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A Cross-Sectional Study on the Flood Emergency Preparedness among Healthcare Providers in Saudi Arabia

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Abstract: This study used a descriptive cross-sectional methodology to measure healthcare workers' knowledge, attitudes, perceptions, and willingness to respond to a flood scenario in Saudi Arabia. A validated survey was distributed to collect data using a convenience sampling technique through multiple social media platforms. A total of 227 participants were included in this study: 52% of them were aged between 26 to 34 years, 74% were residents from Riyadh, and 52.4% worked in nursing divisions. A significant number of respondents (73.2%) had positive perceptions towards their hospitals' ability to provide an effective response to a flood, 89% were willing to report to work following a flood, and 90% of participants reported the need to develop both guidelines and training for flood disaster preparedness. Preparation and successful flood mitigation in the hospital setting requires staff that have both knowledge and training in emergency management. One way to obtain such readiness is through competency-based training, including both table-top and full-scale live exercises. Although the willingness to respond to such a flooding emergency was high among staff, the development of guidelines and educational programs is needed in order to develop the competencies and skills sets to improve disaster preparedness response and preparedness efforts.

Keywords: flood; disasters; emergency preparedness; hospital preparedness; Saudi Arabia

1. Introduction

Morbidity and mortality attributed to flooding can either be caused directly by drowning, electrical shock injuries, and the transmission of communicable diseases, or indirectly

by affecting infrastructure or other essential necessities of life and the interruption of fundamental public health services [1]. Floods can, in general, be categorized into either flash flood events or associated with cyclones, tsunamis, or storm surges [1]. As a result of global warming, climate change has also increased the risk of floods [2]. According to the Organization for Economic Cooperation and Development, the global cost of floods is approximately 40 billion USD per annum [3]. This type of natural hazard is projected to raise the global burden of disease, morbidity, mortality, and social and economic instability and place continued stress on healthcare systems [4].

Saudi Arabia (SA) is a disaster-prone country. Flooding, although infrequent, has posed significant challenges in the past [5]. The country has reported 14 floods that have impacted approximately 30,000 citizens and resulted in economic losses of about \$450 million during the last three decades [5]. Examples include Makkah's 2003 flood, which was the worst in the past 25 years [6]. Then in 2004, Jizan had experienced one of the most devastating floods in 45 years. Widespread devastation was reported during Medina's flood in 2005. Jeddah's floods occurred in 2009 and 2011, which resulted in 172 deaths [7]. In the capital city, Riyadh, floods in 2005 and 2010 resulted in numerous deaths and forced others to evacuate [6]. The frequency of flood occurrences in SA is expected to be at least seven times per year on average, mainly during the winter, and affecting all regions of the country [7–9]. Additionally, projected rainfall trends during 2025–2044, 2045–2064, and 2065–2084 based on data coming from the National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM4) have showed variable patterns, with significant increases in certain regions of SA [10]. It was reported that hospitals in Jeddah had faced a major crisis in 2009 as a result of the aforementioned floods. It raised many concerns at the Ministry of Health (MOH) and with other authorities about the preparedness of hospitals in SA [8].

The healthcare infrastructure in SA is managed by the MOH. Services are made available to the public through a network of 244 hospitals and 2037 primary healthcare centers across the country [6]. However, other governmental agencies also provide healthcare services independently of the MOH. These include the Ministry of Defense and Aviation (MODA), the Ministry of Education (MOE), the Saudi Arabian National Guard (SANG), the Ministry of the Interior (MOI), and the Red Crescent Society [6].

The Presidency of Meteorology and Environment is responsible for disaster risk reduction efforts in SA, and the Civil Defense at the MOI is responsible for emergency planning and response [6,9]. The current disaster risk management paradigm does not utilize a coordinated multi-agency level response approach. Instead, practice remains unconventional and subject to regional variations [11,12]. Alshehri and colleagues surveyed the public in Saudi Arabia, where a majority believed that God is in control of the world, and that disasters may be considered as punishment by God for transgressions by mankind [13]. The study recommended a focus on public awareness in terms of education, training, and volunteering in an effort to improve disaster readiness in the country [12]. Another study by Abosuliman et al. emphasized the need for the identification and coordination of organizational responsibilities and advocated for response team training [14]. Finally, a recent study by Al-Shareef et al. suggested that some hospitals might be inadequately prepared for future disasters in SA [15]. These studies show a significant shortcoming in response capabilities and civilian preparedness.

Floods are considered a major disaster in SA with the potential to disrupt the lives of residents, businesses, and critical government infrastructure, such as hospitals [6]. Flood-related disruptions may come in many different forms. For instance, Thailand's 2011 flood resulted in many damaged hospitals, unavailability and/or disruption of supply chains, and staff shortages [16]. Several studies have reported an unwillingness of healthcare workers to return to work following a disaster, in addition to a general lack of knowledge related to disaster preparedness and response [17–19]. While there is a strong health system operating in SA, improvements are needed in localized and appropriate disaster-related training and investments in workforce education in order to strengthen flood resilience.

The aim of this study was to evaluate healthcare workers' (HCWs) knowledge, attitudes, and perceptions of their preparedness and willingness to respond properly during future flood disasters in the Kingdom of Saudi Arabia.

2. Materials and Methods

2.1. Study Design

A descriptive, cross-sectional study design that measured HCWs' willingness to respond, knowledge levels, attitudes, and perceptions with regard to a flood scenario at their hospital was utilized. Ethical approval was obtained from the Institutional Review Board at King Saud University Medical City. Informed consent was completed electronically. Only anonymous data were kept and shared with the study team. Participants who agreed to give their consent were included in the analysis. The study took place in SA between December 2019 and April 2020.

2.2. Variables

Independent variables included in this study were age, gender, marital status, number of residing children, type of occupation, years of service within the hospital, and the scope of hospital practice, (governmental vs. private). Dependent variables consisted of general knowledge and perceptions towards floods, willingness to report to work following a disaster, and knowledge concerning a flood scenario.

2.3. Sample Size

According to published data from the McKinsey Global Institute, the total number of males and females working in the healthcare sector in SA in 2014 was 600,000, with 350,000 healthcare professionals and 250,000 management and other support staff [20]. To facilitate the identification of differences and similarities, and to illustrate the complexity of this issue between the participants regarding each section of the survey, it was estimated that 196 participants were needed, while fixing the marginal error to 7% and a 95% confidence interval.

2.4. Enrolment

The study participants were HCWs of both genders who were working and living in SA. The process of enrolment was completed anonymously and voluntarily. Data was collected using a convenience sampling technique. To reach our target population, the survey was disseminated electronically using various social media platforms (WhatsApp, Telegram, Twitter, and Instagram) targeting groups and accounts known to be an aggregate of healthcare professionals where information around continuing medical education activities are shared [21]. The link to the survey was shared over a period of 14 days.

2.5. Data Collection Tools and Procedures

A recently developed and validated tool to model HCWs' willingness to respond to an earthquake scenario was used in this study by changing the scenario to flooding. This survey initially aimed to measure HCWs' willingness to respond to a variety of emergency situations. Previous studies have described in detail the design and validation process [16,17]. The flooding scenario was adopted as it is the country's most common natural catastrophe, causing 7 out of 10 of the most devastating natural disasters in the history of SA between 1900 and 2010 [9], and because certain regions of the country are also projected to experience future trends of increased precipitation and extreme rainfall events [10].

The final version of the survey is composed of 34 items. The data collection tool is divided into two sections: one for the demographic information of participants, and the other measures knowledge and perceptions. The latter section contains questions related to HCWs and perceptions towards their roles following a flood, knowledge, competency, and willingness to report to work in the event of a flood scenario, and the factors that

may influence their decisions in such circumstances. Lastly, participants were also asked about their perceptions in terms of guideline development and training sessions on flood disasters. The final questionnaire's presentation, in terms of feasibility, readability, accuracy, design and formatting, and quality of the vocabulary used, was subjected to face validity checks with 10 volunteer experts from King Saud University Medical City. An Arabic version was available, which was translated by two authors and piloted on the same volunteers for validation. A scoring system was developed for knowledge questions: it considers zero to three correct answers as a low level of knowledge, four to seven correct answers as a moderate level of knowledge, and eight to twelve correct answers as a high level of knowledge.

2.6. Data Analysis

All data analyses were performed using International Business Machines (IBM, Armonk, NY, USA) Statistical Package for the Social Sciences (SPSS) 20.0 software (SPSS Inc., Chicago, IL, USA). Demographic data was analyzed and presented using frequencies and percentages. General levels of knowledge and perceptions towards flood disasters was also analyzed and presented using percentages and frequencies, followed by independent sample *t*-test. Lastly, responses regarding the willingness to report to work following a flood in addition to those related to the knowledge and competency concerning the flood scenario were analyzed using independent sample *t*-tests. Chi-square test was used for statistical testing and the significance was set to be less than 0.05.

3. Results

3.1. Demographic Characteristics

A total of 227 HCWs participated in this survey. The demographic characteristics can be found in Table 1. Males accounted for 77% of participants, with females accounting for 23%. Almost half of the total of participants (52%) belonged to the 26- to 34-year-old age group. Nearly one-third (29.1%) had 6 to 10 years of service, followed by 24.2% who had 2 to 5 years of service. A majority (94.7%) reported to work in the governmental sector. The highest numbers of participants were in Riyadh (74%) and married (65.6%). Meanwhile, 72.2% reported living with children. Approximately, half of the participants reported working in nursing divisions (52.4%), and nursing as a profession accounted for (40.1%).

Table 1. Demographic characteristics of the participants.

| | Groups | Female (n = 53) | Male (n = 174) | All (n = 227) |
|----------------------------|--------------|-----------------|----------------|---------------|
| Age | 18–25 years | 13 (24.5) | 28 (16.1) | 41 (18.1) |
| | 26–34 years | 24 (45.3) | 94 (54) | 118 (52) |
| | 35–44 years | 12 (22.6) | 44 (25.3) | 56 (24.7) |
| | 45 and above | 4 (7.5) | 8 (4.6) | 12 (5.3) |
| Length of Service | Less than 1 | 11 (20.8) | 26 (14.9) | 37 (16.3) |
| | 2–5 years | 19 (35.8) | 36 (20.7) | 55 (24.2) |
| | 6–10 years | 9 (17) | 57 (32.8) | 66 (29.1) |
| | 11–15 years | 8 (15.1) | 40 (23) | 48 (21.1) |
| | 16–20 years | 2 (3.8) | 10 (5.7) | 12 (5.3) |
| | 20+ years | 4 (7.5) | 5 (2.9) | 9 (4) |
| Scope of Hospital Practice | Private | 1 (1.9) | 9 (5.2) | 10 (4.4) |
| | Government | 52 (98.1) | 163 (93.7) | 215 (94.7) |

Table 1. Cont.

| | Groups | Female (n = 53) | Male (n = 174) | All (n = 227) |
|--------------------|---------------------------------------|-----------------|----------------|---------------|
| Place of Residence | Riyadh | 41 (77.4) | 127 (73) | 168 (74) |
| | Eastern Region | 3 (5.7) | 2 (1.1) | 5 (2.2) |
| | Makkah | 0 (0) | 8 (4.6) | 11 (2.2) |
| | Madinah | 3 (5.7) | 11 (6.3) | 11 (4.8) |
| | Qassim | 1 (1.9) | 17 (9.8) | 19 (8.4) |
| | Southern Region | 3 (5.7) | 2 (1.1) | 3 (1.3) |
| | Northern Borders | 3 (0.6) | 5 (2.9) | 8 (3.5) |
| Family Status | Single | 29 (54.7) | 49 (28.2) | 78 (34.4) |
| | Married | 24 (45.3) | 125 (71.8) | 149 (65.6) |
| Number of Children | No Children | 20 (37.7) | 43 (24.7) | 63 (27.8) |
| | 1 | 11 (20.8) | 37 (21.3) | 48 (21.1) |
| | 2 | 9 (17) | 37 (21.3) | 46 (20.3) |
| | 3 | 5 (9.4) | 29 (16.7) | 34 (15) |
| | 3+ | 8 (15.1) | 28 (16.1) | 36 (15.9) |
| Department | Nursing | 40 (75.5) | 79 (45.4) | 119 (52.4) |
| | Physician | 5 (9.4) | 10 (5.7) | 15 (6.6) |
| | Paramedic | 0 (0) | 15 (8.6) | 18 (7.9) |
| | Pharmacy | 3 (5.7) | 15 (8.6) | 15 (6.6) |
| | Other Clinical | 2 (3.8) | 41 (23.6) | 43 (18.9) |
| | Support Services | 0 (0) | 9 (5.2) | 9 (4) |
| | Fiscal and Administrative | 3 (5.7) | 5 (2.9) | 8 (3.5) |
| Discipline | Nursing | 26 (49.1) | 65 (37.4) | 91 (40.1) |
| | Physicians | 15 (28.3) | 18 (10.3) | 33 (14.5) |
| | Pharmacy | 3 (5.7) | 14 (8) | 17 (7.5) |
| | Administrative Professional/Secretary | 2 (3.8) | 11 (6.3) | 13 (5.7) |
| | Other | 7 (13.2) | 66 (37.9) | 73 (32.2) |

Data are expressed as n (%).

3.2. Knowledge and Perceptions

In Table 2, an independent sample *t*-test was performed on gender for items related to participants' perceptions towards their roles following a flood. Results demonstrated a significant statistical difference in the item related to familiarity with roles within the hospital's operations following a flood ($p < 0.01$)—mean 3.44 ± 1.29 for males vs. 2.83 ± 1.26 for females. Due to a high percentage of those agreeing to the provided statements related to their roles following a flood, no significant differences were found. Furthermore, in perceptions related to the knowledge and competency concerning a presumed flood scenario, a statistically significant difference was found between males and females in terms of familiarity with the hospital's standard operating procedure ($p < 0.01$)—mean 3.12 ± 1.33 for males vs. 2.57 ± 1.16 for females. Another significant difference was found related to male HCW confidence in managing a flood scenario ($p < 0.05$)—mean 3.32 ± 1.31 for males vs. 2.91 ± 1.26 for females. No other significant differences were detected ($p > 0.05$).

Table 2. Knowledge and perceptions of participants.

| | | Knowledge and Perceptions as <i>n</i> (%) | | | | | <i>p</i> -Value (Independent Sample <i>t</i> -Test) |
|---|--------|---|-----------|-----------|------------|----------------|---|
| | | Strongly Disagree | Disagree | Impartial | Agree | Strongly Agree | |
| Perceptions of the Role Following a Flood | | | | | | | |
| My role is vital to my organization's effective management of a flood | Female | 6 (11.3) | 3 (5.7) | 6 (11.3) | 19 (35.8) | 19 (35.8) | 0.171 |
| | Male | 7 (4) | 9 (5.2) | 18 (10.3) | 72 (41.4) | 68 (39.1) | |
| | All * | 13 (5.7) | 12 (5.3) | 24 (10.6) | 91 (40.1) | 87 (38.3) | |
| The hospital is prepared to provide an effective response to a flood | Female | 4 (7.5) | 1 (1.9) | 12 (22.6) | 26 (49.1) | 10 (18.9) | 0.478 |
| | Male | 8 (4.6) | 22 (12.6) | 14 (8) | 79 (45.4) | 51 (29.3) | |
| | All * | 12 (5.3) | 23 (10.1) | 26 (11.5) | 105 (46.3) | 61 (26.9) | |
| I am familiar with my role in the hospital's operation following a flood | Female | 12 (22.6) | 8 (15.1) | 13 (24.5) | 17 (32.1) | 3 (5.7) | 0.003 |
| | Male | 18 (10.3) | 32 (18.4) | 17 (9.8) | 69 (39.7) | 38 (21.8) | |
| | All * | 30 (13.2) | 40 (17.6) | 30 (13.2) | 86 (37.9) | 41 (18.1) | |
| Perceptions of Knowledge and Competency Concerning a Flood Scenario | | | | | | | |
| I have sufficient knowledge concerning the treatment of flood victims | Female | 8 (15.1) | 14 (26.4) | 8 (15.1) | 19 (35.8) | 4 (7.5) | 0.068 |
| | Male | 24 (13.8) | 28 (16.1) | 20 (11.5) | 73 (42) | 29 (16.7) | |
| | All * | 32 (14.1) | 42 (18.5) | 28 (12.3) | 92 (40.5) | 33 (14.5) | |
| I am familiar with the hospital's standard operating procedure for floods | Female | 12 (22.6) | 15 (28.3) | 11 (20.8) | 14 (26.4) | 1 (1.9) | 0.007 |
| | Male | 29 (16.7) | 36 (20.7) | 16 (9.2) | 71 (40.8) | 22 (12.6) | |
| | All * | 41 (18.1) | 51 (22.5) | 27 (11.9) | 85 (37.4) | 23 (10.1) | |
| I feel safe to stay at the hospital if a flood occurs | Female | 9 (17) | 10 (18.9) | 7 (13.2) | 19 (35.8) | 8 (15.1) | 0.468 |
| | Male | 26 (14.9) | 24 (13.8) | 25 (14.4) | 73 (42) | 26 (14.9) | |
| | All * | 35 (15.4) | 34 (15) | 32 (14.1) | 92 (40.5) | 34 (15) | |
| I feel that I am competent as a caregiver to manage a flood | Female | 12 (22.6) | 7 (13.2) | 9 (17) | 24 (45.3) | 1 (1.9) | 0.043 |
| | Male | 22 (12.6) | 31 (17.8) | 23 (13.2) | 65 (37.4) | 33 (19) | |
| | All * | 34 (15) | 38 (16.7) | 32 (14.1) | 89 (39.2) | 34 (15) | |

Data are expressed as *n* (%); *: Both genders.

In Table 3, we report the results of independent sample *t*-tests to detect gender differences in the willingness to report to work after a flood; no statistically significant difference was reported ($p > 0.05$). However, when factors influencing the decision to report to work following a flood scenario was considered, a significant difference was found in females' concerns for their families' wellbeing ($p < 0.01$)—mean 4.89 ± 0.47 for females vs. 4.60 ± 1.04 for males. A statistically significant difference was found among females regarding concerns of houses being damaged as a consequence of the flood ($p < 0.05$)—mean 4.68 ± 0.78 for females vs. 4.34 ± 1.17 for males. With regards to professional commitment to care for the injured or ill victims, a statistical difference was found, with females having a higher commitment ($p < 0.05$)—mean 4.81 ± 0.56 for females versus 4.59 ± 1.03 for males.

Another statistically significant difference was found in Table 4 with regard to females' perceptions towards the need for the development of guidelines for flood disasters and subsequent training in flood response ($p < 0.05$).

As reported in Appendix A, an average of three questions out of twelve were answered correctly for questions testing the knowledge and competency of the HCWs (range = 5.3% to 53.7%; mean = 25.4%; median = 21.6%). The highest percentages of correct answers per question were reported for responses regarding appropriate actions to be taken for a severely injured person, what is to be considered when an anxiety-stricken patient presents to the hospital, and the authority of issuing an evacuation of a department/unit (53.7%, 52%, and 38.3%, respectively). In contrast, the least correctly answered questions were reported for the questions regarding appropriate actions for a lightly injured casualty, the appropriate method of communications in the case of a shutdown, and the recommended treatment protocol for a casualty suffering from a crush injury (5.3%, 7.5%, and 14.1%, respectively). No significant associations were detected between the given answers and genders ($p > 0.05$).

Interpretation of the knowledge level score created by the authors can be found in Table 5. The answers provided by the participants indicate that almost all of them have low and moderate perceived knowledge levels (99.6%). Additionally, results showed that more than half of the participants scored a low knowledge level (60.8%) followed by a moderate knowledge level (38.8%). Only a single subject (0.4%) scored a high knowledge level, therefore it is not presented in the table. Chi-square test results demonstrated no associations between the level of knowledge and all the demographic information collected ($p > 0.05$).

Table 3. Factors influencing decisions and willingness to report to work after floods.

| | | Willingness to Report to Work Following a Flood—Opinion as <i>n</i> (%) | | | | | <i>p</i> -Value (Independent Sample <i>t</i> -Test) |
|---|---------|--|------------------------|-----------------------------|----------------------|-------------------------|---|
| | | No, I Don't Believe I/They Will Show Up | The Chances Are Low | I Can't Decide | Yes, Almost Positive | Yes, without a Doubt | |
| Will you report to work immediately after a flood? | Female | 1 (1.9) | 2 (3.8) | 2 (3.8) | 12 (22.6) | 36 (67.9) | 0.915 |
| | Male | 4 (2.3) | 5 (2.9) | 11 (6.3) | 35 (20.1) | 119 (68.4) | |
| | All *** | 5 (2.2) | 7 (3.1) | 13 (5.7) | 47 (20.7) | 155 (68.3) | |
| In your opinion, will your colleagues report to work immediately after a flood? | Female | 1 (1.9) | 2 (3.8) | 9 (17) | 14 (26.4) | 27 (50.9) | 0.581 |
| | Male | 5 (2.9) | 7 (4) | 15 (8.6) | 52 (29.9) | 95 (54.6) | |
| | All *** | 6 (2.6) | 9 (4) | 24 (10.6) | 66 (29.1) | 122 (53.7) | |
| | | Factors Influencing Decision to Report to Work Following a Flood—Opinion as <i>n</i> (%) | | | | | <i>p</i> -value (Independent Sample <i>t</i> -test) |
| | | Not at All | To a Small Extent | To an Undefinable Extent | To a Medium Extent | To a Large Extent | |
| Concern for my family's wellbeing | Female | 0 (0) | 1 (1.9) | 0 (0) | 0 (0) | 49 (92.5) | 0.006 ** |
| | Male | 9 (5.2) | 5 (2.9) | 3 (1.7) | 12 (6.9) | 145 (83.3) | |
| | All *** | 9 (4) | 6 (2.6) | 3 (1.3) | 15 (6.6) | 194 (85.5) | |
| Concern that my house will be damaged in the flood | Female | 0 (0) | 3 (5.7) | 1 (1.9) | 6 (11.3) | 43 (81.1) | 0.018 * |
| | Male | 8 (4.6) | 14 (8) | 9 (5.2) | 22 (12.6) | 121 (69.5) | |
| | All *** | 8 (3.5) | 17 (7.5) | 10 (4.4) | 28 (12.3) | 164 (72.2) | |
| Professional commitment to care for the injured or ill | Female | 0 (0) | 1 (1.9) | 1 (1.9) | 5 (9.4) | 46 (86.8) | 0.038 * |
| | Male | 6 (3.4) | 8 (4.6) | 6 (3.4) | 12 (6.9) | 142 (81.6) | |
| | All *** | 6 (2.6) | 9 (4) | 7 (3.1) | 17 (7.5) | 188 (82.8) | |
| Fear of losing my place of employment due to my absence | Female | 10 (18.9) | 9 (17) | 5 (9.4) | 9 (17) | 20 (37.7) | 0.870 |
| | Male | 37 (21.3) | 27 (15.5) | 14 (8) | 18 (10.3) | 78 (44.8) | |
| | All *** | 47 (20.7) | 36 (15) | 19 (8.4) | 27 (11.9) | 98 (43.2) | |

***: Both genders; **: Significant at level 0.01; *: Significant at level 0.05.

Table 4. Perception towards guidelines development and training sessions.

| | | Developing a Guideline for Flood Disasters Accompanied with Training Sessions for Hospital Staff—Opinion as <i>n</i> (%) | | | | | <i>p</i> -Value (Independent Sample <i>t</i> -Test) |
|--|-----------|--|----------------------|--------------------------------|-----------------------|----------------------|---|
| | | Not at All | To a Small Extent | To an Undefinable Extent | To a Medium Extent | To a Large Extent | |
| Developing guidelines for flood disasters | Female | 0 (0) | 2 (3.8) | 1 (1.9) | 4 (7.5) | 46 (86.8) | 0.036 ** |
| | Male | 4 (2.3) | 7 (4) | 7 (4) | 31 (17.8) | 125 (71.8) | |
| | Total *** | 4 (1.8) | 9 (4) | 8 (3.5) | 35 (15.4) | 171 (75.3) | |
| Attending training sessions on how to manage flood disasters | Female | 0 (0) | 3 (5.7) | 0 (0) | 2 (3.8) | 48 (90.6) | 0.021 * |
| | Male | 7 (4) | 10 (5.7) | 5 (2.9) | 20 (11.5) | 132 (75.9) | |
| | Total *** | 7 (3.1) | 13 (5.7) | 5 (2.2) | 22 (9.7) | 180 (79.3) | |

*** Both genders; **: Significant at level 0.01; *: Significant at level 0.05.

Table 5. Level of knowledge and competency concerning a flood.

| | | Knowledge Level as <i>n</i> (%) § | | <i>p</i> -Value (Chi-Square Test) |
|--------------------|------------------|-----------------------------------|------------------------------|--------------------------------------|
| Groups | | Low (<i>n</i> = 138) | Moderate (<i>n</i> = 88) | |
| Gender | Male | 105 (46.5%) | 68 (30.1) | 0.485 |
| | Female | 33 (14.6%) | 20 (8.8) | |
| | Total ** | 138 (61.5%) | 88 (38.9) | |
| Age | 18–25 years | 22 (9.7%) | 19 (8.4) | 0.166 |
| | 26–34 years | 72 (31.9%) | 46 (20.4) | |
| | 35–44 years | 39 (17.3%) | 16 (7.1) | |
| | 45 and above | 5 (2.2%) | 7 (3.1) | |
| | Total ** | 138 (61.1%) | 88 (38.9%) | |
| Length of Service | Less than 1 | 21 (9.3%) | 16 (7.1%) | 0.531 |
| | 2–5 | 36 (15.9%) | 19 (8.4%) | |
| | 6–10 | 38 (16.8%) | 27 (11.9%) | |
| | 11–15 | 33 (14.6%) | 15 (6.6%) | |
| | 16–20 | 5 (2.2%) | 7 (3.1%) | |
| | 20+ years | 5 (2.2%) | 4 (1.8%) | |
| Type of Hospital | Private | 7 (3.1%) | 3 (1.3%) | 0.409 |
| | Government | 130 (58%) | 84 (37.5%) | |
| | Total ** | 137 (60.6%) | 87 (38.4%) | |
| Place of Residence | Riyadh | 97 (43.3%) | 70 (31.3%) | 0.471 |
| | Eastern Region | 3 (1.3%) | 2 (0.9%) | |
| | Makkah | 8 (3.6%) | 3 (1.3%) | |
| | Madinah | 7 (3.1%) | 4 (1.8%) | |
| | Qassim | 12 (5.4%) | 7 (3.1%) | |
| | Southern Region | 3 (1.3%) | 0 (0%) | |
| | Northern Borders | 7 (3.1%) | 1 (0.4%) | |
| Total ** | 137 (60.6%) | 87 (38.4%) | | |

Table 5. Cont.

| | | Knowledge Level as <i>n</i> (%) § | | |
|-----------------------------|---------------------------|-----------------------------------|------------------------------|--------------------------------------|
| | Groups | Low (<i>n</i> = 138) | Moderate (<i>n</i> = 88) | <i>p</i> -Value (Chi-Square Test) |
| Family Status | Single | 43 (19%) | 34 (15%) | 0.156 |
| | Married | 95 (42%) | 54 (23.9%) | |
| | Total ** | 138 (61%) | 88 (38.9%) | |
| Number of Children | 0 | 38 (16.8%) | 24 (10.6%) | 0.690 |
| | 1 | 29 (12.8%) | 19 (8.4%) | |
| | 2 | 32 (14.2%) | 14 (6.2%) | |
| | 3 | 19 (8.4%) | 15 (6.6%) | |
| | 3+ | 20 (8.8%) | 16 (7.1%) | |
| | Total ** | 138 (61%) | 88 (38.9%) | |
| The Department of Workplace | Nursing | 74 (32.7%) | 44 (19.5%) | 0.262 |
| | Physician | 10 (4.4%) | 5 (2.2%) | |
| | Paramedic | 5 (2.2%) | 10 (4.4%) | |
| | Pharmacy | 13 (5.8%) | 5 (2.2%) | |
| | Other Clinical | 24 (10.6%) | 19 (8.4%) | |
| | Support Services | 7 (3.1%) | 2 (0.9%) | |
| | Fiscal and Administrative | 5(2.2%) | 3 (1.3%) | |
| Total ** | 138 (61%) | 88 (38.9%) | | |
| Discipline | Nursing | 51 (22.6%) | 39 (17.3%) | 0.148 |
| | Physicians | 25 (11.1%) | 8 (3.5%) | |
| | Pharmacy | 13 (5.8%) | 4 (1.8%) | |
| | Other | 49 (21.7%) | 37 (16.4%) | |
| | Total * | 226 ** | 138 (61%) | |

§: The only single high knowledge score subject was excluded from the analysis of the Chi-square test to avoid statistical errors. *: Total number of participants with low and moderate knowledge scores. **: Both genders.

4. Discussion

This study assessed flood disaster preparedness among HCWs by measuring knowledge, attitudes, perceptions, and willingness to respond after a flood scenario. Nearly three-quarters of participants (73.2%) believed that hospitals are prepared to provide an effective response. Although many men had claimed to be familiar with their roles in the hospital's operation following a flood, only 56% among all respondents actually felt that they were familiar with their roles following a disaster flood scenario. In parallel, women were reported to be less confident, but perhaps had more realistic views about flooding risks in Saudi Arabia. Though multi-agency collaboration has long been a good base for disaster management, good collaboration between organizations requires a common understanding of their emergency response responsibilities and organizational frameworks [22]. It is expected that if all stakeholders took part in a well-designed and practiced inter-agency all-hazards emergency response, HCWs at multiple hospitals would be more likely to have more faith in their expertise, skills, and competence [23]. Thus, through a case study in Saudi Arabia, it is suggested that the principle of collaboration and its implementation in disaster management should be revisited within the country.

In a cross-sectional survey conducted in the United States (US), results suggested that the majority of HCWs expected to be provided personal protective equipment as well as other measures to ensure hospital staff safety following a disaster [24,25]. Notably,

94% of the US study participants were confident about their hospitals' abilities to respond effectively, with non-clinical staff found to be more confident when compared to clinical staff (OR 1.43, 95% CI: 1.15–1.78) [25]. These findings are in contrast with results of a previous study, which reported high awareness among emergency physicians and nurses in SA [25]. In a local study, a large number of participants (85.7%) were confident in terms of their ability to handle disasters in a large tertiary hospital [25]. This discrepancy may be explained due to the nature of the study sample, which enrolled only emergency department staff [26,27].

When the flood scenario was proposed in this study, 45% of men believed that they were more familiar with the hospital's standard operating procedures. Findings related to perceptions of knowledge and competency revealed that approximately 55% of all participants felt confident in the ability to treat flood victims. Concerns for personal safety, such as the hospital's infrastructure being able to withstand a flood, was reported by 44.5% of participants. An Australian study also reported concerns among HCWs when asked about their personal preparedness. The study reported negative responses among non-emergency nursing staff and physiotherapists. Only a limited number of staff were capable of identifying their roles during a disaster response [28]. The findings in this study have identified a high number of HCWs (89%) who were willing to report to work immediately after a flood. The former percentage dropped slightly when the same surveyed staff were asked about expectations regarding their colleagues and peers (82.8%). Therefore, a low percentage of absenteeism could be expected. However, fear of losing jobs due to absence from work was a prevalent opinion among 55.1% of respondents. It is important to note that a higher percentage of respondents were working in nursing divisions (52.4%), a profession known to be dominated by expatriates in SA [29].

Conversely, an analysis of 2864 responses from an online survey of HCWs in the United States reported safety concerns as the most frequently cited barrier preventing workers from returning to work after an influenza pandemic, or any other disaster involving contagion or contamination [29]. The authors have acknowledged that studies concerned with workforce absenteeism during disasters is increasing, but in general remain an underrepresented issue in emergency planning efforts [30]. Quershi reported that 81% of 6628 HCWs from 47 healthcare facilities in New York City and the surrounding areas were willing to report to work during an environmental disaster [31]. Findings of the Quershi study were consistent with our results.

In this study, females were found to be more committed to reporting to work ($p < 0.05$) as well as more concerned for the wellbeing of their families ($p < 0.01$) and towards their houses sustaining damage due to a flood ($p < 0.05$). In a study by Cone and Cummings [29], data from 1711 respondents revealed that 87% were willing to work after mass casualty events, mainly in the case of natural disasters, but were less willing to return to work if a man-made catastrophe was suggested. While workers in such man-made incidents should not be endangered, disaster planners should consider that reassurance and assistance for HCWs may need to be handled differently. Several studies suggest that fears of one's own safety, concern for the wellbeing of loved-ones, childcare, and other issues were linked to the failure of healthcare professionals to report for duty during crisis [31].

The need for developing flood disaster guidelines, accompanied with relevant training sessions of hospital staff, was a popular opinion for 90% of all participants—statistical significance was found among females ($p < 0.05$). The need for such guidance related to flood preparedness has been previously documented in other studies [32–35].

The hospital staff response was analyzed in terms of personal protective measures, case management/referral, and communication and competency skills listed in the protocols, policies, and procedures. Results of the flood scenario illustrated a surprising low percentage of correct answers, as stated previously. The scoring system from the checklist revealed that 99.6% of all HCWs demonstrated low to moderate levels of competency. Chi-square test results revealed no associations with the collected demographic information ($p > 0.05$). Our findings were consistent with a similar study in SA conducted

solely on nurses that reported a lack of knowledge in regard to disaster and emergency preparedness [36].

To our best knowledge, this is the first study to assess flood disaster preparedness and the willingness to respond among healthcare workers in SA.

Findings of this study revealed multiple significant differences among the independent variables. Thus, it is believed that these findings can serve as a foundation for describing the current situation in the central region of SA.

5. Limitations

A limitation of this study is the potential for misclassification bias. This might be due to the adopted questionnaire being designed to measure disasters preparedness for an earthquake scenario. Nevertheless, key aspects of providing healthcare services during these responses are generally shared among natural disasters, and mainly affected by the management of assets, human resources, victims' management and referral, mental health regulations, inter-agency collaboration, technology, information, communication, budget, and training management [37]. Another potential bias could be related to participants' previous exposure and experiences with floods in the past. Geographic representation of the sample is considered to be another limitation, since participants represented mainly the central region of SA. While the current study demonstrated a lack of preparedness for flooding, further studies on all hazard emergencies preparedness might be of limited value due to the nature of disasters in the Saudi context [21].

6. Conclusions

The study demonstrated that levels of preparation for flood disaster management among healthcare providers in Saudi Arabia is inadequate for effective flood disaster responses. Our findings suggest that a majority of HCWs are confident of their hospitals' preparedness to provide an effective response during flood disasters that is in line with the knowledge or theory side. Nevertheless, most of the participants (99.6%) demonstrated low and moderate levels of competency towards flood emergency preparedness due to the climate and geographical location of the kingdom. It is also estimated that a high percentage of HCWs are willing to report to work following a flood. Expected factors influencing the decision to report to work following a flood were concerns for their families' wellbeing, as well as towards the security of their houses. Our study is consistent with the results in the literature, demonstrating the shortcomings related to preparedness and training for an actual flooding disaster [38]. While future training on general disaster response and preparedness and command center activities to enhance the collaborations between stakeholders seems to be crucial, additional areas of improvement needed for managing the impacts of future episodes of floods requires the development of national preparedness and training guidelines for hospitals in SA, including full-scale disaster exercises to measure the effectiveness of preparedness and response [39–42]. Directions for future research should focus on the differences in terms of preparedness among hospitals belonging to governmental sectors (MOH, MOE, MODA, MOI, and SANG) in order to tailor training programs according to regional- and/or hospital-specific contexts and needs, and should also direct additional focus on all hazard responses, command center operations, and communications [43–47].

Flooding today must be both appreciated and managed as multifactorial events [48–52]. Therefore, developing guidelines and standard operating procedures in addition to the introduction of educational interventions, such as training campaigns, and designing mobile solutions aimed to enhance the knowledge and awareness among HCWs is highly recommended [53–67]. It is essential to make a major shift toward improvement as far as the notion of flood disaster preparedness for healthcare providers is concerned. This study contributes to a fuller understanding of the needs of Saudi healthcare workers and may aid in their better planning for future flood disasters.

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Appendix A

Table A1. Questions and answers regarding knowledge and competency concerning a flood scenario.

| Question | Correct Answers as <i>n</i> (%) | | | <i>p</i> -Value (Chi-Square Test) | |
|--|---|----------------------------|---------------------------|--------------------------------------|--------------------------|
| | Categories | Female (<i>n</i> = 53) | Male (<i>n</i> = 174) | | All (<i>n</i> = 227) |
| What are the protection measures that should be provided for immobile patients during a flood? | Evacuate the patient with his/her bed to an external site outside the department ^a | 13 (24.5) | 58 (33.3) | 71 (31.3) | 0.529 |
| | Evacuate the patient with his/her bed to the departmental protected area | 20 (37.7) | 58 (33.3) | 78 (34.4) | |
| | There is no way to protect immobile patients | 1 (1.9) | 5 (2.9) | 6 (2.6) | |
| | Protect the patients in their beds by placing items under their beds to raise height of beds | 6 (11.3) | 10 (5.7) | 16 (7) | |
| | I don't know | 13 (24.5) | 43 (24.7) | 56 (24.7) | |
| What are the personal protective actions the staff must implement during a flood? | Exit the department into the stairway all the way to the roof. | 18 (34) | 38 (21.8) | 56 (24.7) | 0.392 |
| | Depart externally, outside of the hospital's structure. | 5 (9.4) | 24 (13.8) | 29 (12.8) | |
| | Avoid working alone and wear a coast guard-approved life jacket/vest ^a | 7 (13.2) | 34 (19.5) | 41 (18.1) | |
| | Wear a coast guard-approved life jacket/vest and avoid floodwater areas. | 6 (11.3) | 30 (17.2) | 36 (15.9) | |
| | Dependent on the floor you are present in during the flood | 15 (28.3) | 41 (23.6) | 56 (24.7) | |
| I don't know | 2 (3.8) | 7 (4) | 9 (4) | | |

Table A1. Cont.

| Question | Correct Answers as <i>n</i> (%) | | | <i>p</i> -Value (Chi-Square Test) | |
|--|---|----------------------------|---------------------------|--------------------------------------|--------------------------|
| | Categories | Female (<i>n</i> = 53) | Male (<i>n</i> = 174) | | All (<i>n</i> = 227) |
| According to the standard operating procedure, what are the immediate actions to be implemented immediately following a flood? | Immediate evacuation of all patients from the department | 14 (26.4) | 53 (30.5) | 67 (29.5) | 0.128 |
| | Identification of hospital's departments that were damaged and provision of assistance as needed ^a | 5 (9.4) | 40 (23) | 45 (19.8) | |
| | Scout the area to locate casualties and damage | 13 (24.5) | 33 (19) | 46 (20.3) | |
| | Concentrate staff and patients in the department and wait for instructions from the hospital management | 4 (7.5) | 13 (7.5) | 17 (7.5) | |
| | I don't know | 17 (32.1) | 35 (20.1) | 52 (22.9) | |
| In case of potential damage to gas pipes and/or electricity supply infrastructure, what security measures should be implemented? | An immediate evacuation of the department | 19 (35.8) | 65 (37.4) | 84 (37) | 0.849 |
| | The electricity, water, and gas supplies should be disconnected immediately | 15 (28.3) | 51 (29.3) | 66 (29.1) | |
| | A substitute electricity source should be applied (a generator) ^a | 7 (13.2) | 26 (14.9) | 33 (14.5) | |
| | No action should be taken | 0 (0) | 2 (1.1) | 2 (0.9) | |
| | I don't know | 12 (22.6) | 30 (17.2) | 42 (18.5) | |
| Who is authorized to issue an evacuation of a department/unit? | The hospital's management solely | 10 (18.9) | 41 (23.6) | 51 (22.5) | 0.061 |
| | The hospital's management ^a | 15 (28.3) | 72 (41.4) | 87 (38.3) | |
| | The most senior member of the department | 2 (3.8) | 13 (7.5) | 15 (.6) | |
| | The head of the department | 11 (20.8) | 18 (10.3) | 29 (12.8) | |
| | I don't know | 15 (28.3) | 30 (17.2) | 45 (19.8) | |

Table A1. Cont.

| Question | Correct Answers as <i>n</i> (%) | | | <i>p</i> -Value (Chi-Square Test) | |
|--|---|----------------------------|---------------------------|--------------------------------------|--------------------------|
| | Categories | Female (<i>n</i> = 53) | Male (<i>n</i> = 174) | | All (<i>n</i> = 227) |
| What medical registration procedures apply regarding admittance of patients to the hospital following a flood? | The routine medical registration will be continued | 7 (13.2) | 19 (10.9) | 26 (11.5) | 0.837 |
| | Manual registration will be applied, and a list of casualties will be transferred ^a | 12 (22.6) | 50 (28.7) | 62 (27.3) | |
| | A small card will be utilized for every patient stating basic details and diagnosis | 12 (22.6) | 33 (19) | 45 (19.8) | |
| | In an emergency situation, there is no time for an organized medical registration | 6 (11.3) | 25 (14.4) | 31 (13.7) | |
| | I don't know | 16 (30.2) | 47 (27) | 63 (27.8) | |
| What is the recommended treatment protocol for a casualty suffering from a crush syndrome upon arrival at the hospital? | Amputation of the wounded limb | 3 (5.7) | 11 (6.3) | 14 (6.2) | 0.596 |
| | Fasciotomy and extensive debridement of the necrotic muscle | 9 (17) | 34 (19.5) | 43 (18.9) | |
| | Aggressive treatment with fluids and diuretics to prevent systemic complications ^a | 11 (20.8) | 21 (12.1) | 32 (14.1) | |
| | Immediate hemodialysis | 1 (1.9) | 2 (1.1) | 3 (1.3) | |
| | I don't know | 29 (54.7) | 106 (60.9) | 135 (59.5) | |
| What is the appropriate action when a lightly injured casualty (for example, with limb wounds) presents to the hospital? | The patient should be directed to a designated site deployed outside the hospital area | 12 (22.6) | 47 (27) | 59 (26) | 0.925 |
| | The patient should enter the hospital area and be provided with immediate treatment | 22 (41.5) | 65 (37.4) | 87 (38.3) | |
| | The patient should be evacuated to a distant hospital for treatment ^a | 2 (3.8) | 10 (5.7) | 12 (5.3) | |
| | The patient should be directed to a designated site to be treated by a social worker/psychologist | 3 (5.7) | 8 (4.6) | 11 (4.8) | |
| | I don't know | 14 (26.4) | 44 (25.3) | 58 (25.6) | |

Table A1. Cont.

| Question | Correct Answers as <i>n</i> (%) | | | <i>p</i> -Value (Chi-Square Test) | |
|--|--|----------------------------|---------------------------|--------------------------------------|--------------------------|
| | Categories | Female (<i>n</i> = 53) | Male (<i>n</i> = 174) | | All (<i>n</i> = 227) |
| What is the appropriate action when a severely injured person (for example, suffering from crush syndrome or needing amputation) presents to the hospital? | The patient should be directed to one of the designated sites deployed outside the hospital area | 7 (13.2) | 25 (14.4) | 32 (14.1) | 0.532 |
| | The patient should enter the hospital area and be provided with immediate treatment ^a | 32 (60.4) | 90 (51.7) | 122 (53.7) | |
| | The patient should be evacuated to a distant hospital for treatment | 2 (3.8) | 11 (6.3) | 13 (5.7) | |
| | The patient should be directed to a designated site to be treated by a social worker/psychologist | 0 (0) | 9 (5.2) | 9 (4) | |
| | I don't know | 12 (22.6) | 38 (21.8) | 50 (22) | |
| What is the appropriate action when an anxiety-stricken patient presents to the hospital? | The patient should be directed to one of the designated sites deployed outside the hospital area | 6 (11.3) | 25 (14.4) | 31 (13.7) | 0.687 |
| | The patient should enter the hospital area and be provided with immediate treatment | 2 (3.8) | 15 (8.6) | 17 (7.5) | |
| | The patient should be evacuated to a distant hospital for treatment | 1 (1.9) | 5 (2.9) | 6 (2.6) | |
| | The patient should be directed to a designated site to be treated by a social worker/psychologist ^a | 31 (58.5) | 87 (50) | 118 (52) | |
| | I don't know | 13 (24.5) | 42 (24.1) | 55 (24.2) | |

Table A1. Cont.

| Question | Correct Answers as <i>n</i> (%) | | | <i>p</i> -Value (Chi-Square Test) | |
|---|--|----------------------------|---------------------------|--------------------------------------|--------------------------|
| | Categories | Female (<i>n</i> = 53) | Male (<i>n</i> = 174) | | All (<i>n</i> = 227) |
| Following a flood, how will the control and communication inside the hospital be conducted? | No organized report mechanism can be implemented during an emergency | 3 (5.7) | 5 (2.9) | 8 (3.5) | 0.128 |
| | There is need to report solely to the director of the emergency department | 1 (1.9) | 14 (8) | 15 (6.6) | |
| | An emergency operation center will be created by the management ^a | 12 (22.6) | 41 (23.6) | 53 (23.3) | |
| | An emergency operation center will be created by the management and turned to only when needed | 12 (22.6) | 66 (37.9) | 78 (34.4) | |
| | I don't know | 25 (47.2) | 48 (27.6) | 73 (32.2) | |
| Immediately following a flood, collapse of communication mechanisms may occur between the hospital and external institutions. Who should be reported to during this time? | The regional EMS (emergency medical services) center via ambulance drivers | 25 (47.2) | 90 (51.7) | 115 (50.7) | 0.339 |
| | There is a need to wait for renewal of communication channels, and then a report should be submitted to the Ministry of Health | 5 (9.4) | 19 (10.9) | 24 (10.6) | |
| | Media reporters (television, radio) | 3 (5.7) | 2 (1.1) | 5 (2.2) | |
| | The police via local/field police teams ^a | 3 (5.7) | 14 (8) | 17 (7.5) | |
| | I don't know | 17 (32.1) | 49 (28.2) | 66 (29.1) | |

Data are expressed as *n* (% of participants). ^a Correct answer according to published data.

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