



## Research article

# Who will survive in the next disaster? The associations between sociodemographics and typhoon protective behaviors

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## ARTICLE INFO

**Keywords:**

Disaster management  
Disaster preparedness  
Emergency response  
Multivariate analysis of variance  
Tropical cyclone  
Vulnerable group

## ABSTRACT

Personal protective behaviors play an important role in disaster management because they can effectively reduce the damage caused by disasters. Understanding the relations and differences in protective behaviors among different social classes can help improve disaster management. This study conducted a street questionnaire survey in a typhoon-prone district of Hong Kong. Data were analyzed to understand how sociodemographic parameters (i.e., gender, age, education level, and income) influenced typhoon protective behaviors (i.e., preparedness before typhoons and emergency response during typhoons) of Hong Kong residents. The results showed that the level of preparedness of the respondents was low before the arrival of the typhoon. When the typhoon is approaching Hong Kong, they become more responsive. The higher the intensity of the typhoon, the higher the level of the adoption of emergency response. Among four sociodemographic parameters, only age and income significantly affected protective behaviors. This study supplements the existing literature on typhoon disaster management and provides a reference for improving typhoon disaster management in Hong Kong and other coastal cities affected by typhoons.

## 1. Introduction

Typhoons or tropical cyclones are the most common natural hazards in the coastal areas of South China [1]. The typhoon season in Hong Kong lasts for half a year, from May to November [2], but most typhoons occur between July and October [3]. According to statistics from the Hong Kong Government, 361 typhoons affected Hong Kong from 1960 to 2019 [4], with an average of 6.02 typhoons per year.

The strong winds and heavy rainfall of typhoons can directly cause casualties and damage to properties [5], and typhoons may also induce such as landslides, floodings, and storm surges that cause a secondary wave of damage [6,7]. Typhoons account for the largest proportion of the total number of fatalities among various natural hazards in Hong Kong. In the history of Hong Kong, tragic disasters with a large number of fatalities were mostly related to typhoons. From 1960 to 2019, a total of 510 people died due to typhoons in Hong Kong [8].

As climate change and global warming prevail, typhoons increase in frequency and intensity in the western Pacific [9]. This observation seems to be evident from the typhoon statistics of the past four decades. Between 1980 and 2010, there were only two typhoons of signal number 10 (hurricane) but there were three in the past decade, occurring in 2012, 2017, and 2018 respectively. The increasing frequency and intensity of typhoons expose Hong Kong to higher typhoon risk [10].

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<https://doi.org/10.1016/j.heliyon.2023.e15492>

Received 4 November 2022; Received in revised form 10 April 2023; Accepted 11 April 2023

Available online 14 April 2023

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After years of efforts, an integrated framework of natural disaster management has been developed in Hong Kong [11]. It incorporates all possible programs, activities, and actions that can be undertaken before, during, and after the disaster with the aim of reducing its impacts and restoring society from damage. Practically, disaster management is comprised of four phases or stages: preparedness, response, recovery, and mitigation [12]. Each phase has its own focus with respect to the occurrence of the disaster.

The government plays a major role in the phases of mitigation and recovery. To mitigate the impacts of typhoons, relevant ordinances and building codes require that the strength of buildings and structures must be sufficient in resisting strong winds up to the level of hurricanes [13]. Temporary shelters will be open for providing the needed people with temporary accommodation during typhoons. In case when a disaster occurs, the government brings various departments and agencies together to ensure that their efforts are properly coordinated in providing emergency relief in accordance with the Contingency Plan for Natural Disasters (CPND) for the recovery of society [14]. Because of these beneficial measures, the number of fatalities caused by typhoons was significantly reduced in recent decades [8].

On the other hand, individual persons play a critical role in the phases of preparedness and response [15]. Before the coming of a typhoon, preparedness can essentially lower personal exposure and vulnerability [16,17], thereby reducing the possibility of disaster occurrence [18]. In addition, good disaster preparedness also ensures flexibility for disaster victims to respond to emergencies during the disaster event [19]. However, a few local studies indicated that the preparedness of Hong Kong people is far from satisfactory. For example, Wong and Yan [20] indicated that Hong Kong people only took minimal precautions against typhoons. Loke et al. [21] reported that only 22.4% of respondents were prepared before the arrival of the typhoon. The findings of these studies were consistent with the international literature that overall levels of household preparedness were universally low [22]. When a disaster occurs, how someone reacts could be the difference between life and death [23]. Despite the importance of proper response during a disaster, the number of studies on emergency response is less than those on preparedness. Very few studies had examined both preparedness and response. Because good preparedness ensures the flexibility for people to respond to a disaster event [19], it is meaningful to investigate preparedness and response as a whole. Disaster preparedness and emergency response are two faces of the coin of protective behavior.

Previous social science research has found associations between sociodemographic characteristics and public behaviors [24]. Along this line, sociodemographics are used to predict protective behaviors [15]. Government and policymakers are especially interested in understanding the relationship between people's protective behaviors and their sociodemographic characteristics [25]. It is because the majority of policymaking and public administration are designed based on the consideration of social class, which is primarily defined by the sociodemographic characteristics of the population [26]. In the context of disaster management, vulnerable groups should receive special attention in natural disaster management because they are more susceptible to natural hazards and hence may require more support and additional assistance during the disaster [27].

With the above observations in mind, a quantitative survey was conducted in a typhoon-prone district of Hong Kong. An intercept sample of 286 residents was obtained and the data were analyzed by multivariate statistical analysis to understand the impacts of sociodemographic characteristics of typhoon-vulnerable people on their preparedness before typhoons and emergency response during typhoons. The findings of the study not only supplement the existing literature on typhoon hazards but also provide references for disaster planning and future improvement of typhoon management in Hong Kong and other coastal cities affected by typhoons.

## 2. Literature review

### 2.1. Disaster preparedness and emergency response to typhoons

Although natural disasters often occur rapidly, they do not appear and disappear in a second. They evolve in a life-cycle process [12]. To deal with the challenges of natural hazards, disaster management consists of four major phases: preparedness (i.e., preparation before the disaster), response (i.e., emergency response during the disaster), recovery (i.e., relief and rebuilding after the disaster), and mitigation (i.e., long-term measures for capacity building and vulnerability reduction) [28]. As mentioned earlier, the scope of this study is preparedness and emergency response to typhoons.

Preparedness refers to the precautionary measures or actions taken to reduce the exposure and vulnerability of people that make the impacts of hazards less severe [15,17]. Disasters are less likely to occur when people are well prepared [18]. Because different places have different natural hazards and their social and environmental contexts vary, disaster preparedness may vary around the world [11]. Preparedness may have physical and behavioral dimensions which are usually operationalized as an emergency kit and an emergency plan [29,30]. Using the biblical story of Ten Bridesmaids in the Gospel of Matthew as an illustration, wise bridesmaids kept awake and took lamp oil to meet the bridegroom. A bottle of lamp oil can be considered the emergency kit, and keeping awake is the execution of the emergency plan.

In most cases, emergency kits should have a small amount of drinking water and food, and some basic medical supplies and survival gear (e.g., flashlights) [31]. Additional supplies could be included in the emergency kit for those regions that could experience severe disasters [24]. Because Hong Kong is a compact city with convenience stores and pharmacies located on almost every street corner, a basic first-aid kit is good for typhoon preparation [15].

The emergency plan refers to instructions and procedures for dealing with unexpected or unplanned situations [32]. In foreign countries, the plan may include a detailed list of who and what needs to be done and how it will be delivered [31]. In Hong Kong, the majority of families do not have a written plan, but the emergency plan is the consensus of how family members will behave during typhoons [30].

Emergency response refers to the actions and activities that are taken immediately to save lives and prevent further damage during

a disaster [32]. The most archetypal example of emergency response is the life-saving action of “get down, cover, and hold on” when an earthquake occurs. In Hong Kong, different actions and measures are recommended for citizens to adopt according to the intensity of the typhoon (Table 1) [33].

Low typhoon intensity is indicated by typhoon number 1 or 3. Typhoon (standby) signal number 1 will be issued when a typhoon is concentrated within 800 km of Hong Kong and may affect Hong Kong. Residents are advised to stay alert to the latest development of typhoons [33]. Typhoon (strong wind) signal number 3 will be issued when the typhoon is approaching Hong Kong. The sustained wind speed of reaches 41–62 km/h and gusts exceed 110 km/h, respectively. Residents are advised to check if any objects may be blown away and tie them up or relocate them to the indoor environment [33]. Typhoon (gale) signal number 8, indicating high typhoon intensity, is issued when storm force wind is blowing near sea level, with a sustained wind speed of 63–117 km/h and gusts exceeding 180 km/h. Residents are advised to go home or to seek shelter as soon as possible, lock all windows and doors securely, and reinforce all fragile items (e.g. window glass panes) [33]. If wind speed is expected to further increase, typhoon (increasing gale) signal number 9 will be issued. When the sustained wind speed exceeds 118 km/h and gusts exceed 220 km/h, respectively, typhoon (hurricane) signal number 10 will be issued. Typhoon numbers 9 and 10 indicate extreme typhoon intensity. Residents are advised to stay indoors and not to go out unless necessary until the typhoon signal drops to No. 3 or lower [33].

The majority of research on protective behaviors focused on disaster preparedness, and relatively few studies examined people's emergency responses in disaster situations. Even fewer studies investigated both preparedness and response. Because good preparedness before the disaster facilitates better emergency responses during the disaster [19], it is meaningful to them simultaneously. Both good preparedness and proper emergency response contributed to community resilience [34,35] and trust [36]. How to manage appropriate and progressive protective behaviors of the public at different stages of a disaster event is a great challenge for public administration [37].

## 2.2. Vulnerable groups and their protective behaviors

In the context of disaster management, the identification of vulnerable groups is crucially important [38]. The term “vulnerable group” refers to a population whose life or livelihood is threatened by hazards because of their limited capacity to cope or adapt [39]. They usually are not prepared for a disaster and/or do not respond properly during a crisis [40].

Based on the assumption that sociodemographic characteristics, such as gender, age, education level, and income attach to particular precepts or norms, sociodemographic variables are often used for the identification of vulnerable people [41]. Both in scientific and practical venues, the narrative of some vulnerable groups has formed and has become widespread terminology [42]. In general, women were believed to be less vulnerable than men because females usually have better preparation for disasters than males [43]. Older people are less vulnerable as seniors are more likely to respond to natural hazards than younger people [44]. In addition, well-educated and wealthy people are less vulnerable as they are more willing to prepare for disasters than their counterparts [45]. However, some other studies have held inconsistent or even opposing views on the above results. For example, Oral et al. [46] reported no significant relationship between age, gender, education level, occupation, and disaster preparedness. Baker [47] also reported that men and women did not differ in their disaster preparedness. Addis and Abate [48] reported that older adults were less prepared for disasters than younger groups. Dixit et al. [49] stated that low-income people tend to be more responsive to disasters than high-income ones. Kim and Zakour [50] also reported that the associations between education level and disaster preparedness were not significant.

The inconsistent findings may be due to the interdependence of vulnerable people (i.e., specific individuals or communities who are especially vulnerable) and vulnerable situations (i.e., the contexts that render people vulnerable) [42,51,52]. Furthermore, the significances of different socioeconomic variables are different in various natural disasters, which depends largely on the local society and environment [53]. Even for the same natural hazard, people, with different backgrounds or exposure to hazards, may experience the impacts in different ways [54].

Based on the above observations, this study proposed a novel theoretical framework to examine the impacts of four sociodemographic variables, namely gender, age, education level, and income, on typhoon protective behaviors of local residents, including disaster preparedness before typhoons and emergency response during typhoons (Fig. 1). Specifically, a typhoon-prone district, representing the vulnerable situation, was selected as the studied area, and vulnerable groups can be identified by testing the significance of their sociodemographic characteristics.

**Table 1**  
Definitions of typhoon warning signals and recommended actions and measures.

Typhoon Intensity	Typhoon signal number	Wind condition		Recommended actions and measures
		Sustained wind speed (km/hr)	Gust (km/hr)	
Low	1 (Standby)	Not applicable	Not applicable	Listen to radio and TV broadcasts or other information sources for updated information of the typhoon Secure loose objects or relocate them into indoors
	3 (Strong Wind)	41–62	>110	
High	8 (Gale)	63–117	>180	Lock all windows and doors. Reinforce fragile objects, e.g., large window panes in exposed positions, using adhesive tape Stay indoors or safe place until the typhoon has passed.
	9 (Increasing Gale)	increasing	increasing	
Extreme	10 (Hurricane)	>118	>220	

(source: Hong Kong Observatory [33]).

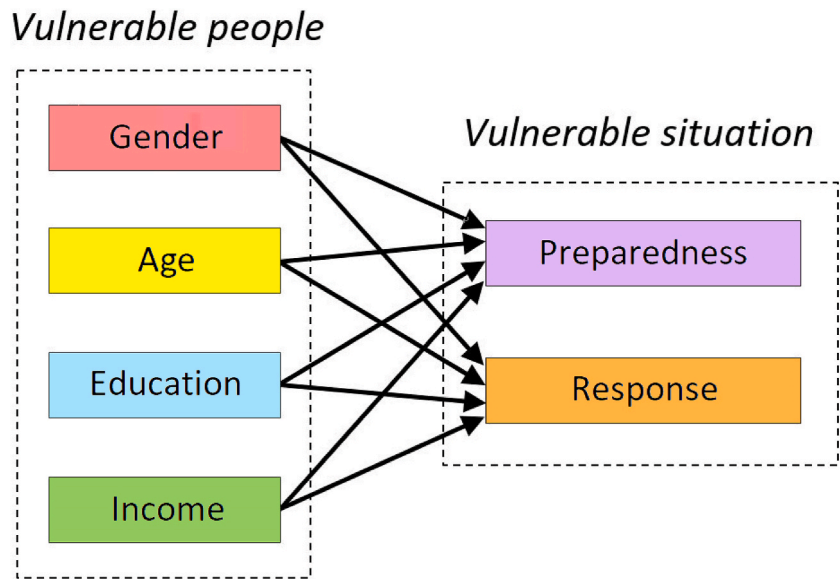


Fig. 1. Theoretical framework of this study.



Fig. 2. Location of Kwun Tong.

### 3. Methods

#### 3.1. Data collection

The conceptual framework was used to design the questionnaire which comprised three sections. They are preparedness before typhoons, emergency response during typhoons, and sociodemographics. Except for the sociodemographic items, all questions are measured using a Likert scale of 5. The questionnaire is included in the supplementary file.

The items of preparedness before typhoons measured the physical and behavioral preparation among the respondents: "I will prepare a first aid kit for an emergency before the coming of a typhoon" and "I will make prepare a household emergency plan before the coming of a typhoon". These items have been extensively adopted by previous studies (e.g. Lam et al. [30]). They have a satisfactory level of reliability with a Cronbach alpha of 0.771.

The measurement items of emergency response during typhoons were adopted from the Hong Kong government's recommended response measures under different scenarios of typhoon signal [33]: "I will listen to the radio, watch TV or browse the Internet for updated information about the typhoon when typhoon signal No. 1 is in force"; "I will take away or fasten loosed objects when typhoon signal No. 3 is in force"; "I will reinforce windowpanes using adhesive tapes when typhoon signal No. 8 is in force"; and "I will stay indoors or remain where it is protected until the typhoon has passed when typhoon signal No. 9 or 10 is in force". The reliability Cronbach alpha for the emergency response items is 0.724.

The sociodemographic items included gender, age, education level, and income. They were measured by categorical scales with reference to the Hong Kong Population Census [55]. These four items are the most commonly used sociodemographic parameters and are widely studied by both individual researchers (e.g., Oldfield [26]; Connelly [56]; Tian et al. [57]) and government (e.g., Hu et al. [58]).

Two independent experts in the field of hazard management were invited to review the questionnaire, then the pilot test ( $n = 20$ ) was held in November 2018 with the aim of removing or modifying ambiguous wordings. The formal questionnaire survey was conducted from December 2018 to May 2019. This period was not the typhoon season, so the opinions collected would not be disturbed by the recent typhoon events.

The questionnaire surveys were carried out in the district of Kwun Tong (Fig. 2). This study first identified potential streets on a map that are highly exposed to strong winds and heavy rainfall of typhoons. These streets were then visited and checked the suitability for the questionnaire survey.

With the consideration of the complexity of vulnerability, this study selected Kwun Tong as the studied area for two reasons. First, Kwun Tong is situated near the east opening of Victoria Harbor, it is exposed to the direct effects of strong winds and heavy rainfall brought by typhoons. Furthermore, Kwun Tong is also prone to a variety of typhoon related hazards, such as landslides and coastal flooding, because of its topography and geology [59]. For example, a fatal landslide occurred in Kwun Tong in 1972; 71 people were killed. Another landslide occurred at the same location in 1976; 18 people were killed [60]. Therefore, Kwun Tong well represents the vulnerable situation of typhoons. Second, Kwun Tong is the poorest district in Hong Kong. Its median monthly household income is HK \$15,960, which obviously is lower than that of the whole of Hong Kong (HK\$20,500) [61]. Kwun Tong also has the highest population density (57,530 persons per  $\text{km}^2$ ) and the highest number of households (227,168) of all districts in Hong Kong [55]. Therefore, Kwun Tong is believed to be sustaining a hazard-vulnerable community.

In this study, intercept sampling techniques were used to sample respondents. This method is believed to work better than traditional techniques of household surveys because of a few reasons. First, the cityscape of Hong Kong is dominated by housing estates whose entrances are guarded by security officers [62]. Unsolicited visits are not allowed. Second, respondents feel more relaxed when interviewing in public areas than in their household premises [63]. Third, researchers are able to select suitable respondents for the interviews. In this study, residents of Kwun Tong who were over the legal age of 18 and had the ability to communicate were invited to the interviews.

This study received ethical approval from the Research Administration Office of the Chinese University of Hong Kong. Respondents were informed verbally about the purpose of this study and their consent was confirmed before starting the questionnaire survey. The respondents were informed that their participation in the questionnaire survey was voluntary. Furthermore, they received the assurance of anonymity and confidentiality.

To enhance sample variability, only one person in a group of pedestrians was selected for the interview to avoid redundant samples. In addition, the survey was conducted on both weekdays and weekends. It should be noted that the street survey naturally excluded those who were not present on the street for mobility and family reasons. However, this does not cause serious sampling bias because people with mobility problems are usually less likely to be affected by typhoons. A total of 300 people were successfully interviewed in this study.

#### 3.2. Data analysis

The collected data were first checked for completeness and then 14 outliers were removed, resulting in a total of 286 cases for data analysis. This sample size is similar to that of a few social surveys in Hong Kong and overseas (e.g., Shapira et al. [64], Wong and Yan [20]).

Categorical data were grouped and their percentages were calculated. The numerical data were checked for normality and reliability. The relations between sociodemographic parameters and protective behaviors were analyzed at two levels using univariate and multivariate statistical methods, respectively. All analyses were conducted using IBM SPSS Statistics (version 26.0).

The first level of analysis used univariate statistical methods. The data were first examined for homoscedasticity by Levene's equal error variance, and then one-way analysis of variance (ANOVA) is used to examine statistical differences in one dependent variable (e.g., preparedness before typhoons) between groups of one independent variable (e.g., age). Because ANOVA examines the unconditional effect of one independent variable on one dependent variable, the associations are often exaggerated so further analysis is needed to clarify the relationship.

The second level of analysis used multivariate statistical methods. After checking the homogeneity of the covariates by Box's M test, two-way multivariate analysis of variance (MANOVA) was conducted. MANOVA is an extension of ANOVA. MANOVA bundles multiple continuous dependent variables (i.e., preparedness before typhoons and three emergency responses during typhoons) into a weighted linear combination or composite variable for analysis. MANOVA compares whether the created sets of dependent variables differ by different groups of independent variables. In this way, MANOVA tests whether the independent variables also explain the statistically significant amount of variation in the dependent variables as a whole. Furthermore, MANOVA also assesses the interaction effects of independent variables [65].

## 4. Results

### 4.1. Descriptive statistics

Table 2 shows the sociodemographic profile of the respondents in this study. The number of male (49.0%) and female (51.0%) respondents was approximately the same. More than half of the respondents (57.0%) were between the ages of 18 and 34. There were relatively few older people. The educational level of respondents was rather high, with more than 60% of respondents receiving tertiary education or above and only 3.8% receiving only primary education or below. The majority of the respondents (68.5%) had a monthly income of \$5000 to \$39,999. Overall, the sociodemographic characteristics of the respondents in this study are somewhat different from the Hong Kong population as a whole because Kwun Tong is the poorest district in Hong Kong, as mentioned earlier. In addition, the study did not interview those who had mobility problems or were homebound for some reason.

Fig. 3 is the boxplot showing respondents' scores of typhoon preparedness and emergency responses. The results indicated that respondents were less willing to prepare for the disaster before the coming of the typhoon. The mean and median scores of preparedness are 2.589 and 2.5, respectively. When the typhoon is approaching, respondents change and become willing to respond. When the typhoon intensity is low, the mean and median scores of emergency response are 3.388 and 3.5, respectively. When the typhoon intensity is high, the mean and median scores of emergency response rise to 3.81 and 4.0, respectively. When the typhoon intensity is extreme, the mean and median scores of emergency response further increase to 4.48 and 5.0, respectively. Also, the lower bound rises from 1.0 to 2.0. In other words, all respondents would adopt the protective behaviors recommended by the government when the typhoon intensity is extreme.

### 4.2. Univariable statistics

Fig. 4 presents the results of ANOVA, mean levels, and 95% confidence intervals of protective behaviors of different sociodemographic cohorts. The results indicate that gender has no effect on all typhoon protective behaviors, but age, education level, and income can affect different protective behaviors to different degrees. Age does not affect disaster preparedness, but does affect emergency response in all typhoon intensities. F-values for low, high, and extreme typhoon intensities are 4.112, 3.160, and 3.314, respectively; all were statistically significant with  $p < 0.01$ . Middle-aged people (i.e., 35–44 and 45–54 years) have the lowest level of emergency response, while older people (i.e., 55–64 and 65 years or older) have the highest level of emergency response. Education level does not affect disaster preparedness and response to extreme typhoon intensity but affects responses to low (F-value = 3.336,  $p$

**Table 2**  
Profile of the respondents in this study (n = 286).

Socio-demographics		This study	Hong Kong population [55]
		Number (percent)	Percent
Gender	Male	140 (49.0%)	46.0%
	Female	146 (51.0%)	54.0%
Age	0–17	–	22.0%
	18–24	91 (31.8%)	
	25–34	72 (25.2%)	14.9%
	35–44	50 (17.5%)	15.6%
	45–54	37 (12.9%)	16.5%
	55–64	26 (9.1%)	15.3%
	Older than 65	10 (3.5%)	15.9%
Education level	Primary or below	11 (3.8%)	20.0%
	Secondary	94 (32.9%)	47.3%
	Tertiary or above	181 (63.3%)	32.7%
Income	Less than HK\$4999	10 (3.5%)	8.1%
	HK\$5000 – HK\$39,999	196 (68.5%)	61.9%
	More than HK\$40,000	80 (28.0%)	30.0%

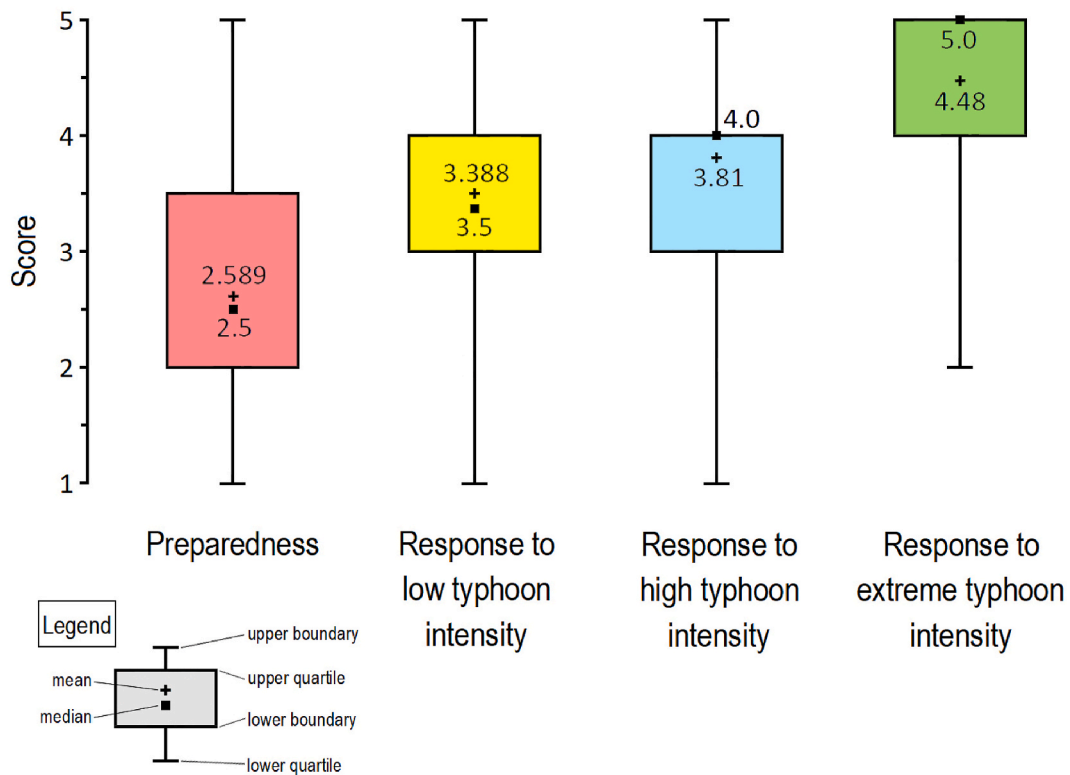


Fig. 3. Boxplot of respondents' scores for typhoon preparedness and emergency response.

< 0.05) and high (F-value = 3.560,  $p < 0.05$ ) typhoon intensities (F-values = 3.336 and 3.560,  $p < 0.05$ ). Interestingly, respondents with a low education level (i.e., primary school or below) had the highest level of emergency response. The effect of income is just the opposite of education level, which affects disaster preparedness (F-value = 7.935,  $p < 0.01$ ) and response to extreme typhoon intensities (F-value = 3.028,  $p < 0.05$ ), but does not affect responses to low and high typhoon intensities.

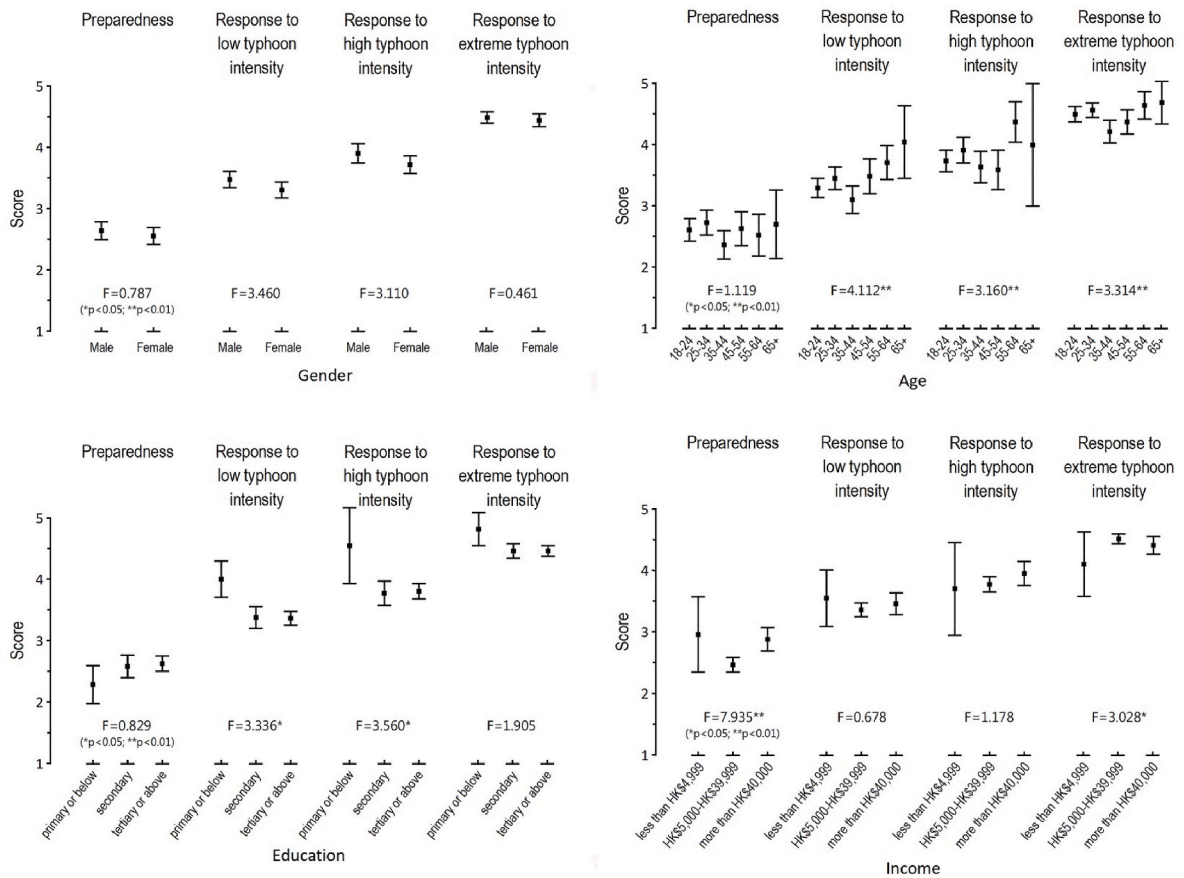
#### 4.3. Multivariate statistics

Gender is excluded from the MANOVA because the results of the one-way ANOVA indicated that there is no difference in all protective behaviors between males and females. Consequently, the MANOVA model has three independent variables (i.e., age, education level, and income) and four dependent variables (preparedness before typhoons, and emergency responses to low, high, and extreme typhoon intensities). The three independent variables generate four interactions, namely age  $\times$  education level, age  $\times$  income, education  $\times$  level income, and age  $\times$  education  $\times$  level income. The results indicate that only age (Wilks  $\lambda = 0.875$ ;  $F = 1.719$ ,  $p < 0.05$ ) and income (Wilks  $\lambda = 0.903$ ;  $F = 3.296$ ,  $p < 0.01$ ) have significant effects on protective behaviors as a whole (Table 3), but education level and all interactions of sociodemographic variables do not significantly affect protective behaviors. Based on the results of MANOVA and ANOVA, young and low-income people are considered vulnerable groups as they are less prepared before typhoons and/or responsive during typhoons than their counterparts.

## 5. Discussion

### 5.1. Typhoon protective behaviors

In this study, the score of typhoon preparedness of the respondents is rather low (2.589). This finding is generally consistent with the existing literature. For example, Chan et al. [15] reported that less than one-fifth of Hong Kong households were prepared for typhoons. Another local study showed that 69% of the population did not take any precautionary measures before the coming of a typhoon [20]. There are a couple of possible reasons for the low level of preparedness. First, residents may be biased toward natural hazards. Optimistic bias refers to underestimating the possibility and severity of a disaster [66]. A local study reported that 82.3% of respondents did not consider Hong Kong a disaster-prone city [15]. Optimistic bias is very common in prosperous countries like the United States [67] and Japan [68]. People are reluctant to consider risks and hazards when they enjoy social and economic stability [68]. Second, respondents do not feel the urgent need to prepare for a disaster because the urban environment of Hong Kong is so convenient [15]. People can easily and quickly go to a nearby convenience store or supermarket to buy their supplies.



**Fig. 4.** Mean and 95% confidence interval of protective behaviors of different sociodemographic groups: (top left) gender; (top right) age; (bottom left) education level; (bottom right) income.

**Table 3**  
MANOVA for the effects of socio-demographics on protective behaviors.

Independent variable	Wilks' Lambda	F	Partial $\eta^2$	Non-centrality parameter	Observed power
Age	0.875	1.719*	0.33	28.410	0.923
Education level	0.964	1.157	0.018	9.254	0.540
Income	0.903	3.296**	0.050	26.370	0.974
Age × Education level	0.864	1.347	0.036	33.933	0.938
Age × Income	0.863	1.363	0.036	34.330	0.942
Education level × Income	0.986	0.440	0.007	3.518	0.207
Age × Education level × Income	0.945	1.212	0.019	12.809	0.628

(\*p < 0.05; \*\*p < 0.01).

Respondents' emergency responses during typhoons are more positive than their preparedness before typhoons. The score of emergency response to low typhoon intensity (3.388) is obviously higher than that of preparedness (2.589), implying that people are more willing to take emergency action when the typhoon is approaching. Scores of emergency response to high and extreme typhoon intensities are 3.81 and 4.48, respectively, indicating that the higher the typhoon intensity, the higher score. When typhoon intensity becomes high or extreme, people are very likely to respond according to the government's recommendations because they simply do not have the time and freedom to make alternative decisions [69]. This finding is also consistent with some local studies. For example, Chan et al. [16] showed that Hong Kong people were generally more concerned about high typhoon signals than about low typhoon signals. However, Wong and Yan [20] indicated that less than 31% of the respondents would tie up loose objects, remove flower pots from the balcony, or go to a shelter when a typhoon signal was in effect.

5.2. Impact of sociodemographic variables on protective behaviors

The results of ANOVA indicate that gender is not a significant factor influencing protective behaviors, but age, education level, and



income influence protective behaviors to varying degrees. Because ANOVA can only test the unconditional effect of one independent variable on one dependent variable, the statistical associations are often overstated. Therefore, in this study, MANOVA is conducted to examine whether multiple independent variables explain the variance of multiple dependent variables as a whole, hence generating more reliable results. The results indicate that only age and income have a significant effect on typhoon protection behaviors, but education level is not a significant factor. Specifically, young and low-income people are identified as typhoon-vulnerable groups.

In general, the results of this study are consistent with the previous studies. However, this study finds that sociodemographic variables are not universally associated with protective behaviors, making it difficult to generalize a pattern. Consequently, the logic behind the relationship between sociodemographic variables and protective behaviors remains largely unknown [70]. Furthermore, although the sociodemographic variables selected for this study are widely used in past studies, the scales of variables used in different studies may not be the same, so strictly speaking, a direct comparison is not appropriate. Therefore, future research should focus on the theoretical inquiry and explanation for the effects of sociodemographics on protective behaviors.

### 5.3. Practical recommendations for policy

This study has two practical recommendations for policymakers. First, because the level of typhoon preparedness in Hong Kong is low, the government should organize more education and outreach activities to raise public awareness of the importance and value of disaster preparedness. Although disaster preparedness may not have immediate benefits, it can serve as a buffer. Preparedness reduces exposure and vulnerability so that it effectively moderates losses when a disaster does occur [16,17]. Furthermore, one human behavior may spill over to another but similar behaviors [71]. In the context of disaster management, preparedness before the disaster motivates or prompts emergency behaviors during the disaster [19]. This means that different protective behaviors are not separate, but rather different stages of a behavioral process. People perform different but they are related behaviors performed at different stages of typhoon event [72]. Different protective behaviors represent the continuum or process of human behaviors [73]. The spillover of protective behaviors deserves further investigation in future studies. Second, this study finds significant effects of age and income on protective behaviors, implying that disaster management should be planned from the perspective of age and income. It makes sense to identify those who are unwilling or unable to prepare for or respond to disasters. Identifying them and matching them with resource allocation and relief programs is a crucial aspect of disaster management [74].

### 5.4. Research limitations and recommendations

This paper has several limitations and recommendations for future research to consider. The first is the limitation of the data collection method. There may be a sampling bias due to the street survey method. Although every effort was made to improve the variability of the sample, the proportion of young people (i.e., those aged 18–45) in the sample is somewhat over-represented. Future studies may consider using probabilistic sampling methods to collect a balanced sample. Secondly, strictly speaking, the questionnaire is not a true measure of typhoon protective behaviors, but only opinions on whether or not the respondent would do so. Because people say they will do does not mean what they actually do, the questionnaire may not accurately reflect actual protective behaviors. Future studies may collect data on behaviors directly through field observations. Third, this study interprets the data based on statistical probability theory, but the statistical associations are not necessarily causal. Future studies may consider qualitative methods such as in-depth interviews and focus groups to identify causal relationships. Fourth, future studies can extend the methodology of this study to other natural disasters (e.g., landslides) in Hong Kong and corroborate the results with each other. Fifth, the study is conducted on a population living in the specific social and cultural environment of Hong Kong. Therefore, it is prudent to apply the results of the study directly to other countries and regions.

## 6. Conclusion

A street survey was conducted in Kwun Tong, a typhoon-prone area of Hong Kong. 286 respondents were successfully interviewed to collect data on their typhoon protective behaviors. The relations between four sociodemographic variables (i.e., gender, age, education level, and income) and four protective behaviors (i.e., preparedness before typhoons and emergency response to low, high, and extreme typhoon intensities) are examined by various statistical methods. The results indicate that the level of preparedness of the respondents is low before the coming of the typhoon. When the typhoon is approaching Hong Kong, they become more responsive. The higher the typhoon intensity, the higher the level of emergency response. Of the four sociodemographic parameters, only age and income have significant effects on protective behaviors as a whole. The findings of this study supplement the existing literature on typhoon disaster management and cast light on improving typhoon disaster management in Hong Kong and other coastal cities affected by typhoons.

### Funding statement

This research was supported by the National Council of Science and Technology, Taiwan, R.O.C. (111-2625-M-034 -004-).

### Author contribution statement

Sai-Leung Ng: Conceived and designed the study; Collected the data; Analyzed and interpreted the data; Contributed reagents,

materials, analysis tools or data; Wrote the paper.

### Data availability statement

Data will be made available on request.

### Additional information

Supplementary content related to this article has been published online at [URL].

### Declaration of competing interest

The author declares no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

### Acknowledgments

The author would like to thank Ms. Joni Fung Mei Wong for coordinating the questionnaire survey, and Ms. Joey Cheuk Yee Chan for carrying out the field interview.

### References

- [1] M. Sajjad, J.C.L. Chan, Tropical cyclone impacts on cities: a case of Hong Kong, *Front. Built Environ.* 6 (2020), 575534, <https://doi.org/10.3389/fbuil.2020.575534>.
- [2] E.K.S. Lee, L. Fok, H.F. Lee, An evaluation of Hong Kong's tropical cyclone warning system, *Asian Geogr.* 29 (2) (2012) 131–144, <https://doi.org/10.1080/10225706.2012.742619>.
- [3] N.K.W. Cheung, W.J. Kyle, Hong Kong's active typhoon season, *Bulletin of Hong Kong Meteorol. Soc.* 9 (1/2) (1999) 16, 15.
- [4] Hong Kong Observatory, Tropical Cyclones in 2019, Hong Kong: Hong Kong Observatory, 2020. Available from, <https://www.hko.gov.hk/en/publica/tc/files/TC2019.pdf> (Accessed 4 Oct 2021).
- [5] C. Choy, , The Hong Kong Federation of Insurers, M. Wu, T. Lee, Assessment of the damages and direct economic loss in Hong Kong due to Super Typhoon Mangkhut in 2018, *Trop. Cycl. Res. Rev.* 9 (4) (2020) 193–205, <https://doi.org/10.1016/j.tcr.2020.11.001>.
- [6] A.S. Muntohar, H.-J. Liao, Analysis of rainfall-induced infinite slope failure during typhoon using a hydrological-geotechnical model, *Environ. Geol.* 56 (2009) 1145–1159, <https://doi.org/10.1007/s00254-008-1285-1>.
- [7] H.Y. Mok, C.M. Shun, S. Davies, W.H. Lui, D.S. Lau, K.C. Cheung, K.Y. Kong, S.T. Chan, A historical re-analysis of the calamitous midget typhoon passing through Hong Kong on 18 September 1906 and its storm surge impact to Hong Kong, *Trop. Cycl. Res. Rev.* (2022), <https://doi.org/10.1016/j.tcr.2022.09.005> published online.
- [8] Hong Kong Observatory, Casualties and damage caused by tropical cyclones in Hong Kong since 1960. <https://www.hko.gov.hk/en/informtc/precaution.htm>, 2021 (Accessed 4 Oct 2022).
- [9] C.H. Chang, Preparedness and storm hazards in a global warming world: lessons from Southeast Asia, *Nat. Hazards* (2011) 667–679, <https://doi.org/10.1007/s11069-010-9581-y>.
- [10] J. Chen, C.Y. Tam, Z. Wang, K. Cheung, Y. Li, N.-C. Lau, D.-S.D. Lau, Future thermodynamic impacts of global warming on landfalling typhoons and their induced storm surges to the Pearl River Delta Region as inferred from high-resolution regional models, *J. Clim.* 35 (15) (2022) 4905–4926, <https://doi.org/10.1175/JCLI-D-21-0436.1>.
- [11] L. Fok, L.T.O. Cheung, Evaluating the impact reduction strategies for the tropical cyclone hazard in Hong Kong, *Asian Geogr.* 29 (2) (2012) 121–129, <https://doi.org/10.1080/10225706.2012.742617>.
- [12] D.T. Guion, D.L. Scammon, A.L. Borders, Weathering the storm: a social marketing perspective on disaster preparedness and response with lessons from Hurricane Katrina, *J. Publ. Pol. Market.* 26 (1) (2007) 20–32, <https://doi.org/10.1509/jppm.26.1.20>.
- [13] Y.F. Xiao, Z.D. Duan, Y.Q. Xiao, J.P. Ou, L. Chang, Q.S. Li, Typhoon wind hazard analysis for southeast China coastal regions, *Struct. Saf.* 33 (4–5) (2011) 286–295, <https://doi.org/10.1016/j.strusafe.2011.04>.
- [14] Security Bureau, *Contingency Plan for Natural Disasters (Including Those Arising from Severe Weather Conditions)*, The Government of Hong Kong SAR, Hong Kong, 2015.
- [15] E. Chan, J. Yue, P. Lee, S. Wang, Sociodemographic predictors for urban community disaster health risk perception and household-based preparedness in a Chinese urban city, *PLoS Curr* 4 (2016), <https://doi.org/10.1371/currents.dis.287fb7fee6f9f4521af441a236c2d519>.
- [16] E.Y.Y. Chan, A.Y.T. Man, H.C.Y. Lam, G.K.W. Chan, B.J. Hall, K.K.C. Hung, Is urban household emergency preparedness associated with short-term impact reduction after a super typhoon in subtropical city? *Int. J. Environ. Res. Publ. Health* 16 (2019) 596, <https://doi.org/10.3390/ijerph16040596>.
- [17] J. Raikes, T.F. Smith, C. Jacobson, C. Baldwin, Pre-disaster planning and preparedness for floods and droughts: a systematic review, *Int. J. Disaster Risk Reduc.* 38 (2019), 101207, <https://doi.org/10.1016/j.ijdrr.2019.101207>.
- [18] Y. Xiao, W.G. Peacock, Do hazard mitigation and preparedness reduce physical damage to businesses in disasters? Critical role of business disaster planning, *Nat. Hazards Rev.* 15 (3) (2014), 04014007, [https://doi.org/10.1061/\(asce\)nh.1527-6996.0000137](https://doi.org/10.1061/(asce)nh.1527-6996.0000137).
- [19] R. Das, Disaster preparedness for better response: logistics perspectives, *Int. J. Disaster Risk Reduc.* 31 (2018) 153–159, <https://doi.org/10.1016/j.ijdrr.2018.05.005>.
- [20] T. Wong, Y. Yan, Perceptions of severe weather warnings in Hong Kong, *Meteorol. Appl.* 9 (3) (2002) 377–382, <https://doi.org/10.1017/S1350482702003110>.
- [21] A.Y. Loke, C.K.Y. Lai, O.W.M. Fung, At-home disaster preparedness of elderly people in Hong Kong, *Geriatr. Gerontol. Int.* 12 (2010) 524–531, <https://doi.org/10.1111/j.1447-0594.2011.00778.x>.
- [22] D. Paton, Disaster preparedness: a social-cognitive perspective, *Disaster Prev. Manag.* 12 (3) (2003) 210–216, <https://doi.org/10.1108/09653560310480686>.
- [23] M. Cin, Ş.A. Değirmençay, Decision-making of middle school students during an earthquake, *Rev. Int. Geogr. Educ. Online* 8 (3) (2018) 556–570, <https://doi.org/10.33403/rigeo.505271>.
- [24] J. Levac, D. Toal-Sullivan, T.L. O'Sullivan, Household emergency preparedness: a literature review, *J. Community Health* 37 (2012) 725–733, <https://doi.org/10.1007/s10900-011-9488-x>.
- [25] M. Najafi, A. Ardalan, A. Akbarisari, A.A. Noorbala, H. Jabbari, Demographic determinants of disaster preparedness behaviors amongst Tehran inhabitants, Iran, *PLoS Curr* 7 (2015), <https://doi.org/10.1371/currents.dis.976b0ab9c9d9941cbbae3775a6c5f6e6>.
- [26] K. Oldfield, Social class and public administration, A closed question opens, *Adm. Soc.* 35 (4) (2003) 438–461, <https://doi.org/10.1177/0095399703254947>.

- [27] C.H.A. Kuran, C. Morsut, B.I. Kruke, M. Kruger, L. Segnestam, K. Orru, T.O. Nævestad, M. Airola, J. Keränen, F. Gabel, S. Hansson, S. Torpan, Vulnerability and vulnerable groups from an intersectionality perspective, *Int. J. Disaster Risk Reduc.* 50 (2020), 101826, <https://doi.org/10.1016/j.ijdr.2020.101826>.
- [28] C. Percy, Y.F. Chen, A. Bibi, D. Coles-Jordan, E. Dodson, T. Evans, D. Klingberg, M. van der Bruggen, The contribution of human psychology to disaster management: mitigation, advance preparedness, response and recovery, *WIT Trans. Built Environ.* 119 (2011) 195–208, <https://doi.org/10.2495/DMAN110181>.
- [29] S. Kohn, J.L. Eaton, S. Feroz, A.A. Bainbridge, J. Hoolachan, D.J. Barnett, Personal disaster preparedness: an integrated review of the literature, *Disaster Med. Public Health Prep.* 6 (3) (2012) 217–231, <https://doi.org/10.1001/dmp.2012.47>.
- [30] R.P.K. Lam, L.P. Leung, S. Balsari, K.-h. Hsiaob, E. Newnham, K. Patrick, P. Pham, J. Leaning, Urban disaster preparedness of Hong Kong residents: a territory-wide survey, *Int. J. Disaster Risk Reduc.* 23 (2017) 62–69, <https://doi.org/10.1016/j.ijdr.2017.04.008>.
- [31] O. Fung, A. Loke, Disaster preparedness of families with young children in Hong Kong, *Scand. J. Publ. Health* 38 (2010) 880–888, <https://doi.org/10.1177/1403494810382477>.
- [32] V. Bhanumurthy, G.J. Shankar, K.R.M. Rao, P.V. Nagamani, Defining a framework for integration of geospatial technologies for emergency management, *Geocarto Int.* 30 (9) (2015) 963–983, <https://doi.org/10.1080/10106049.2015.1004132>.
- [33] Hong Kong Observatory, Precautionary Measures when Tropical Cyclone Warning Signals Are in Force, 2021. Available from: <https://www.hko.gov.hk/en/informtc/tcsignal.htm> (Accessed 4 Oct 2021).
- [34] C. Guo, S. Sim, H.C. Ho, Impact of information seeking, disaster preparedness and typhoon emergency response on perceived community resilience in Hong Kong, *Int. J. Disaster Risk Reduc.* 50 (2020), 101744, <https://doi.org/10.1016/j.ijdr.2020.101744>.
- [35] T. Sim, Z. Han, C. Guo, J. Lau, J. Yu, G. Su, Disaster preparedness, perceived community resilience, and place of rural villages in northwest China, *Nat. Hazards* 108 (2021) 907–923, <https://doi.org/10.1007/s11069-021-04712-x>.
- [36] Z. Han, L. Wang, K. Cui, Trust in stakeholders and social support: risk perception and preparedness by the Wenchuan earthquake survivors, *Environ. Hazards* 20 (2) (2020) 132–145, <https://doi.org/10.1080/17477891.2020.1725>.
- [37] H.-J. Paek, K. Hilyard, V. Freimuth, J.K. Barge, M. Mindlin, Theory-based approaches to understanding public emergency preparedness: implications for effective health and risk communication, *J. Health Commun.* 15 (4) (2010) 428–444, <https://doi.org/10.1080/10810731003753083>.
- [38] M. Ye, D.P. Aldrich, How natural hazards impact the social environment for vulnerable groups: an empirical investigation in Japan, *Nat. Hazards* 105 (2021) 67–81, <https://doi.org/10.1007/s11069-020-04295-z>.
- [39] United Nations Office for Disaster Risk Reduction, Terminology on Disaster Risk Reduction, 2017. Available from: <https://www.undrr.org/publication/terminology-disaster-risk-reduction> (Accessed 6 March 2023).
- [40] M.M. Teo, M. Lawie, A. Goonetilleke, A. Ahankoob, K. Deilami, Engaging vulnerable populations in preparedness and response: a local government context, *Aust. J. Emerg. Manag.* (2018) 38–47.
- [41] O. Ojedokun, The role of socio-demographical and psychological factors in taking littering prevention actions, *Int. J. Adv. Psychol.* 2 (4) (2013) 197–206, <https://doi.org/10.14355/ijap.2013.0204.03>.
- [42] F. Gabel, M. Krüger, C. Morsut, C. Kuran, Bridging the Gap between Vulnerable Groups and Vulnerable Situations: Towards an Integrative Perspective on Vulnerability for Disaster Risk Reduction, Global Assessment Report on Disaster Risk Reduction 2022 Contributing Paper, 2022. Available from: <https://www.undrr.org/publication/bridging-gap-between-vulnerable-groups-and-vulnerable-situations-towards-integrative>. (Accessed 6 March 2023).
- [43] V.M. Cvetković, G. Roder, A. Ocal, P. Tarolli, S. Dragičević, The role of gender in preparedness and response behaviors towards flood risk in Serbia, *Int. J. Environ. Res. Publ. Health* 15 (2018) 2761, <https://doi.org/10.3390/ijerph15122761>.
- [44] W.R. Donner, J. Lavariega-Montforti, Ethnicity, income, and disaster preparedness in Deep South Texas, United States, *Disasters* 42 (4) (2018) 719–733, <https://doi.org/10.1111/disa.12277>.
- [45] F.H. Norris, T. Smith, K. Kaniasty, Revisiting the experience-behavior hypothesis: the effects of hurricane Hugo on hazard preparedness and other self-protective acts, *Basic Appl. Soc. Psychol.* 21 (1) (1999) 37–47, [https://doi.org/10.1207/s15324834baspp2101\\_4](https://doi.org/10.1207/s15324834baspp2101_4).
- [46] M. Oral, A. Yenal, E. Oral, N. Aydin, T. Tuncay, Earthquake experience and preparedness in Turkey, *Disaster Prev. Manag.* 24 (1) (2015) 21–37, <https://doi.org/10.1108/DPM-01-2013-0008>.
- [47] E.J. Baker, Household preparedness for the aftermath of hurricanes in Florida, *Appl. Geogr.* 31 (1) (2011) 46–52.
- [48] Y. Addis, D. Abate, Social work responses and household-level determinants of coronavirus preparedness in rural Ethiopia, *Soc. Work. Publ. Health* 36 (2) (2021) 85–97.
- [49] V.V. Dixit, A. Pande, E. Radwan, M. Abdel-Aty, Understanding the impact of a recent hurricane on mobilization time during a subsequent hurricane, *Transport. Res. Rec.* 2041 (2008) 49–57.
- [50] H. Kim, M. Zakour, Disaster preparedness among older adults: social support, community participation, and demographic characteristics, *J. Soc. Serv. Res.* 43 (4) (2017) 498–509, <https://doi.org/10.1080/01488376.2017.1321081>.
- [51] D. Hilhorst, G. Bankoff, Introduction: mapping vulnerability, in: G. Bankoff, G. Frerks, T. Hilhorst (Eds.), *Mapping Vulnerability: Disasters, Development, and People*, Sterling VA, Earthscan, London, 2004, pp. 1–9.
- [52] B. Wisner, P. Blaikie, T. Cannon, *At Risk: Natural Hazards, People's Vulnerability and Disasters*, Routledge, London, 2004.
- [53] S. Mishra, S. Mazumdar, Psychology of disaster preparedness, *Ecopsychology* 7 (4) (2015) 211–223, <https://doi.org/10.1089/eco.2015.0006>.
- [54] R.J. Eiser, A. Bostrom, I. Burton, D.M. Johnston, J. McClure, D. Paton, J. van der Pligt, M.P. White, Risk interpretation and action: a conceptual framework for responses to natural hazards, *Int. J. Disaster Risk Reduc.* 1 (2012) 5–16, <https://doi.org/10.1016/j.ijdr.2012.05.002>.
- [55] Census and Statistics Department, Population By-Census, Main Results, 2016. Available online: <https://www.bycensus2016.gov.hk/data/16bc-main-results.pdf> (Accessed 4 Jun 2022).
- [56] L. Connelly, Demographic data in research studies, *Medsurg Nurs.* 22 (4) (2013) 269–270. PMID: 24147328.
- [57] L. Tian, P. Yao, S.J. Jiang, Perception of earthquake risk: a study of the earthquake insurance pilot area in China, *Nat. Hazards* 74 (2014) 1595–1611, <https://doi.org/10.1007/s11069-014-1257-6>.
- [58] Z. Hu, X. Zhang, J. Cui, L. Zhang, W. Ahmed, A survey-based analysis of the public's willingness for disaster relief in China, *Nat. Hazards* 107 (2021) 2205–2225, <https://doi.org/10.1007/s11069-021-04538-7>.
- [59] K. Johnson, Y. Depietri, M. Breil, Multi-hazard risk assessment of two Hong Kong districts, *Int. J. Disaster Risk Reduc.* 19 (2016) 311–323, <https://doi.org/10.1007/s13753-018-0158-9>.
- [60] W.K. Pun, P.W.K. Chung, T.K.C. Wong, H.W.K. Lam, L.A. Wong, Landslide risk management in Hong Kong- Experience in the past and planning for the future, *Landslides* 17 (2020) 243–247, <https://doi.org/10.1007/s10346-019-01291-8>.
- [61] Census and Statistics Department, Population Census, Summary Results, 2011. Available online: <https://www.statistics.gov.hk/pub/B11200552011XXXXB0100.pdf> (Accessed 4 Jun 2022).
- [62] A.Y. Lo, J.A. Byrneb, C.Y. Jim, How climate change perception is reshaping attitudes towards the functional benefits of urban trees and green space: lessons from Hong Kong, *Urban For. Urban Green.* 23 (2017) 74–83, <https://doi.org/10.1016/j.ufug.2017.03.007>.
- [63] A.Y. Lo, C.Y. Jim, Citizen attitude and expectation towards greenspace provision in compact urban milieu, *Land Use Pol.* 29 (3) (2012) 577–586, <https://doi.org/10.1016/j.landusepol.2011.09.011>.
- [64] S. Shapira, L. Aharonson-Daniel, Y. Bar-Dayan, Anticipated behavioral response patterns to an earthquake: the role of personal and household characteristics, risk perception, previous experience and preparedness, *Int. J. Disaster Risk Reduc.* 31 (2018) 1–8, <https://doi.org/10.1016/j.ijdr.2018.04.001>.
- [65] G. Tabachnick, L. Fidell, *Using Multivariate Statistics*, Harper Collins, New York, 1989.
- [66] H. Omer, N. Alon, The continuity principle: a unified approach to disaster and trauma, *Am. J. Community Psychol.* 22 (2) (1994) 273–287, <https://doi.org/10.1007/bf02506866>.
- [67] C. Trumbo, M.A. Meyer, H. Marlatt, L. Peek, B. Morrissey, An assessment of change in risk perception and optimistic bias for hurricanes among Gulf Coast residents, *Risk Anal.* 34 (2014) 1013–1024, <https://doi.org/10.1111/risa.12149>.

- [68] Y. Guo, Y. Li, Getting ready for mega disasters: the role of past experience in changing disaster consciousness, *Disaster Prev. Manag.* 25 (4) (2016) 492–505, <https://doi.org/10.1108/DPM-01-2016-0008>.
- [69] I. Cahyantoa, L. Pennington-Gray, B. Thapa, S. Srinivasan, J. Villegas, C. Matyas, S. Kiouisis, An empirical evaluation of the determinants of tourist's hurricane evacuation decision making, *J. Destin. Market. Manag.* 2 (2014) 253–265, <https://doi.org/10.1016/j.jdmm.2013.10.003>.
- [70] A. Bish, S. Michie, Demographic and attitudinal determinants of protective behaviours during a pandemic: a review, *Br. J. Health Psychol.* 15 (4) (2010) 797–824, <https://doi.org/10.1348/135910710x485826>.
- [71] A. Nilsson, M. Bergquist, W.P. Schultz, Spillover effects in environmental behaviors, across time and context: a review and research agenda, *Environ. Educ. Res.* 23 (4) (2017) 573–589, <https://doi.org/10.1080/13504622.2016.1250148>.
- [72] M. Bockarjova, A. van der Veen, P.A.T.M. Geurts, A PMT-TTM Model of Protective Motivation for Flood Danger in the Netherlands (ITC Working Papers Series-Paper 3), International Institute for Geo-Information Science and Earth Observation, Enschede, 2009.
- [73] D. Paton, Disaster risk reduction: psychological perspectives on preparedness, *Aust. J. Psychol.* 71 (2019) 327–341, <https://doi.org/10.1111/ajpy.12237>.
- [74] M.C. De Ruiter, P.J. Ward, J.E. Daniell, J.C.J.H. Aerts, A comparison of flood and earthquake vulnerability assessment indicators, *Nat. Hazards Earth Syst. Sci.* 17 (7) (2017) 1231–1251, <https://doi.org/10.5194/nhess-2017-45>.