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A risk perception scale for travel to a crisis epicentre: Visiting Wuhan after COVID-19

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Abstract

Although the significance of tourist risk perceptions is well documented, perspectives on risk associated with major pandemics such as COVID-19 remain poorly understood, especially from the viewpoint of destination crisis management. This research measured risk perceptions among Chinese residents related to travelling to Wuhan after the outbreak of COVID-19. Based on the concept and dimensions of tourist risk perceptions, a risk perception scale with 13 items on four dimensions (health, financial, social. performance) was developed and validated using exploratory and confirmatory factor analysis. Risk perception differences among visitor groups were identified based on 1,818 survey responses collected during the COVID-19 outbreak in China. The results show that occupations and place of residence had significant effects on all 13 items, while gender, age, educational attainment, and income independently affected some items. Similarly, respondent involvement in disease prevention and control, losses suffered during the pandemic, and previous experiences of visiting Wuhan were found to produce significant differences.

Keywords: Risk perceptions; tourism crises; COVID-19; crisis management; Wuhan

Introduction

The on-going COVID-19 pandemic has affected communities globally (Galvani *et al.*, 2020) and has developed into a serious public health crisis (State Council Information Office of the PRC, 2020). As a result, international and domestic tourism suffered a dramatic downturn (Higgins-Desbiolles, 2020), which has surpassed the losses suffered by this sector of the economy following earlier major events, including the ‘9/11’ terrorist attacks (2001), SARS (2003), the Indian Ocean tsunami (2005), MERS (2012), swine flu (2009), Ebola (2014), and other crises in the twenty-first century (Higgins-Desbiolles, 2020; Hall *et al.*, 2020).

As the nation with the earliest large-scale outbreak of COVID-19, China became the first country in the world to impose a mandatory nationwide self-quarantine from 23rd January to 9th February 2020 (Li *et al.*, 2020). To control the disease, on 24th January 2020 the Chinese government issued a nationwide ban on group and package tours. The subsequent rapid spread of infections and ensuing lockdown resulted in a major loss of consumer confidence affecting the tourism and hospitality sectors across the country (Mao *et al.*, 2020).

However, compared to crisis typologies, far less is known about how people perceive risks associated with health pandemics (de Zawart *et al*, 2009; Dryhust *et al*, 2020), though recent studies have begun to offer insights into the scale of the impact ofCOVID-19 on tourists' risk perceptions (Nazneen *et al*, 2020), including quantitative research on consumers' travel risk perceptions in specific tourism markets, such as the DACH region of Austria, Germany and Switzerland (Neuburger and Eggar, 2020) and Slovenia (Turnšek *et al*, 2020). Building on this evidence, the main aim of this research was to investigate the risk perceptions among Chinese residents associated with future travel to Wuhan - the epicentre of the COVID-19 outbreak in China. In order to achieve this, a risk perception measurement scale was constructed and tested. Differences in risk perceptions differences were investigated using new factors such as epidemic engagement (involvement, loss and lockdown experiences during the pandemic), past experiences of travel to the destination (Wuhan), as well as respondents' links to Wuhan, in addition to other more standard parameters (e.g. demographic characteristics and information sources).

Literature review

Risk perception, as a theoretical concept in cognitive psychology, has been used in consumer behaviour and tourism research especially in studies related to risk management (Korstanje, 2009; Kapuscinski and Richard, 2016) to gain insights into people's psychological and behavioural responses. Research has also shown that risk communication strategies and management measures should be tailored to identity profiles in order to improve their effectiveness (Wu, 2017). For instance, studies have shown that when there are significant positive differences between the perception of risk and the attractiveness of tourism destinations, individuals may decide to travel to those destinations, whereas negative differences tend to result in tourists abandoning their travel plans (Morakabati and Kapuscinski, 2016). Similarly, tourist risk perception has been widely analysed by scholars from a variety of fields, including psychology, management, tourism and public health (e.g., Caponecchia, 2012; Eitzinger and Wiedemann, 2008; Paek and Hove, 2017; Wildavsky and Dake, 1990) as a key factor affecting travel decision-making.

Tourist risk perception

Although risk perception remains a contested concept (Larsen *et al.*, 2017; Quintal *et al*., 2010; Reichel *et al*., 2007; Reisinger and Mavondo, 2006; Yang and Nair, 2014), its definitions can be clustered into three overarching interpretations, namely subjective, objective, and cognitive (Cui *et al.*, 2016). The subjective interpretation defines risk perception as tourists' subjective feelings towards potentially negative consequences and impacts during travel (Huang and Lin, 2008; Chien *et al.*, 2016). This includes the subjective evaluation of uncertainties within that process as well as the results of tourism activities (Liu and Gao, 2008), concerns about possible loss, adverse impacts, and exposure risks (Fuchs and Reichel, 2011). Objective risk perception has been defined by Wong and Yep (2009) as tourists' objective judgments of potentially negative consequences and the extent of uncertainty associated with travel to a tourism destination. By contrast, the cognitive risk perception school of thought argues that tourists think beyond the thresholds of negative consequences or impacts that may occur during travel (Reichel, 2007; Wahlberg and Sjöberg, 2000), or the deviation between a subjective evaluation of psychological expectation and the objective consequences of traveller behaviour (Zhang, 2009). For instance, Moutinho *et al.* (2011) defined tourist risk perception as a function of outcomes and uncertainty resulting from the inherent doubt related to tourism products, the uncertainties associated with purchasing methods and locations, uncertainties related to risk, and uncertainties associated with tourists' previous experiences. This research adopted a subjective perspective on risk perception in as much as it deemed that tourists make subjective judgments related to potentially negative outcomes or adverse consequences. In other words, tourists evaluate risks intuitively and subjectively, rather than rationally and objectively (Chen and Zhang, 2012).

Dimensions of tourist risk perception

Earlier studies in this field suggest that tourist risk perceptions tend to be multi-dimensional in nature (Han, 2005; Wu, 2017; Hasan *et al.*, 2017). They encompass a variety of risks, including physical and health, financial, performance or functional, equipment or facility, social and psychological, time, and communication risks (Table1).

Table 1. Studies on dimensions of tourist risk perception

Researchers	Issues	Dimensions of tourism risk perception
Moutinho,1987	Consumer behaviour in tourism	Functional, physical, financial, social and psychological risks
Roehl and Fesenmaier, 1992	Risk perception and pleasure travel	Physical, financial, time, equipment, satisfaction, social and psychological risks
Sönmez and Graefe,1998	Past travel experience and risk perceptions	Equipment, financial, health , physical, political , social, satisfaction, time, Terrorism and psychological risks
Floyd *et al.*, 2004	Effect of risk perceptions on travel intentions	Safety, social, travel experience and financial risks
Dolnicar, 2005	Barriers to leisure travel	Political, environmental, health, planning and property
Fuchs and Reichel, 2006	Destination risk perception	Human induced risk, financial risk, service quality risk, natural disaster and car accident, socio-psychological, food safety and weather problem
Boksberger *et al.*,2007	Air travel	Financial, personal, social, functional and time risks
Liu and Gao, 2008	Shanghai residents' travel risk perception	Property, health, medical, social, security, facilities, psychological and performance risks
Chen *et al.* , 2009	Risk perception and outbound travel preference	Public health, terrorist attack and war, natural disaster, and financial risks
An, Lee, and Noh,2010	Risk factors at air travel	Natural disaster, physical, political, and performance risks
Jonas *et al.*, 2011	Health risk perceptions when travelling to developing countries	Environmentally induced risks, physical injuries and safety, risks related to sexually transmitted disease and drug use
Cetinsoz and Ege, 2013	Perceived risk and revisit intention	Physical, satisfaction, time, socio-psychological and performance risks
Xu *et al.*, 2013	Dimensions of perceived risk of	Physical, equipment, service, performance, financial, communication, psychological, time and

	tourist	social risks
Baker, 2014	Terrorism and religious tourism	Financial, physical, social , functional, psychological, situational and travel risks
Chew and Jahari, 2014	Image, risk and revisit intention	Financial, physical, socio-psychological risks
Casidy and Wymer, 2016	Risk, satisfaction, and WTP	Financial , social , performance and psychological risks
Cong *et al.*, 2017	Risk perception of interaction with dolphins	Experience quality, physical safety, and amenity risks
Yi *et al*., 2020	Perceived risk on sharing economy in tourism	Physical, financial, privacy, and performance risks

Scholarly research has tended to focus on just one risk or, at best, a limited set of the dimensions of risk outlined above. For instance, physical, health, financial, time and social risks have been used to investigate the risk perceptions affecting international travel (Lepp and Gibson, 2003; Chen *et al*., 2009; Zhu, 2015), while physical, health and psychological risks have been adopted to elicit factors affecting adventure tourism, including hiking and cycling (Tsaur *et al.*,1997; She *et al*, 2016; Wang *et al.*, 2019). Environmental research related to air pollution has favoured the use of functional risks in addition to the more obvious physical and health ones (Li *et al.*, 2015; Zhang *et al.*, 2017). Similarly, whilst research related to the sharing economy has used risk to privacy in addition to physical, financial and performance risks (Yi *et al*, 2020), research related to younger generations has often investigated their risk perceptions related to cruise ships, infection outbreaks, sexually-transmitted diseases, motion sickness, terrorism, and crime (Le and Arcodia, 2018).

Measurement of tourist risk perceptions

Generally, risk perceptions among tourists have tended to be measured adopting a multi-dimensional evaluation approach and two-factor models (Wu, 2017; Cui *et al.*, 2016). While multi-dimensional models have tended to favour the use of Likert scales to evaluate different risk factors (Yang and Nair, 2014; Zeng *et al.*, 2017; Yi *et al.*, 2020), two-factor models require respondents to evaluate the uncertainty and danger of the negative consequences of these risks (Liu and Gao, 2008; Li *el al.*, 2014), even if some scholars contest the idea that risk perceptions should be conceptualised as a reflective construct of accident probability and severity of consequences. For instance, a study by Rundmo and Nordfjærn (2017) showed that risk perception was less conceptual than object-centred and recommended that how risk was perceived should be taken into consideration to a larger extent when measuring travel risk perceptions. Wolff *et al.* (2019) noted that people usually ignore probability and tend to rely instead on outcome severity in their evaluation of risks. This bias has come to be known as probability neglect (Slovic and Peters, 2006; Sunstein, 2002) and refers to people's tendency to overestimate the risk of events with small probabilities, such as terrorism and shark attacks, and to underestimate the risks of seemingly more mundane events with higher probabilities, like a flu epidemic or sunburn (Gigerenzer, 2006; Gaissmaier and Gigerenzer, 2012). However, most tourists usually make destination selection and consumption decisions based on their perception of risks rather than their severity. Therefore, measuring perceived risk is generally more helpful in the context of investigating tourist behaviour, even when their assessment of the probability of that risk occurring can be rather flawed at times (Yang and Nair, 2014).

From a methodology perspective, much of the research in this field has tended to be quantitative in nature (Reisinger and Mavondo, 2005; Floyd *et al*., 2004; Grey and Wilson, 2009; Ozascilar *et al.*, 2019; Kummeneje *et al.*, 2019), though qualitative studies have also been performed (e.g. Fuchs, 2013; Zhang and Fang, 2018) and so have field experiments (Brun *et al.*, 2011). Studies have often investigated risk perceptions using dimension recognition and factor selection as key methods of data analysis (Floyd *et al.*, 2004; Cheng, 2009; Xu *et al.*, 2013), though regression analysis (Li, 2008; Chai *et al.*, 2011), correlation analysis (Zhang, 2009), and structural equation modelling (Reisinger and Mavondo, 2005; Chien *et al.*, 2016; Yi *et al.*, 2020) have also been used by scholars to investigate relationships between tourist risk perceptions and related variables. Studies seeking to elicit differences in risk perceptions among different groups of tourists have often used cross tabulation analysis (Fuchs and Reichel, 2011), chi-square tests (Fuchs and Reichel, 2011), *t*-tests (Cong *et al.*, 2017), one-way ANOVAs (Xu *et al.*, 2013; Cong *et al.*, 2017) and MANOVAs (Lepp and Gibson, 2007; Kim *et al.*, 2016).

Factors influencing tourist risk perception

In addition to gender, age, educational background and other sociodemographic characteristics (Reisinger and Crotts, 2010; Tandi *et al.*, 2018), personality, previous travel experiences, emotions and sources of information may impact perceptions of risk in different tourism scenarios (Lepp, 2003; Morakabati and Kapuscinski, 2016; Le and Arcodia, 2018). In the study related to the COVID-19, Turnšek *et al*(2020) found that age - only among female respondents - affected the perceived threat of COVID-19. The same study found that more frequent travellers and respondents with lower levels of educational attainment tended to experience levels of perceived travel risks. More specifically, a study by Neuburger and Eggar (2020) revealed a significant increase in travel risk perceptions among respondents from the beginning of March 2020). In addition, scholarly research has often focused on the influence of specific factors on tourists' risk perceptions in specific situations and, indeed, crises. For instance, in a study on the risk perception of terrorist attacks on Chinese citizens while travelling abroad, traditional Chinese culture such as the 'golden means rule', 'others oriented' and 'differential order view' were found to have a significant impact on the frame of mind and behaviours of those tourists (Zhang and Fang, 2018).

Overall, a substantial body of knowledge has developed with regards to tourists' feelings towards risk, the evaluation of those risks and associated behaviours, as well as associated risk communication strategies and destination management organisation (DMO) interventions. However, the abstract nature and complexity of risk perception (Wu, 2017) and the highly situational characteristics of tourist risk studies (Xu *et al.*, 2013) mean that there is still considerable scope for further research in this field. Nevertheless, given the growing magnitude of the on-going Covid-19 pandemic globally, further research will be required on tourist risk perceptions in this context and using different perspectives.

Methods

Questionnaire design

This research adopted the scale method to measure respondent risk perceptions regarding travel to Wuhan after China lifted the nationwide restrictions triggered by the COVID-19 outbreak. A scale of 13 items was designed to measure risk perceptions. Each item was measured using five-point Likert scales. The scale items were derived from earlier studies on risk perceptions (Table 1).

The survey questionnaire also included questions related to respondents' demographic characteristics, epidemic engagement (involvement, loss and lockdown experiences during the pandemic), past experiences of visits to Wuhan, as well as their connections to the city. The questionnaire was designed in January 2020. Seven experts in the fields of tourism management, health care and public management, and 15 WeChat contacts were invited to complete two trial rounds and provide feedback. Based on the feedback received, the introduction was amended, and some questions modified. The final version of the 13 items is outlined in Table 2.

Table 2. Sources of risk perception items.

Risk perception measurement items	Sources from research literature
R_1. I am worried that the accommodation facilities will not be sanitary	Xu *et al.* (2013); Zhang *et al.* (2017); Yi *et al.* (2020)
R_2. I'm worried that the diet will be unhealthy	Fuchs and Reichel (2006, 2011); Hartjes *et al.* (2009); Chew and Jahari (2014); Zhu *et al.* (2015); Cui *et al.* (2016); Zhang *et al.* (2017)
R_3. I'm worried about getting sick during my travel	Roehl and Fesenmaier (1992); Fuchs and Reichel (2006, 2011); Dolnicar (2005); Liu and Gao (2008); Chen *et al.* (2009); Zhu *et al.* (2015); She *et al.* (2016); Cong *et al.* (2017); Xu *et al.* (2019)
R_4. I'm worried about other physical harm during my travel	Roehl and Fesenmaier (1992); Dolnicar (2005); Liu and Gao (2008); Hartjes *et al.* (2009); Zhu *et al.* (2015); She *et al.* (2016); Cong *et al.* (2017); Yi *et al.* (2020)
R_5. I'm afraid that I can't get timely treatment for illness or other physical harm during my travel	Dolnicar (2005); Liu and Gao (2008); Li *et al.* (2014); She *et al.* (2016)
R_6. I'm afraid the costs will be higher than before	Yi *et al.* (2020)
R_7. I'm afraid there will be some unexpected expenses	Fuchs and Reichel (2006, 2011); Xu *et al.* (2013); Cong *et al.* (2017)
R_8.I'm worried that I will not get good value for money for my travel	Roehl and Fesenmaier (1992); Fuchs and Reichel (2006, 2011); Boksberger *et al.* (2007); Liu and Gao (2008); Chew and Jahari (2014); Zhu *et al.* (2015); She *et al.* (2016); Cong *et al.* (2017); Xu *et al.* (2019)
R_9. I'm worried that the people will be anxious who care about me	Proposed by the researchers
R_{10}.I 'm afraid the people will think I'm irrational who care about me	Roehl and Fesenmaier (1992); Fuchs and Reichel (2006, 2011); Liu and Gao (2008); Chew and Jahari (2014); Zhu *et al.* (2015); Xu *et al.* (2019)
R_{11}. I'm afraid it will cause conflicts	Liu and Gao (2008); Xu *et al.* (2013)

between couples/family members	
R_{12}. I'm afraid the tourist facilities will be not good enough	Fuchs and Reichel (2006, 2011); She *et al.* (2016); Cong *et al.* (2017); Xu *et al.* (2013)
R_{13}. I'm afraid the tourist services will be not good enough	Fuchs and Reichel (2006, 2011); Xu *et al.* (2013); Yi *et al.* (2020)

Survey distribution

From January 29th to February 2nd, 2020, the survey was administered via WeChat and QQ - the two most popular social media platforms in China – and resulted in 1,948 responses. Once invalid responses were accounted for (e.g., questionnaires with missing values or with answers lasting less than three minutes in duration and those delivered from IP addresses outside China), a total of 1,818 valid responses were included in the data analysis.

Data analysis and procedures

SPSS-AU was used for exploratory factor analysis, reliability tests, confirmatory factor analysis, descriptive statistics, and risk perception scale difference analysis. First, the 1,818 valid questionnaires were randomly divided into two equal sets in order to perform cross validation. Since the sample size of pre-survey was not large enough for exploratory factor analysis to be performed, the first set was used for exploratory factor analysis of the risk perception scale with the second set reserved for confirmatory factor analysis. Second, descriptive statistics were used to analyse the demographic characteristics of the respondents and the overall tourist risk perception levels. Finally, based on the homogeneity test of variance and the robust method, one-way ANOVA and Brown-Forsythe tests were applied to the data to elicit the levels of tourist risk perceptions of travel to Wuhan after the start of the COVID-19 pandemic. Group differences were tested based on demographic characteristics and information sources, extent of involvement, and the connections between the respondents and Wuhan. Where the homogeneity of variance was verified, one-way ANOVA was employed. Otherwise, the Brown-Forsythe test was adopted.

Results

Sample demographics

Table 3 below outlines demographic factors such as gender, age, education, income and occupation for the 1,818 survey respondents who contributed to this study.

Table 3. Respondent demographic characteristics.

Characteristics	Levels	Frequency	%
Gender	Male	738	40.6
	Female	1,080	59.4
Age	12-17	22	1.2
	18-35	991	54.5
	36-55	750	41.3
	56 and above	55	3.0
Education	Junior middle school or below	82	4.5
	High school or technical secondary school	128	7.0
	Junior college or undergraduate	1,231	67.7
	Master’s degree or above	377	20.7
Income (RMB/Month)	None	365	20.1
	Less than 5 000	505	27.8
	5 001-8 000	476	26.2
	8 001-17 000	344	18.9
	More than 17 000	128	7.0
Occupation	Enterprise staff	478	26.3
	Students	358	19.7
	Teachers	284	15.6
	Doctors and nurses	172	9.5
	Public servant and employees of public institutions (excluding teachers)	143	7.9
	Private business owners	98	5.4
	Workers and farmers	83	4.6
	Freelances	51	2.8
	Retired and others	151	8.3
Permanent residence	Wuhan	332	18.3
	Other areas in Hubei Province	469	25.8
	Other provinces and cities in China	1,017	55.9
Total		1,818	100.0

Exploratory factor analysis

The 909 randomized pool of respondents was first tested using the Kaiser-Meyer-Olkin (KMO) Measure of Sampling Adequacy and the Bartlett test of sphericity for further exploratory factor analysis, with KMO = 0.923 and Bartlett's p = 0.000, indicating that the data met the requirements for factor analysis. A total of four factors were extracted. The percentages of explained variance of these four factors after rotation were, respectively, 27.2%, 21.3%, 20.22% and 15.6%, whilst the cumulative percentage of explained variance after rotation was 84.32%. Then, the factor load coefficients were obtained by Varimax rotation, as shown in Table 4. Except for item 5, the other 12 items had clear and unique corresponding factors. Since the content of item 5 and items 1-4 were all related to health risks, items 1-5 were attributed to factor 1, which corresponded to the risk perception dimension of health. The risk perception dimension corresponding to items 6-8 was financial risks; 9-11 were social risks; and items 12-13 were performance risks.

Table 4. EFA results of risk perception on travelling to Wuhan after COVID-19.

Items	Factor loadings				Commonality	Cronbach α
	1	2	3	4		
Health risks						
R_1. I am worried that the accommodation facilities will not be sanitary	0.846	0.209	0.220	0.133	0.825	0.931
R_2. I'm worried that the diet will be unhealthy	0.867	0.208	0.212	0.191	0.876	
R_3. I'm worried about getting sick during my travel	0.800	0.302	0.307	0.199	0.866	
R_4. I'm worried about other physical harm during my travel	0.700	0.321	0.241	0.358	0.779	
R_5. I'm afraid that I can't get timely treatment for illness or other physical harm during my travel	0.553	0.474	0.196	0.376	0.711	
Financial risks						
R_6. I'm afraid the costs will be higher than before	0.245	0.848	0.200	0.199	0.858	0.912
R_7. I'm afraid there will be some unexpected expenses	0.273	0.843	0.229	0.226	0.888	
R_8.I'm worried that I will not get good value for money for my travel	0.375	0.704	0.264	0.341	0.823	
Social risks						
R_9. I'm worried that the people will	0.255	0.230	0.840	0.135	0.842	0.898

be anxious who care about me						
R_{10}.I 'm afraid the people will think I'm irrational who care about me	0.232	0.195	0.875	0.209	0.901	
R_{11}. I'm afraid it will cause conflicts between couples/family members	0.276	0.208	0.726	0.375	0.787	
Performance risks						
R_{12}. I'm afraid the tourist facilities will be not good enough	0.266	0.310	0.323	0.796	0.906	0.916
R_{13}. I'm afraid the tourist services will be not good enough	0.302	0.328	0.282	0.788	0.899	

Reliability and validity tests

The Cronbach α of the tourist risk perception scale was 0.950, indicating that the reliability of the sample data was high. 'The deleted α' was between 0.944-0.947, which meant that the reliability coefficient did not increase significantly after deleting any one of them, so no items needed to be deleted. In general, the reliability of the sample data met the requirements for further analysis.

Subsequently, the remaining randomized sample was used for confirmatory factor analysis (CFA) to test the structural validity of the scale (Table 5). The standard load coefficients of the 13 items were all greater than 0.7 and all p-values were less than 0.001, verifying that all items had a strong correlation with the corresponding factor. The AVE values were between 0.723 - 0.878 (> 0.5), and the combined reliability CR value was between 0.894 - 0.938 (> 0.7), indicating that the scale had good construct validity. In addition, the square root values of AVEs corresponding to the four factors were 0.851, 0.890, 0.870, and 0.937, respectively, and the correlation coefficient between the factors was between 0.528 and 0.727. The minimum value in the square root of AVE was greater than the maximum value of the correlation coefficient between factors of 0.727, indicating that the scale had good discriminant validity.

Table 5. Reliability and validity tests.

Dimensions	Items	Std. estimate	AVE	CR	Cronbach α
Health	R_1	0.794	0.723	0.938	0.925
	R_2	0.861			
	R_3	0.871			
	R_4	0.891			

	R_5	0.833			
Financial	R_6	0.838	0.792	0.916	0.921
	R_7	0.914			
	R_8	0.913			
Social	R_9	0.831	0.757	0.894	0.908
	R_{10}	0.891			
	R_{11}	0.884			
Performance	R_{12}	0.921	0.878	0.935	0.935
	R_{13}	0.952			
Overall risk perceptions	Health	0.893	0.648	0.880	0.878
	Financial	0.879			
	Social	0.736			
	Performance	0.838			

Overall risk perception levels

The measurement of the overall risk perception was based on the 13 items' Likert scores, and the mean scores and standard deviations. The results showed that the means for the 13 items were between 2.67 and 3.35 (Table 6).

Table 6. Descriptive analysis.

Items	Minimum	Maximum	Mean	Std. Deviation
R_1	1	5	3.06	1.050
R_2	1	5	2.95	1.049
R_3	1	5	3.00	1.063
R_4	1	5	2.77	1.034
R_5	1	5	2.66	1.037
R_6	1	5	2.66	0.992
R_7	1	5	2.77	1.005
R_8	1	5	2.70	0.999
R_9	1	5	3.41	1.029
R_{10}	1	5	3.20	1.043
R_{11}	1	5	2.95	1.055
R_{12}	1	5	2.71	0.998
R_{13}	1	5	2.73	1.004

Risk perception difference analysis by demographic characteristics

One-way ANOVA (homogeneity of variance verified) and Brown-Forsythe tests (homogeneity of variance rejected) revealed the impact of demographic characteristics on risk perceptions (Table 7), (underlined are the results of ANOVA, and the others are Brown-Forsythe test results).

Table 7. Risk perceptions on travel to Wuhan after COVID-19 by demographic characteristics.

Items	<u>ANOVA F</u> or Brown F					
	Gender	Age	Education	Income	Occupation	Permanent residence
R_1	1.098	1.769	<u>1.641</u>	0.481	2.120*	10.764***
R_2	1.168	3.314*	<u>2.945*</u>	1.242	3.624*	23.739***
R_3	0.022	<u>5.221**</u>	<u>5.360**</u>	0.978	3.516**	25.207***
R_4	<u>0.128</u>	<u>7.702***</u>	2.726*	4.257**	3.120**	24.868***
R_5	<u>0.000</u>	<u>7.327***</u>	3.863**	<u>2.623*</u>	<u>3.608***</u>	<u>16.954***</u>
R_6	4.197*	<u>2.175</u>	<u>0.721</u>	6.145***	<u>2.672**</u>	<u>13.608***</u>
R_7	7.850**	<u>5.795**</u>	<u>1.405</u>	6.378***	3.606***	14.467***
R_8	5.068*	<u>5.195***</u>	<u>1.210</u>	<u>4.888***</u>	<u>3.267**</u>	15.565***
R_9	<u>0.597</u>	16.471***	<u>8.157***</u>	2.789*	4.747***	28.876***
R_{10}	<u>0.427</u>	<u>10.193***</u>	<u>12.035***</u>	0.806	4.068***	28.813***
R_{11}	<u>1.025</u>	<u>6.426***</u>	<u>5.825**</u>	0.987	<u>2.165*</u>	26.008***
R_{12}	<u>1.973</u>	<u>8.260***</u>	6.704***	2.512*	3.075**	<u>25.908***</u>
R_{13}	4.624*	<u>7.844***</u>	5.458**	4.949**	3.857***	<u>21.475***</u>

$^{*}p < 0.05$ $^{**}p < 0.01$ $^{***}p < 0.001$

Gender: Gender only had an effect on R_6, R_7, and R_8 in the financial risk dimension and R_{13} in the performance risk dimension.

Age: Age affected all items except R_1 and R_6. There was no difference for educational level on the perception of financial risk.

Income levels: Income significantly affected the perception of financial and performance risks, as well as some of the health and social risks.

Occupation and residence place: These two characteristics significantly affected the perception of all 13 items.

The results showed consistency with those of earlier studies. The risk perception level of the 18-35 year-old group was higher than that of the other three groups, which supported the findings of earlier qualitative research showing that ”The risk cognitive level of the people of a mature age is higher than that of teenagers”’ (Cui, 2016). The respondents from Wuhan (the epicentre of the COVID-19 pandemic in China) had a significantly lower level of the perceived risk of travel to Wuhan than the other two groups – residents of Hubei Province excluding Wuhan and outside Hubei Province. This supports the findings of Xie *et al.* (2005) on the psychological panic phenomenon in the SARS crisis that ‘subjects in epidemic areas show a lower state of psychological anxiety than those in non-epidemic areas’. Similarly, people who are close to nuclear plants rate the safety of these facilities higher than the residents who are far away from the facilities. In fact, residents from locations further away were found to deliver more negative evaluations of the nuclear facilities (Maderthaner *et al.*, 1978; Nealey *et al.*, 1983), This finding would appear to be in line with those of earlier studies by Li *et al.*. (2009) after the 2008 Wenchuan earthquake, which found that the people living in more central areas, the lower was their risk perception. This phenomenon became known as the ‘psychological typhoon eye’. A recent psychological survey related to the COVID-19 epidemic from February 20th to 25th, also confirmed the existence of this phenomenon in the outbreak of the epidemic, which may be the result of the comprehensive effects of benefit judgments, psychological immunity, cognitive dissonance and the description-experience gap (Xu *et al*., 2020).

Risk perception difference analysis by other factors

Brown-Forsythe tests were used to analyse the effects of information sources, extent of epidemic involvement (including contribution to epidemic prevention and control, losses suffered, isolation experience in the epidemic) and the connections between the respondents and Wuhan (including association with Wuhan and experience of visiting Wuhan) on the differences in risk perceptions associated with travelling to Wuhan after the nationwide lockdown was lifted (Tables 7 to 12).

Information sources: The source of epidemic information had no significant impact on the risk perceptions associated with R_5, R_6, R_7, and R_{11}, but it significantly affected risk perceptions for the other eight items (Table 8). Those who mainly relied on family members, friends, village and neighbourhood committees to provide information on the epidemic situation had higher levels of risk perceptions for these eight items. Those who mainly obtained epidemic information through video platforms such as *Douyin* and *Kuaishou* had lower scores for the five items of health risk than other groups. To some extent, these results conform the research by Dryhurst *et al* (2020), which demonstrates that people who obtain information related to Covid-19 from friends and family tend to have a higher level of perceived risk. However, these results differed from the findings of earlier research by Dong (2009) involving risk perceptions of travel to disaster-stricken areas after the ‘5·12’ earthquake in Wenchuan, Sichuan. In that analysis, those who mainly relied on ‘interpersonal communication’ sources to obtain post-earthquake safety information had lower risk perceptions than other groups. What exactly caused the difference between these studies and their conclusions needs to be explored by further research.

Table 8. Risk perceptions of travel to Wuhan after COVID-19 by information sources.

Items	ANOVA		Means by information source groups						F	Brown F
	F	p-values	Total n = 1,818	IN_1 n = 650	IN_2 n = 636	IN_3 n = 300	IN_4 n = 178	IN_5 n = 54		
R_1	3.350	0.010**	3.06	3.08	3.01	3.18	3.06	2.61	-	4.167**
R_2	3.197	0.013*	2.95	3.00	2.87	3.05	3.00	2.57		4.040**
R_3	1.244	0.290	2.99	3.00	2.91	3.17	3.00	2.80	3.448**	-
R_4	2.632	0.033*	2.77	2.76	2.71	2.93	2.83	2.61	-	2.961*
R_5	1.286	0.273	2.66	2.66	2.60	2.81	2.69	2.61	2.201	-
R_6	2.543	0.038*	2.66	2.66	2.60	2.73	2.76	2.56	-	1.451
R_7	2.740	0.027*	2.77	2.76	2.72	2.89	2.79	2.74	-	1.462
R_8	2.613	0.034*	2.70	2.69	2.64	2.85	2.72	2.56	-	2.559*
R_9	10.048	0.000***	3.41	3.38	3.36	3.60	3.39	3.39	-	3.216*
R_{10}	5.033	0.000***	3.20	3.19	3.12	3.36	3.18	3.30	-	3.030 *
R_{11}	1.462	0.211	2.95	2.95	2.88	3.09	2.92	2.94	2.076	
R_{12}	1.169	0.322	2.71	2.72	2.63	2.86	2.71	2.69	2.953*	
R_{13}	2.981	0.018*	2.73	2.72	2.65	2.94	2.70	2.65	4.451**	4.612**
Total	-	-	2.89	2.89	2.82	3.04	2.90	2.77	-	-

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. I_1 = WeChat, I_2 = Microblogs, I_3 = Family, friends and community, I_4 = Official media, I_5 =Video platform.

Extent of epidemic involvement: The ways that respondents sought to prevent and control risks associated with the COVID-19 pandemic showed a significant difference in risk perceptions of 11 items excluding R_{10} and R_{11} (belonging to the social risk dimension) (Table 9). For instance, those who worked on the frontline of epidemic prevention and control and those who provided support for frontline workers displayed lower levels of risk perception for these 11 items. A possible, reasonable explanation is that those who fought the COVID-19 virus on the front line and those who provided support services for them had a better level of knowledge about the COVID-19 virus than others. This is in line with the findings of earlier research, which also found that the more knowledge people have related to a crisis event, the lower their perceptions of risks tend to be (Li, 2008).

Table 9. Risk perceptions on travel to Wuhan after COVID-19 by involvement in epidemic prevention and control.

Items	ANOVA		Means by involvement groups						F	Brown F
	F	p-values	Total n = 1,818	C_1 n = 79	C_2 n = 1,421	C_3 n =128	C_4 n = 93	C_5 n = 97		
R_1	1.888	0.110	3.06	3.10	3.10	2.98	2.78	2.84	3.312*	-
R_2	2.615	0.034*	2.95	2.89	3.00	2.81	2.69	2.67	-	4.347**
R_3	3.104	0.015*	2.99	2.84	3.04	2.91	2.78	2.74	-	3.117*
R_4	1.425	0.223	2.77	2.63	2.82	2.67	2.55	2.55	3.704	-
R_5	0.237	0.918	2.66	2.48	2.72	2.52	2.40	2.45	4.843 **	-
R_6	1.301	0.268	2.66	2.67	2.69	2.59	2.29	2.55	4.147 **	-
R_7	1.406	0.230	2.77	2.71	2.81	2.74	2.44	2.54	4.541**	-
R_8	0.184	0.947	2.70	2.58	2.75	2.60	2.41	2.42	5.454***	-
R_9	2.089	0.080	3.41	3.49	3.44	3.41	3.11	3.25	3.018*	-
R_{10}	1.610	0.169	3.20	3.18	3.22	3.21	3.01	3.04	1.474	-
R_{11}	0.957	0.430	2.95	2.90	2.98	2.89	2.75	2.76	2.002	-
R_{12}	0.359	0.838	2.71	2.62	2.75	2.58	2.47	2.55	3.359 **	-
R_{13}	0.460	0.765	2.73	2.57	2.78	2.58	2.44	2.55	4.857**	-
Total	-	-	2.89	2.82	2.93	2.81	2.62	2.69	-	-

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

C_1 = To keep working as always; C_2 = Consciously staying at home; C_3 = Donating or publicizing knowledge of the epidemic; C_4 = Supporting the frontline; C_5 = Working in the frontline.

Losses: Losses suffered by respondents in the epidemic also had a significant effect on their perceptions of risk related to 11 items, excluding R_9 and R12 (Table 10). Those who believed that the greatest impact of the epidemic on them was direct losses (economic losses, loss of development opportunities, loss of loved ones or friends) or 'disturbances to every-day life' had a higher level of risk perception than others.

Table 10. Risk perceptions on travel to Wuhan after COVID-19 by losses.

Items	Homogeneity of variance		Means by loss groups				F	Brown F
	F	p-values	Total n =1,818	L_1 n =1,245	L_2 n = 163	L_3 n = 410		
R_1	11.328	0.000***	3.06	3.17	3.11	2.85	-	9.101**
R_2	6.932	0.001**	2.95	3.06	3.00	2.78	-	6.878**
R_3	2.812	0.060	2.99	3.12	3.05	2.75	13.609***	-
R_4	5.305	0.005**	2.77	2.92	2.81	2.61	-	7.147**
R_5	9.487	0.000***	2.66	2.83	2.69	2.52	-	5.778**
R_6	8.020	0.000***	2.66	2.75	2.68	2.55	-	3.036*
R_7	3.615	0.027*	2.77	2.94	2.81	2.58	-	10.051***
R_8	8.962	0.000***	2.70	2.80	2.73	2.55	-	5.681**
R_9	3.533	0.029*	3.41	3.44	3.44	3.30	-	2.663
R_{10}	7.551	0.001**	3.20	3.24	3.23	3.07	-	3.297*
R_{11}	6.557	0.001**	2.95	3.07	2.97	2.83	-	3.369*
R_{12}	7.652	0.000***	2.71	2.78	2.73	2.61	-	2.330
R_{13}	5.241	0.005**	2.73	2.78	2.76	2.61	-	3.542*
Total	-	-	2.89	2.99	2.92	2.74	-	-

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$. L_1 = Disturbing life, L_2 = Direct loss, L_3 = Others.

Lockdown experiences: Lockdowns during the outbreak period had a significant impact only on perceptions of R_{12} (Table 11). In fact, respondents who had experienced isolation in hospitals or other locations used specifically for this purpose worried less about poor tourism facilities than those respondents who had engaged in preventive isolation at home.

Table 11. Risk perceptions on travel to Wuhan after COVID-19 by lockdown experiences.

Items	ANOVA		Mean by lockdown experience groups				F	Brown F
	F	p-values	Total n = 1,818	IS_1 n = 1,154	IS_2 n = 589	IS_3 n = 75		
R_1	0.454	0.635	3.06	3.05	3.07	3.12	0.222	-
R_2	1.215	0.297	2.95	2.97	2.93	2.83	0.841	-
R_3	1.492	0.225	2.99	2.99	3.01	2.77	1.673	-
R_4	0.814	0.443	2.77	2.79	2.75	2.61	1.228	-
R_5	2.345	0.096	2.66	2.67	2.69	2.44	1.906	-
R_6	1.737	0.176	2.77	2.77	2.79	2.52	0.229	-
R_7	1.378	0.252	2.77	2.77	2.79	2.52	2.458	-
R_8	4.041	0.018*	2.70	2.72	2.68	2.53	-	1.307
R_9	2.950	0.053	3.41	3.43	3.40	3.23	1.469	-
R_{10}	0.705	0.494	3.20	3.21	3.18	3.16	0.227	-
R_{11}	2.442	0.087	2.95	2.97	2.90	2.96	0.739	-
R_{12}	4.908	0.007**	2.71	2.75	2.66	2.49	-	3.435 *
R_{13}	3.425	0.033*	2.73	2.76	2.69	2.52	-	2.446
Total			2.90	2.91	2.89	2.75		

$^{*}p<0.05$, $^{**}p<0.01$, $^{***}p<0.001$.

IS_1 = Not isolated, IS_2 = Isolated at home, IS_3 = Isolated in hospitals or designated places.

Connections with Wuhan: Respondents' previous visits to Wuhan had significant differences for all 13 items (Table 12). Those who had never visited Wuhan in the past had higher levels of risk perceptions associated with travel to the city after the lifting of the nationwide lockdown. On the contrary, the risk perception levels of Wuhan residents and university students in that city were significantly lower. These findings can be explained using the theory of the affect heuristic on perceptions of risk (Finucane, *et al.*, 2000). This theory shows that human emotions are an important factor in individuals' perceptions of risk. Negative emotions, such as anger and fear, tend to lead to higher perceptions of risk, while more positive emotions (e.g., interest and satisfaction) tend to be associated with lower risk perception levels (Meng *et al.*, 2010). In line with this, residents and college students who had lived in Wuhan for a long time were more likely to have positive emotions about Wuhan, and thus displayed lower levels of risk perceptions than people who had just visited Wuhan. Similarly, the latter generally displayed lower levels of risk perception than those who had never visited Wuhan before because they had shown a higher interest in Wuhan by their previous actions.

Table 12. Risk perceptions on travel to Wuhan after COVID-19 by experience of visiting Wuhan.

Items	ANOVA		Means for past experiences of visits to Wuhan						F	Brown F
	F	p-values	Total n = 1,818	V_1 n = 501	V_2 n = 292	V_3 n = 156	V_4 n = 483	V_5 n = 386		
R_1	5.017	0.001**	3.06	3.15	2.99	3.10	3.14	2.88	-	4.930**
R_2	11.417	0.000***	2.95	3.13	2.95	3.06	2.96	2.67	-	11.398***
R_3	10.294	0.000***	2.99	3.15	2.98	3.10	3.02	2.71	-	10.270***
R_4	10.584	0.000***	2.77	2.96	2.79	2.83	2.77	2.51	-	10.492***
R_5	8.623	0.000***	2.66	2.83	2.66	2.75	2.65	2.43	-	8.472***
R_6	9.612	0.000***	2.66	2.82	2.72	2.74	2.60	2.43	-	9.575***
R_7	8.895	0.000***	2.77	2.93	2.82	2.85	2.71	2.55	-	8.910***
R_8	10.227	0.000***	2.70	2.88	2.75	2.78	2.65	2.46	-	10.218***
R_9	13.550	0.000***	3.41	3.61	3.41	3.43	3.44	3.11	-	13.368***
R_{10}	15.363	0.000***	3.20	3.44	3.19	3.20	3.19	2.90	-	15.242***
R_{11}	14.493	0.000***	2.95	3.20	3.01	2.98	2.85	2.69	-	14.455***
R_{12}	12.225	0.000***	2.71	2.91	2.80	2.74	2.64	2.46	-	12.189***
R_{13}	10.778	0.000***	2.73	2.91	2.81	2.73	2.67	2.49	-	10.796***
Total			2.89	3.07	2.91	2.94	2.87	2.64		

$^{*}p < 0.05$, $^{**}p < 0.01$ $^{***}p < 0.001$. V_1 = No visit, V_2 = 1-2 visits, V_3 = 3-5 visits , V_4 = 6 or more, V_5 = residents or college students in Wuhan.

Likewise, the theory of affect would also contribute to explaining that respondents with close ties to Wuhan (including Wuhan residents, university students, those with friends and relatives in Wuhan, and those with business connections in Wuhan) displayed lower levels of risk perception than those with moderate ties to the city (e.g., respondents who had merely travelled to Wuhan), and even less so than those who had no connection at all to Wuhan (Table 13).

Table 13. Risk perceptions on travel to Wuhan after COVID-19 by connection with Wuhan.

Items	ANOVA		Means for connection groups				F	Brown F
	F	p-values	Total n = 1,818	CO_1 n = 494	CO_2 n = 954	CO_3 n = 370		
R_1	1.410	0.244	3.06	3.16	3.01	3.06	3.539*	-
R_2	5.012	0.007**	2.95	3.10	2.86	3.00	-	9.848***
R_3	4.535	0.011*	2.99	3.11	2.90	3.07	-	8.095 ***
R_4	4.287	0.014*	2.77	2.95	2.67	2.81	-	12.537***
R_5	1.250	0.287	2.66	2.82	2.58	2.66	8.714***	-

R_6	3.058	0.047*	2.66	2.82	2.57	2.67	-	11.154***
R_7	4.550	0.011*	2.77	2.93	2.69	2.75	-	9.162***
R_8	6.147	0.002**	2.70	2.89	2.60	2.71	-	14.628***
R_9	8.541	0.000***	3.41	3.57	3.32	3.42	-	10.237***
R_{10}	1.674	0.188	3.20	3.41	3.09	3.20	16.176***	-
R_{11}	3.109	0.045*	2.95	3.16	2.83	2.98	-	16.969***
R_{12}	1.947	0.143	2.71	2.90	2.59	2.77	16.937***	-
R_{13}	3.319	0.036*	2.73	2.89	2.62	2.80	-	13.712***
Total	-	-	2.89	3.05	2.79	2.92	-	-

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.
CO_1 = No connection, CO_2 = Close connection, CO_3 = Moderate.

Conclusions

Exploratory and confirmatory factor analysis were used to construct a risk perception measurement scale with four dimensions and 13 items. The scale was used to assess risk perceptions of Chinese residents during the outbreak of COVID-19 associated with travel to Wuhan after the lifting of the nationwide lockdown measures. The mean scores for four items from the health and social risk dimensions were greater than three, indicating high levels of risk perception, and the remaining nine items were found to achieve only medium levels.

One-way ANOVA and Brown-Forsythe tests showed that gender, age, educational and income levels independently affected risk perception evaluations for some items, while occupation and residence had significant effects on all 13 items. People who mainly relied on video platforms to obtain epidemic information displayed the lowest levels of risk perception, while those who gathered their information mainly from interpersonal communications had the highest levels of risk perception. This is a new finding of this study, which differs from those of previous studies.

Lockdown experiences during the epidemic outbreak did not produce significant differences for most of the items. However, contributions to epidemic prevention and control and losses suffered during COVID-19 significantly affected the evaluations of most items. Those who worked on the front line of prevention and management of the pandemic or provided support for the front line displayed lower levels of risk perception. People who believed that the greatest impact of the epidemic on them was ‘disturbing every-day life’ displayed higher levels of risk perceptions than the control groups. Respondents who had never visited Wuhan and those who thought they had no contact with the city had higher levels of risk perception than their control group.

Theoretical implications and contributions

This research provides a novel contribution to existing knowledge by developing a new 13-item risk perception measurement scale for visitors to Wuhan (China) – the epicentre of the novel coronavirus (COVID-19) pandemic in China. This investigation is also the first ever within this context to be implemented shortly before and during the advent of a major public health crisis. Respondents who obtained their information mainly from interpersonal communications tended to display the highest levels of risk perception, which differs significantly from earlier studies associated with the '5·12' earthquake in Wenchuan, Sichuan. Similarly, people who relied mainly on video platforms to obtain information about the Covid-19 pandemic experienced had the lowest levels of risk perception. This is a new research finding, as video platforms are important sources of information and have often been ignored by scholars within the context of major public health crises. New research findings were also obtained by testing risk perception differences across different groups based on new factors, including epidemic engagement (e.g., involvement, loss and lockdown experiences during the pandemic), past experiences of travel to Wuhan, as well as respondents' links to Wuhan. Generally, respondents who worked on the front line or provided support for the front line displayed lower perceptions of risk than those who did not work at this level. Crucially, respondents who had never visited Wuhan or had the lowest level of relationship with Wuhan tended to display higher levels of risk perception with regards to the on-going Covid-19 crisis.

This study adopted a social science approach by integrating the risk perception and affect theoretical frameworks in a public health crisis context, providing new insights on risk perceptions before and during a major public health crisis – the global COVID-19 pandemic. In this context, this research confirmed the findings of earlier studies with regards to the 18-35 age group being more prone to have a higher levels of risk perception of risks and residents of Wuhan (the epicentre of the pandemic) displaying significantly lower levels of perceived risk of travel, which supports the findings of earlier research by Xie *et al.* (2005) on the psychological panic phenomenon in the context of the SARS public health crisis. The findings of this research are also consistent with those of earlier studies by Li *et al.*. (2009) in a psychological investigation following the 2008 Wenchuan earthquake, where it was found that the closer respondents lived to the earthquake's epicentre, the calmer they tended to be and the lower their levels of perceived risk. This phenomenon was aptly coined as the 'psychological typhoon eye'.

Practical implications

This research has several potential implications for the management and marketing of tourism in Wuhan and other destinations adversely impacted by the pandemic. COVID-19 has tarnished the brand of the city of Wuhan on a global scale as a result of this unprecedented worldwide crisis event and the ensuing global pandemic that followed. Moreover, it appears to have shaken domestic tourism confidence about a city which attracted 285 million domestic and 2.76 million overseas tourists in 2018 (Mao, 2020). The findings signalled a potential diversity in domestic tourism willingness to visit Wuhan in the future. City and destination brand repair must be an immediate strategic priority for the municipal and tourism authorities in Wuhan. However, importantly the findings suggest that new approaches to domestic tourism market segmentation will be required in the near future due to the varying risk perception levels of Chinese residents.

In the short term, tourism authorities should pay particular attention to Wuhan residents and others living in the province of Hubei. They have lower levels of risk perception and should be the foundation for the tourism revival in the city. Thereafter, efforts should be extended to the neighbouring provinces of Anhui, Henan, Hunan, Jiangxi, Shaanxi and Sichuan. Special incentives may need to be offered to convince some tourists to resume their patronage of Wuhan.

Limitations and future research directions

One of the limitations of this research was the short period of time available for its preparation, with only eight days (January 21-28, 2020) for the pre-survey pilot, and thus the sample size for this pilot study was small (n = 37). Due to the social distancing and self-quarantine policies during the COVID-19 outbreak, snowball sampling based on social networks might limit the representativeness of the survey sample. The sample data were gathered in the outbreak period of China's epidemic, so that the research conclusions are only applicable to understanding the risk perceptions in that period. At present, China's first wave of the epidemic has subsided and the country has entered a stage of prevention and control focused on the defence of ‘external input and internal rebound’. In subsequent stages, further evidence and research will be required to establish how and what changes have occurred in the risk perceptions of Chinese residents.

It is conceivable that other dimensions and scale items can be added in the future and these will further enhance the measurement capability precision and contributions of this work. Other theories related to risks and risk perceptions could also be introduced into future studies such as social action theory, risk compensation/homeostasis theory and others.

This research did not investigate potential cause and effect relationships among the four main risk perception variables (health, financial, social and performance) and other constructs. Instead, the focus was on developing a risk perception scale. Future research should apply the appropriate procedures and analysis techniques to build and test a model of these relationships.

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