Architectural Considerations and Design for Rehabilitation Centers for war related Post-traumatic stress disorder patients in Iran

Abstract

Aims: This study explored and proposed architectural design strategies for rehabilitation centers serving individuals affected by war-related Post-Traumatic Stress Disorder in Iran.

Methods: Employing a comprehensive mixed-methods approach, the study integrates a literature review of global best practices in healing architecture, expert consultations involving architects, psychologists, and PTSD patients, as well as on-site analyses of existing rehabilitation facilities within Iran.

Findings: The literature review revealed a consistent emphasis on trauma-informed design principles such as predictability, privacy, and sensory modulation as critical components in reducing anxiety and fostering emotional regulation. Case studies of exemplary facilities worldwide demonstrated the success of incorporating natural light, views of nature, flexible layouts, and quiet zones in PTSD-centered spaces.

.Survey results highlighted the high importance placed on elements like natural lighting, calming color schemes, sound insulation, ergonomic furnishings, and spatial arrangements that balance privacy with social interaction. These findings were triangulated with feedback from mental health professionals and architects, resulting in a set of evidence-based design guidelines tailored to the cultural and socio-economic context of Iranian rehabilitation settings.

Conclusion: This research contributes to the field of architectural design for mental health by offering actionable and context-sensitive strategies. These recommendations aim to enhance the quality of care and accelerate the healing process for war-affected individuals, while addressing the limitations of existing infrastructure and resources.

Keywords:
Post-Traumatic Stress Disorder (PTSD), Architecture, Rehabilitation, Therapeutic Design,

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Introduction:

Post-traumatic stress disorder (PTSD) is one of the most common psychological consequences of exposure to life-threatening events. A systematic review reported prevalence rates of 10–50% among disaster survivors, with an overall odds ratio of 1.84 compared with non-exposed groups [1]. Causes are diverse, ranging from natural disasters such as earthquakes and floods to human-induced trauma including war, torture, and forced migration. A meta-analysis of flood survivors found a PTSD incidence of 15.7% (95% CI: 11.3–20.8%), while a 2018 review identified exposure severity, female gender, socioeconomic disadvantage, and low psychosocial resources as consistent predictors of PTSD [2]. Much of the research has focused on survivors of natural disasters, emphasizing protective factors such as social support and community cohesion.

In Iran, decades of war and political upheaval have left a lasting psychological impact. The World Health Organization estimates PTSD prevalence at 30% among Iranian war veterans [3], while a 2021 meta-analysis reported a rate of 27.8% among veterans, combatants, and freedmen of the Iran-Iraq War [4]. These levels surpass those reported in some civilian and military contexts, underscoring the need for specialized interventions, including the design of rehabilitation environments tailored to this population.

PTSD is linked to neurobiological alterations in the hippocampus, amygdala, and prefrontal cortex [5], producing symptoms such as hyperarousal, intrusive memories, and emotional dysregulation. Psychological theories of recovery from cognitive-behavioral models emphasizing cognitive restructuring to psychodynamic approaches highlighting the processing of trauma illustrate the importance of environments that support safety, reflection, and social connection.

The concept of healing architecture recognizes that physical environments influence psychological wellbeing. Empirical evidence demonstrates that natural light improves mood [6], acoustic quality reduces stress, and calming colors enhance comfort and safety [7]. Intuitive way-finding, social spaces, control over the environment [8], air quality, and ergonomic design all contribute to recovery. Studies confirm that trauma-informed design features such as private spaces, adjustable lighting, and access to green communal areas improve emotional regulation and reduce re-traumatization [9–13]. Ulrich's seminal work (1984) further established that patients exposed to natural views recover faster and require less medication, findings equally relevant to mental health and PTSD care [14].
Despite extensive global evidence, traditional mental healthcare facilities in Iran often lack such therapeutic design features. Considering the country's history of war and continuing conflicts, the absence of specialized rehabilitation centers for PTSD represents a critical gap. Addressing the architectural and environmental dimensions of care within Iran's cultural and social context is therefore an urgent priority.

Instrument and Methods:

This study employed a mixed-methods research design to comprehensively examine the architectural requirements and therapeutic impacts of rehabilitation environments for war-affected individuals with Post-Traumatic Stress Disorder (PTSD) in Iran. The research process unfolded in four interrelated phases, each building upon the previous stage and culminating in the formulation of evidence-based and contextually appropriate architectural guidelines.

In the first phase, a systematic review of international and regional literature was conducted to identify key architectural and environmental factors that support trauma recovery, with a particular focus on healing architecture, environmental psychology, and evidence-based design (EBD). The sources included peer-reviewed journals, books, technical reports, and institutional guidelines. Based on insights from this review, a primary draft of a structured questionnaire was developed, aimed at capturing stakeholder perceptions of therapeutic architectural features.

The second phase engaged experts and stakeholders to refine and finalize the questionnaire. Using purposive sampling, three main groups were recruited: mental health professionals (psychiatrists, psychologists and therapists), war-affected PTSD patients and their families, and architects/designers specializing in healthcare facilities. The qualitative component included 18 semi-structured interviews (6 professionals, 7 patients/family members, 5 architects/designers),

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which were transcribed, coded, and analyzed using thematic analysis. The quantitative component consisted of the distribution of the finalized questionnaire to 65 participants (40 professionals, 15 patients/family members, 10 architects/designers). The questionnaire employed Likert-scale, yes/no, and open-ended questions addressing spatial perception, safety, privacy, sensory experience, connection with nature, and overall satisfaction. The quantitative data were analyzed using descriptive statistics (means, standard deviations, frequencies, and percentages), while qualitative responses added interpretive depth (figure 1).

Section / Category	Item / Question	Response Type / Assessment	Notes
Demographics	Age	Open-ended	
Demographics	Gender	Male / Female / Other	
Demographics	Role (Patient / Family / Professional / Architect)	Multiple choice	
Demographics	Years of experience / duration of treatment	Open-ended	
Psychological Impact of Spatial Elements	Satisfaction with lighting	Likert scale 1–5	
Psychological Impact of Spatial Elements	Effect of colors and materials on mood or stress	Yes / No; explain	
Psychological Impact of Spatial Elements	Spatial layout supports ease of movement and reduces anxiety	Likert scale 1–5	
Privacy, Control, and Security	Private spaces sufficient for therapy/personal reflection	Likert scale 1–5	
Privacy, Control, and Security	Feeling safe and oriented in the facility	Likert scale 1–5	
Privacy, Control, and Security	Safety measures reduce stress	Likert scale 1–5	
Social Interaction & Connection	Facility allows positive social interaction when desired	Likert scale 1–5	
Social Interaction & Connection	Spaces support solitude and personal space	Likert scale 1–5	
Social Interaction & Connection	Accessibility to nature or outdoor areas	Likert scale 1–5	

Figure 1. Developed questionnaire for experts and PTSD patients/families

In the third phase, findings from the finalized questionnaire were operationalized into a checklist, which guided a field-based evaluation of rehabilitation environments. Ten rehabilitation centers in Tehran, Isfahan, Shiraz, and Mashhad were purposively selected to reflect geographic diversity, operational scale, and service range. Using the checklist, data were collected on spatial organization, natural and artificial lighting, acoustics, ventilation, circulation, accessibility, zoning of private and communal spaces, integration of natural elements, and cultural appropriateness. Observational data, user-flow mapping, technical measurements, and photographic documentation were combined to identify strengths and design-related barriers across sites.

In the fourth phase, findings from the systematic review, expert/stakeholder engagement, and site assessments were synthesized into a set of architectural design guidelines. These guidelines were structured under thematic categories including sensory regulation, safety and orientation, social interaction versus privacy, nature integration, and cultural sensitivity. Each recommendation was supported by empirical evidence derived from the previous phases.

Finally, the proposed guidelines were validated through a two-round Delphi study involving 10 multidisciplinary experts (architecture professors, clinicians, facility managers) and an interactive workshop with more than 30 participants from architectural and therapeutic fields. Feedback was systematically categorized and incorporated, enhancing the reliability, applicability, and contextual relevance of the final framework.

Findings;

The data obtained from structured surveys and interviews with PTSD patients, mental health professionals, and architects reveal clear patterns regarding the architectural needs of war-affected individuals in rehabilitation settings. Across all three groups, several core environmental attributes consistently emerged as critical to mental health recovery, emotional regulation, and therapeutic engagement.

Patient Perspectives: Prioritizing Comfort, Safety, and Autonomy (Phase 2): Among the 15 PTSD patients surveyed, the architectural elements with the highest perceived importance were:

- Safety (5.0): Universally rated as the most critical factor. Patients emphasized the need for a secure and predictable environment to reduce hypervigilance and fear. Participants cited features like controlled access, visual openness, and the absence of enclosed dark corners as supportive of psychological stability.
- Social Support (4.9): Communal areas that facilitated informal social interaction (such as lounges, outdoor patios, and group therapy rooms) were seen as crucial for reducing isolation and promoting healing through peer support.
- Natural Light (4.4): Respondents frequently mentioned how exposure to daylight improved mood, sleep regulation, and motivation. Spaces with large windows, skylights, or courtyards were particularly valued.
- Spatial Layout (4.7): Patients favored open, non-institutional layouts that allowed for both social engagement and personal retreat. Flexible zones that support different activities (group therapy, solitude, art therapy, physical therapy) contributed to a sense of freedom.
- Color Schemes (4.6) and Acoustics (4.5): Cool, muted color palettes were associated with emotional calming, while noise insulation was highlighted as essential to prevent overstimulation or triggering.

Other elements such as Privacy and Control (4.5) and Air Quality (4.0) were also identified as significant contributors to emotional regulation and physical comfort. Patients expressed appreciation for having control over their personal space, including adjustable lighting or temperature where possible. (Table 1)

Table 1: The responses of PTSD patients regarding the importance of various architectural elements in rehabilitation centers.

Architectural Element	Importance Level (1-5)	Comments
Natural Light	4.4	Felt it significantly improved mood and energy levels.
Color Schemes	4.6	Calming colors helped alleviate anxiety; cooler tones preferred.
Acoustics	4.5	Quiet environments were crucial for comfort; distracting noises worsened symptoms.
Spatial Layout	4.7	Open spaces with distinct zones for activities provided choice and comfort.

Safety	5.0	Safety was unanimously regarded as critical for mental well-being.
Wayfinding	4.4	Clear and accessible pathways reduced anxiety related to navigation.
Social Support	4.9	The feeling of community was vital in recovery; shared spaces fostered connection.
Control and Privacy	4.5	Personal spaces were essential for creating a sense of security and autonomy.
Air Quality and Ventilation	4.0	Adequate ventilation directly impacted comfort; fresh air was noted as vital.
Ergonomics	3.9	Comfortable seating arrangements facilitated better engagement in therapy.

Mental Health Professionals: Linking Environment to Therapeutic Outcomes (Phase 2): Among the 40 psychologists and therapists surveyed, architectural elements were evaluated based on their therapeutic utility and impact on clinical outcomes. The top-rated factors included:

- Natural Light (5.0) and Safety (5.0): Both were identified as foundational to creating a non-threatening, healing atmosphere. Light exposure was linked to the regulation of circadian rhythms, reduction of depressive symptoms, and increased cognitive function.
- Acoustics (4.8) and Social Support Infrastructure (4.3): Professionals stressed the importance of acoustic design to create quiet zones for individual therapy and reflection. Likewise, they emphasized that communal spaces should not be merely functional but therapeutically intentional, promoting spontaneous peer engagement.
- Color Schemes (4.7) and Privacy/Control (4.2): Muted, warm tones were believed to reduce agitation and intrusive thoughts. Private, personalizable spaces were linked to trauma-informed care models, allowing patients to regulate their own exposure to stimuli.

Notably, Way-finding (4.2) was highlighted as an often-overlooked but essential element in reducing confusion and disorientation among patients, many of whom experience anxiety in unfamiliar environments (table 2).

Table 2: The feedback from mental health professionals regarding design elements that significantly impact therapeutic effectiveness in rehabilitation centers.

Architectural Element	Importance Level (1-5)	Comments
Natural Light	5.0	Essential for overall psychological health and to counter depressive symptoms.
Color Schemes	4.7	Color schemes conducive to tranquility and comfort should be prioritized.
Acoustics	4.8	Necessary for creating a peaceful environment, minimizing stressors.
Spatial Layout	4.6	Thoughtful layouts reduce feelings of confinement and foster open interaction.
Safety	5.0	A secure environment is foundational for the therapeutic process.
Wayfinding	4.2	Facilitate clear navigation to help patients feel safe and oriented.
Social Support	4.3	Architectural designs that encourage interaction can enhance treatment outcomes.

Control and Privacy	4.2	Privacy allows patients to process feelings without external pressure.
Air Quality and Ventilation	4.2	Proper ventilation is linked to cognitive clarity and comfort levels.
Ergonomics	3.7	Ergonomic designs promote accessibility and comfort, enabling engagement in therapy.

Architects' Perspectives: Integrating Functionality with Human-Centered Design (Phase 2): Ten architects specializing in healthcare and rehabilitation environments participated in the survey. Their assessments reflected a balance between technical feasibility and user-centered design principles: (Table 3)

- Safety (5.0) and Natural Light (4.9) were prioritized for their functional and psychological impacts. Architects advocated for transparent, layered security strategies and maximizing natural illumination through atria, clerestories, and glazed facades.
- Spatial Layout (4.8) was emphasized as mechanisms for ensuring inclusivity and usability. Modular and adaptable spaces were preferred to accommodate different therapeutic activities and patient needs.
- Air Quality and Ventilation (4.5): Sustainable, passive ventilation strategies and air purification technologies were recommended to ensure continuous fresh air and mitigate infection risk and sensory discomfort.
- Social Support (4.1): Communal spaces were considered not only for functionality but also as symbolic zones that reinforce dignity, collaboration, and trust.

Architects also provided specific design recommendations, including:

- Use of acoustic panels and vegetated buffer for sound control,
- Integration of calm-inducing color palettes using natural materials (wood, stone),
- Creation of intuitive circulation paths and visual connections across spaces for orientation.

Table 3: The perceptions of architects on important architectural elements in the design of rehabilitation centers.

Architectural Element	Importance Level (1-5)	Comments
Natural Light	4.9	Considerations should maximize daylight to enhance mood and reduce reliance on artificial lighting.
Color Schemes	4.4	Use of soft colors that promote calmness can significantly impact patient experience.
Acoustics	4.5	Sound-absorbing materials should be prioritized to create peaceful environments.
Spatial Layout	4.8	Spaces should balance collaboration and privacy to meet varied patient needs.
Safety	5.0	Design must reflect a commitment to patient safety, incorporating secure materials and layouts.
Wayfinding	4.5	Clear signage and intuitive designs are crucial for reducing disorientation.
Social Support	4.1	Incorporating communal spaces can facilitate support networks among patients.
Control and Privacy	4.4	Providing options for personalized spaces enhances feelings of control.
Air Quality and Ventilation	4.5	Natural ventilation strategies should be incorporated to enhance air quality.

Ergonomics	4.0	Special attention is needed for furnishings that cater to diverse needs and promote comfort.

Cross-Group Comparisons and Emergent guidelines (phase 3 and 4): (table 4) A cross-analysis of the three respondent groups reveals significant convergence on certain critical architectural features, notably:

- Safety, Natural Light, and Spatial Layout were consistently rated among the top three priorities across all groups.
- The importance of acoustic quality was also widely recognized, reflecting the necessity of calm and predictable sound environments for PTSD patients.
- Control and Privacy were seen as central to respecting the autonomy of trauma survivors and enabling self-paced recovery.

However, nuanced differences were observed:

- Patients emphasized emotional comfort and trust, often speaking from lived sensory experiences.
- Psychologists prioritized therapeutic potential and emotional regulation, tying design features to clinical frameworks.
- Architects highlighted spatial efficiency, flexibility, and environmental sustainability, aiming to balance technical execution with human needs.

Table 4: The converged critical architectural Guidelines for PTSD patients

Architectural Element	Mean Importance (All Groups)	Most Frequent Theme
Safety	5.0	Foundation of therapeutic stability
Natural Light	4.9	Mood regulation, energy enhancement
Social Support Spaces	4.8	Community, shared healing
Spatial Layout	4.7	Flexibility, activity zoning
Color Schemes	4.6	Emotional modulation
Acoustics	4.6	Minimization of sensory triggers
Control and Privacy	4.4	Autonomy, comfort, self-regulation
Air Quality/Ventilation	4.2	Comfort, health, sensory balance
Way-finding	4.3	Navigation, spatial confidence

Discussion:
The findings of this study highlight the significant impact of architectural design elements on the therapeutic experiences of patients with PTSD, as perceived by patients, psychologists, and architects. Natural light emerged as the most influential factor, consistently associated with improved mood, energy, and engagement in recovery activities. Psychologists emphasized its therapeutic role in reducing depressive symptoms, while architects stressed the importance of maximizing daylight in design. These results are consistent with quasi-experimental evidence showing that naturalistic light reduces depressive symptoms and anxiety among stroke rehabilitation patients [15], and with studies demonstrating that unobstructed views of nature contribute to improved mental and physical health outcomes [16]. The restorative potential of real natural environments, as reported by Kjellgren and Buhrkall [16], further reinforces the importance of daylight and natural views in rehabilitation settings.

Color schemes were also central to patient wellbeing. Calming palettes reduced anxiety among PTSD patients, while psychologists noted their influence on emotional regulation. Architects recognized

the need for careful color selection to achieve therapeutic benefits. Previous studies recommend muted hues such as pale blues, greens, and earth tones [17], which Elliot and Maier [17] confirmed promote calmness, while red tones increase arousal. Liu et al. [18] further demonstrated that blue-green environments in counseling rooms enhanced satisfaction and comfort, underscoring the functional as well as aesthetic role of color.

Acoustic quality and safety also emerged as critical. Patients emphasized the importance of reducing noise, psychologists associated acoustics with therapeutic peace, and architects recommended sound-absorbing materials. These findings align with Bayer's evidence-based review [19], which highlights acoustic quality and safety as foundational to stress reduction and recovery. Similarly, patients, psychologists, and architects unanimously stressed that safety fosters trust, emotional openness, and engagement, consistent with Bayer's conclusion that safety is a cornerstone of healthcare design [19].

Social support and privacy further contributed to recovery. Communal spaces promoted peer connections and reduced isolation, supporting findings from Calhoun et al. [20], Harvey et al. [21], and DeLauer et al. [22] on the value of social interaction. At the same time, access to private spaces was essential for autonomy and empowerment, a balance supported by Nuamah et al. [23]. These results suggest that design must integrate both shared and private spaces to address diverse patient needs.

The study also resonates with broader research showing that PTSD shares sensory sensitivities with Autism Spectrum Disorder (ASD) and Attention-Deficit/Hyperactivity Disorder (ADHD) [24–26]. Evidence from Iran and elsewhere indicates that strategies such as sensory regulation, acoustic optimization, and flexible spatial layouts improve outcomes in ASD and ADHD populations [27–30], and our findings suggest these approaches are transferable to PTSD care.

While these results provide valuable insights, limitations include the subjective nature of self-reported data and potential sampling bias. Future studies should adopt more diverse and representative samples, complemented by longitudinal research, to refine evidence-based design guidelines and ensure their applicability across cultural and clinical contexts.

Conclusion:

This study highlights the critical role of architectural design in the rehabilitation of war-psychologically injured individuals in Iran. The comprehensive set of evidence-based guidelines emphasizes the need for environments that prioritize natural light, acoustics, color schemes, and social integration. By implementing these design principles, rehabilitation centers can create therapeutic spaces that promote recovery and enhance the quality of care provided to those affected by PTSD, ultimately improving their overall well-being. The insights gained from this research contribute significantly to understanding and addressing the complex interplay between architecture and mental health, paving the way for innovative and healing-focused rehabilitation environments.

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Ethical Permissions:

This study did not include any interventions, observations, or experiments involving individuals. Therefore, ethical approval from an institutional review board was not required. The research followed a comprehensive mixed-methods approach, including a systematic literature review and consultations with domain experts. Expert input was obtained solely in the form of professional opinions, without collection of personal or identifiable information. All consulted experts participated voluntarily and with full knowledge of the study's aims. The study adhered to ethical standards of academic integrity, transparency, and responsible conduct of research.

Authors' Contribution: