Factors Associated with High-Rise Evacuation: Qualitative Results from the World Trade Center Evacuation Study

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Keywords: disasters; evacuation; high-rise buildings; human behaviors; human factors; organizational factors; workplace disasters; World Trade Center

Abbreviations:
WTC = World Trade Center

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Abstract

Introduction: Due to the fact that most high-rise structures (i.e., >75 feet high, or eight to ten stories) are constructed with extensive and redundant fire safety features, current fire safety procedures typically only involve limited evacuation during minor to moderate fire emergencies. Therefore, full-scale evacuation of high-rise buildings is highly unusual and consequently, little is known about how readily and rapidly high-rise structures can be evacuated fully. Factors that either facilitate or inhibit the evacuation process remain under-studied.
Objective: This paper presents results from the qualitative phase of the World Trade Center Evacuation Study, a three-year, five-phase study designed to improve our understanding of the individual, organizational, and environmental factors that helped or hindered evacuation from the World Trade Center (WTC) Towers 1 and 2, on 11 September 2001.
Methods: Qualitative data from semi-structured, in-depth interviews and focus groups involving WTC evacuees were collected and analyzed.
Results: On the individual level, factors that affected evacuation included perception of risk (formed largely by sensory cues), preparedness training, degree of familiarity with the building, physical condition, health status, and footwear. Individual behavior also was affected by group behavior and leadership. At the organizational level, evacuation was affected by worksite preparedness planning, including the training and education of building occupants, and risk communication. The environmental conditions affecting evacuation included smoke, flames, debris, general condition and degree of crowdedness on staircases, and communication infrastructure systems (e.g., public address, landline, cellular and fire warden's telephones).
Conclusions: Various factors at the individual, organizational, and environmental levels were identified that affected evacuation. Interventions that address the barriers to evacuation may improve the full-scale evacuation of other high-rise buildings under extreme conditions. Further studies should focus on the development and evaluation of targeted interventions, including model emergency preparedness planning for high-rise occupancies.

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Introduction

High-rise buildings, generally defined as ≥75 feet (23 meters) in height (eight to ten or more stories) may be susceptible to various emergencies. However, emergencies rarely result in full-scale emergency evacuation due to the robust construction and redundant fire safety features of high-rise structures. Nevertheless, in the last decade, several events have resulted in the need for full-scale emergency evacuation. These events highlight the underlying vulnerability of high-rise structures and the difficulty of mass evacuation, especially under extreme conditions. Recent events, such as terrorist attacks targeting iconic or government structures (e.g., the bombing of the World Trade Center (WTC) in 1993, the Murrah building bombing in Oklahoma in 1995, and the WTC disaster in 2001),[1–3] technological disasters (e.g. during the blackout in the eastern United States in 2003),[4] and high-rise fires (e.g., 2003 and

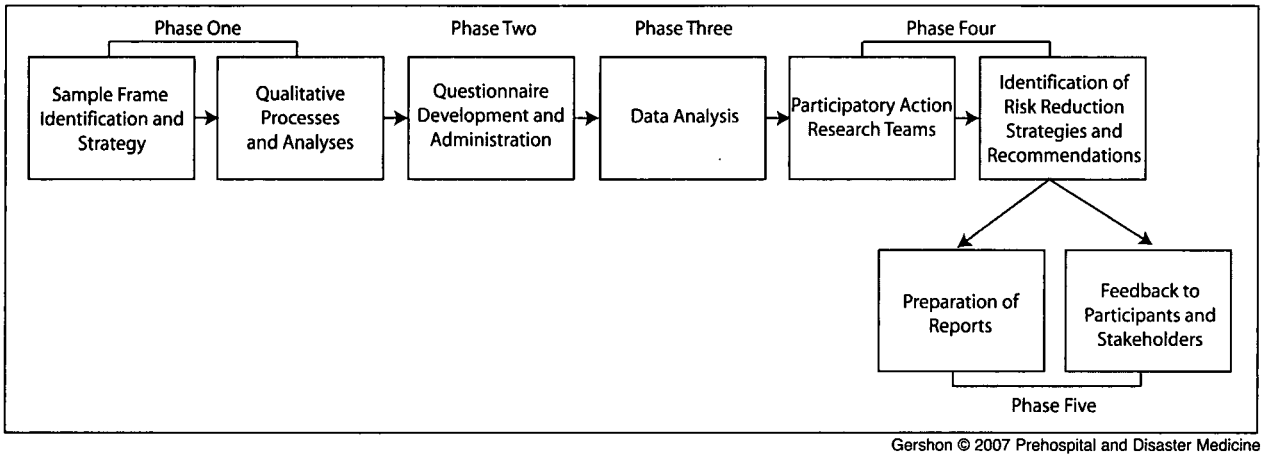

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Figure 1—World Trade Center Evacuation Study overview

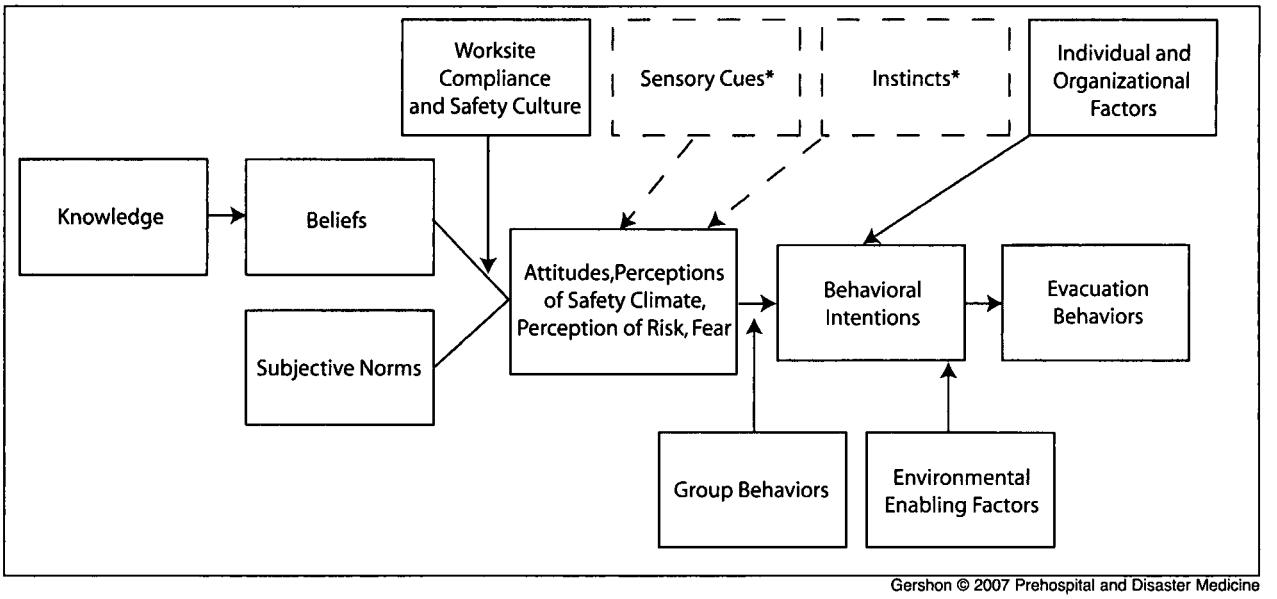

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Figure 2—Model used to guide the key and sub hypothesis of the study
* dotted lines denote factors added to the original model based on qualitative findings

2004 Chicago fires)[5,6] highlight the complexity of evacuating a large number of occupants in a short period of time. These events also emphasize the necessity of planning for high-rise evacuation—even though evacuation may rarely be needed.

Background Information

At 08:46 hours (h) on 11 September 2001, terrorists flew an American Airlines Boeing 767 passenger plane into WTC Tower 1.[7] The impact occurred on the north side of the building between the 94th and 98th floors (each tower had 110 floors). At the time of impact, the airplane was traveling 470 mph and carried an estimated 10,000 gallons of fuel. Seventeen minutes later, a second, terrorist-flown United Airlines Boeing 767 hit the south side of WTC Tower 2 between the 78th and 84th floors. This plane was traveling 590 mph and also carried an estimated 10,000 gallons of fuel. In WTC Tower 1, the impact destroyed all three sets of fire-escape stairwells above the 92nd floor, cut all elevator lines, and rendered the public announcement (PA) system inoperable. In WTC Tower 2, two sets of stairs were destroyed above the 77th floor and one set remained intact, although engulfed in smoke. The impact destroyed most of both buildings' elevator, electrical, and internal communication systems. The communications towers on the roof of WTC Tower 1 quickly were inactivated by fire damage, rendering most mobile telephones within the building inoperable. The collapse of WTC Tower 2 occurred 57 minutes after impact, followed by the collapse of WTC Tower 1, 102 minutes after impact. With nearly 2,800 deaths related to the WTC attacks (including 157 individuals on the two airplanes),[8] this was the worst terrorist attack in US history (the Pearl Harbor death toll was 2,403).

Of the approximately 17,400 individuals present in WTC Towers 1 and 2 when the attack occurred (there were typically 100,000 occupants and visitors on an average weekday), >14,000 successfully evacuated the buildings. Had the buildings been fully occupied, it has been estimated that the evacuation would have taken more than four hours.[7]

This report describes the qualitative results of the first phase of the WTC Evacuation Study, which was designed

Construct	Characteristics	Major Factor Category
Attitudes, perceptions of safety climate, perception of risk, fear	The individual's perceived risk to self, as well as his/her perception of his/her employer's commitment to safe work practices	Individual
Behavioral intentions	The behavioral intentions regarding evacuation	Individual
Beliefs	Belief in one's own ability to determine the need for evacuating and belief in one's capability to do so	Individual
Environmental enabling factors	The physical environment facilitators which helped the evacuee during the evacuation	Environmental
Evacuation behaviors	Specific actions taken by the individual evacuee regarding evacuation	Individual
Group behaviors	Collective behavior of a group of individuals	Individual and organizational
Individual and organizational factors	Specific characteristics of the individual or organization that might affect evacuation	Individual and organizational
Knowledge	The individual's awareness and understanding of evacuation protocols and procedures, as well as possible means of egress from the building	Individual
Subjective norms	Basic understanding of what was considered to be appropriate for the situation within the context of the social work environment; Influence of co-workers and supervisors	Organizational
Worksite compliance and safety culture	Safety practices and procedures of employers, and the managers, and fire safety personnel of the WTC buildings	Organizational
Sensory Cues*	Cues in the environment (e.g., smoke, fire, noise, alarms) that served to make the individual aware of an event	Individual
Instinct*	Instinctive sense ("gut feeling") of danger	Individual

Table 1—Model constructs and predefined characteristics (WTC = World Trade Center)
* dotted lines denote factors added to the original model based on qualitative findings

to identify the individual, organizational, and environmental factors that either aided or hindered evacuation from the WTC Towers 1 and 2 on 11 September 2001. The purpose of Phase 1 of this study was to validate the theoretical model that guided the development of the Phase 2 survey of evacuees (Figure 1). In-depth interviews were conducted and focus groups were convened to explore the applicability of the study model (Figure 2), which was based upon DeJoy's behavioral diagnostic safety model, as well the literature on human behaviors in emergencies.[9–29] The constructs of the model are illustrated in Table 1.

Methods

Eighteen months after the attack, a multimedia study recruitment campaign was launched. Surviving WTC volunteers chose to participate in one of two qualitative procedures (i.e., in-depth interviews or focus groups). Data from 30 semi-structured interviews and five focus groups, each with four participants, were collected. Each interview and focus group was two to two and one-half hours in length, and was conducted by experienced, doctorally trained interviewers using a prepared script, which addressed the study constructs. Sessions were tape-record-

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Decision to Initiate Evacuation	Facilitators	Barriers
Individual factors	-Emergent perception of risk formed by sensory cues -Intuition -Prior experience in WTC in 1993 -Thought it was a terrorist event -Knew what to do in order to evacuate -Told by significant other to leave	-Low knowledge level; not sure of location of stairwell exits -New to job, hesitant to leave for fear of consequences of evacuating -Delaying behaviors (calling others, work tasks, gathering personal belongings, etc.) -Fearful or unsure of physical capabilities
Organizational factors	-Instructed by person in authority to leave -Instructed by colleague to leave -Informed by colleagues of the event -Person with authoritative voice shouted directions	-No guidance immediately provided on what had occurred, areas affected, or what occupants should do -Ambivalent or contradictory messages -New managers unsure of procedures to follow, staff were waiting for a directive from them -PA announcement to stay or return to offices (WTC Tower 2)
Environmental/Sensory cues	-Heard/saw and felt and explosion, at same time, felt building sway -Saw a flash of light, or plane hit the other building -Lights flickered on and off -Smelled smoke or fumes -Saw debris out of the window	-Received no environmental cues (did not see, hear, feel immediate impact or aftermath) -Communication failures

Table 2—Key factors related to *initiation* of evacuation (PA = public address; WTC = World Trade Center)

ed and later transcribed for analysis, resulting in approximately 3,000 pages of transcribed data. All aspects of the study strictly adhered to published guidelines regarding the ethical conduct of disaster research,[30] and several steps were taken to assess and minimize the risk of adverse effects related to participation.[31] All procedures involving human subjects had prior review and approval of the Columbia University Institutional Review Board, and signed informed consent was obtained from participants before each session.

Analysis

An eclectic approach was taken that utilized manifest and latent thematic coding as well as deductive and inductive data analysis procedures.[32] First, in order to become familiar with the data, each transcript was independently read twice by two senior investigators. Then, each transcript was read once more, and each investigator independently highlighted key words and phrases and wrote summary notes in the margins of each document. Afterwards, point comparisons were made between the investigators' entries; inter-rater reliability was assessed and was extremely high (*kappa* = 0.92). Each transcript was read for a fourth time in order to perform manifest analysis, in which key words and phrases were collated. Major themes were identified and coded into three major categories: (1) individual; (2) organizational; or (3) environmental factors. Then, latent thematic analysis of each factor was conducted, and each factor was characterized as either a facilitator or a barrier to evacuation.

Utilizing a deductive analysis process, each identified factor was mapped to the original theoretical model (predefined constructs of the initial model are listed in Table 1). Afterwards, an inductive analysis approach was taken to identify additional factors and themes that were not included in the original model. The final goal of the analysis was to examine evacuation behaviors and the social processes that helped to form these behaviors.

Results

Sample Demographics

A majority (60%) of the participants were male, the mean value of their ages was 44 years, and most were well-educated (90% with 13 or more years of education). The average tenure at their WTC place of employment was seven years.

Individual Factors that Influenced Evacuation

Facilitators of Initiation—In concordance with other emergency evacuation studies,[16–18] peri-event sensory cues were important in motivating individuals to rapidly initiate evacuation (Table 2). Some evacuees first became aware of the incident by feeling the initial impact, hearing an explosion, and/or simultaneously feeling a powerful sway of the building. This quickly was followed, for some individuals, by a powerful odor of burning fuel. In both WTC Towers 1 and 2, these cues, when coupled with seeing one or both planes strike the buildings, prompted an almost immediate decision to evacuate. Of the individuals who did not see the planes, but did feel that something unusual had happened, those who had experienced the 1993 WTC bombing or other high-rise building fires, or who thought that there had been a terrorist attack, reported feeling fearful and quickly decided to leave. One individual reported, "I just had a sense that something was not right," while another

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Evacuation Progress	Facilitators	Barriers
Individual	-High degree of fire safety knowledge from prior training or prior experience in 1993 -High level of knowledge of the building (also helped to guide others out) -Good footwear -Followed the crowd -Followed supervisors, other leadership -Heeded encouragement by others (firefighters, other first responders, and building management) to keep moving	-Poor physical condition, obesity, experienced fatigue on stairs, mobility challenged -Low levels of fire safety knowledge: New employee, never participated in a drill; generally unfamiliar with the stairs or evacuation route, considered switching to an elevator -Inappropriate footwear slowed speed of walking down the stairs, subsequent removal of shoes led to injury in the lobby due to glass/debris
Organizational	-Management behaviors: Executive used bullhorn to order evacuation; people left and kept going; a few followed supervisors off floor, down stairs -First responders in the lobby assisted with direction out of building -First responders on stairs encouraged evacuees to keep going	-Stopped evacuation in response to the PA announcement: "All safe, can return to office", some went back, others slowed down -Lack of direction out of building

Environmental	-Strong environmental cues: Evacuees heeded strong environmental cues to continue or speed up pace of evacuation, these included:
	  -Building swayed
	  -Felt vibration on stairs when second plane hit WTC Tower 2
	  -Smelled smoke or fumes
	  -Smoke conditions intensified
	-Supportive social milieu on staircase
	  -Group behavior on the stairs for most part civilized, orderly, calm
	  -Individuals assisted and supported each other
	-Stairwell in good condition; well-lighted; marked railings; verbal and physical support on stairs, lobby, and street
		-Debris on stairs
		-Smoke conditions on stairs made it difficult to breathe
		-Crowds and first responders on staircase
		-Slow moving individuals slowed group behind them (persons who were elderly, had mobility problems, were obese, those who were injured, hysterical (rare))
		-Locked doors prevented exit out of stairwell back onto floors
		-Glass and debris in lobby slowed progress through this area
		-Rare accounts of social disorganization: People hysterical, people screaming, two people got into a fight about taking an elevator
		-In lobby area: Some people shoving to get out of building

Table 3—Key factors related to *progression* of evacuation

noted, "I heard a tremendous crash and...my first instinct was that something was very, very wrong." Many individuals did not know all of the facts, but initiated evacuation due to their "gut reaction". Other cues, such as seeing paper and debris floating in the air outside of the windows, described as "silver rain", were difficult for individuals to make sense of and led to further investigation.

Barriers to Initiation—Frequently, even in the presence of one or more cues, participants who did not see the plane(s) or who lacked prior experience, reported a number of delaying activities (Table 2). These included: (1) completing last minute personal and/or work activities (e.g., making phone calls, shutting down computers, collecting personal items); (2) seeking permission to leave; (3) and/or seeking information (e.g., regarding what had happened, what floors were involved, how to respond, whether to take the elevator (if operable) or stairs).

Participants also reported delays related to certain concerns (e.g., their ability to walk down multiple flights of stairs) and their unfamiliarity, in general, with the building layout regarding where individual stairwells were located and where they terminated (i.e., whether or not they would end at street-level exits).

Facilitators of Progression—Sensory cues also played an important role in the evacuation progression (Table 3). For example, some participants reported that they were in WTC Tower 2 stairwells when the second plane impacted their building; they felt the building shake, smelled fuel, and saw smoke. These cues served to motivate them to continue evacuation, increase their pace, and not return upstairs, despite the fact that there had been several previous announcements telling them that it was safe to return to their offices. These cues served to create a sense of danger that resulted in purposeful movement of the evacuees.

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Another factor that aided progression was a positive social milieu on the stairwell. Most respondents reported that group behavior on the stairs was calm, orderly, and civilized. Group activities, such as chanting, counting floors, cheering as each flight of stairs was completed, were described as helpful. Individuals praying aloud also was cited as comforting to others around them. Subjects described multiple instances in which evacuees provided psychological, social, and physical support to one another. The participants described a sense of social cohesion that created a protective atmosphere for the group. Few individuals reported encountering social disorganization or people acting in an uncontrolled manner. Where individual cases of panic-like behavior (i.e., freezing) or extreme anxiety were reported, those nearest to the panicked individual promptly acted to reduce the panic behavior (e.g., held the person tightly, shook them, carried them over their shoulder).

Barriers to Progression—Certain types of footwear played an important role as a barrier to progression (Table 3). Several female participants reported that uncomfortable shoes (e.g., high heels, slip-ons) slowed them down, and in some cases, they had to be removed. Missing or lost shoes became problematic in the lobby area where glass and debris made it hazardous to walk barefoot; some participants reported that they had to be carried. Many participants reported their physical condition slowed them down. Other individuals reported that evacuees who were obese, in generally poor physical condition, or who had a disability, slowed down those who were behind them on the staircase.

Organizational Factors that Influenced Evacuation

Leadership—Several participants reported that rapid, decisive direction by a person perceived to be an authority figure prompted them to initiate evacuation (Table 2). As one participant reported, "This man spoke in an authoritative voice...that served to get my antennae up...." Conversely, where the directive was given by a person of perceived lesser authority, others were slower to react. Some participants reported that they received an ambivalent message from management regarding leaving, which caused delays in the initiation of evacuation.

Along the route of evacuation, the presence or absence of leadership also affected evacuation progress (Table 3). Many participants reported that the assistance they received from first responders directing traffic and providing direction through the lobby was very helpful and reassuring, as many were confused and disoriented, especially if they were exiting the building via a route or exit with which they were unfamiliar. Only a small number of individuals reported that a company manager led the way into the stairway, down the stairwell, and out of the building, although those who did report this clearly identified their manager as an evacuation leader. Several participants reported that certain non-management individuals emerged as leaders. These leaders used an authoritative voice to issue clear directives and, as one participant noted, "[the person] just seemed to take charge."

Participants also reported that the lack of official information, and in some instances, lack of managers present at the time of the attack, caused them to hesitate with regards to initiating the evacuation. They reported that they did not want to make decisions on their own, especially decisions based on limited information. This resulted in information-seeking behaviors (milling about, seeking out others, trying to use cell phones and telephones, etc.), which, in turn, further delayed the initiation of evacuation. Several participants stated that they delayed evacuating because they believed that senior administrators and/or direct supervisors would disapprove of employees leaving their work area without permission.

Emergency Preparedness—While most individuals reported that they had received prior fire safety training, few had ever been inside of a stairwell as part of that training (Table 3). Participants who had received extensive fire and emergency preparedness training by their employer reported a high degree of confidence and acted quickly. In addition, those with experience from the 1993 WTC bombing or with first responder or military training, reported that this experience/knowledge helped them to act quickly and calmly during the evacuation process. It seems that these pre-existing individual factors could, to some extent, compensate for a lack of training on the organizational level. Newly hired employees were less likely to have received any evacuation or fire drill training. Some individuals reported that while they had a low level of knowledge, they followed what appeared to be a knowledgeable crowd. Both individual and collective knowledge frequently were cited as assisting in evacuation.

Communications—Communication within individual organizations had a strong influence on the initiation and progression of the evacuation. In cases in which the organization had an emergency evacuation plan that was communicated to the employees before the events that day, and in instances where management ordered the evacuation in a clear, direct manner, people reported that they immediately left and stayed on task (Table 3). Where employees were unfamiliar with the emergency plan and/or did not receive a direct order, the initiation of the evacuation was delayed. An important organizational barrier to sustaining rapid evacuation progress in WTC Tower 2 was a PA system announcement which repeatedly stated that the WTC Tower 2 was safe, and that people could return to their offices. Most of the participants who heard this announcement disregarded the directive, although several reported that they had considered returning or that they knew of people who actually did return. As one participant noted after hearing the announcement, "At that point, a lot of people got off the staircases, it was quite noticeable. I mean before we were kind of packed in there while we were walking and I kind of felt it did help me get out quicker because of the great amount of people who exited onto the floors."

Environmental Factors that Influenced Evacuation—As noted, sensory cues also affected the progression of evacuation (Table 2). Many individuals reported that the buildings'

physical safety features, such as adequate lighting on the staircases, and handrails, and steps marked with reflective tape, also significantly facilitated the orderly evacuation (Table 3).

However, there also were building conditions that impeded progress of the evacuation. Key barriers included: (1) structural damage, such as debris on the stairways and collapsed interior walls that blocked egress routes; (2) heavy congestion on certain stairways due to the sheer number of people descending and counter flow of first responders moving upwards with equipment; (3) slowly moving individuals (which caused a back-up of those behind them); (4) debris and glass in the lobby; (5) smoke and water conditions on the stairs, which intensified towards the end of the evacuation; and, in a few cases, (6) locked staircase doors (i.e., doors leading back onto floors). Slow moving individuals included people with various types of conditions, including general poor health or fitness, obesity, persons who use wheelchairs or guide dogs, and the elderly.

Discussion

Although it was initially thought that environmental cues mainly affected evacuation by serving as barriers to egress, it was found that sensory cues, even when ambiguous and relatively subtle, were very influential in terms of individual decision-making for both initiation and progression. These findings are similar to those of other research on emergency behaviors, indicating that environmental cues play a key role in the assessment of risk.[18,33] During the evacuation process, a high level of knowledge related to fire safety procedures, staircase location, and building layout, coupled with ongoing sensory cues that indicated that the situation was dangerous, supported the evacuation process. Well-lighted, uncluttered staircases, with well-marked handrails, also served to facilitate rapid evacuation. Significant social cohesion and support helped to minimize panic-type behavior and further supported progress. Progress was slowed where: (1) knowledge about fire safety procedures and/or the location of the staircases was limited; (2) there was a lack of direction from managers; or (3) there were slower moving individuals on the staircase due to physical health conditions or inappropriate footwear.

While individual knowledge and organizational preparation were important factors, prior individual emergency experience could mitigate gaps in organizational preparedness, and conversely, a high level of organizational preparedness also could, to some degree, compensate for deficiencies at the individual's preparedness level.

Participants reported that service workers and temporary employees were less likely to have participated in fire safety training or been informed of procedures during an emergency. Therefore, these workers were at a disadvantage because of their lack of familiarity with the building evacuation procedures. Even some seasoned workers reported that they were unaware of how to evacuate through routes that deviated from their normal travel path. Therefore, orienting high-rise occupants to their buildings and planning for visitors and new employees is important for fire safety directors and building managers to address. These findings are consistent with previous studies by Drabek and others.[22,26,33]

There were several factors that served as facilitators for some individuals, but within the same context, were barriers for others. For example, several respondents reported that while they felt that evacuation was warranted, they first felt compelled to search for people who would help confirm this. While this was beneficial for the group, it potentially increased the length of time to evacuate for the individual. Similarly, the heroic efforts of those assisting others with mobility impairments may have helped save many lives, but in doing so, these helpers delayed their own evacuation progress. This created a dilemma for some of those providing aid. One individual stated that "you want to help others, but you don't want to hinder yourself." The issue of designating and training evacuation leaders and helpers should be the subject of further discussion and study.

Similarly, communication played an important role both as a facilitator and a barrier. The widespread failure of the various communication systems in both Towers soon after the impacts led to information-seeking behaviors, which in turn delayed initiation of evacuation. However, the lack of information regarding what actually had happened may have helped to prevent panic-type behaviors. Participants reported that when information was received, it was more influential if it came from a trusted, close personal source (e.g., immediate supervisor, co-worker, family member) Many people in WTC Tower 2 decided not to follow the PA announcements to stay in place, which was made shortly after WTC Tower 1 was attacked. While the decision to ignore this announcement led to a positive outcome in this instance, not heeding official announcements in other emergency situations could prove to be a bad decision with a disastrous outcome. The challenges presented by the communication failures at all levels in the WTC disaster must be addressed in future high-rise emergency planning.

Recent events indicate that high-rise occupancies can also be high-risk occupancies. Therefore, occupants of high-rise buildings should be prepared for total building evacuation within a limited time span. Research from the WTC Evacuation Study and other similar initiatives can help inform stakeholders, such as builders, developers, building managers, fire safety directors, lease holders, employee groups, emergency planners, and insurance companies about risk reduction strategies. This information also can inform regulators at the federal, state, and local levels. Further studies should focus on the development and evaluation of model emergency preparedness programs for high-rise occupancies to ensure adequate readiness.

Conclusions

With respect to the overall findings of the qualitative phase of this study, these data support the original study model; all the constructs were found to be relevant. Within each of the three domains (individual, organizational, and environmental), the original constructs were found to affect either initiation, progression, or both. However, two important additions to the original study model were identified: (1) sensory cues were important for facilitating emergent risk perception; and (2) intuition ("gut feelings") emerged as a strong evacuation motivator for some individuals. Even in

Individual Level	-High-rise building occupants should be provided with appropriate training and education to ensure their familiarity with the building and with all of the building's safety features. -Occupants should personally assess their ability to descend multiple floors and be prepared by having appropriate footwear readily available. -Individuals requiring assistance should work closely with their employer and/or building management to address this in preparedness plans. -Occupants of high-rise buildings must know not only who has authority to order an evacuation of their building, but under what conditions they should personally take responsibility for initiating their own evacuation. -In the absence of clear evidence and direction from authorities, and with limited information, individuals should be prepared to evacuate following their building's plan, especially if they have an instinctive sense of potential danger.
Organizational Level	-Clear assignment of responsibilities must be established among building owner/operator, tenant/leaseholder (i.e., the employer), and building management of high-rise occupancies in terms of preparing a written evacuation plan, conducting fire/evacuation drills, conducting building orientation walk-throughs, and assessing readiness and ability of employees to evacuate. -Emergency communication strategies and message development should be addressed in the preparedness planning. -Written plans and policies should be prepared and practiced to ensure the safe evacuation of individuals with disabilities or health conditions affecting mobility (e.g., obesity, asthma, pregnancy). -Evacuation training, including training for new employees, as well as annual training, should be mandatory for all employees or building occupants. Training should be tailored to the needs (e.g., language) of the occupants. Complete orientation to the building should include the location and destination of all exit routes. -Contracted service employees and temporary or casual workers (e.g., food service workers, contractors, repair personnel) also should receive evacuation training that addresses their unique work areas (e.g., construction sites). Training and information also should be provided to workers on evening and night shifts. Plans for assisting these individuals should be the responsibility of both the building manager, as well as the contracting employer. -Fire drills should include entering all stairwells, with special emphasis on any unusual stairwell features such as locked stairway doors (e.g., locked for security purposes) and crossover points. Where feasible, drills should include actually descending two or three levels, preferably ending at street-level floors. -Evacuation leaders should be recruited and provided with special training in evacuation procedures and crowd management. These leaders should be identified clearly. -Planning of evacuation should be coordinated with local agencies (such as fire, police, emergency operations, transportation, utilities).
Environmental Level	-Adequacy of existing safety features to support full building evacuation should be assessed and, if needed, addressed (e.g., emergency lighting, signage, communication system backup, stairwell number and width, reinforced stairwell walls, etc.).

Table 4—Recommendations

the absence of clear-cut cues or information, risk assessments were made and perceptions were formed—this, in turn, may have contributed to the "gut feeling" to which several participants referred. While these two factors were not part of the initial study model, they were addressed in the final survey instrument as a result of the qualitative findings. The results of the quantitative phase of this study will further assess the utility of this model in terms of the understanding high-rise evacuation. Based on the qualitative data, a number of recommendations are made (Table 4); most of these are low cost, practical interventions, which readily can be implemented by building managers and leaseholders.

These qualitative findings are consistent with current theories on human behaviors during emergencies, as well as other reports on emergency evacuation, and also support the preliminary findings.[9–29,34] It is acknowledged that these qualitative findings cannot provide an estimate of prevalence of these factors and are subject to a number of study limitations, including both recall and responder biases and lack of generalizability. Importantly, these findings apply to high-rise business occupancies and not necessarily to residential buildings. The factors that affect evacuation from residential high-rises may be quite different from business high-rises and should be the focus of additional study. It also should be noted that these findings are limited to a small sample of WTC Towers 1 and 2 occupants who successfully evacuated; information regarding those who perished during the disaster are not addressed here. Nevertheless, by the very nature of in-depth interviews and focus groups, qualitative findings provide valuable insights into complex problems.

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