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Emergency Health Care Workers' Preparedness and Willingness to Respond to a Dirty Bomb-related Disaster in Pakistan

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Original Research

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Abstract

Objective: Our study examined the association between willingness-to-respond (WTR) and behavioral factors, demographics, and work-related characteristics among emergency department healthcare workers (HCWs) toward a radiological dispersal device (RDD) ("dirty bomb") blast scenario in Pakistan.

Methods: A cross-sectional survey was conducted in August to September 2022 among emergency department HCWs from 2 hospitals in Karachi, Pakistan. Nonprobability purposive sampling was used to recruit participants. Multivariate logistic regression analyses were performed to examine the association between WTR and key attitudes/beliefs, including perceived norms, preparedness, and safety, as well as the EPPM variables.

Results: Among behavioral factors, perceived likelihood that colleagues will report to work duty, perceived importance of one's role, and psychological preparedness showed particularly significant associations with WTR; 53.6% of participants indicated low perceived threat, while 46.43% showed high perceived threat, toward an RDD disaster scenario.

Conclusion: Our findings point to the need to improve WTR toward an RDD event by shifting behavioral factors among HCWs through efficacy-focused training; enhancing WTR through such training strategies is imperative beyond mere delivery of information. Changing norms around response, along with institutional support, may further boost WTR during RDD emergencies.

Introduction

Over the past 2 decades, the global threat of terrorism has intensified, with devastating attacks occurring in both high-income countries (e.g., USA 2001, Madrid bombings 2004, London bombings 2005) and low- and middle-income countries (LMICs) (e.g., Mumbai attacks 2006 and 2009, Karachi bomb blasts in 2009 and 2013).[1–7] Bombing incidents have also occurred in several regions of Pakistan, especially in the provinces of Khyber Pakhtunkhwa and Baluchistan.[8]

Bomb blasts have been a devastating reality in Pakistan for over 2 decades. Since 2000, the country has witnessed 7883 explosions, with 360 incidents reported in 2024 alone. These attacks have taken a heavy toll, claiming nearly 70,000 lives, including many health care workers (HCW).[9–13] Beyond the fatalities, the injuries from these blasts are severe, often requiring urgent and extensive medical care, emphasizing the need for stronger emergency response systems, better trauma care, and policies aimed at reducing the frequency and impact of such attacks.[14,15]

Radiological dispersal devices (RDDs), also known as dirty bombs, are relatively simple and imprecise weapons. They combine conventional explosives such as dynamite with radioactive material. The explosion can scatter radioactive material across a wide area.[16] These man-made disasters have a dual impact: physical injuries from the blast itself and psychological trauma from the fear of radiation exposure.[17] Experts believe that while an RDD might not cause widespread physical casualties from a public health perspective,[18,19] the fear and panic it creates within the general population can be significant. Furthermore, radiological disasters pose serious health and safety risks for both the affected population and first responders who provide emergency medical care and mitigation at the incident site.[20] The US Centers for Disease Control and Prevention

(CDC) estimates that 50-80% of victims of an explosive event arrive at medical facilities within the first 90 minutes.[21] In Pakistan, the average ambulance response time is approximately 30 minutes; however, many ambulances are poorly equipped, and drivers often lack the necessary training to manage mass casualty emergencies.[22] Most ambulance services in the country operate through private or charity-based organizations, such as Edhi, Chhipa, and Aman Foundation. In recent years, the not-for-profit organization "Aman Foundation" has introduced an ambulance that includes advanced medical services with trained paramedics, aiming to improve pre-hospital emergency care.[22] Later, it partnered with Sindh Integrated Emergency & Health Services (SIEHS-1122), revolutionizing emergency care by introducing Pakistan's first state-of-the-art, life-saving ambulance service.[23]

A prior study conducted in the US indicates that HCWs are less likely to report to work in case of radiological events when compared to other disasters.[24] In Pakistan, most bomb blast victims are rushed into ambulances and other vehicles by the "Scoop & Run" method, with mostly just one emergency transport provider, the driver onboard without any trained staff.[25–27] Lack of coordination among different responding organizations in Pakistan exists; this usually leads to the victims being dropped off at the nearest trauma center, irrespective of its capacity, causing significant overcrowding and further overwhelming the health care staff.[26] Often, these mass casualty events are followed by large-scale public outbursts and violence, with emotionally charged people entering emergency departments.[26] The influx often exceeds the capacity of hospital security systems, making it challenging to maintain order and ensure the delivery of timely medical care. Currently, no standard system of triage, prehospital decontamination, or transfer protocol exists in Pakistan, increasing the risk of HCWs' exposure to radiation in case of a dirty bomb explosion.[25,26,28]

Given these challenges, HCWs' willingness to respond (WTR), an attitudinal dimension distinct from knowledge and skills, has critical implications for health care institutional surge capacity in emergency situations.[29] Our study examined the association between WTR and behavioral factors, demographics, and work-related characteristics among emergency department HCWs during a dirty bomb scenario in Pakistan. Findings of the study can help guide effective intervention strategies for enhancing HCWs' WTR in such disasters. [29]

Methods

A cross-sectional survey was conducted in August to September 2022 among HCWs in the Emergency Departments of Aga Khan University Hospital (AKUH) and Jinnah Postgraduate Medical Centre (JPMC) in Karachi, Pakistan. This survey evaluated willingness to respond (WTR) to 3 hazardous scenarios: weather-related disasters (published previously),[30] a pandemic (published previously)[31] and RDDs [dirty bombs]. We aimed to examine how self-efficacy and other behavioral factors, along with demographics and work-related characteristics, are associated with WTR.

The methodology, including participant recruitment, inclusion and exclusion criteria, and data analysis techniques, has been detailed in previous publications.[30,31] This paper specifically presents findings on WTR in dirty bomb situations, utilizing a modified version of the Hospital Infrastructure Response Survey Tool, which incorporates selected items from the General Self-Efficacy Scale.[29]

In this study, "WTR if asked" refers to HCWs who are off duty but willing to respond if called upon by the hospital, whereas "WTR if required" signifies that all HCWs are on duty and obligated to respond.[30,31]

Data Analysis

In total, 362 individuals completed the survey, constituting 97.83% of emergency department staff at AKUH and JPMC. Responses from a total of 252 emergency department health workers were analyzed (Table 1), after excluding those who provided only "don't

Table 1. Demographic characteristics of emergency department health workers in Karachi, Pakistan (n = 252)

	N	%
Sociodemographic characteristics		
Gender		
Male	105	41.67
Female	147	58.33
Age		
20–29	164	65.08
30–39	61	24.21
40–49	18	7.14
50–59	8	3.17
60 or older	1	0.40
Education		
High School Diploma	50	19.92
Bachelor's Degree	13	5.18
Master's Degree	160	63.75
Professional Degree	28	11.16
Single parent		
No	216	86.40
Yes	34	13.60
Living with children		
No	154	61.11
Yes	98	38.89
Living with elderly		
No	102	40.48
Yes	150	59.52
Living with pets		
No	218	86.85
Yes	33	13.15
Using public transportation for commute		
No	151	60.16
Yes	100	39.84
Work-related characteristics		
Hospital affiliation		
Aga Khan University	180	72.87
Jinnah Postgraduate Medical College	67	27.13

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Table 1. (*Continued*)

	N	%
Primary affiliation		
No	17	6.77
Yes	234	93.23
Length of hospital affiliation		
Less than 1 year	56	22.40
1–5 years	129	51.60
6–10 years	37	14.80
More than 10 years	28	11.20
Work hours per week		
Less than 10 hours	18	7.20
11–19 hours	13	5.20
20–29 hours	5	2.00
30–39 hours	30	12.00
40–49 hours	92	36.80
More than 50 hours	92	36.80
Role in department		
Faculty	11	4.37
Resident physician/Fellow	99	39.29
Physician Extender (PA; NP)	7	2.78
Nurse	93	36.90
Clinical Support Staff	18	7.14
Research	2	0.79
Other	22	8.73
Length of role affiliation		
Less than 1 year	60	23.81
1–5 years	133	52.78
6–10 years	34	13.49
More than 10 years	25	9.92

know" responses or did not respond to any WTR or belief statements in RDD emergencies.

Ethics Statement

Ethical approval for the study was obtained from the Johns Hopkins Bloomberg School of Public Health Institutional Review Board (IRB00019662), the AKUH Ethics Review Committee (6959) and the JPMC Institutional Review Board (f.2-81/2022-GEN/133/JPMC).

Results

Of the survey respondents, 147 (58.33%) participants were females and 105 (41.67%) were males. More than half of respondents (n = 164, 65.08%) were aged 20 to 29. Most had a master's degree (n = 160, 63.75%), and approximately one-fifth had a high school diploma (n = 50, 19.92%). Thirty-four (13.60%) participants were living as single parents. More than half of health workers (n = 150, 59.52%) were living with elderly dependents. Ninety-two (36.80%) participants reported working from 40 to 49 hours a week, and the same number of people worked over 50 hours a week on average. Most participants were either resident physicians (n = 99, 39.29%) or nurses (n = 93, 36.90%). The resident group reported no firsthand experience of managing bomb blast event in Karachi.

Associations between demographic characteristics and willingness to respond to dirty bomb emergencies are described in Table 2. Health workers' overall willingness to respond was 59.13% if required and 61.13% if asked. WTR between female and male participants was not significantly different. HCWs aged 40 and 49 were more willing to respond than those aged 20-29 (OR 3.63, 95% CI 1.01–13.03) if required, but not if asked (but not required). WTR to dirty bomb emergencies did not vary by health workers' education level or family dynamic. Those using public transportation for commute showed higher WTR than those were not if required (OR 1.75, 95% CI 1.04–2.97). Among work-related characteristics, work hours were negatively associated with WTR. Participants who worked more than 50 hours per week were 75% less likely to report to work during dirty bomb emergencies if required, compared with those who worked less than 10 hours (OR .25, 95% CI .08–.82). One's role in the emergency department and length of affiliation were not significantly associated with WTR.

Table 3 shows associations between WTR and attitudes/beliefs about dirty bomb emergency response. Age and role within hospital were found to be independently associated with both WTR if required and WTR if asked in a multivariate analysis and were controlled in the logistic regression analyses. After adjusting for these factors, most attitudes/beliefs were significantly associated with WTR if required. Participants who believed that colleagues would report during dirty bomb emergencies were 23 times more likely to show WTR than those who did not if required (OR 22.82, 95% CI 11.03–47.21) and 12 times more if asked (OR 12.10, 95% CI 6.07–24.12), demonstrating the highest associations among the attitude/belief factors. Health workers who know how important their roles are in the hospital showed 13 greater odds of responding to dirty bomb disasters than their counterparts if required (OR 13.03, 95% CI 6.89–24.65). Psychological preparedness and family preparedness were significantly positively associated with WTR (OR 10.35, 95% CI 5.55–19.31; OR 9.06, 95% CI 4.82–17.04). Emergency-specific self-efficacy beliefs, including perceived ability to perform duty (OR 8.62, 95% CI 4.60–16.14), perceived ability to address patient concerns (OR 8.37, 95% CI 4.51–15.53), and perceived high impact of one's response (OR 7.05, 95% CI 3.90–12.76) were significantly associated with WTR if required. General self-efficacy was not associated with WTR. Most attitudes/beliefs were significantly associated with WTR if asked, but with lower odds ratios than WTR if required. Health workers aware of role-specific responsibilities (OR 6.95, 95% CI 3.86–12.51) and having skills for those responsibilities (OR 6.42, 95% CI 3.56–11.57) were more likely to report.

Participants' EPPM profile and its association with WTR are described in Table 4. 53.57% participants showed low perceived threat, while 46.43% showed high perceived threat toward dirty bomb emergencies. Having higher perceived threat was significantly associated with WTR if required (OR 3.51, 95% CI 2.04–6.03) and if asked but not required (OR 2.13, 95% CI 1.25–3.63). In total, 51.19% of participants had low efficacy, and 48.81% of participants showed high efficacy toward dirty bomb events. Health workers who reported having high efficacy were 7 times more likely to report to work when required (OR 7.22, 95% CI 4.03–12.92) and

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Table 2. Associations between participant demographics and willingness to respond to a dirty bomb emergency

	WTR, if required		WTR, if asked	
	59.13%		61.13%	
All[d]	% Agree[a]	OR (95% CI)[b,c]	% Agree[a]	OR (95% CI)[b,c]
Sociodemographic characteristics				
Gender				
Male	59.05	–	61.76	–
Female	59.18	1.01 (.60, 1.67)	60.69	.96 (.57, 1.61)
Age				
20–29	57.93	–	61.11	–
30–39	52.46	.80 (.44, 1.45)	57.63	.87 (.47, 1.59)
40–49	83.33	**3.63*** (1.01, 13.03)	70.59	1.53 (.51, 4.54)
50 or older	87.50	5.08 (.61, 42.28)	75.00	1.91 (.37, 9.76)
Education				
High School	58.00	–	53.06	–
Bachelor's Degree	53.85	.84 (.25, 2.88)	58.33	1.24 (.35, 4.44)
Master's Degree	56.88	.96 (.50, 1.82)	61.64	1.42 (.75, 2.71)
Professional Degree	78.57	2.66 (.92, 7.69)	74.07	2.53 (.90, 7.06)
Single parent				
No	57.41	–	59.24	–
Yes	67.65	1.55 (.72, 3.34)	70.59	1.65 (.75, 3.63)
Living with children				
No	59.09	–	64.24	–
Yes	59.18	1.00 (.60, 1.68)	56.25	.72 (.41, 1.21)
Living with elderly				
No	54.90	–	55.10	–
Yes	62.00	1.34 (.80, 2.23)	65.10	1.52 (.90, 2.56)
Living with pets				
No	58.72	–	61.50	–
Yes	60.61	1.08 (.51, 2.29)	57.58	.85 (.40, 1.79)
Using public transportation for commute				
No	53.64	–	58.00	–
Yes	67.00	**1.75*** (1.04, 2.97)	65.62	1.38 (.81, 2.35)
Work-related characteristics				
Hospital affiliation				
Jinnah Postgraduate Medical College	67.16	–	65.62	–
Aga Khan University	55.00	.60 (.33, 1.07)	58.43	.74 (.41, 1.34)
Primary affiliation				
No	76.47	–	70.59	–
Yes	57.69	.42 (.13, 1.33)	60.26	.63 (.22, 1.85)
Length of hospital affiliation				
Less than 1 year	67.86	–	64.71	–
1–5 years	55.04	.58 (.30, 1.12)	59.54	.80 (.41, 1.57)
6–10 years	56.76	.62 (.26, 1.47)	59.46	.80 (.33, 1.91)
More than 10 years	64.29	.85 (.33, 2.22)	61.54	.87 (.33, 2.32)

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Table 2. (*Continued*)

	WTR, if required		WTR, if asked	
	59.13%		61.13%	
All[d]	% Agree[a]	OR (95% CI)[b,c]	% Agree[a]	OR (95% CI)[b,c]
Work hours per week				
Less than 10 hours	77.78	–	80.00	–
11–19 hours	69.23	.64 (.13, 3.25)	57.14	.33 (.07, 1.53)
20–29 hours	40.00	.19 (.02, 1.57)	33.33	.13 (.01, 1.75)
30–39 hours	66.67	.57 (.15, 2.19)	60.00	.38 (.10, 1.40)
40–49 hours	65.22	.54 (.16, 1.76)	56.32	.32 (.10, 1.04)
More than 50 hours	46.74	**.25*** (.08, .82)	62.64	.42 (.13, 1.36)
Role in department				
Faculty	45.45	–	30.00	–
Resident physician/Fellow	56.57	1.56 (.45, 5.46)	60.00	3.5 (.85, 14.34)
Physician Extender (PA; NP)	71.43	3.00 (.40, 22.71)	40.00	1.56 (.17, 14.65)
Nurse	54.84	1.46 (.42, 5.11)	59.78	3.47 (.84, 14.28)
Clinical Support Staff	100.00	–	100.00	–
Research	0.00	–	0.00	–
Other	0.00	2.1 (.48, 9.14)	66.67	4.67 (.92, 23.79)
Length of role affiliation				
Less than 1 year	63.33	–	64.39	–
1–5 years	54.14	.68 (.37, 1.28)	57.14	.74 (.39, 1.41)
6–10 years	58.82	.83 (.35, 1.96)	64.71	1.02 (.42, 2.48)
More than 10 years	76.00	1.83 (.64, 5.28)	70.83	1.35 (.48, 3.80)

[a]Percent agreeing with WTR statement.
[b]Odds ratios represent the odds of stating a positive WTR for the respective positive attitude/belief response compared to the negative response.
[c]*P <.05, **P <.01, ***P <.001.
[d]Percent pertaining to all survey respondents.

Table 3. Associations between attitudes/beliefs and self-reported willingness to respond to a dirty bomb emergency

	WTR, if required		WTR, if asked	
	% Agree[a]	OR (95% CI)[b,c]	% Agree[a]	OR (95% CI)[b,c]
Perceived likelihood of occurrence in this region	72.32	3.33 (1.86, 5.95)	71.30	2.30 (1.29, 4.08)
Perceived severity of health consequences	75.57	4.74 (2.68, 8.37)	70.31	2.17 (1.26, 3.73)
Perceived likelihood of being asked to report to duty	82.54	9.56 (5.18, 17.66)	76.86	3.83 (2.18, 6.74)
Perceived likelihood that colleagues will report	89.92	22.82 (11.03, 47.21)	88.70	12.10 (6.07, 24.12)
Perceived knowledge about the public health impact	75.17	6.07 (3.37, 10.91)	78.77	6.38 (3.55, 11.47)
Perceived awareness of role-specific responsibilities	77.78	8.34 (4.57, 15.24)	79.43	6.95 (3.86, 12.51)
Perceived skills for role-specific responsibilities	79.53	7.42 (4.12, 13.39)	81.60	6.42 (3.56, 11.57)
Perceived importance of one's role in the hospital's response	81.51	13.03 (6.89, 24.65)	76.60	4.82 (2.73, 8.53)
Psychological preparedness	79.45	10.35 (5.55, 19.31)	77.78	5.49 (3.08, 9.79)
Perceived confidence in safety to get to work	78.36	7.36 (3.99, 13.57)	79.26	5.76 (3.18, 10.44)

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Table 3. (*Continued*)

	WTR, if required		WTR, if asked	
	% Agree[a]	OR (95% CI)[b,c]	% Agree[a]	OR (95% CI)[b,c]
Perceived confidence in personal safety at work	80.99	7.88 (4.25, 14.60)	78.33	4.05 (2.26, 7.25)
Perceived preparedness of family in absence	81.36	9.06 (4.82, 17.04)	77.59	4.37 (2.45, 7.80)
Perceived hospital ability to provide timely information	82.93	9.17 (4.97, 16.91)	73.77	2.85 (1.65, 4.93)
Perceived need for preevent preparation and training	76.12	5.37 (3.07, 9.40)	71.09	2.44 (1.43, 4.17)
Perceived need for during/postevent psychological support	74.38	3.86 (2.23, 6.69)	71.55	2.42 (1.41, 4.15)
Self-efficacy and response efficacy				
General self-efficacy	64.29	1.59 (.98, 2.59)	61.87	.84 (.50, 1.40)
Emergency-related self-efficacy				
Perceived ability to perform duties	77.30	8.62 (4.60, 16.14)	79.86	7.21 (3.92, 13.28)
Perceived ability to address patient concerns	76.35	8.37 (4.51, 15.53)	74.83	5.06 (2.85, 8.98)
Perceived high impact of one's response	76.60	7.05 (3.90, 12.76)	76.09	4.58 (2.59, 8.12)

[a]Percent agreeing with WTR statement.
[b]Odds ratios represent the odds of stating a positive WTR for the respective positive attitude/belief response compared to the negative response.
[c]All associations with WTR were statistically significant, except for general self-efficacy. Perceived occurrence, perceived severity, perceived need for preevent preparation, and perceived need for postevent support showed significant associations with WTR if asked at $P < .01$. All other associations were significant at $P < .001$.

Table 4. Associations between EPPM categories and self-reported willingness to respond (WTR) to a dirty bomb emergency

		WTR, if required		WTR, if asked	
Extended Parallel Process Model profile	N(%)[a]	% Agree[b]	OR (95% CI)[b,c,d]	% Agree[b]	OR (95% CI)[b,c,d]
Low threat	135 (53.57)	45.93	–	53.33	–
High threat	117 (46.43)	74.36	3.51*** (2.04, 6.03)	70.54	2.13** (1.25, 3.63)
Low efficacy	129 (51.19)	37.98	–	42.97	–
High efficacy	123 (48.81)	81.30	7.22*** (4.03, 12.92)	80.67	5.53*** (3.11, 9.85)
Low threat/low efficacy	85 (33.73)	29.41	–	40.70	–
Low threat/high efficacy	50 (19.84)	74.00	7.06*** (3.19, 15.65)	75.51	4.43*** (2.02, 9.69)
High threat/low efficacy	44 (17.46)	54.55	3.03** (1.41, 6.54)	47.62	1.33 (.63, 2.82)
High threat/high efficacy	73 (28.97)	86.30	15.87*** (6.94, 36.27)	84.29	7.93*** (3.65, 17.24)

[a]Frequencies and percent of respondents in each respective threat and efficacy category.
[b]Percent agreeing with WTR statement.
[c]Odds ratios represent the odds of stating a positive WTR for the respective positive attitude/belief response compared to the negative response.
[d]*$P < .05$, **$P < .01$, ***$P < .001$.

6 times more likely to report if asked but not required (OR 5.53, 95% CI 2.02–9.69), compared to those who had low efficacy.

The analysis of EPPM-based profiles further revealed the role of efficacy and risk beliefs. 28.97% of participants were in the high threat/high efficacy profile, while approximately one-third (33.73%) of participants were in the low threat/low efficacy profile. Health workers in the high threat/high efficacy profile were approximately 16 times more likely to be willing to respond to dirty bomb disasters

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than those in the low threat/low efficacy profile if required (OR 15.87, 95% CI 6.94–36.27), and those in the low threat/high efficacy profile were 7 times more likely to show WTR (OR 7.06, 95% CI 3.19–15.65). Those in the high threat/low efficacy category were 3 times more likely to show WTR if required (OR 3.03, 95% CI 1.41–6.54), compared with participants in the low threat and efficacy group. Similarly, participants with high perceived threat and high efficacy were 7 times more likely to respond to dirty bomb emergencies if asked (OR 7.93, 95% CI 3.65–17.24), compared with the low threat and low efficacy group. In contrast with WTR if required, those in the high threat/low efficacy profile were not significantly different in exhibiting willingness from the low threat/low efficacy group during dirty bomb emergencies.

Discussion

Bomb blasts have been a persistent security threat and place immense pressure on hospitals and emergency services. Due to the sudden and aggressive nature of these events, they severely disrupt the functioning of the emergency department.[25] HCWs often must work additional hours under significant stress in disasters, and the emergency department represents a critical nexus for improving response capacity in such situations. This study examined Pakistan-based emergency department HCWs' perceptions and perspectives toward willingness to respond (WTR) to an RDD ("dirty bomb") blast scenario. We investigated the association of demographic and attitudinal/belief characteristics with WTR and assessed the impact of Extended Parallel Process Model (EPPM) perceived threat and perceived efficacy categories on WTR. Overall, HCWs' WTR in response to a dirty bomb emergency was 59.13% if required, and 61.1% if asked but not required. Age and reliance on public transport were positively associated with WTR if required, while longer working hours were negatively associated.

As with previous research on self-efficacy with regard to disaster response, multiple attitudes/beliefs and perceptions[32,33] were found to be significant predictors of willingness to respond. In particular, multiple attitudes/beliefs were found to be strong predictors of WTR to the dirty bomb scenario.

Both WTR if required and WTR if asked but not required were positively associated with perceived likelihood that colleagues would report. Other factors positively associated with WTR, if required, included the perceived importance of one's role, psychological preparedness, perceived preparedness of one's family in their absence, and perceived ability to provide timely information. WTR, if asked, was linked to perceived awareness and knowledge of the public health impact, as well as awareness of and perceived skills for role-specific responsibilities. A study conducted in 2 government-run trauma centers in Karachi indicated that there were no simulated drills or disaster management courses for HCWs in the emergency department. [34] Despite that, our study identified a positive association regarding perceived knowledge of the public health impact, with approximately 75% of participants agreeing with its importance. Readiness and skills to deal with such a situation can be acquired through didactic teaching, simulated training, and real-life experience.[35] Studies have shown that disaster-specific training positively influences HCWs' response in emergencies and disasters. A study from Saudi Arabia indicated that although a high number of participants had training in disaster management and were supposed to be able and ready, most of them were unwilling to provide care unconditionally in the bomb blast or dirty bomb scenario.[36] Special focus toward addressing their barriers toward responding such as such as lack of self-efficacy and emotional distractions because of uncertainty about the safety issues can help them to respond cohesively. [36]

Two other studies from the US and Japan also identified significant differences in WTR depending on whether HCWs were asked versus required to respond.[17,37] Our previous studies on weather and pandemic scenarios[30,31] showed similar variations in WTR if required versus if asked but not required among HCWs, which contrasts with studies conducted in other regions.[38,39]

Among the demographic characteristics, age was one of the important factors influencing WTR. This study found a significant association between age and WTR, with those aged 40-49 years being 3.63 times more likely to be willing to respond to dirty bomb emergencies. Similarly, a study conducted in the US reported a higher WTR among individuals aged 50-59 years,[17] highlighting the potential role of age-related factors such as experience, confidence, and risk perception in emergency preparedness. While other research[17] reports negative association of WTR with public transport, this study showed positive association between public transport and WTR; this finding requires further contextual exploration of perceived safety, self-efficacy, and availability of alternate transport options.

The overall WTR in a dirty bomb scenario was 59.13% if asked, which aligns with previous studies in the US, showing similar findings.[17] Prior research on radiological disaster scenarios indicates that WTR among HCWs ranges from 39% to 76%, and our findings align with the higher end of this range, even with the differences in training of HCWs, lack of drills, and suboptimal coordination of disaster response in Pakistan.[24,37,40–42] The anticipated behavior of coworkers emerged as a significant predictor of HCWs' WTR to dirty bomb scenarios. Turner et al. also found that firefighters and emergency medical services (EMS) personnel were more likely to exhibit WTR if required, if they believed their colleagues would also respond, emphasizing the influence of peer behavior on individual willingness to respond. [43]

Perception of family preparedness during disasters was identified as a significant predictor of HCWs' willingness to respond (WTR) in this study.[43] Balicer et al. reported that HCWs were 7.73 times more likely to respond in RDD scenarios if they believed their families were prepared to function in their absence.[17] Similarly, our findings demonstrated that the odds of reporting to work were nine times higher if HCWs were required to respond and 2.85 times higher if they were asked to respond. These results highlight the critical role of perceived family preparedness in enhancing willingness, potentially by reducing personal and emotional barriers associated with leaving loved ones during emergencies.

We observed a negative association between working hours and willingness to respond (WTR). Specifically, individuals who work more than 50 hours per week tend to show a lower WTR when required. During critical events, HCWs are often required to work extended hours under stressful conditions, potentially putting their safety at risk. In the context of an RDD event, health care professionals may experience significant psychological distress due to the perceived threat and uncertainty associated with such incidents.[17]

While HCWs' *ability* to manage disasters is important, ability itself is not always sufficient. Willingness also serves as an important construct, and studies have reported that HCWs, although trained in disaster management, can be unwilling to provide care.[38] This study provides insights into WTR determinants and offers an opportunity to address barriers that could be amended by appropriate interventions such as transportation and addressing psychological distress and personal safety as suggested by previous studies. [40]

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Limitations

This study was limited to 2 large urban teaching institutions and thus limited to external validity. It can be interpreted that these results are conservative, indicating that the actual willingness to respond in a real-life event may be lower, though it is improbable that it would be higher. The findings and recommendations for enhancing training and organizational support systems are nonetheless still broadly relevant to HCWs in other regions of Pakistan.

Conclusion

This Pakistan-based study provides insights into the factors influencing HCWs' willingness to respond to a dirty bomb emergency in an LMIC setting. Our findings highlight the importance of psychological preparedness, perceived support from colleagues and family, and organizational support in enhancing WTR. The study also underscores the need for targeted training programs and organizational policies to improve knowledge, skills, and confidence among HCWs.

By addressing the identified factors, such as self-efficacy, perceived risk, and organizational support, health care institutions in resource-challenged settings can significantly improve the preparedness and willingness of their workforce to respond to such emergencies. Future research should explore the long-term impact of these interventions and investigate the role of cultural and societal factors in shaping HCWs' response behaviors. Additionally, longitudinal studies can provide valuable insights into the evolving dynamics of HCWs' preparedness over time. The findings of this study suggest the substantial potential for efficacy-centered training to enhance HCWs' WTR to a radiological disaster scenario in an LMIC environment. In a related practical vein, this study's findings point to the timely need for applied research into the utility, feasibility, and impact of low-cost, efficient training modalities such as mHealth, to bolster HCWs' WTR and accordingly enhance health system disaster surge capacity in resource-challenged environments.

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