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Revitalization of Historical Contexts with a Biophilic Architecture Approach for Enhancing Mental Health

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Abstract

The revitalization of historical contexts using a biophilic approach can contribute to improved mental health and enhanced spatial experiences for users. This study aimed to investigate the role of biophilic design in the revitalization of historical contexts and to analyze its impact on mental health and users' spatial experiences. The study employed a mixed qualitative–quantitative approach, focusing on Fin Garden in Kashan. Data were collected through participatory and non-participatory field observations, semi-structured interviews with landscape architecture and environmental psychology experts, document analysis including historical maps and photographs, psychological questionnaires, and physiological measurements such as HRV, salivary cortisol, and alpha/beta EEG ratio. Qualitative findings indicated that natural elements, flowing water, light and shadow, and diverse vegetation provide a multisensory and calming experience for users and improve the perceived quality of space. Quantitative analyses, including t-tests, ANOVA, mediation regression, and structural equation modeling (SEM), also demonstrated that biophilic design, both directly and indirectly through enhancing spatial quality, reduces anxiety and depression and promotes users' mental health. This research confirms the importance of applying biophilic principles in the revitalization of historical contexts and shows that such an approach can play a significant role in increasing well-being, positive spatial experience, and psycho-sensory interaction of users with the environment.

Keywords: (Historical context revitalization, biophilic design, spatial quality, mental health, multisensory experience)
2022 MSC: O20, O10

Introduction

The rapid growth of urbanization and changes in urban living patterns in recent decades have raised concerns about citizens' mental health. International studies have shown that continuous human interaction with natural elements can reduce stress, improve mood, and enhance cognitive performance. These findings are rooted in the biophilia theory, which posits that humans have an innate tendency to connect with nature [9]. Biophilic architecture, as a

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design-oriented approach, seeks to recreate this connection within built environments. The use of natural light, plants, water, organic patterns, views of nature, and natural materials creates environments that can contribute to mental health improvement. Studies have demonstrated that the presence of biophilic elements not only enhances positive emotions but also modulates physiological stress indicators such as heart rate and heart rate variability (HRV) [15, 25].

Urban historical contexts, as carriers of cultural, identity, and aesthetic layers, hold a unique place in citizens' lived experiences. Beyond their heritage value, these contexts can foster a sense of belonging, tranquility, and social cohesion. However, many historical contexts, due to physical deterioration, poor spatial quality, and lack of natural spaces, have failed to play a supportive role in enhancing mental health. Therefore, revitalizing these spaces with an approach that preserves historical authenticity while enhancing the spatial and psychological qualities of the environment is a crucial requirement in contemporary urban planning and design [13].

The biophilic design approach has significant potential to improve the quality of historical contexts, as it can reinforce natural patterns within existing structures without destructive interventions. Research has shown that integrating natural elements into historical spaces—such as adding native vegetation, incorporating small water features, enhancing natural light, or creating organic shading—improves user experience and generates positive psychological outcomes [18, 4]. However, most existing studies are descriptive, and quantitative, multidimensional assessments of the effects of biophilic design in historical contexts are limited, especially where conservation constraints and structural complexities influence intervention strategies. A major research gap remains: there is still no comprehensive framework linking biophilic design principles with heritage considerations while evaluating psychological outcomes. Many studies have focused solely on the presence of green space, paying little attention to which biophilic elements, in which locations and with what spatial qualities, have the greatest impact on mental health. Moreover, the assessment of biophilic designs using a combination of psychological data and physiological markers has been limited, even though wearable technologies and physiological measurements now enable more precise analysis of bodily responses to the environment [5].

In the process of revitalizing historical spaces, the use of three-dimensional modeling and environmental simulation tools has also been limited. These tools can predict the impact of proposed designs on daylight, ventilation, views of nature, and environmental comfort before implementation, preventing inefficient interventions [6]. Given these gaps, the main research problem is how biophilic design principles can be integrated into historical contexts in a way that aligns with heritage values while improving users' psychological and physiological indicators. The key research question is how biophilic revitalization, through specific spatial qualities (such as light, ventilation, and views of nature), can play a mediating role in enhancing users' mental health. This study, by combining architectural design methods, modeling and environmental simulation, psychological questionnaires, and physiological measurements, aims to provide a comprehensive, evidence-based framework for revitalizing historical contexts using a biophilic architecture approach.

Literature Review

The revitalization of historical contexts in Iran has attracted increasing attention from researchers in recent years, particularly with the aim of enhancing urban livability and quality of life. Khaksar and Mahdavi [10] found that factors such as environmental safety, improved urban services, adequate accessibility, sense of place attachment, and better sanitary conditions play key roles in restoring life to historical contexts and improving residents' quality of life. Similarly, Pourahmad et al. [16] emphasized in Tabriz that historical revitalization focusing on tourism, in addition to economic and social dimensions, improves spatial quality and urban services. Other studies in Isfahan have shown that revitalization of historical contexts based on local identity and culture, sustainable design, and attention to social and tourism aspects contributes to both the physical and cultural restoration of the urban fabric.

In parallel, research in biophilic architecture and urban design emphasizes the impact of nature-based design on environmental quality and mental health. Ahmadi [1] demonstrated that incorporating natural elements in urban spaces can improve mental health and environmental quality for individuals. Asari and Tajarloo [4], through a literature review, showed that biophilic design reduces stress, enhances relaxation, and increases users' satisfaction with spaces. Furthermore, Hoshmandkhaligh et al. highlighted that the presence of nature and green design in urban environments enhances quality of life and psychological well-being. Examining these studies indicates that both historical revitalization and biophilic architecture individually have positive effects on quality of life and mental health. However, the integration of these two approaches in revitalized historical contexts and the assessment of their impact on residents' psychological well-being has not yet been explored in the Iranian literature. This research gap highlights the need for an innovative study that evaluates revitalized historical contexts using a biophilic approach to promote mental health and residents' quality of life.

Recent international studies have shown that nature-based or "biophilic" design can have a significant impact on mental health, well-being, and quality of life. According to the biophilia hypothesis, humans have an innate tendency to connect with nature, and exposure to natural environments or nature-inspired designed environments can reduce stress, improve mood, increase motivation, and enhance cognitive performance. Recent empirical studies support this hypothesis. For example, Shing et al. [24] found that exposure to spaces with biophilic characteristics, compared to spaces lacking such features, leads to higher psychological well-being, greater cognitive motivation, and reduced stress indicators.

In the context of urban heritage and historical spaces, limited studies have examined the relationship between historical contexts and mental health. Shibaita et al. [19] showed that traditional and vernacular buildings possess inherent biophilic features, such as natural materials, adequate daylight, ventilation and airflow, and design forms harmonious with nature, which can create positive psychological experiences for users. Although this study did not directly investigate psychological effects, it highlighted the potential of historical contexts for integration with biophilic design to enhance psychological well-being.

Lee et al. [11], studying historical alleys in Daegu, South Korea, found that applying biophilic patterns combined with artificial intelligence technologies can transform historical contexts into vibrant, engaging, and calming spaces. This study emphasized the preservation of historical identity and the improvement of environmental experience and users' psychological well-being. Asim [2] demonstrated that integrating biophilic principles with historical buildings, in addition to preserving cultural and physical values, can enhance mental health and user well-being. Incorporating natural elements, appropriate light and ventilation, and connections to nature provides users with positive and calming spatial experiences.

Overall, international research suggests that revitalizing historical contexts using a biophilic approach offers a novel and effective pathway for promoting mental health and social well-being, yet this topic has received limited attention in the scholarly literature. Therefore, the present study, focusing on the integration of three components—historical heritage, biophilic design, and mental health—can fill existing gaps in the literature and provide practical strategies for sustainable and human-centered revitalization of historical spaces.

Theoretical Framework

Rapid urban transformations, urbanization expansion, and increasing environmental stressors have heightened the need for health-oriented interventions in urban revitalization. Historical contexts, as carriers of collective identity and urban memory structures, have faced challenges in recent decades, such as physical deterioration, reduced spatial quality, and declining social interactions [21]. In this context, approaches that can simultaneously preserve heritage and enhance mental health and residents' quality of life have gained increasing importance. One emerging approach with significant explanatory and practical potential is biophilic architecture, which is based on Wilson's (1984) biophilia hypothesis and emphasizes humans' inherent need for contact with nature as a design foundation [9]. According to the World Health Organization, mental health is defined not merely as the absence of disease but as the presence of mental well-being, a sense of meaning, positive functioning, and adaptive capacity [23].

Over recent decades, numerous studies have demonstrated that the built environment plays a decisive role in shaping individuals' psychological states. Components such as the quality of green spaces, natural light, presence of natural elements, adequate ventilation, and place identity are directly associated with reduced stress, lower depressive symptoms, and increased satisfaction and psychological well-being [24, 15]. Accordingly, biophilic architecture seeks to integrate nature into the built environment through both direct elements (e.g., plants, water, light) and indirect elements (e.g., natural materials, organic patterns) [20].

Several scientific mechanisms have been proposed to explain the relationship between nature experience and mental health. First, Ulrich's (1991)errorStress Reduction Theory posits that observing or experiencing natural elements leads to rapid decreases in sympathetic activity, reduced heart rate, lowered cortisol levels, and overall stress reduction. Second, Kaplan and Kaplan's (1989) errorAttention Restoration Theory suggests that natural environments, due to their "soft fascination" and low cognitive load, restore attentional resources and enhance concentration and cognitive performance [8]. Third, Antonovsky's Salutogenesis Theory indicates that meaningful, comprehensible, and manageable environments enhance a sense of coherence and psychological adaptability [19]. Additionally, recent research on place attachment has shown that culturally meaningful and memorable spaces—especially when enriched with natural elements—strengthen a sense of belonging and social connection [11].

In the context of historical contexts, recent studies indicate that these environments inherently possess restorative features, as they convey identity, cultural continuity, and meaning to users [22]. Integrating biophilic elements can

further amplify these effects and enhance the psychological experience of space. For instance, studies have shown that access to natural views, presence of native plants, small water features, natural light, and natural materials not only improve the perceived quality of space but also significantly reduce stress, anxiety, and depression [14].

Therefore, the biophilic approach to revitalizing historical contexts represents a dual strategy:

1. Preservation of historical, cultural, and identity values
2. Enhancement of psychological mechanisms associated with contact with nature

From an urban and social perspective, combining these approaches can foster social interactions, increase presence, strengthen place attachment, and improve the quality of lived experiences. Moreover, recent epidemiological studies indicate that the quality and accessibility of nature are more important for mental health than mere presence; therefore, interventions in historical contexts should not only introduce natural elements but also enhance perceptual quality, accessibility, biodiversity, and spatial legibility [14].

In summary, the existing theoretical body suggests that the biophilic approach, by establishing a multi-layered human–nature connection, provides the psychological foundations for stress reduction, cognitive restoration, a sense of meaning, and place attachment. When applied in identity-rich settings such as historical contexts, its effects are amplified, making it a potentially effective model for urban revitalization with a focus on mental health.

Research Methodology

This study employed a mixed qualitative–quantitative approach, focusing on the case study of Fin Garden in Kashan to examine the revitalization of historical contexts based on biophilic architecture principles and its impact on users' mental health. The research design was planned in a multi-stage, multi-level manner to identify both the physical and spatial characteristics of the historical context and to evaluate the effects of design interventions on user experience.

The study consisted of three main stages:

1. **Qualitative Analysis of the Historical Context:** In this stage, the physical, spatial, and environmental features of Fin Garden were identified through field observations, document analysis, and examination of historical maps and photographs. Data collection included mapping, documentation of natural and artificial elements, and analysis of existing spatial quality.
2. **Design Interventions Based on Biophilic Principles:** Using biophilic design patterns, the garden spaces were redesigned. Three-dimensional modeling and environmental simulations were conducted using software such as Rhino and Grasshopper, and microclimatic conditions (light, ventilation, temperature) were analyzed with Envi-met. The designed models were simulated via virtual reality (Oculus Quest) for experimental evaluation by users.
3. **Assessment of Impact on Mental Health:** Quantitative and qualitative data were collected through physiological measurements, psychological questionnaires, and expert interviews to evaluate the effects of design interventions on users' mental health.

The study population included permanent residents and visitors of Fin Garden, aged 18–65 years, with no gender restrictions, emphasizing groups sensitive to mental health such as the elderly and youth. The sample size for quantitative data was determined using Cochran's formula, including 384 participants divided into experimental and control groups. For the qualitative interviews, purposive sampling was applied to 20 experts in architecture, environmental psychology, and urban management with experience in designing historical spaces and mental health. Inclusion criteria required informed consent, a minimum of three years of relevant professional experience, and familiarity with biophilic design principles. Individuals with severe psychiatric disorders or inability to respond were excluded.

Qualitative data were collected through semi-structured interviews with experts and document analysis, including maps, historical photographs, and municipal reports. Quantitative data included the standardized GHQ-28 questionnaire to assess mental health (anxiety, depression, and social functioning) and the PRS-11 restorative perception scale to evaluate biophilic spatial quality. In addition, physiological measurements were conducted, including heart rate and HRV monitoring using the Polar H10 wearable device, salivary cortisol assessment, and EEG recording for a subsample of 50 participants.

Research Implementation Stages

1. **Preliminary Stage (2 months):** Selection of the case study and collection of baseline data, including mapping, documentation, and initial measurements of mental health and physiological indicators.
2. **Design Stage (3 months):** Application of biophilic principles in space redesign, three-dimensional modeling, and environmental simulation for design validation.
3. **Intervention and Evaluation Stage (4 months):** The experimental group experienced the redesigned spaces for at least four weeks, with data collected through pre- and post-test questionnaires, physiological measurements, and VR experiences. The control group was evaluated in unchanged spaces.
4. **Analysis Stage (2 months):** Qualitative data were analyzed using thematic coding in MAXQDA, and quantitative data were analyzed using descriptive statistics, paired t-tests, ANOVA, and structural equation modeling (SEM).

Qualitative data were analyzed by extracting main themes such as sense of belonging, relaxation, and stress reduction induced by natural elements. Quantitative data were used to examine the effect of design interventions on users' mental health and the mediating role of spatial quality. Reliability of instruments was ensured with Cronbach's alpha above 0.7, and construct validity was confirmed through factor analysis.

Findings

Qualitative Findings: Case Study of Fin Garden, Kashan

In the qualitative investigation of Fin Garden, data were collected through participatory and non-participatory observation, semi-structured interviews with landscape architecture, urban planning, and environmental psychology experts, and document analysis, including maps, historical photographs, and municipal reports. Data analysis revealed that Fin Garden, with its natural elements and intelligent spatial design, provides a multi-dimensional and restorative experience for users. To better understand pathway design and its relationship with natural views, Figure 1 is presented.

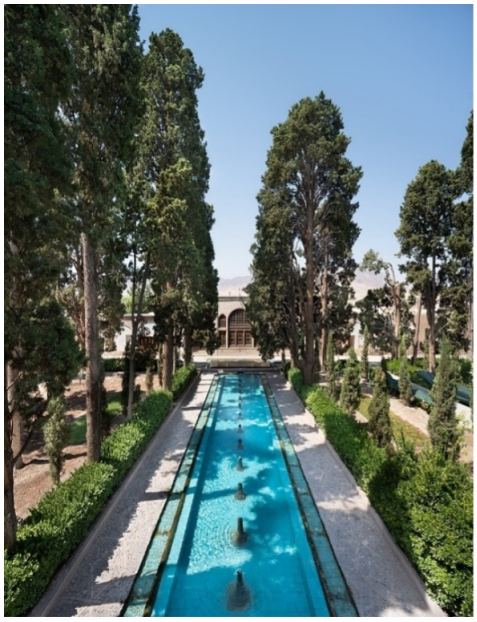

Figure 1: Integration of Pathway Design and Natural Views in Fin Garden

Using a checklist based on biophilic principles, components such as access to natural views, social interaction, natural materials and textures, and biotic patterns in the design of pathways and spaces were identified as the garden's strengths. Analysis of Fin Garden's physical and spatial elements indicates that the garden naturally and intelligently implements many biophilic principles, enriching visitors' sensory, psychological, and spatial experience.

One of the most prominent elements is the direct connection with nature. The flow of water in channels and fountains, in addition to creating visual and auditory effects, provides visitors with a dynamic and variable spatial experience.

The diverse vegetation, including flowers, tall trees, and shrubs, creates different green layers and levels, enhancing visual depth and interaction. Ancient trees, with their physical presence and extensive shade, reinforce a sense of calm and psychological tranquility. Collectively, these elements guide visitors toward a psychological and sensory connection with the natural environment. Light and shadow are also managed intelligently within the garden. Pathways and open spaces are designed to create variation in light and shadow as the sun's angle changes throughout the day. These spatial changes not only provide dynamic and attractive visual landscapes but also introduce a natural rhythm of time into the spatial experience, enhancing a sense of active and dynamic presence in the environment.

Additionally, natural sounds, particularly flowing water, play an important role in promoting psychological relaxation. The sounds of streams and fountains, besides reducing stress and anxiety, enhance the visitor's multisensory experience, as the auditory sense engages alongside visual and tactile interactions with natural elements, creating a comprehensive and immersive environmental experience.

Natural patterns and geometry in Fin Garden, including symmetrical pathways, the placement of pools, and the network of water channels, exemplify the harmony between artificial geometry and natural patterns. These patterns, in addition to their aesthetic aspect, create a sense of balance and mental harmony, making the spatial experience orderly and predictable while maintaining interaction with natural elements.

Multisensory experience is another prominent aspect of Fin Garden. Visitors simultaneously perceive diverse plant forms and colors, touch different textures, and smell fragrances, resulting in a deep and holistic environmental experience. This multidimensional interaction elevates the visitor's presence from a visual to a psychological and sensory level, highlighting the importance of engaging all human senses to enhance well-being and the quality of spatial experience.

Finally, the design of pathways and resting spaces on a human scale facilitates comfortable movement and direct interaction with natural elements. Pathways are designed for leisurely walking and short rests, and resting areas at key points encourage visitors to engage closely with trees, flowers, and water features. This human-scale design ensures that the visitor's experience is comfortable, enjoyable, and participatory, strengthening their tangible and experiential connection with nature. To illustrate the green pathways and their design, Figure 2 is presented.

Figure 2: Green Pathways of Fin Garden

Analysis of historical maps and photographs revealed that the preservation of water networks and green pathways, the traditional patterns of the Persian garden, and the use of natural materials in buildings and garden elements align with the principles of biophilic architecture. This analysis enabled a comparison between the current condition and the original garden design and helped identify areas in need of revitalization. To examine the conformity with the initial design and analyze the garden's spatial network, Figure 3 and Figure 4 are presented.

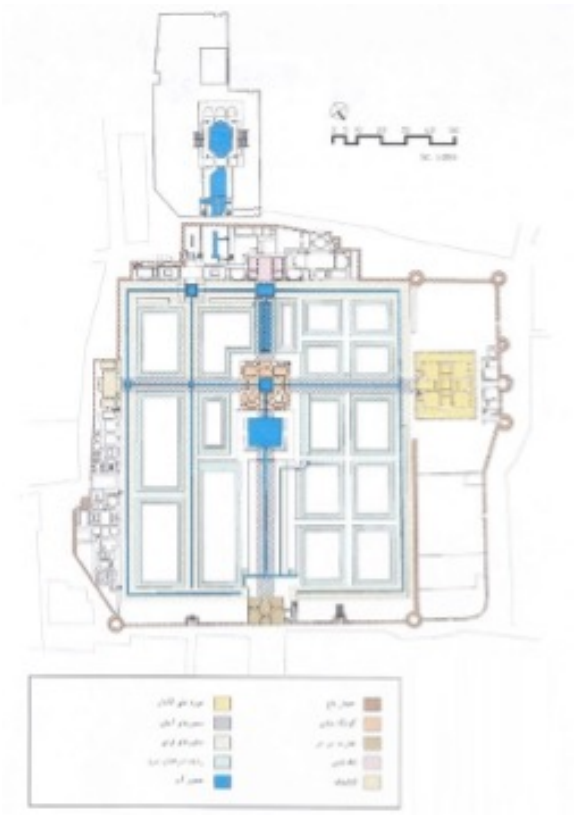

Figure 3: Fin Garden Map [17]

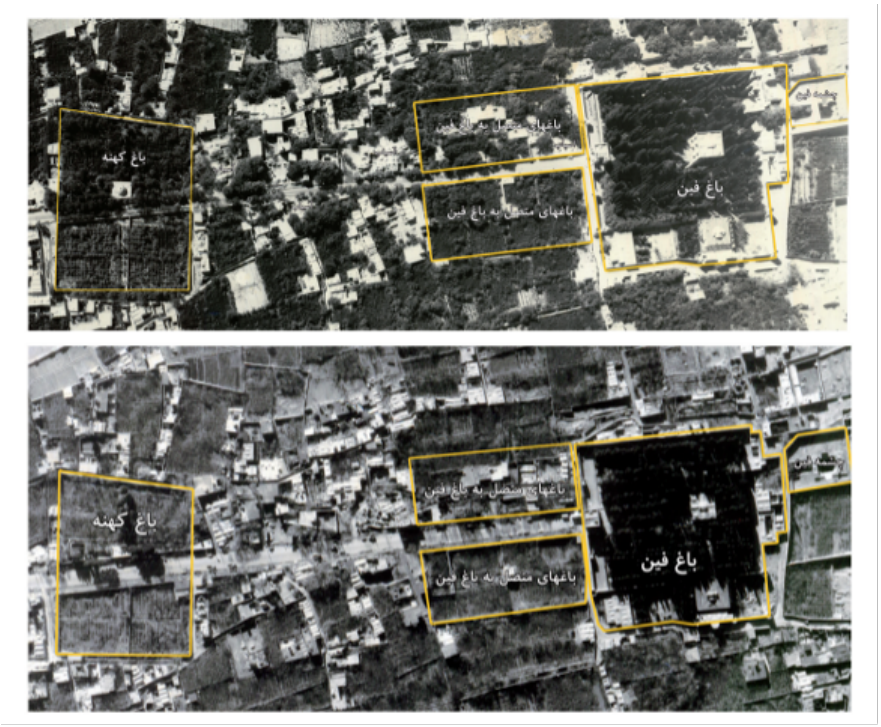

Figure 4: Top: Aerial photograph of the Small Fin in 1973 showing Fin Spring, Fin Garden, adjacent gardens, mills, and the Old Garden. Bottom: Aerial photograph of the same area in 1984 (based on National Cartography Organization images) [17]

Findings from Interviews

The qualitative findings are presented according to main themes and sub-themes, each mapped to Kellert's 14 biophilic principles:

Theme 1: Connection with Nature

Sub-themes: Water flow, vegetation, ancient trees

Interviews with experts revealed that the flow of water in channels and fountains, in addition to creating visual and auditory effects, establishes the natural rhythm of the environment and provides visitors with a dynamic spatial experience. Experts noted that this feature enhances active presence and environmental awareness, aligning with biophilic principles such as direct connection with nature and environmental dynamics.

The diverse vegetation, including tall trees, shrubs, and flowers, creates layered greenery and visual depth, strengthening users' psychological connection with nature. Ancient trees, with their wide shade and physical presence, increase feelings of calm and psychological tranquility. Experts emphasized that these elements elevate users' experience from a visual to a sensory and perceptual level, consistent with biophilic principles of biodiversity complexity and connection with living organisms.

"When visitors walk along the stream path and hear the flowing water, they unconsciously feel relaxed and perceive themselves as part of the natural environment." – Environmental Psychologist

Theme 2: Spatial Quality and Biophilic Design

Sub-themes: Pathway geometry, pool symmetry, human scale

Analysis of environmental simulations and interviews indicated that the geometric alignment of pathways and placement of pools creates a sense of balance and mental organization, making the spatial experience predictable and pleasant. Experts highlighted that the scale of pathways and resting spaces is designed to match human dimensions and visitor movement needs, facilitating direct interaction with natural elements. These features align with biophilic principles of human scale and natural/geometric patterns.

"The geometric symmetry of pathways and pools organizes the mind and creates a sense of security and calm; users subconsciously perceive this balance." – Landscape Architect

Document analysis also showed that maintaining water networks, green pathways, and the use of natural materials in buildings and garden elements aligns with the biophilic principles of use of natural materials and connection with historical and cultural landscapes.

Theme 3: Multisensory Experience and Sensory Stimulation *Sub-themes:* Tactile textures, colors, fragrances, natural sounds

Interviews with environmental psychologists indicated that spaces engaging multiple senses simultaneously have the most positive psychological effects. Touching different plant and material textures, observing diverse plant colors and forms, hearing flowing water, and smelling floral scents create a comprehensive, multidimensional environmental experience, consistent with biophilic principles of direct sensory experience and active environmental awareness. Experts noted that simultaneous activation of multiple senses makes the visitor's presence more authentic and enhances relaxation, psychological security, and spatial satisfaction.

"When a user experiences sight, sound, and smell simultaneously, their presence in the environment feels more real, and the psychological impact is stronger." – Environmental Psychologist

Theme 4: Social Interaction and Spatial Functionality *Sub-themes:* Collective spaces, access pathways, resting points

Interviews revealed that pathway and resting space design in the garden not only enhances individual experience but also facilitates social interaction and participatory activities. The presence of walking paths with open views and semi-open resting areas allows observation and interaction with others, increasing users' sense of belonging and social participation. These features align with biophilic principles of shared human spaces and social connection.

"Redesigned spaces that allow sitting and seeing others not only provide individual relaxation but also enhance social interactions." – Urban Manager

Theme 5: Challenges and Limitations Experts indicated that cultural heritage preservation and limitations in resources and space restrict the implementation of all biophilic components in some garden areas. For example, adding new water paths or green spaces was limited in certain sections. Experts recommended focusing on key natural elements, flexible design, and enhancing multisensory stimulation even with limited changes to maintain positive psychological effects.

"Even adding a few water or natural light elements in a small section can greatly enhance the spatial experience and produce positive psychological effects." – Landscape Architect

Quantitative Findings

Descriptive statistics for the study variables before and after the intervention are presented in Table 1.

Table 1: Descriptive Statistics

Variable	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)
Anxiety (GHQ-28)	12.3 ± 3.5	18.7 ± 4.2
Depression (GHQ-28)	10.5 ± 2.8	16.2 ± 3.9
Social Functioning (GHQ-28)	14.8 ± 3.1	12.1 ± 3.4
Spatial Quality (PRS-11)	38.2 ± 5.4	27.6 ± 4.7
Biophilic Index (Kellert)	42.5 ± 6.1	30.8 ± 5.3

Descriptive findings indicate that participants in the experimental group, exposed to biophilic interventions in the renovated historical site, showed better outcomes in all psychological and spatial perception indicators compared to the control group. Mean anxiety (GHQ-28) was 12.3±3.5 for the experimental group and 18.7 ± 4.2 for the control group. Mean depression scores were 10.5 ± 2.8 and 16.2 ± 3.9, respectively, indicating a significant reduction in anxiety and depression levels. Social functioning was higher in the experimental group (14.8 ± 3.1) than in the control group (12.1 ± 3.4), suggesting enhanced social interactions and positive user experiences in the renovated spaces. Spatial quality (PRS-11) was markedly higher in the experimental group (38.2 ± 5.4) compared to the control (27.6 ± 4.7), and the Kellert Biophilic Index was also greater (42.5 ± 6.1 vs. 30.8 ± 5.3). These results demonstrate that applying biophilic principles provides a restorative, engaging, and calming spatial experience while strengthening users' connection with nature and biophilic design elements. **Paired-sample t-tests** for anxiety and depression are shown in Table 2.

Table 2: Paired-sample t-test (Pre- and Post-intervention – Experimental Group)

Variable	Pre-test (Mean ± SD)	Post-test (Mean ± SD)	t	df	p
Anxiety	18.9 ± 4.1	12.3 ± 3.5	14.62	191	<0.001
Depression	16.4 ± 3.8	10.5 ± 2.8	12.87	191	<0.001

Paired t-tests indicate that following exposure to biophilic-renovated historical spaces, anxiety decreased significantly ($t = 14.62, df = 191, p < 0.001,$ Cohen's$d = 1.06$) and depression reduced from 16.4 ± 3.8 to 10.5 ± 2.8 ($t = 12.87, df = 191, p < 0.001,$ Cohen's$d = 0.93$), indicating a strong intervention effect. These findings align with qualitative data; the observed sense of calm and stress reduction in interviews is directly reflected in GHQ-28 scores. **Multivariate ANOVA (MANOVA)** for spatial quality across groups and user types is presented in Table 3.

Table 3: Multivariate ANOVA (Spatial Quality by Group and User Type)

Group	Mean ± SD Spatial Quality	F	df	p	Assumptions Tested
Residents	39.1 ± 5.2	12.5	1,382	<0.01	Normality and homogeneity (Shapiro-Wilk $p > 0.05$, Levene $p > 0.05$)
Visitors	37.3 ± 5.5	—	—	—	—

ANOVA results show that user type (resident or visitor) significantly affects spatial quality ($F = 12.5, df = 1, 382, p < 0.01, \eta^2 = 0.03$). Residents reported higher spatial quality (39.1 ± 5.2) than visitors (37.3 ± 5.5). Longer, sustained exposure to natural elements and renovated pathways appears to enhance perceived spatial quality, while short-term visitors have less opportunity for a full experience. **Physiological Measurements** are presented in Table 4.

Table 4: Physiological Data

Biological Indicator	Experimental Group (Mean ± SD)	Control Group (Mean ± SD)	t	df	p	Effect Size (Cohen's d)
HRV (ms)	72.5 ± 10.4	58.3 ± 9.7	8.14	98	<0.001	1.62
Salivary Cortisol (nmol/L)	12.3 ± 3.2	18.6 ± 3.8	9.05	98	<0.001	1.81
EEG Alpha/Beta Ratio	0.85 ± 0.09	0.61 ± 0.11	7.22	98	< 0.001	1.44

Physiological measurements included HRV, salivary cortisol, and EEG alpha/beta ratio in a sub-sample of 50 participants. Mean HRV was 72.5 ± 10.4 ms for the experimental group and 58.3 ± 9.7 ms for the control group, with significant differences ($t = 8.14, df = 98, p < 0.001$, Cohen's$d = 1.62$), indicating lower stress and greater cardiac flexibility. Salivary cortisol was lower in the experimental group (12.3 ± 3.2 nmol/L) than the control (18.6 ± 3.8 nmol/L) ($t = 9.05, df = 98, p < 0.001$, Cohen's$d = 1.81$), reflecting reduced HPA-axis stress response. EEG alpha/beta ratio was higher in the experimental group (0.85 ± 0.09) versus control (0.61 ± 0.11) ($t = 7.22, df = 98, p < 0.001$, Cohen's$d = 1.44$), consistent with enhanced neural relaxation and reduced brain tension. These physiological findings align with qualitative and quantitative results, validating the triangulation of methods. **Mediation Analysis (Role of Spatial Quality)** is presented in Table 5.

Table 5: Mediation Regression (Spatial Quality Role)

Variable Path	β	SE	t	p	Assumptions Tested
Biophilic Design → Spatial Quality	0.68	0.07	9.71	< 0.001	Linearity and homoscedasticity checked, VIF <2
Spatial Quality → Mental Health	0.42	0.06	6.84	< 0.01	Residuals normal and homoscedastic
Biophilic Design → Mental Health (Direct)	0.31	0.05	5.23	< 0.01	—

Mediation results show that biophilic design has significant direct and indirect effects on users' mental health. The direct path from biophilic design to mental health ($\beta = 0.31$, $p < 0.01$) indicates that the environment itself can directly reduce anxiety and depression and enhance mental well-being. Additionally, the path from biophilic design to spatial quality ($\beta = 0.68, p < 0.001$) and from spatial quality to mental health ($\beta = 0.42, p < 0.01$) were significant, indicating that spatial quality mediates a substantial portion of the biophilic design's effect on mental health. In other words, part of the positive effect of environmental design on mental health is transmitted through the restorative spatial experience and natural elements. These findings emphasize that biophilic design, both independently and in interaction with high-quality spatial experience, can enhance users' psychological well-being. Therefore, historical site regeneration with biophilic principles not only preserves cultural and physical values but also provides an effective tool to improve mental health and spatial experience. **Structural Equation Modeling (SEM) Fit Indices** are presented in Table 6.

Table 6: SEM Model Fit

Fit Index	Value	Assumptions Tested
CFI	0.95	Adequate sample size ($n = 384$)
RMSEA	0.04	Approximate data normality
SRMR	0.05	Linear relationships between variables
χ^2/df	1.82	No severe multicollinearity

Structural Model Fit and Direct/Indirect Effects

The model fit indices indicate an excellent fit for the proposed structural model: $CFI = 0.95$, $RMSEA = 0.04$, $SRMR = 0.05$, and $\chi^2/df = 1.82$. These indices demonstrate that the model accurately represents the relationships among biophilic design, spatial quality, and mental health, and that the collected data align closely with the proposed theoretical framework.

SEM results confirm that biophilic design improves users' mental health both directly and indirectly through spatial quality. In other words, the reconstructed spatial experience and biophilic elements of the environment act as

significant mediators in enhancing mental well-being. The structural model quantitatively illustrates that historically renovated environments can have a substantial and multifaceted impact on users' psychological well-being. These findings are consistent with the mediation regression results, highlighting that spatial quality and biophilic design elements constitute crucial pathways for mental health improvement. The use of SEM thus reinforces the scientific validity of the study's theoretical model and provides a solid basis for design and management recommendations for historical sites.

Table 7: Direct and Indirect Effects Analysis

Variable Path	β	**t**	**p**	**Interpretation**
Biophilic Design → Spatial Quality	0.68	9.71	<0.001	Very strong positive effect on spatial experience
Spatial Quality → Mental Health	0.42	6.84	<0.01	Key mediating role in reducing anxiety and depression
Biophilic Design → Mental Health (Direct)	0.31	5.23	<0.01	Direct positive effect on mental health

The analysis of direct and indirect effects from the mediation model demonstrates a coherent pattern: biophilic design in historical contexts enhances mental health both by improving spatial quality and through direct influence on users' psychological perception. The strongest relationship is between biophilic design and spatial quality ($\beta = 0.68,\ t = 9.71,\ p < 0.001$), indicating that interventions such as adding natural elements, enhancing daylight, using organic materials, and creating semi-open spaces substantially enrich users' perceptual experience. These interventions increase users' sense of calm, coherence, and environmental legibility.

The relationship between spatial quality and mental health is also significant ($\beta = 0.42,\ t = 6.84, p < 0.01$), suggesting that the more users perceive the environment as natural, safe, organized, and restorative, the more their anxiety and depression levels decrease, and overall mental well-being improves. This finding aligns with environmental psychology theories, which consider environmental quality as one of the strongest predictors of mood enhancement, stress reduction, and cognitive resource strengthening.

The direct path from biophilic design to mental health ($\beta = 0.31,\ t = 5.23,\ p < 0.01$) indicates that biophilic elements can independently reduce psychological symptoms, such as physiological arousal, improve positive mood, or increase users' sense of connectedness with nature, regardless of spatial quality. The simultaneous presence of direct and indirect effects confirms that biophilic design operates through a dual mechanism: it influences users' perception and experience while also providing a perceptual-cognitive pathway via improved spatial quality.

Overall, the path model highlights that spatial quality serves as a key mediator in transmitting the effects of biophilic design to mental health, but it does not fully account for the total effect, leaving a portion of the impact direct. This dual role emphasizes the importance of biophilic design in:

1. Enhancing the physical and perceptual quality of space, and
2. Directly influencing users' psychological experience.

These findings confirm that regenerating historical environments with a biophilic approach is not only effective for physical and aesthetic restoration but also represents a serious health-oriented intervention for improving users' mental well-being.

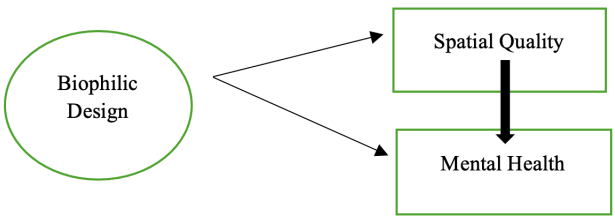

Figure 5: Research Model (Study Findings)

Discussion and Conclusion

The findings of this study indicate that the regeneration of historical contexts using biophilic design principles provides users with a multidimensional and restorative experience, significantly influencing mental health and spatial perception. Qualitative analysis of Fin Garden in Kashan revealed that natural elements—such as flowing water, diverse vegetation, ancient trees, and geometric patterns and pathways—not only create visual and auditory appeal but also enhance active presence, psychological relaxation, and deep sensory-cognitive engagement. Multisensory experience and interaction with the environment, along with intelligent management of light and shadow, human-scale spaces, and communal areas, improve spatial satisfaction and promote social interactions. These outcomes align with biophilic principles, including connection to nature, human scale, biodiversity, and direct sensory experience.

Quantitative findings also demonstrated that exposure to historically regenerated spaces based on biophilic principles significantly reduced anxiety and depression, improved social functioning, and enhanced spatial perception. Biological data—including HRV, salivary cortisol, and the EEG alpha/beta ratio—confirmed reduced stress responses and increased neural relaxation in the experimental group. These physiological outcomes are consistent with the qualitative and descriptive data, reinforcing the validity of triangulation.

Mediation regression and structural equation modeling (SEM) analyses revealed that biophilic design exerts both a direct effect on mental health and an indirect effect via improved spatial quality, facilitating reduced anxiety and depression and enhanced psychological well-being. The strongest effect was observed in the pathway from biophilic design to spatial quality, and spatial quality served as a key—but partial—mediator of biophilic design's impact on mental health. These results indicate a multi-pathway mechanism: biophilic design enhances both perceptual-spatial experience and users' psychological and physiological states directly.

In comparison with prior research, the present study aligns with domestic studies [1, 2] showing that historical regeneration improves quality of life, place attachment, and social interaction among residents, though the direct impact of natural elements and biophilic design on mental health was less explored. International studies [6, 24] have emphasized that nature-based design integrated with historical architecture not only preserves cultural and physical values but also enhances users' mental health and well-being. This study addresses this gap, demonstrating that combining historical regeneration with biophilic design provides both restorative spatial experiences and positive psychological effects.

For biophilic regeneration of historical sites, several key strategies can optimize visitor experience and psychological outcomes:

1. Prioritize natural and multisensory elements—flowing water, diverse vegetation, natural light and shade, and simultaneous sensory stimulation—to create rich and impactful experiences.
2. Design pathways and spaces based on human scale and provide opportunities for direct interaction with natural elements to enhance participatory and enjoyable spatial experiences.
3. Integrate biophilic design with heritage preservation, maintaining water networks, green paths, and using natural materials, aligning with biophilic principles and cultural values.
4. Focus on spatial quality as a mediator of psychological effects; improving environmental legibility, geometric balance, and biodiversity enhances perceptual experience.
5. Employ flexible, phased interventions when resources or space are limited; even adding key biophilic elements in small areas can generate tangible positive psychological effects.
6. Support and train urban managers and landscape architects in combining biophilic principles with historical regeneration and develop practical guidelines to sustain and enhance health-oriented interventions.

Regeneration of Fin Garden in Kashan, using biophilic principles, incorporates all key components of Kellert's framework naturally and intelligently. The combination of natural elements, geometric patterns, multisensory experience, human-scale design, and communal spaces creates not only a restorative and engaging spatial experience but also improves users' mental health, reduces anxiety and depression, and enhances social functioning. Spatial quality acts as a strong mediator facilitating the transmission of biophilic design effects to mental health, while the direct impact of the environment highlights the multi-pathway mechanism of this approach.

Overall, these findings underscore that historical regeneration with a biophilic approach preserves the cultural and physical value of the site while serving as an effective health-oriented intervention to enhance mental health, spatial

experience, and social interaction. This research provides a robust scientific basis for designing and managing historical environments with a focus on psychological well-being, multisensory experience, and human interaction, demonstrating that integrating natural elements, intelligent geometric patterns, and human-scale design is key to creating historically regenerated spaces with positive psychological outcomes.

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