always |
| Avoid public transit | |
| Stay at home | |

Independent variables

- Age
- Apartment/mobile
- BS degree
- Experience
- Exposure_Work
- Health insurance
- HHsize
- Income
- Income/HHousehold: HH income in ten-thousand dollars. Pseudo continuous income based on range mid-points
- Income/HHIncome
- InfoSource
- Workplace

Knowledge

- Respondent knows the difference between 'stomach flu' and influenza (0 = No, 1 = Yes)
- Kids_0_12
- Male
- Metro
- Race White (non-Hispanic)
- Race White (Hispanic/non-Hispanic)
- Single
- Single parent
- Stores risk rating
- Transit risk rating
- Vaccine
- Work risk rating
- Working

Models for people’s risk perceptions were developed for select locations, including mandatory trips (i.e., work and school), discretionary trips (i.e., restaurants and libraries), and medical trips (i.e., hospitals and doctor’s offices). The ordered logit methodology was used as all models passed the parallel regression assumption. Table 2 presents the six models, where the work model was estimated only on responses from employed participants and the school model on responses from households that had children 12 years old and younger. The McFadden pseudo-$R^2$ was used to indicate the model goodness-of-fit, which typically has low values and should not be interpreted as a linear regression R-squared value. Previous researchers (Norusis, 2012; Grilli and Rampichini, 2014) using the ordered logistic regression have reported values from 0.012 to 0.075.

As indicated in Table 2, males significantly perceived lower risk at work, school and the doctor’s office. This finding is consistent with literature where, in a review of studies related to gender and risk perception, Gustafson found that while men and women are concerned about the same things, women frequently worry more (Gustafson, 1998). Davidson and Freudenburg suggested that the traditional gender role of women being nurturers and care providers within a family could lead to higher health risk perceptions (Davidson and Freudenburg, 1996).

If the participant or someone in their household had been infected with influenza in the past 6 months, that person had a heightened risk perception at all of the locations with work having the greatest increase. This is similar to the findings in Leung et al. (2003), where in the context of severe acute respiratory syndrome (SARS), those with relevant symptoms were more likely to take precautionary measures.

Employees of jobs that involve close contact with the public viewed their workplaces as having higher risk. This type of employment allows more likely to take precautionary measures. This indirect relationship is consistent with other literature that found that higher income individuals/households were more capable of making purchases to reduce their risk (Dosman et al., 2001). Those living in a metropolitan area perceived higher risk at the library compared to those not living in a metropolitan area. Those with children 12 years old and younger did not have significantly different risk perceptions for work and discretionary trip locations, but did view medical locations as having higher risk. This may be due to children having immature immune systems compared to adults, where immunity memory is established during the first 18 years of a person’s life (Dietert et al., 2000). Also, having knowledge of the difference between influenza and the stomach flu increased risk perception at hospitals.
The source and type of information on influenza spread affects how people perceive health risks (Suciu, 2019). Survey responses could indicate more than one information source, so they were not mutually exclusive. Finding out about an influenza outbreak by word of mouth increased risk perception for discretionary trips than for the other two trip categories. Social media is increasingly used as an information source (WeberShandwick, 2018), and the respondent is not infected) are discussed in Section 4.2 and presented in Tables 3a and 3b. Results for Scenario 2 (i.e., travel-related actions when the respondent is sick and always avoid public places) are presented in Table 4. None of the models in this section passed the parallel regression assumption and, therefore, were required to use the generalized ordered logit methodology.

4. Risk mitigation results

Results for Scenario 2 (i.e., travel-related actions when the respondent is infected) are discussed in Section 4.1 and presented in Tables 3a and 3b. Results for Scenario 3 (i.e., travel-related actions during an influenza outbreak and the respondent is not infected) are discussed in Section 4.2 and presented in Table 4. None of the models in this section passed the parallel regression assumption and, therefore, were required to use the generalized ordered logit methodology.

4.1. Scenario 2

Tables 3a and 3b present the results for visiting the doctor, avoiding public places, avoiding public transit, and staying home in Scenario 2. In the ‘Visit Doctor’s Office’ model, the Race White (non-Hispanic) variable did not meet the parallel regression assumption and, therefore, has different coefficients and trends change across the marginal effects percentages. That is, self-identified Caucasian, non-Hispanics were 3.65% more likely to respond ‘Never’ to visiting the doctor when sick compared to other races/ethnicities, 4.27% more likely to respond ‘Sometimes,’ and 7.92% less likely to respond ‘Always.’ This trend increases then decreases across the ordered responses. In the same model, the Vaccine variable did pass the parallel regression assumption, causing both of the variable’s coefficients to be equal at 0.573.

The results show that males were less likely to prevent the spread of the disease, as they were statistically less likely than females to avoid public places, avoid public transit, and stay at home. This is noticeable in the marginal effects, where male respondents were, for example, 2.89% more likely to avoid public places, 1.92% more likely to avoid public transit, and 7.92% less likely to stay at home in Scenario 2. In the ‘Avoid public places’ model, the Race White (non-Hispanic) variable did not meet the parallel regression assumption and, therefore, were required to use the generalized ordered logit methodology.

4.2. Scenario 3

Results for Scenario 3 (i.e., travel-related actions during an influenza outbreak and the respondent is not infected) are discussed in Section 4.2 and presented in Table 4. None of the models in this section passed the parallel regression assumption and, therefore, were required to use the generalized ordered logit methodology.
individuals were more likely to avoid transit to reduce the spread of in-
fection. The frequency of presenteeism (i.e., working while sick) has been analyzed in literature and it has been statistically significant in avoiding public places in Scenario 3. Having children in the household reduces one’s ability to avoid public places when they are sick. This could be due to obligations that the caregiver or other children in the household cannot get out of easily as well as the necessary errands a caretaker needs to make. Neither knowledge nor experience statistically significantly impacted a person’s travel-related risk mitigation. Risk perception was significant in all three models. Respondents were more likely to avoid public places and stay at home if there was increased perceived risk in stores and more likely to avoid transit when there is increased risk perceived of contracting influenza in the transit system. However, respondents perceiving medium or high risk of contracting influenza at work were less likely to stay at home. This may be reasonable since employees may only be able to miss work when they are actually sick themselves.

In Scenario 2, household income per capita, self-identifying as Caucasian, non-Hispanic, and employment are indirectly related to taking action to prevent the spread when infected and the respondent’s age was directly related to taking action. These indirect and direct relationships are also seen in Scenario 3’s results with trying to reduce exposure to influenza. This suggests that people who take travel-related actions when infected with influenza to prevent the spread are more likely to take travel-related actions to prevent getting infected during an influenza outbreak.

Also, the significant variables in Scenario 3’s models show that respondents with a higher education (i.e., at least a bachelor’s degree) were less likely to stay at home to reduce exposure during an influenza outbreak. Single individuals (i.e., divorced, never married, or widowed) were more likely to avoid transit compared to their married counterparts, while those living in a metropolitan area were less likely to stay home. In general, findings from both Scenarios 2 and 3 support that wealthier and educated respondents (i.e., high household income per capita, are employed, and have at least a bachelor’s degree) were less likely to reduce travel in response to influenza. This is evident from the statistical significance of the Income/HHSiZe, BS Degree, and Working variables. Specifically, in Scenario 2 high household income per capita was statistically significantly linked to less likely staying at home and those employed were less likely to avoid public places and stay at home. In Scenario 3, a high household income per capita was linked to respondents being less likely to avoid public

| Table 3b additional travel-related actions to prevent the spread of disease. |
|---------------------------------------------------------------|
| Avoid public transit                                          | Stay home                                      |
| Parameters | Marginal effects | Parameters | Marginal effects |
| Nevertomally and Always | Nevertomally and Always | Nevertomally and Always | Nevertomally and Always |
| Male     | -1.691*** | 0.171*** | -0.361*** | 2.35% | 5.93% | -8.29% |
| Kids 0-12 | Experience | Health insurance | Knowledge | Working | Income/HHSiZe |
| Age      | 0.0235*** | 0.0235*** | -0.29% | 0.18% | 0.47% |
| Constant cuts 1 & 2 | Observations | AIC | BIC | 0.035 |
| 191      | 363.545 | 3387.816 | 3438.02 |
| R-squared | 0.045 |

Note: Significance. Codes: ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ‘ 1.

compared to female respondents. Males, however, were not statistically signif-
icantly less likely to visit the doctor and, therefore, were not any less ac-
tive in obtaining treatment than females. Due to this insignificance, the

gender variable is not included in the Visit Doctor’s Office model.

For all Scenario 2 models, families with at least one child 12 years old or
younger did not show statistically significantly different behavior than fam-
ilies without a child in that age range. Previous experience with influenza
was a statistically significant predictor of behavior for avoiding public
places and staying at home, where respondents with experience had a
high likelihood of sometimes taking each travel-related action. This
means that having experience with influenza decreased the chances of
never or always taking these actions. Also, respondents who had received
the vaccine and had health insurance were more likely to always visit the
doctor’s office if infected with influenza. These findings support that people
who receive the annual vaccine are likely proactive about taking health
measures, and having access to the health insurance allowed them to obtain
affordable medical treatment.

Respondents who were employed were 11.42% less likely to always avoid
public places and 16.65% less likely to always stay at home compared to
those not currently employed. Similarly, respondents with a higher family
income per capita showed a reduced rate in taking travel-related social dis-
tancing actions by being less likely to stay at home. The reduced rate of mit-
igation behavior of the employed could be due to the inability to take time
toff from work, either for financial or work policy reasons, even when in-
fected with influenza. The frequency of presenteeism (i.e., working while sick)
has been analyzed in literature and it has been “estimated that em-
ployee presenteeism is between 1.8 to 10 times more frequent than absen-
teeism” (Sauci, 2019). It is important to note that government regulations
and stay-at-home orders for non-essential personnel during the COVID-19
pandemic likely prevented presenteeism that was seen in previous influ-
enza outbreaks, such as seasonal.

Also, Scenario 2 models show that respondents who had knowledge of the
difference between influenza and a stomach flu were more likely to
avoid public places and to stay home when sick with influenza compared to
their counterparts. Those identifying as Caucasian, non-Hispanic had de-
creased chances of visiting a doctor’s office when having influenza. Older
individuals were more likely to avoid transit to reduce the spread of influ-
enza than their younger counterparts. Living in an apartment or mobile
home increased the chances of seeking medical attention when infected.

4.2. Scenario 3

Table 4 presents the generalized ordered logit model results for Scen-
ario 3, which includes the same travel-related actions as Scenario 2 with

the exception of visiting the doctor as the respondent is not infected in
this scenario and does not need to seek medical attention. Similar to the
findings in Scenario 2, males were less likely to avoid public places and to
stay at home to reduce exposure to influenza. However, males were much
less likely to take action when already infected compared to women (Sce-
nario 2) than when not infected (Scenario 3). Across all models in both sce-
narios, having a child younger than 12 years old in the household was only
statistically significant in avoiding public places in Scenario 3. Having chil-
dren in the household reduces one’s ability to avoid public places when they
are not sick. This may be due to obligations that the caregiver or other chil-
dren in the household cannot get out of easily as well as the necessary er-
rands a caretaker needs to make. Neither knowledge nor experience
statistically significantly impacted a person’s travel-related risk mitigation.
Risk perception was significant in all three models. Respondents were more
likely to avoid public places and stay at home if there was increased per-
ceived risk in stores and more likely to avoid transit when there is increased
risk perceived of contracting influenza in the transit system. However, re-

spondents perceiving medium or high risk of contracting influenza at work
were less likely to stay at home. This may be reasonable since em-

ploees may only be able to miss work when they are actually sick

by themselves.

In Scenario 2, household income per capita, self-identifying as Caucas-
ian, non-Hispanic, and employment are indirectly related to taking action
to prevent the spread when infected and the respondent’s age was directly
related to taking action. These indirect and direct relationships are also
seen in Scenario 3’s results with trying to reduce exposure to influenza.
This suggests that people who take travel-related actions when infected
with influenza to prevent the spread are more likely to take travel-related
actions to prevent getting infected during an influenza outbreak.

Also, the significant variables in Scenario 3’s models show that respon-
dents with a higher education (i.e., at least a bachelor’s degree) were less
likely to stay at home to reduce exposure during an influenza outbreak. Sin-

gle individuals (i.e., divorced, never married, or widowed) were more
likely to avoid transit compared to their married counterparts, while
those living in a metropolitan area were less likely to stay home. In general,
findings from both Scenarios 2 and 3 support that wealthier and educated
respondents (i.e., high household income per capita, are employed, and
have at least a bachelor’s degree) were less likely to reduce travel in re-

sponse to influenza. This is evident from the statistical significance of the
Income/HHSiZe, BS Degree, and Working variables. Specifically, in Scen-
nario 2 high household income per capita was statistically significantly
linked to less likely staying at home and those employed were less likely
to avoid public places and stay at home. In Scenario 3, a high household

income per capita was linked to respondents being less likely to avoid public
Table 4
Scenario 3 travel-related actions to reduce exposure to influenza.

|                        | Avoid public places | Avoid public transit | Stay home |
|------------------------|---------------------|----------------------|-----------|
|                        | Parameters          | Marginals            | Parameters          | Marginals            | Parameters          | Marginals            |
| Never vs Sometimes     | -0.464***          | -0.115               | 4.66%               | 2.29%               | -2.37%               | -0.639               | 0.671*               | 9.47%               | -20.02%              | 10.55%               | -0.206**             | -0.206**             | 3.11%               | 0.18%               | -3.29%               |
| and Always             |                     |                      |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |                     |
| Never and Sometimes    | -0.398***          | -0.398***            | 4.37%               | 3.46%               | -7.82%               |                     |                      |                     |                     |                     |                     |                     |                     |
| vs Always              |                     |                      |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |
| Male                   | 0.718***            | 0.249***             | -8.36%              | 3.37%               | 4.99%                | 1.061*               | 1.061*               | -18.85%             | 5.47%               | 13.37%               | 0.602**             | 20.70%               | -9.99%              | 6.79%               | 3.20%                |
| Kids_0-12              |                     |                      |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |
| Experience Knowledge   |                     |                      |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |
| Store risk             | -0.111***          | -0.116***            | 1.16%               | 1.23%               | -2.39%               | -0.187***            | -0.187***            | 2.81%               | 0.18%               | -2.99%               | -0.103***            | -0.103***            | 1.56%               | 0.99%               | -1.65%               |
| Transit risk           | 0.0114***          | 0.0114***            | -0.11%              | -0.12%              | 0.24%                | 0.0267***            | 0.0267***            | -0.40%              | -0.03%              | 0.43%                | -0.257**             | -0.257**             | 3.78%               | 0.42%               | -4.20%               |
| Work risk              | -0.202**           | -0.202**             | 1.96%               | 2.28%               | -4.24%               | 0.839**              | 0.839**              | -12.90%             | -0.02%              | 12.92%               | -0.320**             | -0.320**             | 4.94%               | 0.06%               | -5.00%               |
| Age                    | 0.014***           | 0.016***             | -0.11%              | -0.12%              | 0.24%                | 0.0267***            | 0.0267***            | -0.40%              | -0.03%              | 0.43%                | -0.257**             | -0.257**             | 3.78%               | 0.42%               | -4.20%               |
| Income/HHsize          | -0.116***          | -0.116***            | 1.16%               | 1.23%               | -2.39%               | -0.187***            | -0.187***            | 2.81%               | 0.18%               | -2.99%               | -0.103***            | -0.103***            | 1.56%               | 0.99%               | -1.65%               |
| Race White Single      | -0.202**           | -0.202**             | 1.96%               | 2.28%               | -4.24%               | 0.839**              | 0.839**              | -12.90%             | -0.02%              | 12.92%               | -0.320**             | -0.320**             | 4.94%               | 0.06%               | -5.00%               |
| Work risk              | -0.202**           | -0.202**             | 1.96%               | 2.28%               | -4.24%               | 0.839**              | 0.839**              | -12.90%             | -0.02%              | 12.92%               | -0.320**             | -0.320**             | 4.94%               | 0.06%               | -5.00%               |
| BS degree              | -0.229*            | -0.229*              |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |
| Metro                  | -0.741***          | -0.741***            | 10.33%              | 2.43%               | -12.76%              | 2.726***             | 0.167                |                     |                     |                     |                     |                     |                     |
| Working                |                      |                      |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |                     |
| Constant cuts 1 & 2   | 1.808***           | -0.953***            | -0.228              | -3.808***           |                     |                     |                      |                     |                     |                     |                     |                     |                     |                     |
| Observations           | 2023               | 178                  | 1921                | 3692.154            | 337.625              | 3563.719             | 3624.886             | 0.2                  |                     |                     |                     |                     |                     |
| AIC                    | 3692.154           | 337.625              | 3563.719            | 3624.886            |                     |                     |                      |                     |                     |                     |                     |                     |
| BIC                    | 3748.277           | 363.079              | 3624.886            | 0.041               |                     |                     |                      |                     |                     |                     |                     |                     |
| McFadden adj. Required | 0.041              | 0.043                |                     |                     |                     |                     |                      |                     |                     |                     |                     |                     |

Note: Significance. Codes: **** 0.001, ** 0.01, * 0.05, . 0.1, 1.
places, avoid public transit, and stay at home. Those with a bachelor's degree or higher were less likely to stay at home. Also, those who were employed were less likely to stay at home.

5. Policy implications

This study shows the links between an individual's health, public health, risk perception and travel behavior. The findings first suggest that certain channels are more effective in disseminating risks associated with an influenza outbreak. Given that those receiving influenza outbreak information through word of mouth perceived higher risk at mandatory and medical trips while television lead to higher risk perception for discretionary trips, it is possible that the effectiveness of any one media channel is not consistent across people and trip purposes. This provides supportive evidence that government public outreach should utilize several dissemination channels during a virus outbreaks. To the authors' knowledge, there are no studies in literature on the changing effect of information source on risk perception by trip type to validate this finding.

Second, findings suggest certain policies could alter an individual's travel behavior during an influenza outbreak and could promote the health of the general public. For example, government notices and policies encouraging individuals to be more proactive about their health, as well as recommendations for self-quarantine (as in the COVID-19 situation), could reduce an individual's travel when sick and, therefore, could reduce the spread of the disease within the general public. This study found individuals who are proactive in their health are also proactive in protecting others from getting the disease. This was shown through the statistical significance of receiving the annual vaccine and maintaining health insurance coverage with reduced travel and greater likelihood of visiting the doctor when sick.

Third, this study highlights the importance of educating the public about influenza, how it is spread, and how it differs from a stomach flu. Individuals who knew the difference between influenza and the stomach flu before the survey were more likely to reduce travel when sick to reduce the spread to the general public. This knowledge had more influence than even an individual having an influenza experience in their household in the last 6 months (either themselves or a household member).

Fourth, the findings indicate that individuals who are wealthier, educated, and employed may be less likely to exhibit social distancing by avoiding public places and staying at home. In Scenario 2, when the individual is already infected with influenza, those with a higher family income per capita and those who were employed both were less likely to stay home to prevent the spread of the disease to others. Similarly, in Scenario 3, when the individual is not infected during an influenza outbreak, individuals who had at least a bachelor's degree, higher family income per capita, and/or were employed were less likely to reduce travel that could increase exposure to influenza. From a public health perspective, it could be beneficial to promote more flexible work hours and telecommuting (Liao et al., 2012).

Lastly, findings from Scenario 3 suggest that those who perceived higher risk for contracting influenza in the workplace were less likely to stay at home. Other trip types found a direct relationship between threat appraisal and self-efficacy in Scenario 3, such as for trips to the store and using transit. Therefore, model results indicate low levels of self-efficacy for work trips compared to other trip types. This counterintuitive relationship between risk perception and behavior was evident during the COVID-19 pandemic where employees with high interaction with the public (e.g., medical care staff, grocery shelves stocker, cashier, and food deliverer) were considered "essential" and therefore were required to continue their high-risk jobs (Hoff, 2020).

6. Conclusions and future research direction

This study contained several generalized ordered and ordered logit models surrounding an individual's risk perception and travel behavior during an influenza outbreak. Males were statistically significantly less likely than females to perceive risk as well as alter their travel patterns by voluntarily social distancing in response to the possibility of spreading the disease or increased exposure to the disease. Having children ages 12 and younger in the household did not impact an individual's likelihood of visiting a doctor's office, avoiding public places, avoiding transit, or staying home when already sick and the individual was less likely to avoid public places when they were not infected. This suggests that households with younger children may face challenges with voluntary social distancing when they and their household members are well. According to the marginal effects, having knowledge about influenza and how it is different from a stomach flu (before the survey) was more effective in reducing travel (avoiding public places and staying home) when the respondent is already sick than having experience with influenza in one's household in the last six months. Individuals who were proactive about taking care of their health (i.e., received annual vaccines and had health insurance coverage) were also proactive in reducing their exposure and spread of influenza. Lastly, in alignment with the Protection Motivation Theory, in general, individuals tended to reduce travel to locations in which they perceived medium or high risk of contracting influenza, such as stores. However, perception of increased risk at work locations did not show an increased likelihood to stay home.

Future research in this area could combine the findings from this study with agent-based models that track individual's travel participation and responses to virus outbreaks. This could lead to more refined estimates of transmission and levels of exposure. The effectiveness of workplace policies, other location specific policies, government orders, and general interventions may be tested with such models.

Additional studies could look more into the link between information channel and risk perception, including a validation and more in-depth analysis of why the effectiveness of information channels changes by trip type. Also, this link should be analyzed under several situations. Specifically, in this study, social media was found to be insignificant while word of mouth and television was significant. However, given that COVID-19 required social distancing and quarantine measures, it would be interesting to see if a person's reduced ability to get word of mouth information about a trip's risk meant other channels became more significant, such as social media. Lastly, future studies on the COVID-19 pandemic could evaluate the effects of telecommuting and e-learning options on travel-related risk mitigation.

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CRediT authorship contribution statement

Susan Hotle: Methodology, Formal analysis, Writing - review & editing. Pamela Murray-Tuite: Conceptualization, Methodology, Writing - review & editing, Funding acquisition. Kunal Singh: Writing - review & editing.

Declaration of competing interest

None.

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