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Earthquake preparedness in an urban area: the case of Dhaka city, Bangladesh

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Abstract

This study aims to assess people's preparedness for a potential earthquake in Dhaka, the capital of Bangladesh. We have employed a model with six dimensions of holistic individual preparedness. A self-reported online survey included 677 total participants. The multiple linear regression model and the Spearman rank correlation were used as needed. The majority of the participants (> 65%) did not have experience with any earthquake preparedness program, despite the fact that 92% of the population surveyed claimed to have experienced an earthquake in their region. More than 50% of those who experienced earthquakes acquired knowledge. 30% of people do not have access to immediate financial support in the event of a crisis. It was estimated that almost 50% of the population did not have earthquake insurance. Females lack the adaptability of males. A person's level of earthquake preparedness was significantly associated with their level of education, household head occupation and monthly income, type of residential unit, and experience of earthquake preparedness program. Therefore, these factors should be considered while figuring out how to better prepare for earthquakes. A combination of holistic earthquake preparedness programs and effective education is generally required for competent holistic earthquake preparedness.

Keywords Bangladesh, Earthquake safety, Earthquake injury, Risk assessment, Disaster preparedness

Introduction

Earthquakes have historically been one of the most severe natural hazards humans confront, posing a significant threat to human lives and property (Zaremohzzabieh et al. 2021; Wu et al. 2022; Kiani et al. 2022). Under comparable risk conditions, deaths from catastrophic earthquakes are often significantly more than fatalities from severe floods or cyclones (Brecht et al. 2013). The number of deaths and injuries caused by earthquakes is affected by several factors, including population growth, poverty, building collapse, poor construction techniques, secondary hazards like fires, landslides, and tsunamis, and on-site behavior during the quake as well as the efficiency of emergency response systems (Elhami Khorasani and Garlock 2017; Paton 2019; Zaremohzzabieh et al. 2021; Abdo 2022). Recent years have seen an increase in the frequency and severity of earthquakes in urban areas worldwide (Kamal 2013; He et al. 2021; Kiani et al. 2022). Two-thirds of the world's population is

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projected to live in cities by 2050 (Lederbogen et al. 2011; UN 2018). Populations are more vulnerable to natural hazards like earthquakes due to urbanization's effect on the concentration of people, buildings, and other assets (Bloom et al. 2008; UN 2018). The urban expansion rate has exceeded the urban population increase (Riahi et al. 2017; UNDP (United Nations Development Programme) 2018). The typical pattern of urban sprawl is the transformation of farm and forest areas into single-story neighborhoods (Spence 2007; Güneralp et al. 2020). The rate of construction on the urban periphery frequently results in the construction of dubious quality (Green 2008; Oteng-Ababio 2012), as the emphasis of development is often on acquiring affordable access to urban employment possibilities and facilities (Bilham and Gaur 2013) rather than the quality of life created by development. Urbanization in developing countries is typically accompanied by increased susceptible structures and infrastructure (Spence 2007; Kamal 2013; Rahman 2019; Zaremohzzabieh et al. 2021; Kiani et al. 2022) because adequate building codes may not exist or be poorly applied (Paul and Bhuiyan 2010; Kamal 2013; Aitsi-Selmi et al. 2015). Developing countries also have the highest rate of urbanization, with many rapidly expanding urban areas situated in earthquake-prone regions (Jiang and O'Neill 2017; Pesaresi et al. 2017; Chen et al. 2020).

According to the UNDRR, preparedness can be defined as "the knowledge and capacities developed by governments, response and recovery organizations, communities and individuals to effectively anticipate, respond to and recover from the impacts of likely, imminent or current disasters" (UNDRR 2009). Preparedness action is conducted within the context of disaster risk management and attempts to establish the capabilities required to manage all sorts of catastrophes effectively and accomplish orderly transitions from response to sustained recovery (UNDRR 2009). Preparedness includes contingency planning, storing equipment and supplies, developing coordination, evacuation, and public communication plans, and training and field drills. UNDRR defines resilience as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management" (UNDRR 2009). Thus, preparedness can be a part of resilience (Paton and Johnston 2001; Mukherjee et al. 2020). In summary, preparedness involves preparing for an occurrence or situation like an earthquake, whereas resilience is how we handle or adapt to it. As we have seen, these terms vary in definition and result, but each has a place in disaster risk reduction. Preparedness always makes the action easier. Resilience is how we address problems at our planned event.

When it comes to climatic and geophysical catastrophes, Bangladesh is high on the list of most vulnerable countries (Ozaki 2016). Bangladesh ranks 9th, according to the World Risk Report 2022 (Atwii et al. 2022). Natural catastrophes such as storms, floods, storm surges, lightning, fires, earthquakes, and disease pandemics constantly threaten the country (Hsan et al. 2019; Rahman et al. 2021, 2022c; Bhuiya and Shao 2022). Bangladesh is highly susceptible to earthquakes based on the historical seismic activity pattern in Bangladesh and neighboring regions (Paul and Bhuiyan 2010; Saiful Islam et al. 2011; Kamal 2013; Steckler et al. 2016; Rahman 2019; Bhuiya and Shao 2022). According to the Bangladesh Geological Survey, the country had at least 465 minor-to-moderate magnitude earthquakes between 1971 and 2006 (Paul and Bhuiyan 2010; Islam et al. 2011). Although the frequency of destructive earthquakes in Bangladesh has been relatively low, the potential for catastrophic devastation and damage is extremely significant (Ozaki 2016). Bangladesh has had many tropical cyclones and floods but no large earthquakes in recent decades. It has made the public and some decision-makers assume Bangladesh is not at risk from earthquakes. Bangladesh is surrounded by seismically active regions, particularly the Dauki Fault system (Sarker et al. 2010). This country is earthquake-prone due to inadequate design drawings, construction quality, supervision, and building code compliance (Alam and Haque 2022). Particularly, there is a growing fear that a moderate-to-severe earthquake in any of Bangladesh's major cities could result in catastrophic losses of lives and property. The Indian and Eurasian plates, two active tectonic plates, are converging to form two subduction zones close to where the country is situated (Paul and Bhuiyan 2010; Kamal 2013). One of the seismically active locations in the globe is thought to be where these plates collided, creating the Himalayan and Burmese mountain belts (Paul and Bhuiyan 2010). Several active structures, including the Himalayan Main Frontal Thrust, Dauki Fault, Ramree and Chittagong sections of the Arakan megathrust, Naga Thrust Fault, and other faults in the Ganges basin like the Madhupur Fault, exist throughout the country and have the potential to cause earthquakes (Kamal 2013).

Although there have been no significant earthquakes in Bangladesh in recent years, historical records indicate Dhaka, the capital of Bangladesh, has a high earthquake risk (Paul and Bhuiyan 2010; Steckler et al. 2016; Rahman 2019; Bhuiya and Shao 2022). Recent earthquakes in Dhaka have been both teleseismic (remote) and local; however, there is limited documentation of historical megathrust earthquakes (Akhter 2010). As a result, there is no reliable method for estimating the frequency, magnitude, or shaking potential of such earthquakes (Apu and Das 2021). The new generation of this city has not experienced a big earthquake, with the exception of the occurrence and damage caused by frequent earthquakes of magnitude between 4 and 6 within the country or near its borders. As these tremors fail to discharge the majority of the stress that accumulates within fault rupture zones, seismologists believe that a huge and potentially catastrophic earthquake is imminent (Udías 2005). Dhaka, predicted to host more than 20 million people by 2025, is one of the fastest-growing, unplanned cities in Southern Asia, with rapid urban growth (Kamal 2013). The city has the fastest-growing development and a dense population (H. and Islam 2015). Climate change-induced increased migration has made these issues worse (Rigaud et al. 2018). This city is more susceptible to any impending earthquake as a result of unplanned development, the presence of extremely high population density, old, dilapidated, unreinforced masonry buildings, a limited road network, the proximity of adjacent buildings, irregular building shape, a lack of open spaces, and other factors (Paul and Bhuiyan 2010; Kamal 2013). Experts agree that the collapse of many structures built without the required construction materials and in violation of building rules would result in a great human catastrophe and economic calamity if an earthquake measuring 7.0 on the Richter scale struck this city (Paul and Bhuiyan 2010).

In recent years, Dhaka has had a high frequency of earthquakes, but the volume and extent of damage have not been noteworthy (Hasan and Kadir 2020). In the last decade (2006–2016), there have been 15 earthquakes in Bangladesh (including Dhaka) of a magnitude of 4.5 or higher on the Richter scale, according to data from the United States Geological Survey (Debnath 2013). Four of these earthquakes occurred within the borders of the country. Meghalaya, Tripura, Assam, and Sikkim were the locations where the epicenters of the remaining earthquakes were located. Other neighboring nations, like Nepal, Afghanistan, and Pakistan, have also experienced multiple earthquakes in recent years (Hasan and Kadir 2020). Dhaka is situated at the intersection of the Indian plate, the Eurasian plate, and the Burmese microplate. Collisions between these plates may generate earthquakes measuring between magnitudes 4 and 9 on the Richter scale (Al zaman and Jahan Monira 2017). This makes this area the most seismically active location in the globe (Unb 2011). Dhaka's proximity to the Madhupur fault line, which is only 90 km away, is another geographical factor contributing to the city's earthquake sensitivity (Bhuiya and Shao 2022).

When discussing the history of earthquakes in Bangladesh or the Indian subcontinent, evidence is always lacking. We have no specific knowledge of the earthquakes that occurred around 500 years ago other than some historical evidence that is insufficient to determine the earthquakes' exact intensity or magnitude. There is evidence of devastating earthquakes in Sylhet, Chittagong, and Dhaka in 1548, 1642, 1663, 1762, 1765, 1812, 1865, and 1869, but their magnitudes are unknown (Al zaman and Jahan Monira 2017). In 1548, severe earthquakes were felt in Sylhet, Chittagong, and Dhaka, while the 1663 earthquake in Assam and Sylhet reportedly lasted around half an hour (Iyengar et al. 1999). The 1762 earthquake was very destructive and violent as it was felt all over Bengal and Arakan, and it originated somewhere along the Chittagong–Myanmar coast. It damaged vast areas of Dhaka, Chittagong, and Myanmar (Martin and Szeliga, 2010). According to reports, the 1765 earthquake was so powerful that it increased the shore of Foul Island by 2.74 m and the northwest coast of Chedua island by 6.71 m above sea level, as well as permanently submerged 155.40 square kilometers of land near Chittagong. In Dhaka, the earthquake claimed 500 lives (Islam 2003). The 1812 Dhaka earthquake on April 10 and May 11 powerfully shook Dhaka and damaged a number of properties and structures in Tejgoan (Sella et al. 2002). The Bengal earthquake of July 1885 was one of the most destructive. The tremor was followed by eleven aftershocks between 21 July and 5 September 1885 (Middlemiss 1885). It was likely caused by the Madhupur fault. The magnitude of the earthquake on the Richter scale was 7. The great Indian earthquake occurred on June 12, 1897, and it is one of the most devastating and violent earthquakes ever recorded (Apu and Das 2021). The earthquake occurred in the western portion of the Shillong Plateau, approximately 200 km north of Dhaka. On April 25, 2015, a destructive earthquake with its center 745 km northwest of Bangladesh shook Dhaka, Chittagong, Barisal, Rajshahi, Dinajpur, Rangpur, and other portions of the country (Apu and Das 2021). Figure 1 shows the history of earthquakes in Bangladesh.

Although preventing earthquakes may not be possible, their impacts can be reduced with effective preparedness, mitigation, and planning. These actions can be taken at different levels. Building safety codes and land use zoning laws are two steps taken at the state and local levels to lessen earthquake damage (Paul and Bhuiyan 2010). Individuals and families can better prepare for earthquakes by learning about the threats they face, making their homes and places of work more earthquake-proof, learning how to shut off gas and other utilities, stocking up on fire extinguishers, and maintaining a first-aid kit (Alam 2020; Yildiz et al. 2020). Some studies show how people in Dhaka perceive the risk of earthquakes (Paul and Bhuiyan 2010; Rahman 2019; Bhuiya and Shao 2022).

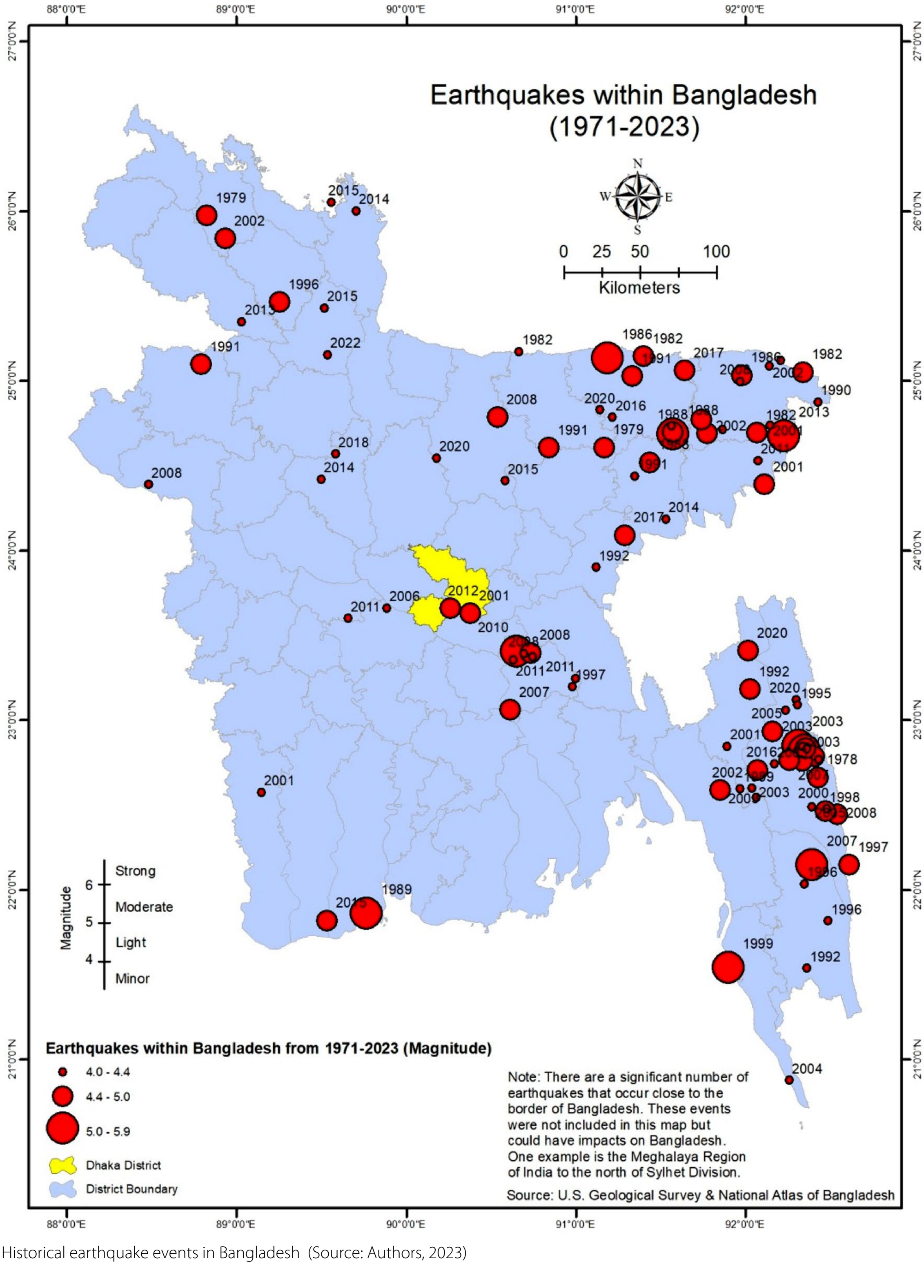

Fig. 1 Historical earthquake events in Bangladesh (Source: Authors, 2023)

For example, one research looked at how movement-impaired people in Dhaka perceived the risk of earthquakes and anticipated what to do in the event of one (Bhuiya and Shao 2022). Other studies examine how the people of Dhaka City perceived the risk of earthquakes as well as their level of preparedness (Paul and Bhuiyan 2010; Rahman 2019). Nonetheless, studies analyzing the people of Dhaka's preparedness for earthquakes were lacking.

Prior research on individual/household preparedness was critiqued in a study for failing to create competency in the theory of preparedness or what it involves (Nojang and Jensen 2020). They claimed that such a framework needed to (a) take into account the results of the study on individual and household response and recovery; (b) encourage progressive investigation; and (c) allow for efficient application across time, location, risk, and culture (Nojang and Jensen 2020). Prior research, termed the Holistic Individual Preparedness Model (HIPM), created an early conceptual model that matched the criteria for inclusion (Nojang and Jensen 2020). According to this concept, Holistic Individual Preparedness (HIP) represents a community's readiness to respond to and recover from hazards across six dimensions and the surrounding environment (Jensen 2014; Nojang and Jensen 2020). The six theoretical factors include knowledge, subsistence, loss minimization, social integration, technology integration, and mental and physical adaptability (Fig. 2). Examining the often included items in preparedness inventories to determine the theoretical basis for their inclusion led to the development of the first three categories (Nojang and Jensen 2020). The latter three components were established from empirical information about the factors impacting individual and household responses to and recoveries from disasters (Nojang and Jensen 2020). Each HIPM dimension was operationalized concerning the earthquake risk in Bangladesh.

We have employed the above conceptual framework to assess an individual's holistic preparedness (Jensen 2014; Nojang and Jensen 2020). Previous research using this framework effectively assessed Dhaka's citywide fire preparedness (Rahman et al. 2022a, b). Thus, in summary, this research aims to do two things: (1) to use a new method proposed by Jensen (Jensen 2014; Nojang and Jensen 2020); and (2) to take a look at how prepared city dwellers are to handle an earthquake from a HIP perspective. According to our knowledge, it is the first study of its kind to use the Jensen model to evaluate HIP in relation to earthquakes in Dhaka.

Dhaka is the primary subject of our research because of the city's high earthquake risk and the consequent need to examine individual and household preparedness.

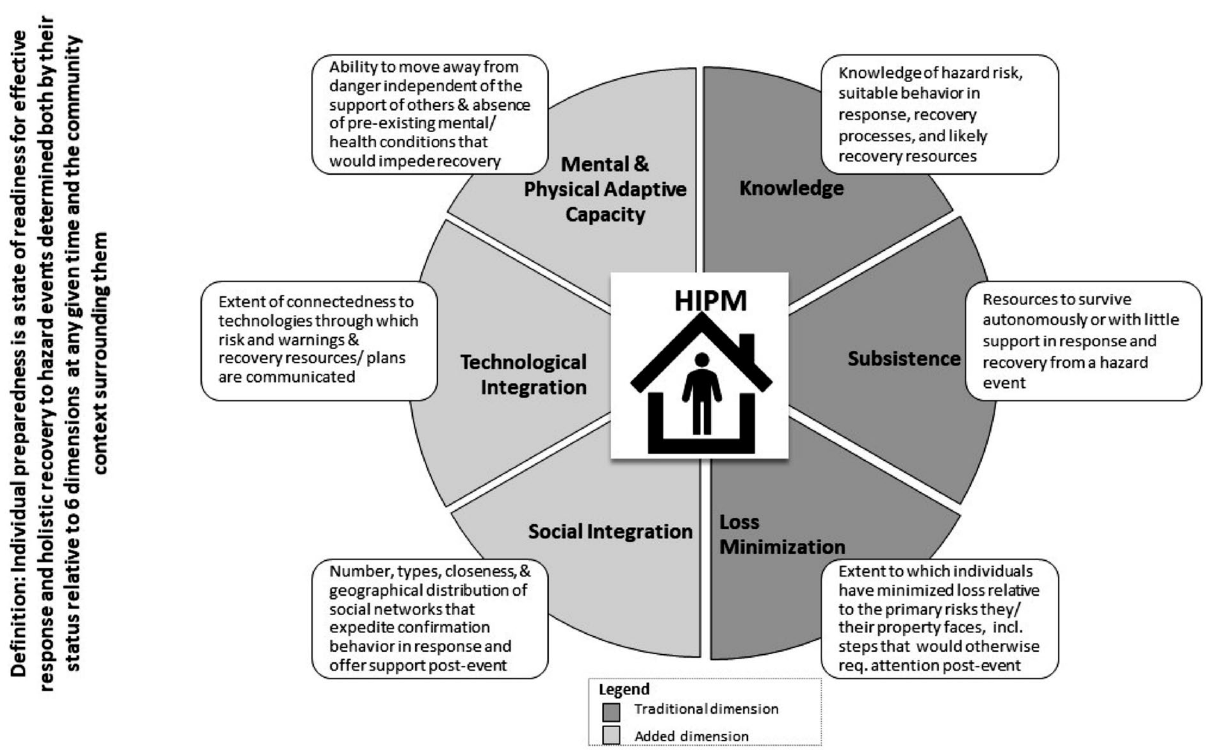

Fig. 2 Holistic Individual Preparedness Model (HIPM). Source: (Jensen 2014; Nojang and Jensen 2020)

This research has the potential to inform policymakers in Dhaka and elsewhere on the state of earthquake preparedness in the city, as well as other urban areas throughout the country and around the world.

Methods

Research design

This cross-sectional research was conducted to assess earthquake preparedness among individuals (18 years and older) residing in Dhaka City, Bangladesh. Figure 3 shows the study area. A brief online self-reported survey was administered. Dhaka has one of the most significant internet users in the country (The Business Standard 2022). The survey was conducted following The Checklist for Reporting Results of Internet Surveys (CHERRIES) recommendations (Eysenbach 2004).

Ethical approval

This research was approved as part of a study by the Bangladesh University of Professionals' Research Ethics Committee in Dhaka (BUP REC-200619). It meets all the associated ethical requirements. Participants' consent was collected via phone and online interactions. The questionnaire also had information regarding the consent to participate in the survey. In addition, the duration of the survey, the confidentiality of the data, the purpose of the study, and any relevant ethical considerations were expressed explicitly on the questionnaire's cover page. No monetary incentive was offered for participation. Respondents were permitted to discontinue participation in the online survey at any time.

Survey

We utilized Google Forms to make questionnaires in both English and Bengali. The survey's questions were drawn from the HIPM and other research (Mulilis et al. 1990; Kunreuther and Kleffner 1992; Kirschenbaum 2002; Sutton and Tierney 2006; Rooney and White 2007; Lindell and Perry 2012; Tatsuki 2013; Alam 2016, 2020; Islam et al. 2016; Becker et al. 2017; Kelman 2018; Mano et al. 2019; Nojang and Jensen 2020; Yildiz et al. 2020). A pilot survey was conducted among 35 university students before preparing the final questionnaire. It was then revised based on their feedback and experts' opinions. The final questionnaire had two sections: demographic information and question concerning earthquakes (i.e., "Did you ever experience an earthquake incident?" and "Have you ever participated in an earthquake-related drill/ exercise/workshop?"). Age, gender, marital status, location in Dhaka, residential unit, education level, occupation of household head, and monthly household income were considered as demographic information. The second section contained preparedness cues based on HIPM. There were 27 items in the HIPM (knowledge = 06, subsistence = 05, loss minimization = 03, social integration = 04, technological integration = 06, mental and physical adaptive capacity = 03). Each item was assigned the same 1 to 5 scale value (Strongly disagree = 1, Disagree = 2, Moderate = 3, Agree = 4, and Strongly agree = 5). Cronbach's alpha was used to determine the reliability of the six HIPM dimensions: around 0.70 or more for all six dimensions and overall HIPM (HIPM = 0.94, Knowledge = 0.86, Subsistence = 0.71, Loss minimization = 0.69, Social integration = 0.80, Technology integration = 0.85, and Physical and Mental Adaptive Capacity = 0.77). Cronbach's alpha value > 0.60 shows the validation of the questionnaire's internal consistency (Radhakrishna 2007; Ursachi et al. 2015).

Data collection and analysis

We used online platforms such as Facebook, WhatsApp, etc., to collect data in May 2022. Google Form link was shared where the people can be easily reached through this online platform. Using these online platforms, we have sent the Google Form link directly to the participants who are city residents of Dhaka. There were some Dhaka city-related Facebook groups where we also posted the link. It was stated clearly on the questionnaire cover page that only Dhaka city residents could participate in the survey. If they agree to all the information mentioned on the cover page, then they could participate in the survey. The boundary condition to participate in the survey was the adult people (18 years and above) of Dhaka city. Thus, we followed the convenience sampling technique. The sample size was calculated following Yamane's formula (Yamane 1967):

$$n = \frac{N}{1 + N(e^2)},$$

where n = sample size, N = population, and e = error tolerance.

According to the Bangladesh Bureau of Statistics' recent "Population and Housing Census 2022" report, the overall population of Dhaka city is above 10.2 million (Correspondent 2022). Therefore, the minimum number of samples needed was 400 (0.05 error tolerance). As a result, 677 replies out of around 800 individuals approached were included in the final analysis, indicating an 84.62% participation rate for this study.

We have used the 'R' program, version 3.6.3 (R Development Core Team 2019), for all statistical analyses. Descriptive data were calculated where applicable.

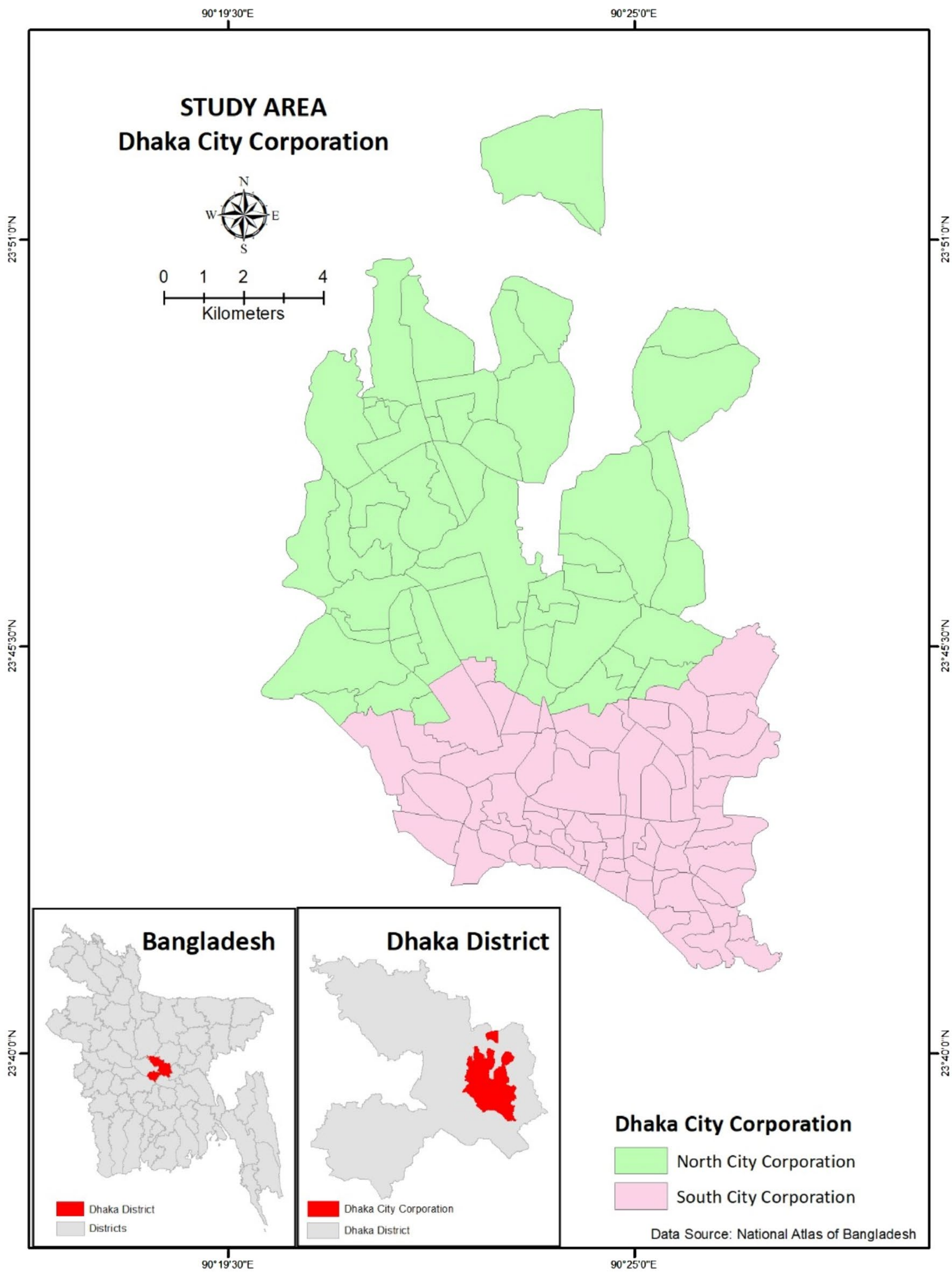

Fig. 3 Study area (Source: Authors, 2023)

First, the average score was determined so that all of the data could be analyzed on the same scale. It was accomplished by tallying up the scores for all items along a given dimension. We then divided total scores by the number of items in that dimension to get a mean score (Eq. 1). Next, the sum HIP score was determined using Eq. 2. In this case, there are a total of six dimensions. So, the HIP score and the other six dimensions used the same measure (1–5 scale):

$$Average\ score\ of\ dimension = \frac{\sum score\ in\ items}{\sum item\ number}, \quad (1)$$

$$\text{Knowledge Score(KS)} = \sum\nolimits_{1}^{06} \frac{K_i}{n},$$

$$\text{Subsistence Score(SS)} = \sum\nolimits_{1}^{05} \frac{S_i}{n},$$

$$\text{Loss Minimization Score(LMS)} = \sum\nolimits_{1}^{03} \frac{LM_i}{n},$$

$$\text{Social Integration Score(SIS)} = \sum\nolimits_{1}^{04} \frac{SI_i}{n},$$

$$\text{Technological Integration Score(TIS)} = \sum\nolimits_{1}^{06} \frac{TI_i}{n},$$

$$\text{Adaptive Capacity Score(ACS)} = \sum\nolimits_{1}^{03} \frac{AC_i}{n},$$

where i is for ith item's score and n is the total number of items.

$$HIP\ Score\ (HIPS) = \frac{KS + SS + LMS + SIS + TIS + ACS}{06} \quad (2)$$

A multiple linear regression model was utilized to examine the association between the information provided by respondents and the six HIPM dimensions. Demographic and earthquake-related information are independent variables or predictors, whereas the responses regarding HIPM dimensions are dependent or outcome variables. Initially, the univariate linear regression model was implemented. In the multiple linear regression model, only significant variables were utilized from the univariate linear regression model. In multiple linear regression models, there are seven models, with the outcome variable being the individual dimension of HIPM in the first six models and HIP in the seventh model. We have also examined the correlation in HIPM using Spearman's rank correlation. We have successfully applied a similar process in previous research (Rahman et al. 2022a, b). Another study considered this; similarly, the KAP survey model examined comparable methodology (Rahman et al. 2023).

Limitations and strengths

Due to the study's non-probability, convenience sampling methods, and skewed demographics (with a large proportion of young, educated participants), this research may have limited applicability outside its immediate context. The information was also self-reported and collected at a certain period. Therefore, the findings may reflect social desirability bias and a changing level of preparedness over time. Even though we have already successfully used HIPM, it might still have some limitations. However, HIPM is a novel method for assessing earthquake preparedness, and this study establishes its use despite its shortcomings. The impacts of an earthquake are very much related to the types of buildings and their condition. This research did not consider the observation of building types and their condition. However, this baseline perception-based study expands the possibilities for studying Dhaka's earthquake preparedness. It is possible to undertake field surveys in earthquake-prone areas of the city, considering the vulnerable population (based on exposure and socioeconomic status). Observation of building types and conditions can also be considered. In addition, the other megacities of the country, such as Chattogram and Sylhet, as well as the earthquake-prone area of Mymensingh (Islam et al. 2016), can be regarded as study areas for future research. In order to assess earthquake preparedness in these regions, researchers may use the methods of the existing study. Nevertheless, limitations should be minimized by implementing the aforementioned recommendations. In addition, this study paves the way for future research on earthquake preparedness in other earthquake-prone regions of the world. In the case of HIPM, researchers will be able to adjust and improve based on the risks and study population.

Results

Sample profile

Due to the online survey, many participants were young men (18–25 years) (Fig. 4). Many were also living in the northern area of the city. 47% of the population resided in a high-rise. The household heads of the participants were government employees, business people, or employees of private companies. The monthly income range of most participants was < 15000 BDT to < 50000 BDT. The bulk of them have a university degree. Most of the participants had prior earthquake experience. However, more than half of the participants had never participated in an earthquake-related drill, exercise, or workshop.

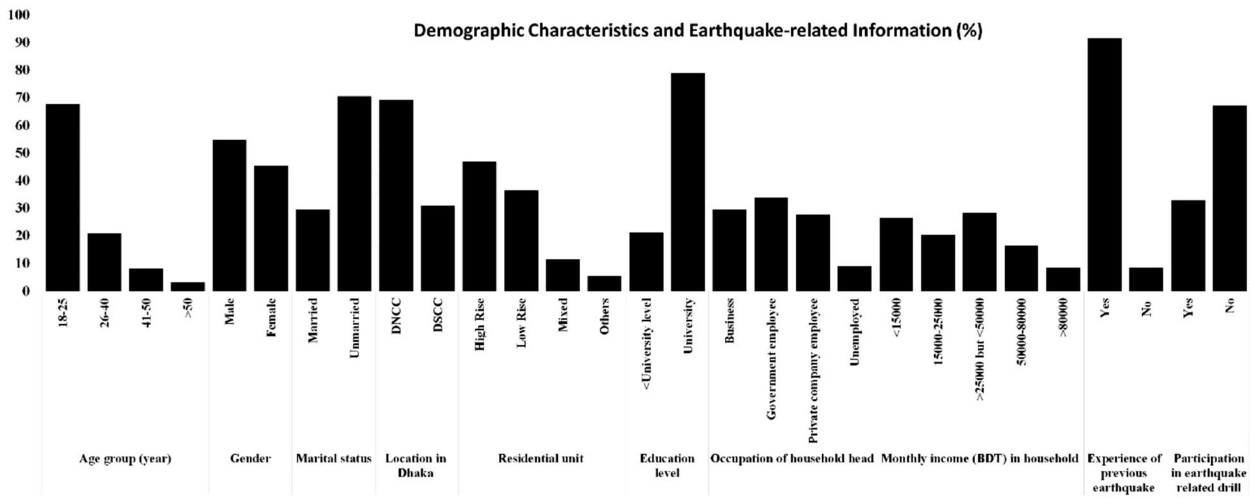

Fig. 4 Demographic characteristics and earthquake-related information. DNCC = Dhaka North City Corporation, DSCC = Dhaka South City Corporation, High Rise = > 5-floor building, Low Rise = < 5-floor building, Mixed = Shop, factory, office, and residence in the same building, BDT = Bangladeshi Taka

Knowledge

Table 1 and Fig. 5 show responses to various questions on earthquake preparedness in Dhaka. Following the six dimensions of the HIPM, there are six sections. The first section comprised six items with corresponding sources and is titled "Knowledge". Their understanding of earthquake preparedness has been evaluated. Typically, prior experience can facilitate the accumulation of knowledge. Thus, many of our study population acquired earthquake-related knowledge from prior experience. Moreover, half knew earthquake protection measures. 17% did not know the escape route. Over 15% had no safe place before the regular situation. Most understood earthquakes might create fire. They also agreed that earthquakes are especially dangerous for the elderly, children, pregnant women, and the disabled. Respondents scored an average of 3.71 ± 0.72 on a scale from 1 to 5 (Fig. 6).

Table 2 shows multi-linear regression model results. Some variables have no value in certain models, such as gender, which has value exclusively in Model VI (adaptive capacity). As stated in the methods, only variables that were significant in the univariate linear regression model were considered in the multiple linear regression models; therefore, gender was only significant in univariate linear regression with respect to adaptive capacity. Age, housing unit, education, household head's occupation, past earthquake experience, and earthquake preparedness programs associated with knowledge ($P < 0.05$). Our research reveals that earthquake preparedness programs, earthquake experience, and higher education may boost comprehension. Young adults in low-rise buildings outscored elders and high-rise residents in knowledge.

Subsistence

The second section of Table 1 is subsistence. Prior to the occurrence of a hazard event, this dimension indicates if persons have what they need to survive in the immediate aftermath of an incident. Over 80% had emergency equipment such as a helmet, fire extinguisher, escape route, backup lighting, dry food and drink, medical supplies, first-aid kit, etc. Over 10% did not have earthquake emergency equipment. Further investigation found that 39% of residents had fire extinguishers, and 21% had helmets. 40% of respondents reported their residence had an emergency exit, and 25% mentioned emergency lights. 36% brought first-aid supplies. 30% lacked savings and tools to secure documents in an earthquake. 25% were insured against earthquakes. They averaged 3.29 ± 0.66 of the five items (Fig. 6).

This component was associated with age, residential unit, household head's occupation, and earthquake preparedness program experience (Table 2). Based on our data, participants between 41 and 50, those who reside in low-rise buildings, and those who have engaged in earthquake preparedness programs are better at subsistence than younger participants, those in high-rise buildings, and those who have not. Households with the business had a better subsistence than jobless.

Table 1 HIP regarding earthquake

Dimension	Item number	Items with sources	Responses [n (%)]				
			SA[g]	A[h]	M[i]	DA[j]	SDA[k]
Knowledge	K1	Based on my previous earthquake experiences, I have enriched my knowledge of it (Becker et al. 2017)	133 (19.65)	330 (48.74)	162 (23.93)	41 (6.06)	11 (1.62)
	K2	Assuming I am in a building during an earthquake, I know what I am supposed to do to protect myself from injury once the first tremor stops (Alam 2016)	116 (17.13)	362 (53.47)	139 (20.53)	48 (7.09)	12 (1.77)
	K3	I know where emergency evacuation exists are in where I live (Rooney and White 2007)	98 (14.48)	325 (48.01)	133 (19.65)	97 (14.33)	24 (3.55)
	K4	I know where to wait until authorities mark clear my living place safe after an earthquake event (Islam et al. 2016)	87 (12.85)	325 (48.01)	125 (18.46)	119 (17.58)	21 (3.10)
	K5	I am aware that other hazards can be triggered after an earthquake event (for example, fire incident, building collapsed, etc.) (Lee et al. 2008; Elhami Khorasani and Garlock 2017; Kelman 2018; Vitorino et al. 2020)	159 (23.49)	342 (50.52)	115 (16.99)	48 (7.09)	13 (1.92)
	K6	I know what types of special support is needed during an earthquake (e.g., Old People, Children, Pregnant women, Disabled) (Tatsuki 2013; Yildiz et al. 2020)	146 (21.57)	334 (49.34)	128 (18.91)	58 (8.57)	11 (1.62)
Subsistence	S1	I have emergency tools (such as helmet, fire extinguisher, emergency exit, crescent and pipe wrenches, emergency lights, stored water, wheelchair) in my residential building or house for earthquake preparedness. Please agree if you have any of these (Rooney and White 2007)	0 (0.00)	566 (83.60)	0 (0.00)	111 (16.40)	0 (0.00)
	S2	I have savings for emergency situations like earthquake (Yildiz et al. 2020)	74 (10.93)	218 (32.20)	182 (26.88)	167 (24.67)	36 (5.32)
	S3	I have the following items in my home to use in earthquake emergency situation—Dry food and water, prescribed medicine, flashlight, extra batteries, first-aid kit, whistle. Please agree if you have any of these (Alam 2020; Yildiz et al. 2020)	0 (0.00)	602 (88.92)	0 (0.00)	75 (11.08)	0 (0.00)
	S4	I have earthquake safety insurance (Kunreuther and Kleffner 1992)	54 (7.98)	120 (17.73)	120 (17.73)	278 (41.06)	105 (15.51)
	S5	I have ensured that all of my important documents are protected from earthquake and fire (Kirschenbaum 2002; Sutton and Tierney 2006)	58 (8.57)	240 (35.45)	181 (26.74)	162 (23.93)	36 (5.32)

Table 1 (continued)

Dimension	Item number	Items with sources	Responses [*n* (%)]				
Loss Minimization	L1	Top-heavy and large objects in my home have been secured to prevent falling (Yildiz et al. 2020)	51 (7.53)	238 (35.16)	185 (27.33)	164 (24.22)	39 (5.76)
	L2	I live in a structure that has been built according to the Bangladesh National Building Code (Islam et al. 2016; Alam 2020)	88 (13.00)	258 (38.11)	180 (26.59)	116 (17.13)	35 (5.17)
	L3	Flammable and toxic substances in my home are stored securely (Islam et al. 2016)	69 (10.19)	292 (43.13)	158 (23.34)	122 (18.02)	36 (5.32)
Social Integration	SI1	There are voluntary organizations near where I live who would help people after an earthquake (Alam 2016)	70 (10.34)	246 (36.34)	188 (27.77)	143 (21.12)	30 (4.43)
	SI2	I discuss earthquake preparedness plan (such as evacuation route) with my community members (Alam 2016; Yildiz et al. 2020)	65 (9.60)	223 (32.94)	165 (24.37)	181 (26.74)	43 (6.35)
	SI3	I believe that my neighbors would help me during an earthquake if they could (Alam 2016)	80 (11.82)	287 (42.39)	194 (28.66)	90 (13.29)	26 (3.84)
	SI4	In the event of an earthquake, I have close family or friends who I may stay with or turn to for financial aid (Yildiz et al. 2020)	91 (13.44)	321 (47.42)	168 (24.82)	74 (10.93)	23 (3.40)
Technological Integration	T1	I have all the necessary emergency numbers, including those for the fire department (Yildiz et al. 2020)	81 (11.96)	275 (40.62)	165 (24.37)	132 (19.50)	24 (3.55)
	T2	I will receive formal warnings through warning technologies government uses (Lindell and Perry 2012; Islam et al. 2016)	74 (10.93)	295 (43.57)	178 (26.29)	101 (14.92)	29 (4.28)
	T3	I will receive earthquake information through social media as authorities make emergency announcements (Mano et al. 2019)	94 (13.88)	344 (50.81)	160 (23.63)	64 (9.45)	15 (2.22)
	T4	I will receive earthquake information through television as authorities make emergency announcements (Mulilis et al. 1990)	88 (13.00)	333 (49.19)	148 (21.86)	88 (13.00)	20 (2.95)
	T5	I will receive earthquake information through radio as the authorities make emergency announcements (Mulilis et al. 1990)	87 (12.85)	257 (37.96)	150 (22.16)	151 (22.30)	32 (4.73)
	T6	I know how to contact emergency first responders (for example, fire brigade, local authority, etc.) in case of earthquake incident (Alam 2016)	97 (14.33)	343 (50.66)	143 (21.12)	76 (11.23)	18 (2.66)

Table 1 (continued)

Dimension	Item number	Items with sources	Responses [*n* (%)]				
Mental and Physical adaptive capacity	M1	I have physically and mentally disabled person, old person, pregnant woman, small children any of them in my house (Enarson and Fordham 2001; Tatsuki 2013; Park et al. 2019)	123 (18.17)	308 (45.49)	114 (16.84)	106 (15.66)	26 (3.84)
	M2	In the event of an earthquake, I believe that my mental state will allow me to assist myself and my family (Becker et al. 2017; Nojang and Jensen 2020)	115 (16.99)	324 (47.86)	169 (24.96)	50 (7.39)	19 (2.81)
	M3	If there is an earthquake, I believe my physical state good that I will be able to protect myself and my family (Aitsi-Selmi et al. 2015)	116 (17.13)	324 (47.86)	161 (23.78)	58 (8.57)	18 (2.66)

SA[g] strongly agree, *A*[h] agree, *M*[i] moderate, *DA*[j] disagree, *SDA*[k] strongly disagree

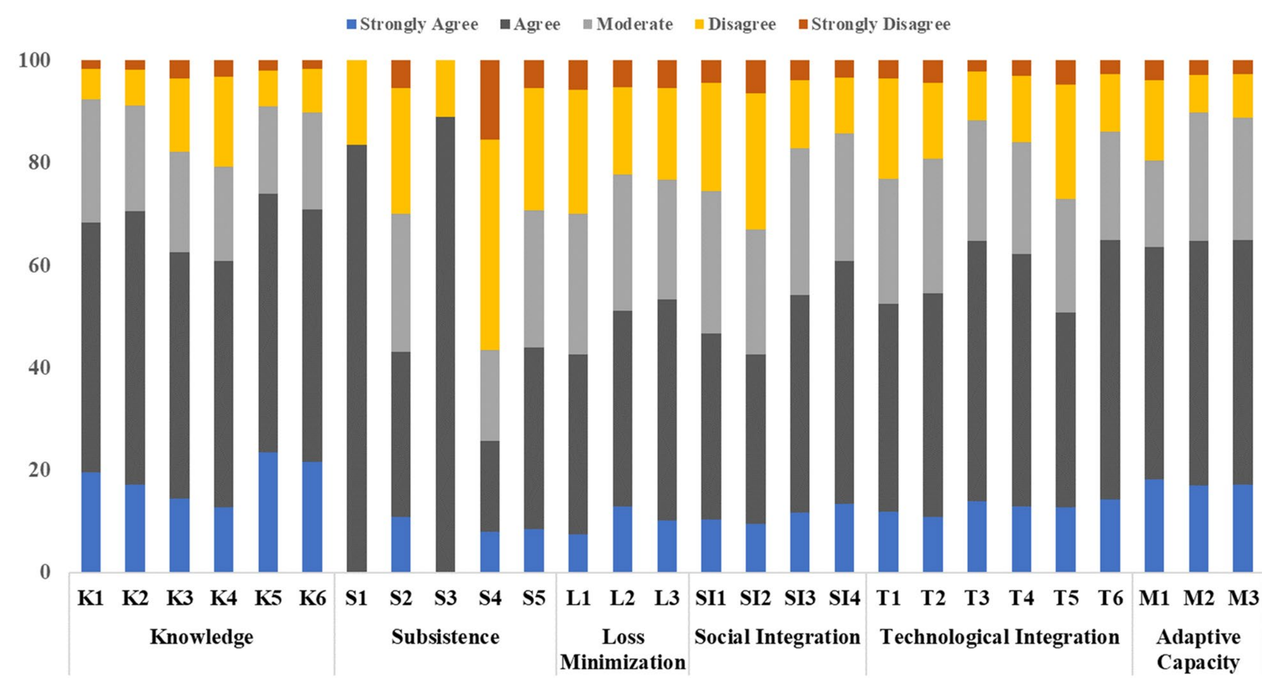

Fig. 5 Responses (%) regarding HIP

Loss minimization

This dimension focuses on evaluating the amount to which individuals have minimized loss in relation to the major risks they and their property face, particularly whether they have taken precautions that would otherwise necessitate post-event monitoring. Table 1 shows that around half of the respondents believed their dwelling complies with the Bangladesh National Building Code and they had a safe place to store flammable and unsafe substances. Some respondents secured their top-heavy and huge earthquake-prone objects. Participants scored 3.29 ± 0.83 (Fig. 6).

Table 2 displays factors related to loss minimization. Like the knowledge dimension, the youngest participants (18–25), low-rise dwellers, university-educated participants, households with government employees,

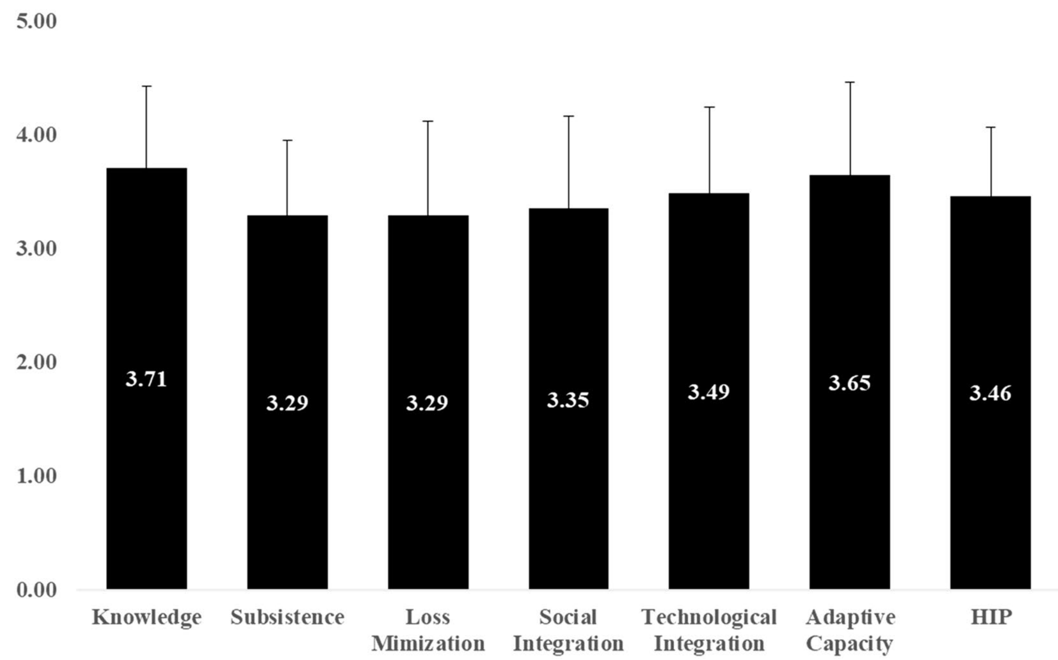

Fig. 6 Mean and standard deviation of six dimensions in HIPM and HIP (column shows the mean value, where the line shows the standard deviation)

and earthquake preparedness program participants had higher loss minimization scores. High monthly household income also minimizes loss.

Social integration

Those with greater social connections will likely affirm and act more quickly than those with fewer ties. Many agreed they had volunteer organizations that might help after an earthquake. Half of them also felt a strong sense of community after the earthquake and had close friends or family members they could stay with or turn to for financial relief. On a 1–5 scale, this dimension averaged 3.35 ± 0.81 (Fig. 6).

A residential unit, education level, household head's occupation, previous earthquake experience, and earthquake preparedness program experience are associated. It also showed that low-rise residents, those with a university degree, business as a household occupation, those who had experienced the previous earthquake, and those who had participated in an earthquake preparedness program had better social integration than high-rise residents, those without a university degree, unemployed, those without earthquake experience, and those who never participated.

Technological integration

Having access to information across many channels (such as radio, television, social media, and formal warning technology) enhances the possibility that individuals will obtain crucial response-related information. Around half of the participants have an emergency number list. Over half of the population may phone fire brigades and municipal authorities in an earthquake. Many individuals learned about earthquakes from TV, radio, and social media. This dimension scores 3.49 ± 0.75 (Fig. 6).

Residential units, education, monthly household income, and earthquake preparedness activities were associated. High-rise residents, those with university-level education, high household income, and earthquake preparedness program experience are better prepared than mixed and other unit residents, participants with lesser education, low-income households, and those without programs.

Adaptive capacity

Research shows that psychologically and physically healthy people respond and recover better (Nojang and Jensen 2020). Individuals with preexisting mental health disorders, previous or chronic health conditions, and impairments are more likely to be hurt and die than those without these characteristics; those without mental or physical health barriers are able to respond most rapidly and properly (Phibbs 2015). Our research population reported that they were psychologically and physically equipped to care for themselves and their families in an earthquake. However, many had physically and

Table 2 Predictors of six dimensions and HIP regarding earthquakes

Characteristics	β[#] (95% CI)						
	Model I ***knowledge***	**Model II** ***subsistence***	**Model III** ***loss minimization***	**Model IV** ***social integration***	**Model V** ***technological integration***	**Model VI** ***adaptive capacity***	**Model VII** ***HIP***
1. Age (year)							
18–25							
26–40	− 0.06 (− 0.18; 0.07)	0.03 (− 0.09; 0.17)	− 0.20 (− 0.37; − 0.01)*			0.07 (− 0.08;0.22)	− 0.03 (− 0.14;0.07)
41–50	− 0.06 (− 0.25; 0.13)	0.24 (0.05; 0.43)*	− 0.17 (− 0.43;0.08)			− 0.09 (− 0.31;0.12)	− 0.02 (− 0.18;0.14)
> 50	− 0.34 (− 0.63;− 0.05)*	− 0.08 (− 0.36; 0.20)	− 0.20 (− 0.57;0.16)			− 0.31 (− 0.64;0.02)	− 0.20 (− 0.44;0.04)
2. Gender							
Male							
Female						− 0.17 (− 0.29;− 0.05)**	
3. Marital status							
Married							
Unmarried		− 0.03 (− 0.16; 0.09)	0.13 (− 0.03;0.29)				
4. Location in Dhaka							
DNCC[a]							
DSCC[b]			− 0.10 (− 0.23;0.04)				
5. Residential unit							
High rise[c]							
Low rise[d]	0.14 (0.03;0.25)*	0.13 (0.03; 0.24)*	0.15 (0.02;0.28)*	0.16 (0.03;0.28)*	0.04 (− 0.07;0.16)	0.08 (-0.05;0.21)	0.12 (0.02;0.21)*
Mixed[e]	− 0.14 0.14(0.03;0.03)	0.01 (− 0.15; 0.16)	0.11 (− 0.09;0.31)	− 0.10 (− 0.29;0.09)	− 0.19 (− 0.37;− 0.02)*	− 0.24 (− 0.43;− 0.04)*	− 0.09(− 0.23;0.05)
Others	− 0.54 (− 0.78;− 0.30)***	− 0.12 (− 0.34; 0.09)	− 0.28 (− 0.57;0.01)	− 0.30 (− 0.58;− 0.02)*	− 0.54 (-0.79;-0.28)***	− 0.39 (-0.66;-0.11)**	− 0.36 (− 0.57;− 0.16)***
6. Education level							
< University							
University	0.19 (0.06;0.32)**		0.18 (0.03;0.34)*	0.16 (0.01;0.30)*	0.19 (0.06;0.33)**	0.13 (− 0.02;0.28)	0.15 (0.04;0.26)**
7. Occupation of household head							
Business							
Government employee	0.14 (0.01;0.26)*	0.09 (− 0.02; 0.21)	0.20 (0.05;0.36)**	0.03 (− 0.11;0.18)	0.10 (− 0.03;0.24)	0.11 (− 0.03;0.26)	0.11 (0.00;0.22)*
Private company employee	− 0.08 (− 0.21;0.05)	0.04 (− 0.08; 0.17)	0.12 (− 0.04;0.28)	− 0.09 (− 0.25;0.06)	− 0.04 (− 0.18;0.10)	− 0.00 (− 0.16;0.15)	− 0.01 (− 0.13;0.10)
Unemployed	− 0.16 (− 0.35;0.03)	− 0.27 (− 0.45; − 0.09)**	− 0.14 (− 0.37;0.09)	− 0.34 (− 0.56;− 0.12)**	− 0.19 (− 0.39;0.01)	− 0.15 (− 0.37;0.07)	− 0.20 (− 0.36;− 0.04)*
8. Monthly income (BDT[f]) in household							
< 15000							

Table 2 (continued)

Characteristics	β[#] (95% CI)						
	Model I *knowledge*	Model II *subsistence*	Model III *loss minimization*	Model IV *social integration*	Model V *technological integration*	Model VI *adaptive capacity*	Model VII *HIP*
15000–25000	0.09 (− 0.12;0.18)	0.05 (− 0.09; 0.18)	0.09 (− 0.09;0.27)	0.07 (− 0.10;0.24)	0.16 (0.00;0.32)*	0.18 (0.01;0.35)*	0.10 (− 0.03;0.23)
> 25000 but < 50000	0.14 (− 0.00;0.28)	0.07 (− 0.06; 0.20)	0.19 (0.01;0.36)*	0.13 (− 0.03;0.30)	0.25 (0.09;0.40)**	0.32 (0.15;0.49)***	0.19 (0.06;0.31)**
50000–80000	0.11 (− 0.05;0.27)	− 0.02 (− 0.17; 0.13)	0.13 (− 0.07;0.32)	− 0.01 (− 0.19;0.17)	0.18 (0.01;0.35)*	0.26 (0.07;0.44)**	0.11 (− 0.02;0.25)
> 80000	0.09 (− 0.11;0.30)	0.13 (− 0.05; 0.31)	0.29 (0.05;0.53)*	− 0.00 (− 0.24;0.23)	0.13 (− 0.08;0.34)	0.27 (0.04;0.51)*	0.16 (− 0.01;0.33)
9. Experience of previous earthquake							
Yes							
No	− 20 (− 0.38;0.02)*		− 0.14 (− 0.35;0.08)	− 0.24 (− 0.45;-0.04)*	− 0.09 (− 0.28;0.09)	− 0.18 (− 0.38;0.03)	− 0.15 (− 0.30;0.00)
10. Participation in earthquake-related drill/exercise/workshop							
Yes							
No	− 0.32 (− 0.42;-0.21)***	− 0.47 (− 0.57; − 0.37)***	− 0.32 (− 0.45;− 0.19)***	− 0.46 (− 0.58;-0.33)***	− 0.33 (− 0.45;− 0.22)***	− 0.34 (− 0.47;-0.22)***	− 0.37 (− 0.47;− 0.28)***
	$R^2 = 0.18$	$R^2 = 0.12$	$R^2 = 0.12$	$R^2 = 0.14$	$R^2 = 0.15$	$R^2 = 0.14$	$R^2 = 0.20$

The beta coefficient indicates how the outcome variable varies for each one-unit change in the predictor variable (Swinscow and Campbell 2002)

DNCC[a] Dhaka North City Corporation, *DSCC*[b] Dhaka South City Corporation, *High rise*[c] > 5-floor building, *Low rise*[d] < 5-floor building, *Mixed*[e] shop, factory, office, and residence in the same building, *BDT*[f] Bangladeshi Taka. *β*[#] Beta (coefficient). *CI* confidence interval

[*] p < 0.05

[**] p < 0.01

[***] p < 0.001

intellectually impaired, pregnant women, small children, and senior people. 3.65 ± 0.81 is the average 1–5 score (Fig. 6).

Gender, dwelling units, monthly household income, and earthquake preparedness programs affected adaptive capacity. High-rise people adapt better than mixed and other unit residents, such as technological integration.

HIP

We estimated HIP using Eq. 2. In Fig. 6, subsistence and loss minimization scored 3.29, knowledge 3.71, technological integration 3.49, and social integration 3.35. Participants' six HIP situations varied.

Spearman's rank correlation was used to find multicollinearity between dimensions and the HIP score. All dimensions correlated ($P < 0.001$). HIP correlates with all six dimensions ($P < 0.001$), as expected, given their collinearity. This suggests we quantified the concept. These insights directed our preparedness evaluation. HIP averages 3.46 ± 0.61 (Fig. 6).

Table 2 illustrates that HIP is related to a residential unit, education level, household head's occupation, monthly income, and earthquake preparedness program. For example, people living in low-rise buildings, having a university education, government employee in the household, better monthly income, and earthquake preparedness program experience were better prepared than those living in high-rise buildings with lower education, business as household head, lower monthly income, and no earthquake preparedness program experience.

Discussion

Our research investigates the holistic individual earthquake preparedness in the urban population of Bangladesh (Fig. 7). The focus has been on Dhaka city in light of earthquake history and risk (Paul and Bhuiyan 2010; Saiful Islam et al. 2011; Steckler et al. 2016; Rahman

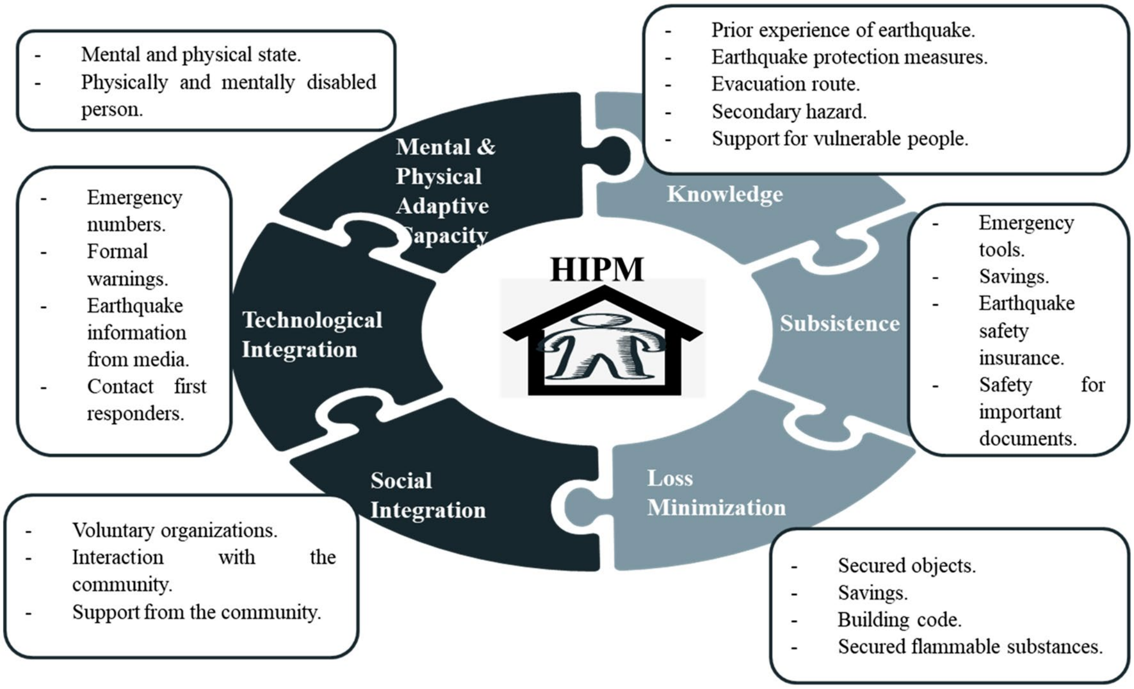

Fig. 7 Holistic individual earthquake preparedness in Dhaka city

2019). Many individuals have prior earthquake experience (92%), and public safety is a major concern in the city. Despite these facts, a deficient HIP was identified (3.46 in 5 scales, around 70%). Participants, in particular, were not as well-prepared as they could have been concerning subsistence and limiting losses. These factors mainly consider the safety nets in an earthquake and its aftermath, such as a fire (in an urban context), as well as implementing measures to mitigate the earthquake risk. It might be difficult to ensure one's subsistence and minimize losses if one lacks the means due to the high cost of doing so. Across several preparedness dimensions, persons with low income were shown to be less prepared due to the likelihood of financial obstacles. The high insurance cost may explain why a small proportion of the sample has it.

After an earthquake, fire can be one of a series of phenomena that may occur (Lee et al. 2008; Elhami Khorasani and Garlock 2017; Vitorino et al. 2020). Many participants in our study were aware of it. In urban places, the impacts of fire following an earthquake might be greater than the effects of the earthquake itself. Most regulations neglect the risk of fire following an earthquake. Therefore, buildings may not be sufficiently constructed for fire safety (Vitorino et al. 2020). Residents must be prepared with tools to reduce fire risk following an earthquake. Many citizens of Dhaka lacked emergency tools such as fire extinguishers, helmets, etc. We have also found the same results in our previous fire preparedness studies in Dhaka (Rahman et al. 2022a, b). However, these tools are also effective (Rooney and White 2007; Chen et al. 2019) but are expensive, yet not all are valued similarly. For instance, the Auto Fire Off Ball Fire Extinguisher Ball has recently been increasingly popular. Price-wise and accessibility-wise, it's a no-brainer (obtained through a local internet store or supermarket) (Peroni et al. 2012). However, it has some limitations, too (Löffel and Walls 2020; Rahman et al. 2022b). Smoke detectors, which are essential for decreasing the home's fire risk, are also reasonably inexpensive (Glauberman and Qureshi 2018). Moreover, relocating combustible and dangerous goods away from possible fire sources incurs no expense. It appears that affordable approaches might enhance subsistence and loss minimization; nevertheless, some participants lacked understanding. They lacked an appropriate understanding of earthquake preparedness, including an evacuation plan, safety precautions, and a safe place during an earthquake. These characteristics are crucial for fire preparedness (Rooney and White 2007; Islam et al. 2016). They also lack an understanding of low-cost subsistence strategies and loss minimization techniques.

Insufficient social and technical integration were found for earthquake preparedness. Many of the people surveyed did not know of any community groups or individuals that could help them out in the aftermath of a disaster, like an earthquake; however, this may be a perception, not a reality. If this finding results from a misunderstanding, then earthquake awareness and preparedness training may also be effective in this instance. Participants in the study were informed that in the aftermath of a catastrophic event like an earthquake or a fire, the elderly, young children, and people with disabilities would need special help (Rahman et al. 2015; Cvetković et al. 2018; Yildiz et al. 2020; Bhuiya and Shao 2022). However, many did not communicate their earthquake preparedness plans with their neighbors, a source of knowledge that might be considered informal. Formal and informal sources influence earthquake preparedness's actual and perceived levels (Kirschenbaum et al. 2017). Through massive media campaigns, official sources like emergency services and municipal government may disseminate information to the public during a disaster (Kirschenbaum et al. 2017). Family, friends, neighbors, and acquaintances via both "traditional" and electronic/virtual social networks are all examples of informal routes (Kirschenbaum et al. 2017). The popularity of social media has grown in Bangladesh (NW et al. 2018; Mano et al. 2019). Additionally, we found out that the majority of participants prefer social media for earthquake information. We found that many people in Dhaka do not have access to an emergency communication network or know how to get in touch with the fire brigade in the event of a fire following the earthquake. It will be required to educate the public about the kinds of technology they should integrate to guarantee that persons are incorporated in this regard. Although the individuals lacked social and technical integration, their adaptability improved considerably. The majority describes being in good mental and physical health and able to maintain themselves and their families in the event of an earthquake.

Using the HIPM, our primary goal was to find out how many and which groups of individuals were better and worse prepared for the earthquake (e.g., how prepared people were concerning one dimension versus another). Our secondary goal was to examine how various independent factors correlate with collective and personal preparedness measures. Analyzing independent variables has a long history in the research on individual and household preparedness (Faupel and Styles 1993; Russell et al. 1995; Paul and Bhuiyan 2010; Najafi et al. 2015; Rahman 2019; Chen et al. 2019; Brown et al. 2022). We have also evaluated this preparedness in our previous fire preparedness studies (Rahman et al. 2022a, b). Higher levels of preparedness were connected with higher levels of education and participation in emergency training exercises, according to a study (Chen et al. 2019). Our study findings are also consistent with these. Our research shows that prior earthquake preparedness program experience is essential for enhancing any facets of the preparedness process. It is compatible with our previous studies in Dhaka city, where the experience with fire preparedness programs showed important factors for fire preparedness (Rahman et al. 2022a, b). In addition, our study revealed that education plays a crucial role in earthquake preparedness. One study revealed that planning for emergencies was related to a greater level of education and income (Russell et al. 1995). Preparedness levels were shown to vary with age and income (Sattler et al. 2000). Literature-wide, the association between these factors and preparedness has been inconsistent, and they each account for a significant amount of the variance in preparedness. Nevertheless, in accordance with the custom of investigating these independent factors, we have done so here as well. Females are more at risk than males in a crisis (Rahman et al. 2015). With the exception of adaptive capacity, gender is not a significant factor in our study. Our study suggests that females may have unique needs in times of crisis, particularly mental and physical adaptability. Females living in disaster-prone regions are vulnerable to developing and experiencing mental health issues (Mamun et al. 2019). During and after a broad crisis, the risk of family violence rises significantly (Campbell 2021). Pre-disaster acts of violence frequently escalate and become more frequent and severe. Family violence may cause the female to experience mental health issues. Difficulties in locating adequate shelter, food, safe water, and cooking fuel, as well as difficulties in maintaining personal hygiene and sanitation, prevent female from carrying out their typical domestic duties (Azad et al. 2013). All of these are challenges relating to female's gender identification and social roles. Our finding also shows that people living in high-rises are less likely to have taken any precautions to protect themselves from an earthquake. Research indicated that building codes were not adhered to during the construction of the majority of Bangladesh's high-rise buildings (Islam et al. 2016). Dhaka city's high-rise building fires are another cause for concern for locals (Star Digital 2021).

Authorities in Bangladesh have already developed several precautions to reduce the earthquake risk and subsequent fire risk (Kamal 2013; BFSCD 2020; MODMR). Despite this, more work must be devoted to this aspect of preparedness, as knowledge levels continue to be low, and knowledge expansion is crucial to advancing preparedness dimensions. Authorities must run campaigns, rally public opinion, communicate with people, and provide up-to-date earthquake safety information and training. Workshops, seminars, training sessions, and the incorporation of earthquake preparation subjects into school and higher education curricula can help people get ready. Community-wide earthquake preparedness education programs may also be disseminated via television, mobile and web-based applications, and social media, with consideration given to the population's education levels and cognitive comprehension. The people of Bangladesh now rely heavily on these venues as their primary access to the news. These platforms may be used by future disaster management authorities and groups to disseminate HIP information. Officials should not limit information sharing to just themselves. The authority must ensure that knowledge on earthquake preparedness, response, and recovery is widely disseminated, and this responsibility extends to the academic community, companies, healthcare organizations, media outlets, and community leaders. Preparedness also depends on the facilities provided for the community (Syamsidik et al. 2020; Mawarni et al. 2020; Riviwanto et al. 2021; Halkia and Grant Ludwig 2022).

While sharing information will be crucial, it will not be enough. Some parts of the country (such as remote rural areas) lack access to the internet and other modern conveniences. In order to reach all segments of society, it is necessary to provide access to the internet and other technologies. In addition to enforcing stricter construction rules and increasing the accessibility of emergency assistance, authorities might better prepare the populace by requiring the installation of emergency equipment in all houses. After an earthquake, authorities ought to put money into a fire-detection and suppression system. Due to Bangladesh's status as a developing nation, external funding may be necessary to implement these initiatives. Nonetheless, these measures are required since education alone limits what can be achieved; a sizable percentage of the population will still lack the financial resources to purchase commodities for survival and risk mitigation. HIP support should be made through research and other knowledge creation at the same rate. The HIP is a significant issue worthy of investigation; nevertheless, the existing literature on the topic is plagued with theoretical and methodological difficulties (Nojang and Jensen 2020). In this study, we found the theoretically based HIPM to help operationalize preparedness like our previous studies for fire preparedness evaluation (Rahman et al. 2022a, b). The HIPM enabled us to contribute to the accumulated study of preparedness by providing a worldwide framework to place our data and ensure that it was culturally relevant, resilient, and dependable in its execution (i.e., in terms of dimensions). We identified statistical links between a number of the independent variables included in this study and various preparedness-related aspects. In further studies, we want to investigate this phenomenon in greater detail. We encourage other scholars to expand the HIPM's scope beyond Bangladesh and use it as the basis for their work. We conclude that HIPM is the best option for advancing a theory of HIP because it provides a framework for doing so, as well as a set of interconnected statements about what HIP is, its dimensions, the relationship between the dimensions and things external to the topic, and, most importantly, why and how those relationships exist and exhibiting the characteristics of "good" theory. The realization of such a theory will have both academic and practical value in the context of increased vulnerability and hazard occurrences in Bangladesh and around the world.

Conclusion

This study's primary purpose is to analyze the HIP regarding earthquakes in urban populations. We have utilized HIPM from the standpoint of Bangladesh. However, it may also be utilized in other high-risk locations. Dhaka City is vulnerable to a major earthquake, although nothing has been done so far to prepare its citizens for such an occurrence. This study has offered helpful information on the degree of earthquake preparedness among this city's more than ten million citizens. The survey data highlighted those who were prepared and indicated vulnerable demographics. A summary of the study's findings shows that about 92% of the population has experienced an earthquake. Over 65% of the population has never received earthquake safety training. Numerous individuals in the research population possess exceptional knowledge, social bonds, and adaptability. However, the subsistence and loss minimization aspects of HIPM might be highlighted further. In addition, the statistics imply that having the correct knowledge and a positive attitude may benefit earthquake safety. Females are less capable of adapting than males. The HIP of inhabitants of high-rise buildings was lower than that of residents of low-rise buildings. Additionally, a person's education degree may be crucial in preparing them for an earthquake. Effective earthquake preparedness efforts and appropriate education and policy are required to boost HIP. This information may be utilized to develop earthquake preparedness measures in Dhaka City and the rest of Bangladesh. In the city, preparedness should be stressed as part of the everyday routine. Institutionalizing preparation is critical to reducing the risks to populations from severe natural catastrophes. The present study can serve as a basis for analogous future research in other major cities of Bangladesh. The population preparedness level in an earthquake might be the subject of a prospective study. The findings of this study should generally be relevant, given that earthquakes pose a serious threat to many major cities in developing countries. In addition, these studies will give crucial information to the field of earthquake research.

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Author contributions
MMR, AS and NJC: methodology, MMR, AS and NJC: software, MMR, AS and NJC: formal analysis and investigation. MMR, AS and NJC: visualization, MMR, AS, NJC, HGA, AAA and MAM: writing—original draft preparation, MMR, AS, NJC, HA, HGA, AAA and MAM: writing—review and editing, MMR, AS, NJC, HA, HGA, AAA and MAM: supervision. All authors read and approved the final manuscript.

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Availability of data and materials
The data that support the findings of this study are available on request from the corresponding author.

Declarations

Ethics approval and consent to participate
This article does not contain any studies with human participants or animals performed by any of the authors.

Consent for publication
Not applicable.

Competing interests
The authors have no competing interests to declare.

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