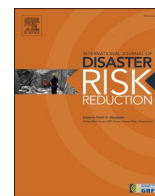




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## Public perception and attitudes to disaster risks in a coastal metropolis of Saudi Arabia

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### ABSTRACT

Disaster risk reduction is an increasingly important policy issue, especially in developing countries that suffer most of the global human and economic losses associated with disasters. Indeed, public awareness and attitudes can help in disaster risk reduction and management efforts toward reducing mortality and economic losses. In Saudi Arabia, many cities have been recently experiencing incidences of disasters, such as floods, disease epidemics, and sandstorms. However, studies on public perception of disaster risk in the country are few and nascent. Therefore, based on a questionnaire survey ( $n = 683$ ), this paper explores public perception and attitudes to disaster risks in Dammam, a coastal metropolis in Saudi Arabia. The findings indicate that although almost two-thirds (64.7%) of the participants are aware of disasters, and 81% are concerned about disaster risks, less than half (47.3%) believe that their settlements could be at risk. While 37% opine that disasters are caused by both natural factors and human activities, about half (54%) indicate that they can personally contribute to reducing disaster risks. Chi-square analysis indicates a significant positive relationship between place of residence and perception of disaster risks ( $\chi^2(6) = 56.18, p < 0.05$ ), and between place of residence and concern about disaster risks ( $\chi^2(12) = 68.47, p < 0.05$ ). The paper recommends raising public awareness and encouraging positive behaviors in reducing disaster risks in the study area and similar environments.

### 1. Introduction

In 2017, more than 95.6 million people worldwide were affected by 335 disasters that caused 9697 mortalities and damages worth USD335 billion (the highest record ever), with populations from developing countries tenfold more likely to suffer disaster-related human and economic losses [1]. From 1990 to 2013, about 90% of global mortality caused by disasters happened in low and middle-income countries [2]. Asian countries are the most vulnerable to disasters in the world. In 2017, 44% of the global disaster events happened in Asia, which account for 58% of the total fatalities and 70% of the total people affected [2]. The International Strategy for Disaster Reduction Disasters (UNISDR) highlights the negative impacts of disasters, including the threat to human life and dignity, driving vulnerable people into impoverishment, degrading the environment, and challenging efforts for sustainable development of communities [3].

Compared to the global North, cities in developing countries are more prone to disaster risks due to rapid urbanization, poorly planned urban expansion, concentrated poverty, poor governance, and

environmental degradation [4,5]. Climate change is also expected to intensify the number and severity of disasters far into the future, according to the Intergovernmental Panel on Climate Change [6]. The world's urban population is expected to rise from the current 54% to about two-thirds by 2030, most of which will take place in developing countries, with Asia and Africa alone expected to account for around 90% of the estimated 2.5 billion increase in global urban population between 2015 and 2050 [7]. Therefore, the urban areas of developing countries are central in international actions toward reducing the risks of disasters.

To lessen the catastrophic impacts of disasters on people, assets and the environment, governments, scholars and international agencies are increasingly focusing on strategies for reducing and adapting to disaster risks. The Sustainable Development Goal (SDG) 11.5 targets, by 2030, to "significantly reduce deaths and economic losses caused by disasters, including water-related disasters" [7]. Also, advancing climate change adaptation is contingent upon managing the hazards of extreme events and disasters [8,9]. The literature stresses the importance of public perception and attitudes to disaster risks in developing and

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implementing disaster management plans, building resilience and adaptation measures, which refer to adjustment in the existing physical, socioeconomic or political systems in response to actual or anticipated risks [10–15]. Developing risk management procedures is also hampered by the dearth of data. According to the 2018 review of SDGs implementation, “a number of challenges in data availability to track progress towards implementation of SDG 11 also present significant barriers to assessing global progress on the goal” [1]. Enhancing public awareness of disaster risks is found to effectively enhance disaster risk management by formulating more effective hazard mitigation policies and intervention measures. Citizens are nowadays seen as active partners in risk management, which is an emerging and popular field of disaster science [4,16,17].

Saudi Arabia is a country at risk of disasters including floods, epidemics, sandstorms, and earth tremors, according to the General Directorate of Civil Defence [18]. The country is placed on the 84th highest position on the 2018 Global Climate Risk Index due to frequent coastal flooding, lack of freshwater sources, high temperatures, and vegetation cover of less than 2% of the total land area [19]. Despite the existence of many seismic and volcanic areas, the country has only experienced low-magnitude earthquakes of not more than 4 on the Richter scale [18]. The most catastrophic disasters in the country are floods, sandstorms, and disease epidemics such as swine flu, severe acute respiratory syndrome, and Rift Valley fever [16,20–22]. In 2009, swine flu affected 15850 people and caused 124 deaths throughout the country [20]; p. 12). Jeddah and Dammam cities being coastal settlements, and Riyadh being surrounded by valleys are the three major cities that faced yearly incidences of floods in the country. However, “less attention is paid to natural disasters, despite their frequent occurrence and the devastation they caused on people’s lives and property” compared to human-made disasters such as fires, stampedes and road accidents [21]; p. 3256).

Given the country’s vulnerability to several forms of natural hazards, the objectives of this study are (a) to assess the level of public perception and awareness of disaster risks, (b) their sense of responsibility during disasters, and (c) their sources of information about disasters, within the context of Dammam Metropolitan Area (DMA) of Saudi Arabia. A review of the literature indicates that no similar study has ever been undertaken in DMA. In Jeddah city, Al Saud [23] utilized satellite images and geographic information system to map zones susceptible to flood hazards and evaluate flood influencing factors: drainage systems, elevation, soil type, and human activities. In Riyadh city, Rahman et al. [22] assessed public vulnerability to flash flooding. At the national-level, Alshehri et al. [11] studied public perception and attitudes to disease epidemics [16]. Apart from a national study that accessed public perception, awareness, and sense of responsibility towards disaster risk reduction [11], no prior study has explored public opinion about the existing approaches of reducing disaster risks or their preferred methods of accessing information about disaster risks.

The present study, therefore, builds on the existing literature by addressing these limitations. The study is important because public perception and attitudes to disaster risk are nowadays considered vital input into the decision-making process for more effective disaster risk management. Similarly, DMA is the third-largest metropolis and the oil capital of Saudi Arabia with the largest seaport on the Arabian/Persian Gulf, which has been experiencing severe flash floods in recent years.

## 2. Literature review

A disaster can be defined as “an unforeseen and often sudden event that causes great damage, destruction and human suffering,” which often overwhelms the society’s capacity to handle the situation based on its resources [2]. Disaster risk is the likelihood of the event and its real or anticipated consequences. Disaster risk management or adaptation refers to the capability of society to evade or decrease the various likely costs of a disaster by adjusting the existing environmental,

socioeconomic and administrative systems [24]. Its essential elements include preparedness and response measures that are concerned with systematically formulating and implementing policies and approaches to prevent or lessen the adversative consequences of disasters by decreasing vulnerability, securing assets, and protecting the ecosystem [6,25].

Collaborative efforts involving various stakeholders including the government, the private sector, citizens, and civil societies, from information provision to protecting vulnerable groups, can enhance disaster preparedness and response [25–27]. Citizens are increasingly and particularly identified as key to progress in disaster management, given their contributions to risk information management and adaptation measures. The efficacy of participatory risk management depends on identifying public perceptions of risks and integrating them with good practices. However, in developing countries, obstacles to disaster management include limited integration of public perception and attitudes to disaster risks, insufficient financial and human resources, and inadequate risk monitoring and research [28].

The concept of risk perception can be defined as societies’ views, feelings, attitudes, and judgments, as well as their cultural values and dispositions toward a risk [4]. The concept originated from studies on cognitive psychology that posit that people employ some mental strategies (heuristics) to make sense out of uncertain events such as disasters [14]. In disaster risk studies, people are commonly asked to estimate the risks or safety level of disasters [12,29], as well as to solicit information about how concerned the citizens are about disaster risks [15,30], their sense of personal responsibility during disasters [11], their opinions about the efficacy or importance of existing risks reduction approaches [21,31], their level of awareness of emergency procedures, and their sources of information about disasters [32].

Public perception of risks is affected by socioeconomic and demographic factors such as age, education, income, and location [10,11], types of disasters, and prior exposure to previous disasters like floods, landslides and earthquakes [12,24]. Also, emotions such as fear, cynicism, and helplessness concerning disaster risks play a vital part in risk perception [26]. Similarly, social capital can provide considerable social protection that can mitigate the adverse effect of disasters [4]. In Nagoya City (Japan) for example, the four main factors that influence people’s preparedness for disasters are the level of disaster anticipation and fear, disaster experience, the enormity of damage from a previous disaster, and homeownership [33]. Disaster awareness fosters behavioral change for reducing a wide range of risks. It is a facilitator of taking precautionary measures and protective behaviors such as taking property insurance, staying in a safe area and away from windows, not driving, informational listening and checking for updates, and following evacuation instructions from local authorities [24]. Given that disaster perception and awareness are useful in assessing the level of public preparedness, it is imperative to ask: to what extent do the residents of cities that are vulnerable to natural hazards such as Dammam perceive the risks of disasters?

Risk perception also influences communities’ response to disasters and their readiness and impetus to employ precautionary behaviors to lessen the associated risks [15]. While low-risk perception could lead to inadequate coping mechanisms, the high-risk perception has been associated with adopting protective behaviors useful in supporting higher resilience. Raising public awareness of disaster risks can influence their attitudes to be more proactive in disaster preparedness [13, 34]. Therefore, exploring public perception of disaster risks can assist emergency and public health agencies with the information essential for formulating relevant risk management strategies and educational programs required to raise public awareness about disaster risks and behavior change, which are vital in building confidence about and ensuring compliance with official instructions [24]. Public perception and attitudes toward disaster risks are the key drivers of precautionary actions, and thus an important source of information about and determinant of public behavioral outcomes. As such, it is vital to explore city

residents' sense of responsibility for adopting precautionary behaviors and participating in reducing disaster risks.

Disaster risk studies have most often been studied from the perspective of public agencies' approach to risk reduction, including preparedness and response. For example, In Jordan, Al-Nammari and Alzaghali [10] investigated the institutional capacity for and limitations to disaster risk reduction in Jerash municipality. Abosuliman et al. [21] interviewed local public officials about their priorities for flood disaster control in Jeddah, Saudi Arabia, without exploring residents' opinions about the efficacy of the approaches for disaster risk reduction. Thus, few studies explored public perception about natural hazards in the country. Alshehri et al. [16] for instance studied the levels of public knowledge and attitudes to the threats posed by severe acute respiratory syndrome and swine flu that have recently affected the country. However, since disease epidemics are caused by the large-scale spread of microorganisms like bacteria and viruses, it is pertinent to explore public perception of risks associated with natural hazards such as floods, earthquakes, and sandstorms that are caused by climatic and geological conditions.

Internationally, Ho et al. [12] examined the influence of disaster type and residents' characteristics on risk perception in Taiwan and suggested that risk communication is key to increasing the likelihood of risk mitigation activities at the household level. Miceli et al. [13] explored risk perception and preparedness among some communities susceptible to flood and landslide in the Alpine region in northwest Italy. To reduce the vulnerability of citizens during flood disasters, the study called for "improving the communication and dissemination of information on environmental hazards in a given area" (p. 172). In Cologne, Germany, Grothmann and Reusswig [24] investigated why some residents took precautionary actions against flood risks while others did not. The authors found that to encourage people to participate in damage prevention, it is essential to communicate flood risks and its consequences, and the feasibility and efficacy of personal precautionary measures. These studies, therefore, indicate the impetus for disaster risk studies to identify more effective disaster information sources and risk communication approaches.

Similarly, using a survey of the residents of Nagoya City, Japan, Motoyoshi [14], examined the influence of homeownership on flood risk perception and found that fear of floods and the amount of housing damage from during previous floods determined the level of residents' precautionary measures. However, the study neither asked the residents their perceived causes of floods nor their preferred methods of disaster risk communication. In Jingdezhen City (China), Wang et al. [17] found that previous flood knowledge and experience, and trust in government significantly influenced public perception of flood risks but did not investigate whether the respondents were willing to participate in risk mitigation activities in the event of a disaster. As such, the present research contributes to filling these knowledge gaps and builds on the literature using the following methods.

### 3. Methods

#### 3.1. Study setting

Dammam Metropolitan Area (DMA), located along the coast of the Arabian/Persian Gulf and 400 km from Riyadh, is the administrative capital of the Eastern Province and the oil capital of Saudi Arabia. It is the third-largest metropolitan area in the country after Riyadh and Jeddah. The metropolis' population was 1.166 million people in 2018, and it is one of the seven metropolises that house half of the country's 33 million population [35]. In about half a century (1950–2014), the population has dramatically risen from 100,000 to almost 1.66 million people, which is expected to reach 2.13 million in the next decade [36]. The size of DMA has expanded from a small fishing town to a metropolis spanning about 562 km<sup>2</sup> with a population density of about 2000 persons/km<sup>2</sup> [37]. DMA consists of the three main cities; Dammam, Khobar

and Dhahran, in addition to the suburban area of Aziziyah and Half Moon Bay (Fig. 1). While the city of Dammam contains most of the regional administrative institutions, Khobar city consists of commercial centers and corporate headquarters, and Dhahran city serves as the center for science and technology, as it hosts Dhahran Techno-valley and the headquarter of Saudi Arabian American Oil Company. Aziziyah and Half Moon Bay area is a new sprawling residential development along the Arabian/Persian Gulf, famous for its recreational and tourist centers. The study area has been recently experiencing severe storms that left streets drenched, homes and schools in low-lying areas flooded and residents stranded when their day-to-day lives were disrupted [38]. These incidences have caused road and rail accidents, injuries, loss of properties and damage to infrastructure and the local economy [39].

Saudi Arabia is susceptible to disasters, including floods, volcanic and seismic activities, sandstorms, and draughts [40]. In the last 20 years, the country has experienced 14 natural hazards that affected 30, 000 people, with floods and disease epidemics causing at least 572 deaths (Fig. 2), and about \$450 million economic losses [41]. Globally, out of 335 cases of disasters that killed 9697 people in 2017, there were more incidences of floods (37.9%), followed by storms (37.6%), with earthquakes coming distant third (6.6%) [2]; p. 3). In Saudi Arabia, the agency responsible for disaster risk reduction is the Presidency of Meteorology and Environment, whereas the General Directorate of Civil Defense is responsible for emergency planning and response [18]. However, disaster risk management is yet to create a framework to support local participatory efforts in the country [41].

#### 3.2. Data collection and analysis

This study used a questionnaire survey, a reliable data collection technique for discovering and estimating the prevalence of a phenomenon such as a disaster, and for acquiring information on public opinions and attitudes about it [42]. The questionnaire design was adopted from similar prior studies [16], and structured into four sections: (i) social and demographic characteristics including gender, educational attainment, employment type, household size; (ii) awareness about disasters and their causes, impacts, and risk reduction; (iii) personal responsibility during disasters; and (iv) sources of information about disasters. Most of the questions were close-ended requiring responses on a five-point Likert Scale: strongly agree, agree, neutral, disagree, and strongly disagree. Other questions require ranking of responses as well as selecting from yes, no, or neutral options. The questionnaire was designed in English with Arabic translation. It was first piloted among the researchers' colleagues to improve its validity by testing the accuracy of the questions [42].

Between September and December 2018, a cross-sectional survey was conducted in the study area using Survey Monkey online platform, ([www.surveymonkey.com](http://www.surveymonkey.com)), due to the vastness of DMA and for the fact that online surveys are quicker, economical and ensure more anonymity compared to print surveys [43]. The link to the survey was distributed via email and social media (e.g. Twitter, Facebook) using a snowball sampling technique in which respondents were asked to share the link with others living in the study area [44]. After four months, the questionnaire has reached 683 participants, which according to Cochran's formula is considered an adequate sample size for a city of 1.17 million people and based on 0.05 level of significance [45]. Ethical issues have been taken into consideration. The confidentiality of all participants and utilizing the survey data for only academic purposes have been guaranteed in writing, as well as the voluntary nature of participation in the study. Snowballing, albeit being a non-probability sampling approach, is considered a robust scientific approach that enables a researcher to anonymously study a community and with a high response rate [44]. Moreover, it is beneficial in circumstances where it is challenging or expensive to reach study participants. For instance, in Saudi Arabia, it is quite difficult to distribute print questionnaires to the public or recruit female respondents due to cultural privacy concerns [46].



Fig. 1. The four settlements that constitute DMA [https://www.google.com/maps/@26.3356897,49.5882482,10.5z].

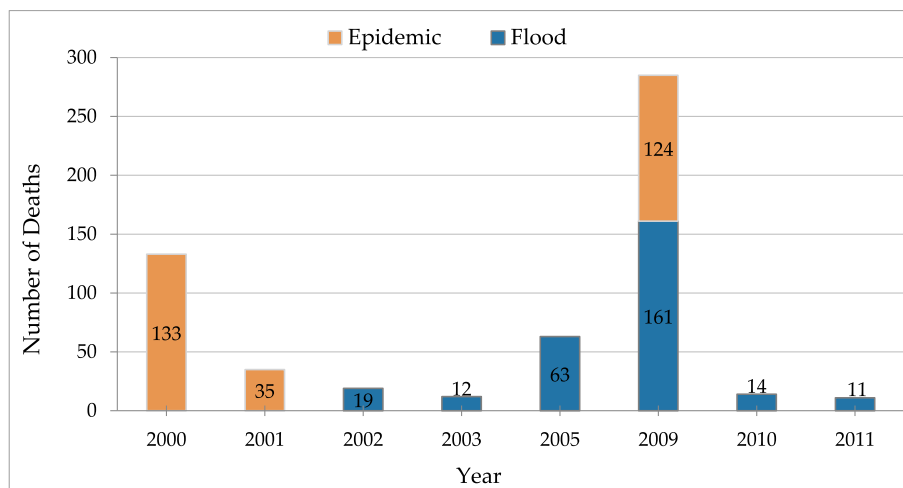


Fig. 2. Natural hazards in Saudi Arabia, 2000–2011 (adapted from Alshehri et al. [11]; p. 1814).

The data was analyzed using descriptive (frequency, percentage, mean and standard deviation) and inferential statistics (Chi-square) with the aid of SPSS 20©. Pearson’s Chi-square test is suitable for establishing whether there is a statistically significant relationship between a dependent variable such as public perception/attitudes to disaster risks and a categorical predictor variable with at least two independent groups such as place of residence, gender or educational level [11,33]. To ensure the consistency of questionnaire items, checking data reliability is essential, and the Cronbach’s alpha of 0.6 or higher is an

acceptable level of reliability in exploratory research [47]. In the present study, the Cronbach’s alpha is 0.72, thus the overall reliability of the questionnaire items is adequate.

Table 1 illustrates the general characteristics of the respondents who are largely male (73%). This low representation of women is not unexpected in a patriarchal society, coupled with the fact that the local culture frowns on women interacting with unrelated persons. Low female response rates in Saudi Arabia have been reported in similar studies, such as 25.3% [11] and 31% [16]. About two-thirds (69%) of



**Table 1**  
Descriptive statistics of the respondents (n = 683).

Variables	Categories and percentages
Age (years):	18–30 (42.3%); 31–40 (23.6%); 41–50 (19.3%); 51–60 (11.2%); 61 or more (3.6%)
Gender:	Male (72.6%); Female (27.4%)
Marital status:	Married (68.7%); Single (31.3%)
Residence:	Dammam (40.3%); Khobar (27.3%); Dhahran (12.3%); Aziziyah (20.1%)
Household size:	2 (37.5%); 3 (9.1%); 4 (13.7%); 5 (21.8%); 6 or more (17.9%)
Educational level:	High school (19.6%); Diploma (8.1%); Bachelor (41.3%); Postgraduate (31.0%)
Employment:	Student (23.7%); Public sector (44.9%); Private sector (16.2%); Unemployed (9.4%); Retired (5.8%)

the participants are married, comparable to 72.3% documented by Alshehri et al [11]. Around 63% of the respondents have household sizes of at least three, comparable to the country’s average family size of 5.6 [35]. Two-thirds (66%) of the participants are aged 18–40 years, which reflects the country’s demography that is dominated by the youthful population: 30 years median age [48]. All the participants are educated up to high school, which mirrors the country’s 94.7% literacy rate [48]. As expected, the public sector is the main employer of this study respondents (45%), which is similar to 57% government sector employment reported by Alshehri et al. [11], followed by 23.7% students, 16.2% company employees and few retirees, while 9.4% are unemployed, which is close to 7.6% unemployment rate reported in a similar study [11], but quite lower than the 2018 estimated national unemployment rate of 24.3% [44]. About two-thirds of the respondents reside in Dammam, followed by Akhobar (27.3%), Aziziya and Half Moon Bay (20.1%), and Dhahran (12.3%).

**4. Results**

This section reports and discusses the extent of public awareness and perception of, and concerns about disasters, their sense of personal responsibility during disasters, their opinions about causes of disasters, potential impacts and approaches for reducing disaster risks, as well as public sources of information concerning disasters.

**4.1. Awareness and perception of disaster risks**

To explore the level of public awareness and perception about disasters, their causes and risks, respondents were asked three questions. First, they were given a list of seven major disaster events [2] to select those they consider as having risks to their lives and properties (Table 2). The result shows that, despite the absence of a high-magnitude earthquake in the whole country, it was selected by 73% of the respondents, perhaps due to its destructive nature that respondents often observe through the media. The flood came second (67%), trailed slightly by disease epidemics (65%), while the least chosen event was landslide (40%), which is not surprising considering that the country being in a desert environment does not experience landslides. However, as mentioned earlier, floods followed by epidemics are the most common natural hazards in the country [11]. Disaster risk awareness and

**Table 2**  
Awareness of disaster events that can risk lives and properties.

Events	Response (%)	Rank
Earthquake	501 (73.4)	1
Floods	459 (67.2)	2
Disease epidemic	442 (64.7)	3
Tsunami/hurricanes	408 (59.8)	4
Sandstorm	322 (47.2)	5
Volcanic eruption	298 (43.6)	6
Landslide	271 (39.7)	7

perception are indeed influenced by the type of disaster and persons’ character.

Second, the study participants were asked to indicate if they think their households are at risk of a disaster, and close to half of them (47.3%) answered in the affirmative, 28.9% answered no, and 23.8% did not know (Table 3). Because the four settlements that constituted DMA differ in proximity to the Arabian/Persian Gulf, this study also explored whether there is a significant relationship between the difference in respondents’ place of residence and their perception of disaster risks. This is because previous studies have strongly linked location with different levels of risk perception [24]. The Chi-square value (56.18) shows a statistically significant ( $p < 0.05$ ) relationship between respondents’ thoughts about the likelihood of imminent disasters and their location (Table 3). In all the four cities that constitute the study area, respondents that believed that they could be affected by a disaster at any time are almost twice those that think that they cannot be affected. This could be attributed to the incidences of floods that occur almost annually in their cities [23].

Third, the participants were asked the extent to which they are concerned about the risks of disasters in DMA. The majority (56%) of the respondents felt extremely concerned, 25% very concerned, and only 11% of them slightly concerned, while about 7% were not at all concerned (Table 4). The cross-tabulation result shows a statistically significant ( $p < 0.05$ ) association between respondents’ place of residence and their concerns about disaster risks ( $\chi^2 = 68.47$ ). Those living in Dammam have the highest proportion of respondents (21.3%) that were “very concerned” about disaster risks, compared to Aziziyah with the highest incidence (2.3%) of those that were “not at all concerned”. Moderately concerned respondents are also more in Dammam (12.8%), followed by those living in Khobar (4.6%). For those that were “slightly concerned”, most of them were residing in Khobar (4.7%), and the least (0.7%) lived in Aziziyah.

**4.2. Personal responsibility during disasters**

Respondents were also asked the extent to which they individually feel responsible for participating in activities to reduce disaster risks. As presented in Fig. 3, a little over half of the respondents (54%) indicate that they can personally contribute to reducing risks of disasters, and it is their responsibility to do so. However, 35% of them indicated that they cannot help, and 11% were undecided. Chi-square result shows a statistically significant relationship between place of residence and a sense of personal responsibility during a disaster ( $\chi^2 = 64.59, p < 0.05$ ). Participants residing in Dammam indicate the highest level (22.0%) of willingness to “personally contribute in reducing disaster risks”, followed by those living in Khobar (15.1%), Aziziyah (9.9%) and then Dhahran (6.8%).

**4.3. Causes of disasters, potential impacts, and approaches to reducing disaster risks**

This section explores participants’ knowledge about the causes and potential impacts of disasters, and their opinions on the approach for reducing disaster risks. About 37% of the participants believed that

**Table 3**  
Perception of disaster risks.

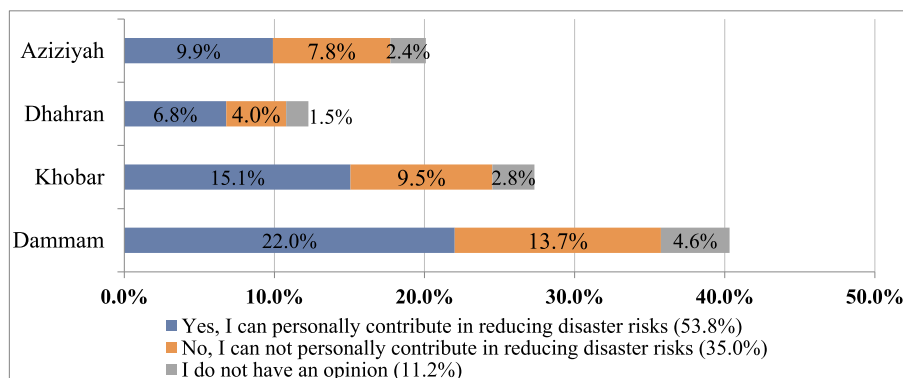
Settlement	Responses			
	Yes	No	Don’t know	Total
Aziziyah	67 (9.8)	32 (4.7)	38 (5.5)	137 (20.1)
Dhahran	39 (5.7)	20 (2.9)	25 (3.7)	84 (12.3)
Khobar	88 (12.9)	45 (6.6)	54 (7.9)	187 (27.3)
Dammam	129 (18.9)	65 (9.5)	81 (11.9)	275 (40.3)
Total	323 (47.3)	162 (23.8)	198 (28.9)	683 (100)

$\chi^2 (6) = 56.18, p < 0.05$ .

**Table 4**  
Concerns about disaster risks in DMA.

Settlement	Concern level					Total
	Very concerned	Moderately concerned	Slightly concerned	Not at all concerned	No opinion	
Aziziyah	93 (13.7)	22 (3.2)	5 (0.7)	16 (2.3)	1 (0.1)	137 (20.1)
Dhahran	32 (4.7)	28 (4.1)	8 (1.2)	14 (2.1)	2 (0.3)	84 (12.3)
Khobar	113 (16.6)	31 (4.6)	32 (4.7)	8 (1.2)	2 (0.3)	186 (27.3)
Dammam	145 (21.3)	87 (12.8)	29 (4.3)	12 (1.8)	1 (0.1)	274 (40.2)
Total	383 (56.2)	168 (24.7)	74 (10.9)	50 (7.4)	6 (0.9)	681 (100)

$\chi^2 (12) = 68.47, p < 0.05.$

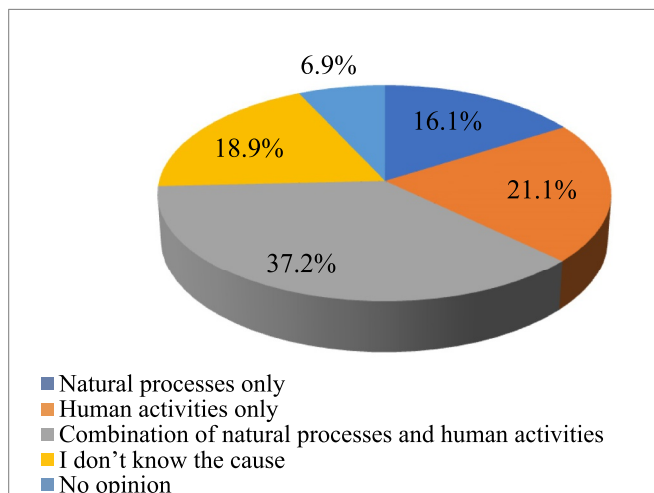


**Fig. 3.** Personal responsibility to participate in reducing disaster risks (n = 677,  $\chi^2 (6) = 64.59, p < 0.05.$ )

disasters are caused by both natural processes and human activities (Fig. 4). While 21% opined that disasters are caused by human activities alone, 16% believed that they are caused by natural phenomena only. While 19% of the participants do not know what causes disasters, 7% of them had no judgment on disaster causes.

Also, the participants were requested to rate the potential impacts of disasters in DMA based on their level of severity (very high-very low). The participants believed that human injury and death are the most severe impact of disasters on their settlements (mean = 2.2, SD = 1.4), followed by damage to critical infrastructure (mean = 2.3, SD = 1.25), while they view the negative impact of disasters on agricultural production as the least important (mean = 4.23, SD = 1.62) (Table 5). This finding is not surprising given that, apart from mortality and injuries, the respondents also appreciate the importance of water, electricity and sewer infrastructure on their wellbeing [49].

Additionally, participants were asked to rank some approaches that



**Fig. 4.** Perception of disaster causes.

**Table 5**  
Rating of the likely impacts of disasters on DMA.

Impact	Mean	SD	Rank
Human injuries and mortality	2.17	1.413	1
Damage to critical infrastructures such as water, sewer, electricity, transportation, and telecommunication	2.34	1.247	2
Damage to buildings such as homes, schools, hospitals, and shops	2.56	2.160	3
Impacts on oil production and exports	3.15	1.784	4
Impacts on the natural environment	3.45	2.087	5
Impacts on agricultural production	4.23	1.615	6

can help reduce disaster risks in their localities (most important – least important). As presented in Table 6, for each suggested approach, the mean, standard deviation, and the rank have emphasized how important each approach is according to respondents' opinions. With a mean of 2.68, raising public awareness was ranked as the most significant approach for reducing disaster risks, followed by adopting protective behaviors, disaster warning systems, and evacuation plans, with averages of 3.22, 3.62, and 3.91 respectively. Surprisingly, disaster response time was ranked as the least important factor with a mean of 4.31, which is likely due to the lack of public understanding of the role of time in mitigating hazard risks.

**4.4. Sources of information about disasters**

How information about disaster risks and emergency procedures is

**Table 6**  
Approaches for reducing disaster risks.

Approach	Mean	SD	Rank
Raising public awareness	2.68	1.35	1
Adopting protective behaviors	3.22	1.19	2
Disaster warning systems	3.62	1.42	3
Evacuation plans	3.91	1.28	4
Disaster response time	4.31	1.06	5

acquired by the public is important in building resilience, especially in a setting with minimal public involvement in public matters and restricted communication with the government [32]. In this study, a little over half of the respondents (56%) indicated being aware of the emergency procedures that need to be followed in the event of disasters (Fig. 5). By contrast, 25% of them were not aware of these procedures and 19% had no opinion. The result from Chi-square analysis reveals a statistically significant association (p-value = 0.001) between the place of residence and awareness of the emergency procedures during disasters ( $\chi^2 = 58.87$ ). More respondents living in Dammam (21.0%) are aware of emergency procedures, followed by those living in Khobar (14.5%), Aziziyah (11.9%) and Dhahran (8.6%). Even though public awareness can help lessen the harmful effects of disasters, a prior study found that “cultural misconceptions and incorrect beliefs and attitudes” could cause inadequate public behavior in disaster preparedness and response [30]. Apart from educational institutions, informal education acquired at the family and community level is also valuable in encouraging an individual to act for reducing risks [22,50].

Also, identifying the most effective means of accessing disaster-related information is important in communicating risk information among citizens and developing more adaptive and resilience schemes for disaster management involving educating the public. The present study found that 67% of the respondents do access information about disaster risks and mitigation and they were given eight options to select their main existing and preferred methods of accessing the information. As Table 7 shows, television is the main existing avenue respondents used to access disaster-related information (28%), followed by mobile text messages (24%). However, close to half (46%) preferred to access such information via text messages, followed by social media like Facebook, Twitter, WhatsApp (27%). By relegating from the first existing information source to the fourth preferred source, it seems that television is becoming an outdated avenue of disseminating information about disasters. The radio, newspapers, family and friends and other approaches such as meetings and seminars also remain the last four (ranked 5–8) existing and preferred approaches. Thus, mobile phone text messages and social media are key in contributing to raising public awareness about and raising their confidence level in responding to disaster risks.

5. Discussion and recommendations

People express varying opinions when asked to characterize and evaluate hazardous events such as disasters, forming a basis to understand and anticipate their responses to the associated risks. In this study, participants’ perception of disaster risks somewhat tallies with both the national and the global statistics. The participants ranked earthquake first in terms of risks to lives and properties, even though floods cause

Table 7

Existing and preferred methods of obtaining information about disaster risks (n = 458).

Media channel	Existing method		Preferred method	
	Frequency	Rank	Frequency	Rank
Television (satellite or local)	127 (27.7%)	1	82 (17.9%)	4
Mobile phone text messages	108 (23.8%)	2	211 (46.1%)	1
Internet (government websites)	76 (16.6%)	3	107 (23.4%)	3
Social media (Facebook, Twitter, WhatsApp, etc.)	51 (11.1%)	4	125 (27.3%)	2
Radio	45 (9.8%)	5	52 (11.4%)	6
Newspapers	32 (7.0%)	6	78 (17.0%)	5
Family or friends	14 (3.1%)	7	10 (2.2%)	7
Other approach (meetings, seminars etc.)	5 (1.1%)	8	9 (2.0%)	8

the highest human loss in the country [11] and globally [2]. Their perception is likely influenced by emotions, experience or the devastating nature of earthquakes [12,25]. The second-ranked (floods) and third-ranked disaster events (disease epidemics) are indeed the first and second natural hazards with the highest human cost in the country, respectively [11]. A prior national study has reported that 78% of the participants were aware of the risks of the last disaster that affected the country [16]. In Taiwan, landslide received the highest risk rating followed by floods and earthquakes, but contagious diseases were considered the least risky [12]. Globally, in 2017, floods ranked first (34.4%) in terms of human loss due to disasters, followed by storms (25.9%), landslides (23.8%) and earthquakes (10.4%) ([2]; p. 4). In terms of global economic loss, in 2017, storms overwhelmingly constituted the highest share (85.2%), followed distantly by floods (0.6%), wildfires (0.5%) and earthquakes (0.3%) ([2]; p. 6). In 2017, 12 million people were affected by floods in China, and a single flood incidence caused the death of 834 people in Bangladesh, Nepal and India [2]; p. 2). Worldwide, floods affect more people compared to other natural hazards.

Also, about 81% of this study respondents expressed moderate or high levels of concerns about disaster risks. This finding is quite encouraging, given that residents that are more concerned about disaster risks are more likely to take precautionary actions and follow emergency procedures [13,24]. Comparatively, Alshehri et al. [16] found less (64%) study participants that felt that their area of residence could be affected by a disaster, while 12% did not, and 24% were neutral. However, this study finding contrasts with that of a study in Selfoss (Iceland) where only 9% of the participant thought that floods

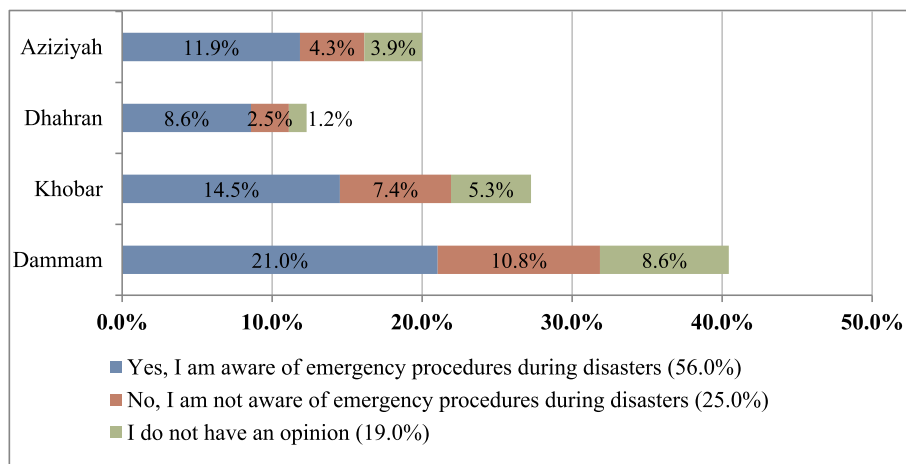


Fig. 5. Awareness of emergency procedures during disasters (n = 675,  $\chi^2 (6) = 58.87$ , p < 0.05).



pose a significant risk in their neighborhoods, but 55% believed that there is no risk at all [15]. Also, anxiety about risks has been linked to a higher level of disaster concerns and preparedness in Italy [13].

In terms of the sense of responsibility during disaster events, a little over half (53.8%) expressed their willingness to participate in efforts for reducing disaster risks. In a related study by Alshehri et al. [16]; the vast majority of participants (96%) stated their willingness to take measures to help in reducing the effects of a disaster, and 70% agreed with complying with the authority's evacuation procedures. In Cologne, self-protective manners by residents of urban areas prone to floods helped in reducing the economic cost of floods by about 80% [24]. In Jingdezhen city in China, only 13.8% of the participants of a study held that the public should also be responsible for flood protection [17]. In the north of Italy, 60% of study participants felt willing to adopt some behaviors for reducing their vulnerability to floods or landslides [13]. Thus, residents of DMA should be encouraged to be more willing to partake in disaster risk reduction activities using platforms such as on-line social media and educational institutions, which are effective avenues for changing common perceptions of disaster risks, increasing public awareness about disaster management, and encouraging them to take cautionary behaviors [30,32].

Concerning, disaster causes, 37.2% of the present study participants opined that disasters are caused by both natural factors and human activities, whereas 21.1% and 16.1% feel that disasters are due to human and natural factors, respectively. Factors that cause and intensify disasters are mostly anthropogenic factors, including rapid urbanization, land use and land cover change, climate change, and other socio-cultural, economic and institutional factors, as well as the influence of natural events occurring in the biosphere such as earth movements, air and sea currents and climate extremes [8,27,51]. Some scholars held that disasters should not be associated with the word 'natural', given that most of the damages and death tolls are attributable to the consequences of anthropogenic interventions such as urbanization, land-use changes, etc., which have little to do with the natural systems [51].

Pertaining participants' perception of the potential impacts of disasters, this study respondents reported that loss of lives and human injuries as their uttermost concern. In Saudi Arabia, natural hazards caused 310 death and millions of dollars in damage to properties within the last decade [11]. Similar findings have also been reported in the literature. In Taiwan, the main concerns of flood and landslide victims were financial and human losses, respectively [12]. Miceli et al. [13] reported that loss of assets, followed by home destruction were the main public concerns about disaster risks in northwest Italy. Thus, disaster impacts are deeply affected by the level of vulnerability a community has.

Also, the respondents believed that raising public awareness and adopting protective behaviors are the most important approaches to reducing disaster risks, followed by disaster warning systems and evacuation plans, with disaster response time being the least important factor. This result is consistent with that of a similar study that found that raising public risk awareness was rated as the first factor for reducing disaster risks followed by early warning systems [11]. However, our respondents' opinion sharply contrasts with experts' assessment of the quality of flood disaster management by Civil Defense and Red Crescent after the 2009–2010 floods in Jeddah. According to the experts (40 senior officials involved in disaster and emergency management in the city), response time and efficiency were the most important factors for reducing disaster risks [21]. In line with the findings of this study, adopting protective behaviors such as having a working flashlight, a list of emergency phone numbers and teaching relatives and neighbors what to do in emergency cases are the most important approaches for reducing flood risks in the north of Italy [13]. Choices of cautionary and protective behaviors made by persons living in disaster-prone settlements are related to their risk awareness, perception, and evaluation [5].

Lastly, the study explored public awareness of emergency procedures

(56%), as well as their existing and preferred sources of information about disasters. Instead of utilizing the existing traditional approach of using state-owned television, the government should rather utilize text messaging services, social media, and the Internet (ranked as the first, second and third most preferred approaches of getting disaster-related information, respectively) for timely communicating of disaster risks. In another study, Alshehri et al. [16] found that 55% of study participants access official information about biological disasters through the Internet. After the 2011 flood in Jeddah, online social media was used for publicizing the gravity of the disaster, advising people what to do and what to avoid, and mobilization for help and rescue [32]. Social media has been useful in communicating the impacts of disasters, their possible causes and who was responsible, and suggesting actions for remedying the situation. The Internet and social media have been considered as promising in providing opportunities for greater social and political participation.

Given the Internet penetration rate of 40.2% in the Middle East, compared to 34.3% global average [30], the social media should be extensively used for sharing information about disaster situations and identifying the needed support, which is indeed the approach most preferred by the citizens. There is also the need to improve public access to vital information about disaster preparedness for increasing community awareness, knowledge and skills in disaster risk mitigation [52]. In 2013, the Saudi Ministry of Interior has developed emergency call and operation centers for event reporting and dispatch operations towards enhancing disaster response efficiency to be established in each of the country's 13 provinces [53]. While these centers could support the operational capacities of safety and security agencies [53], utilizing social media can facilitate citizen participation and engagement in public affairs. Social media can be effective for disaster warning and evacuation procedures and it can influence decision-makers to be more responsive in disaster mitigation. They are also effective in motivating and guiding inhabitants of disaster-prone areas to actively partake in risk preparedness and prevention [24]. Integrating local knowledge with scientific and technical know-how is crucial to disaster risk management for minimizing human and economic losses [31].

## 6. Conclusion

This article found that while about two-thirds of this study respondents are aware of the risks of disaster events, a little less than half (47%) perceived that their households are at risk of disasters, and 56% have a sense of responsibility during disasters. While their main existing source of public information about disasters is television, they prefer text messaging and social media channels. The paper has some important implications for practice given that exploring public perception of disaster risks and their likely adopted preventive behaviors could offer information and basic knowledge that is particularly valuable for officials, policymakers, and experts working in Civil Defense and associated agencies.

Certainly, planning and developing disaster risk management activities is facilitated by taking cognizance of the risk perception and preparedness levels and concerns of the target population [54]. Therefore, for more adaptive and resilience schemes for disaster management, the Saudi Civil Defense in collaboration with the Presidency of Meteorology and Environment, the Ministry of Health and educational institutions need to focus more on educating the public about disaster risks and encourage positive behaviors for dealing with their impacts. Raising public awareness of disaster risks through text messaging and social media can play a powerful role in facilitating citizens' coping with disasters and reducing its adverse impacts.

Risk management can help in reducing mortality and economic losses caused by disasters and thereby improving the human and environmental conditions. According to the 2012/2013 State of the World Cities report, "the city of the 21st century is one that reduces disaster risks and vulnerabilities for all, including the poor, and builds resilience

to any adverse forces of nature” ([55]; p. xii). It is also vital to obtain information on communities residing in other disaster risk zones to know whether and to what extent they can adopt behaviors essential for adaptively dealing with impending disasters. Although Saudi Arabia has a high Internet penetration rate and per capita use of social media, potential exclusion bias could result from the use of online surveys. Similar studies involving female researchers could improve the participation of female respondents.

### Declaration of competing interest

The authors declare that they have no conflict of interest in the conduct of this research.

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