Journal of Human Environment and Health Promotion

Print ISSN: 2476-5481 Online ISSN: 2476-549X

Evaluation and Analysis of Physical Resilience of Comprehensive Health Service Centers against Earthquakes: A Case Study of Comprehensive Health Service Centers in Babol City in 2021

Seyed Morteza Mojtabavi [a, b] | **Hamed Mohammadi** [a] | **Mehran Mohammadian Fazli** [a *]

a. Department of Environmental Health, School of Health, Zanjan University of Medical Sciences, Zanjan, Iran.
b. Department of Environmental Health, Vice-Chancellor of Health, Babol University of Medical Sciences, Babol, Iran.

*Corresponding author: Department of Environmental Health, School of Health, Zanjan University of Medical Sciences, Zanjan, Iran. Postal code: 4515786349. E-Mail: mhrnmoh@zums.ac.ir

ARTICLE INFO

Article type:
Original article

Article history:
Received: 25 MARCH 2023
Revised: 13 APRIL 2023
Accepted: 7 MAY 2023

DOI: 10.52547/jhehp.9.2.78

Keywords:

Evaluation
Physical resilience
Comprehensive health service centers
Safety
Earthquake

ABSTRACT

Background: The present study aimed to investigate the level of structural safety and resistance of comprehensive health service centers, which provide critical services during earthquakes. For this purpose, a total of 30 comprehensive rural health centers and 14 comprehensive urban health centers in Babol city were examined.
Methods: To assess the cultural safety and resilience of comprehensive health service centers in Babol city against earthquakes, we integrated two questionnaires, one from the research of Pourahmad et al. (2018) and the other from the Ministry of Health and Medicine, both of which have been confirmed for validity and reliability. Using these questionnaires, we obtained 9 structural safety indicators and applied this questionnaire to all 44 health units in the city. The data were analyzed using SPSS. 20 software. Additionally, we used the Vicor software to evaluate, score, and rank the physical resilience of comprehensive health service centers against earthquakes.
Results: The total area of the evaluated structures in this research was 18, 340 m^2, with construction dates ranging from 1968 to 2019. The physical resilience of all comprehensive health service centers in Babol city in 2021 was the following results: 18.2% were categorized as favorable, 18.2% as relatively favorable, 15.9% as average, 20.5% as relatively unfavorable, and 27.3% as unfavorable.
Conclusion: In the face of disasters and earthquakes, the health and safety of society depend on the infrastructure and resilience of critical service centers, such as comprehensive health service centers. Upgrading the infrastructure of these centers is crucial to ensure their resilience and protect the health and safety of society. The investigation of comprehensive health service centers in Babol city reveals that more than half of the structures are over 30 years old and lack sufficient resilience against natural disasters. Therefore, investments are needed to improve the physical resilience of these centers. Strategies such as structural reinforcement, regular maintenance, and the implementation of safety standards can enhance their resilience and help them better cope with earthquakes.

1. Introduction

In the modern world, natural disasters and man-made crises, pose significant challenges to people's lives, and many societies are unprepared to cope with them [1]. Even small and large organizations, which are expected to provide services and solve problems, can sometimes fall into crisis and lack the necessary resources to maintain their

How to cite: Mojtabavi SM, Mohammadi H, Mohammadian Fazli M. Evaluation and Analysis of Physical Resilience of Comprehensive Health Service Centers against Earthquakes: A Case Study of Comprehensive Health Service Centers in Babol City in 2021. *J Hum Environ Health Promot.* 2023; 9(2): 78-82.

organizational life, necessitating external assistance [2]. These issues have led to a new global attitude towards disaster management and the control of natural event consequences, with organizations seeking to improve different aspects of their resilience in addition to reducing their vulnerability [3]. The concept of disaster resilience refers to the ability of a society, organization, or region to rebuild after a disaster. This term usually implies the restoration of critical infrastructure such as facilities, food, water, and shelter, but it also encompasses the long-term process of returning households, businesses, and other systems to a suitable condition. According to most sources, resilience can be achieved when the resources and capabilities of society are oriented towards the restoration of these systems [4]. In 2020, Timmerman introduced the concept of resilience to the field of risk assessment, becoming one of the first scientists to discuss the resilience of society to climate change. He views resilience as a measure of a part or whole system′s ability to absorb and recover from hazardous events and considers it closely related to vulnerability [5]. From the point of view of resilience, attention to the internal system and its reproducibility, learning mechanisms, component integrity, and other adaptive features is critical in increasing the system′s ability to adapt to changes and environmental shocks [6]. Resilience can absorb disturbances and their effects by improving the capacities of the system, making it easier for the system to return to its pre-accident state [7]. Resilience is not limited to physical solutions such as infrastructure and buildings; it also encompasses broader capabilities in social, economic, and organizational systems within a city. This perspective emphasizes the importance of people's participation, social development, and building capabilities in these systems [8]. The concept of resilience has attracted significant attention since the 1960s and the early 1970s, following World War II. Due to its uncertain definition and flexible definition, resilience has been developed across a wide range of systems, including engineering, ecology, physical, geographical, economic, management, and, psychology has improved today [9]. Physical resilience is an important dimension of, resilience that has received more attention than other dimensions and its importance is better understood by different societies. The physical environment encompasses all developed lands, such as cities, suburbs, and villages, as well as human-created elements, including houses, streets, sidewalks, lighting, signs, public arts, parks, and all types of structures, furniture, and objects [6]. Physical resilience refers to the ability and capacity to respond and recover the structural and physical infrastructure of society after an accident, which can include residential units, health facilities, pipelines, and roads [10]. Global information and evidence show that accidents and incidents have not decreased in the second half of this century but have occurred with greater intensity and frequency, causing significant destruction to human life. This trend has promoted humanity to increase its response and preparedness capacity at the local and national levels to manage disaster risk reduction [11]. Iran is one of the most vulnerable countries in the world and experiences various natural disasters every year with 6% of global casualties resulting from unexpected accidents occurring in Iran [12], highlighting the importance and necessity of disaster risk reduction management in the country. In this regard, attention to the facilities and health infrastructure of cities plays an important role in reducing or increasing injuries and casualties caused by natural disasters, such as earthquakes. Therefore, good healthcare components in cities can lead to fewer injuries and casualties after an earthquake [13]. Based on the research problem proposed in this study, the question arises as to what level of physical resilience health care centers in Babol city exhibit against earthquake risk. To answer this question, the present study aimed to determine the level of physical resilience of healthcare centers in Babol city and identify existing inequalities in infrastructural terms.

2. Materials and Methods

2.1 Study design

This is a descriptive and analytical study that was conducted in the city of Babol, Iran, from 2020 to 2021.

2.2 Sample size and sampling procedure

The statistical population for this study included all 44 comprehensive urban and rural health service centers in Babol city, which were selected and investigated using a census method.

2.3 Data collection and measures

Two questionnaires were used as data collection tools in this study. The first questionnaire was the "Physical Resilience Index Table" which was designed and validated by Pourahmad et al (2016) [14]. Its validity and reliability were confirmed, and it was used to investigate the physical resilience of worn-out urban tissues in District 10 of Tehran Municipality. was investigated. This tool consists of 4 indicators: "Building frame" "Material type" "Building age" and "Building quality", which are rated as described in Table 1. According to the number of options for each indicator, the spectrum of resilience is scored. The second questionnaire used in this study was the "Structural Safety Assessment" questionnaire [15] of the disaster risk reduction management program of the Ministry of Health, Treatment, and Medical Education. This tool was designed by the experts of the disaster risk reduction management group of the Ministry and is used in all comprehensive health service centers in Iran for periodic assessment of structural safety. The questionnaire consists of four indicators, each of which has three classifications: high safety (score 2), medium safety (score 1), and low safety (score 0). Two methods can be used to complete the questionnaire: 1) Accurate engineering evaluation, which involves conducting probes of the structure, and 2) The Rapid Visual Screening (RVS) method, which is a fast and cost-effective method. In this study, the RVS method was used.

2.4 Data analysis

The data were analyzed using SPSS.20 software. The frequency percentage was used to describe each index. In the inferential statistics section, the K-S test was used to measure the distribution of the data in terms of normal distribution. The independent t-test and chi-square test were then used to compare the results between urban and rural centers. Further, Vicor software was used to evaluate, score, and rank comprehensive health service centers.

Table 1: Indicators of physical resilience

Indicators	Type	Physical Resilience spectrum
Building Structure	Metallic	Much
	Concrete	Medium
	No Skeleton - other	Unbearable
Material type	Beams and bricks	High resilience
	Brick and cement	Medium resilience
	Cement block	Low resilience
	Clay and mud	Non-resilient
The age of the building	Less than 10 years	High resilience
	Between 10 and 20 years	Medium resilience
	Between 20 and 30 years	Low resilience
	More than 30 years	non-resilient
Building quality	Newly-built	A lot of resilience
	Acceptable	High resilience
	Restoration	Medium resilience
	Destructive	Low resilience
	Poor	Very low resilience

3. Results and Discussion

The present study evaluated, scored, and ranked 44 comprehensive health service centers in Babol city based on nine structural safety indicators or criteria. The centers had a total infrastructure of 18340 m^2 and an average year of construction of 1993. The construction year of the structures ranged from 1968 to 2019, indicating the presence of structures over 50 years old among the comprehensive health centers (Table 2). The present study found no statistically significant differences between rural and urban centers in terms of average land area, average building area, and average year of construction. The study also determined the physical resilience status of comprehensive health centers in Babol in 2021 and found that 18.2% had a favorable status, 18.2% had a relatively favorable status, 15.9% had an average status, 20.5% had a relatively unfavorable status, and 27.3% had an unfavorable status. Moreover, the study compared the resilience levels of comprehensive urban and rural centers and found no statistically significant difference between them (p = 209) (Table 3). These results suggest the need for comprehensive investigation and action to address the high proportion of health units with unfavorable conditions. The findings of this study are consistent with those of Ferdowsi and Mardoudi (2016), who reported that 50% of cities in Semnan province lacked optimal resilience in terms of health-treatment centers. These researchers also considered the suitability of human resources working in health-treatment centers for the covered population in their study [11]. The national report on the safety assessment of health centers against disasters, presented by the Disaster Risk Reduction Management Office of the Health Department of the Ministry of Health in 2013, revealed that the national structural safety index was about 14%, indicating a safety level of 3 out of 10. Furthermore, the report indicated that the structural safety of health centers covered by Babol University of Medical Sciences was approximately 7.8%, and the overall safety was 17%. The structural safety of other healthcare centers in the country ranged from 0.4% to 50% [16]. In the study by Junadi Jafari et al. (2017), the structural safety of health-treatment centers covered by the Iran University of Medical Sciences in 2014 was found to be 20%. Another study conducted in the city of Tabriz it was found that the structural safety of healthcare centers was about 27.39% [17]. Khademipour et al. (2022) also showed that primary healthcare facilities in the South East of Iran did not have favorable conditions in terms of resilience [18]. Similarly, the safety of healthcare centers covered by the Tehran University of Medical Sciences in 2014 was around 20.3% [19]. The present study was conducted approximately 7 years after the report of the Disaster Risk Reduction Management Office and 5 years after other studies. In these years, there has been relatively acceptable growth in the level of structural safety. However, about half of the comprehensive health service centers in Babol city still have less than the average level of safety. The implementation of the disaster risk reduction management program and the health system transformation plan, which improved the situation in terms of education, monitoring, sensitization, and allocation of funds to the health system, can be effective factors in improving structural safety and Physical resilience. Among the advantages of the present study is the utilization of nine appropriate indicators for evaluating physical resilience. By using Vicor's method and appropriate weighting to these indicators, a suitable decision was made regarding the ranking of the health centers. Importantly, the study did not solely report a raw average of scores but instead ranked the health centers based on the role of other criteria, leading to a more accurate evaluation of physical resilience. The relative humidity of the air is an important factor in geography research [20, 21]. The southern Caspian Sea region, where this study was conducted, has a temperate and humid climate with high relative humidity levels, typically above 80% [22]. Historical evidence suggests that structures in this region were designed to be compatible with the local climatic conditions to maintain their stability in various conditions [23]. Studies have shown that high relative humidity can increase the strength of concrete structures, while metal structures are less affected if their base is insulated. Architects of old and adobe structures in the region typically considered a distance between the ground and the floor of the structure to allow for airflow, creating an insulating layer that prevents moisture from penetrating the floor of the structure [20]. Based on this evidence, it can be concluded that the relative humidity of the air in the region cannot be considered a serious influencing factor in the safety of the structures.

Table 2: Infrastructure characteristics of comprehensive urban and rural health centers of Babol city

Type	names of urban and rural centers	The year of construction	Land Area (m^2)	Building Area (m^2)
Urban Compreh-ensive Health Centers	Modares	1981	1350	337
	Raziakla	1986	598	267
	Musa Al-Reza	1986	834	552
	Keshvari	1987	3586	1653
	Charshanbe pish	1988	276	175
	Syed Jalal	1988	358	293
	Zainabiya	1989	123	61
	ShohadayeGomnam	1989	400	92
	Shahid Zakarian	1991	3486	495
	22 Bahman	1994	2540	374
	Shahid Rostami	1997	1276	1216
	Amirkola 2	2002	2200	600
	Amirkola 1	2009	520	293
	Sar pol	2016	235	130
Rural Compreh-ensive Health Centers	Galogah	1968	3417	686
	Diva	1968	2680	462
	Noshirwankola	1968	1000	225
	Derazkola	1971	1600	312
	Bala Ahmadchale Pay	1973	731	369
	Khoshrudepay	1973	4500	530
	Syed Kola	1977	3647	295
	Pichakola	1979	4084	278
	Kolagar mahaleh	1979	3212	288
	Ahangar kola	1986	2400	255
	Dooneh sar	1987	3000	485
	Amin Abad	1989	1628	259
	Aly zamin	1989	2358 3	480
	Beeshe sar	1990	2312	300
	Firuzja	1993	3000	385
	Narivaran	1993	2968	479
	Paeen gatab	1994	2540	374
	Salahdar kola	2020	800	500
	Paeen Ganj Afrooz	2003	1600	480
	Darzikola bozorg	2003	3000	499
	Dehak	2003	3153	499
	Paeen darzikola	2005	1170	353
	SultanMohammad Taher	2005	1800	353
	Siyah kola mahaleh	2005	4370	353
	Gorgi Abad	2005	1050	353
	Daroon kola sharghi	2015	1000	350
	Otaghsara	2015	900	350
	Darvish khak	2015	805	350
	Paeen Ahmadchale Pay	2018	380	400
	Poost kola	2019	750	500

Table 3: Comparing the frequency of physical resilience levels in rural and urban centers, Babol city in 2021

Levels of physical resilience	Urban Comprehensive Health Centers		Rural Comprehensive Health Centers		Total		*P*-Value†
	N	%	N	%	N	%	
Desirable	3	21.4	5	16.8	8	18.2	0.209
Relatively desirable	0	0	8	26.7	8	18.2	
Medium	3	21.4	4	13.3	7	15.9	
Relatively Undesirable	4	28.6	5	16.7	9	20.5	
Undesirable	4	28.6	8	26.7	12	27.3	

† P value derived from chi-square test

4. Conclusion

Iran is considered one of the top 10 richest countries in the world in some international rankings. However, out of the 43 types of natural disasters known worldwide, 31 types are likely to occur in Iran. These statistics highlight the reality of Iran's geography and serve as a warning to officials and members of society to pay more attention to safety, disaster risk reduction, and resilience in all dimensions, including physical and structural safety. It is imperative to consider safety and disaster resilience as a requirement and necessity rather than a choice with a cross-sectional, short-term, and slogan-based approach. The findings of the present study show that many of the structures of comprehensive health centers in Babol city have a lifespan exceeding 30 years and that about half of them lack the necessary resilience against disasters. While there has been progress in structural safety since previous reports, the current conditions still fall far short of ideal conditions.

4.1 Suggestions:

Codified criteria should be designed to evaluate the structural resistance of health and treatment centers, given their sensitivity as critical buildings during the disaster response phase. These criteria should be developed with the input of experts and stakeholders and should reflect the specific needs and circumstances of the regional area in which the centers are located.

4.2 Research limitations:

This study has some limitations that should be acknowledged. The first limitation is that the building plans of some comprehensive health service centers were not available due to the age of the building. The second limitation is the problem of coordinating with the experts of the technical office to complete the checklists and collect data.

Authors' Contributions

Morteza Mojtabavi: performing the experiment; Collect data and fill in checklists; data analysis; writing-original draft. Hamed Mohammadi: methodology; advisor. Mehran

Mohammadian Fazli: Conceptualization; methodology; reviewing the manuscript.

Funding:

This research did not receive any external funding.

Conflicts of Interest

The authors declare no Conflict of interest.

Acknowledgements

The Technical Office of the health department, in conjunction with the statistical guidance offered by Mr. Amozadeh deserves appreciation. (Ethics no. IR.ZUMS.REC.1399.189).

References

1. Rousta M, Ebrahimazadeh I, Istgaldi M. Assessment of Urban Social Resilience (Case Study: City of Zahedan). 2018; 1-14.

2. Stephenson A, Seville E, Vargo J, Roger D. Benchmark Resilience: A Study of the Resilience of Organisations in the Auckland Region. 2010.

3. Aronson RB, Adger WN, Hughes TP, Folke C, Carpenter SR, Rockström J. Social-Ecological Resilience to Coastal Disasters. Science, 309: 1036-9. Aronson RB, Precht WF, Macintyre IG, Murdoch TJT. Coral Bleach-Out in Belize, Nature 405: 36. Status of Caribbean Coral Reefs after Bleaching and Hurricanes in 2005. 2008; 46: 145.

4. Paton D. Emergency Planning: Integrating Community Development, Community Resilience and Hazard Mitigation. *J Am Soc Prof Emerg Manag.* 2000; 7(1): 109-18.

5. Timmerman JG. Building Resilience through Transboundary Water Resources Management. *Palgrave Handb Clim Resilient Soc.* 2020; 1-19.

6. Mohammadpourlima N, Bandarabad A, Majedi H. Evaluation of the Urban Form Resilience of the Residential Neighborhoods; Case Studies: Oudlajan and Sangelaj Neighborhoods in the Historical Texture of Tehran. *Armanshahr Archit Urban Dev.* 2020; 13(32): 301-13.

7. Cutter SL, Barnes L, Berry M, Burton C, Evans E, Tate E, et al. A Place-Based Model for Understanding Community Resilience to Natural Disasters. *Glob Environ Change.* 2008; 18(4): 598-606.

8. Karamouz M, Taheri M, Khalili P, Chen X. Building Infrastructure Resilience in Coastal Flood Risk Management. *J Water Resour Plan Manag.* 2019; 145(4): 04019004.

9. Habitat U. Trends in Urban Resilience. City Resilience Profiling Programme Nairobi, Kenya: United Nations Human Settlements Programme Recovered from es. unhabitat. org. 2017.

10. Rezaei MR, Rafieian M, Hosseini SM. Measurement and Evaluation of Physical Resilience of Urban Communities against Earthquake (Case Study: Tehran Neighborhoods). *Hum Geogr Res.* 2015; 47(4): 609-23.

11. Ferdowsi S, Mododi Arkhodi M. Evaluating the Hygienic-Therapeutic Resilience of Semnan Province Cities to Natural Disasters. *Q Sci J Rescue Relief.* 2018; 10(4): 86-99.

12. Bolhari J, Chime N. Mental Health Intervention in Bam Earthquake Crisis: A Qualitative Study. *Tehran Univ Med J.* 2008; 65: 7-13.

13. Amiri M, Olfat L, Feizi K, Salehi Abarquee MA. A Model for Organizational Resilience. *J Product Manag.* 2018; 12(1 (44)): 35-65.

14. Pourahmad A, Ziyari K, Sadeghi A. Spatial Analysis of Physical Resilience Components of Urban Attrited/Beaten Tissues against Earthquakes (Case Study: District 10 of Tehran Municipality). *Spat Plan.* 2018; 8(1): 111-30.

15. Asadi G, Karampourian A, Kalatpour O, Khazaei S. Assessment of Safety Status and Functional, Structural and Non-Structural Preparedness of Health Centers in Hamadan against Disasters. *J Occup Hyg Eng.* 2022; 8(4): 69-77.

16. Jahangiri K, Rostami N, Sahebi A. Challenges of Utilizing the Primary Health Safety Index Tool for Assessing the Vulnerability of Healthcare Centers to Disasters. *Front Emerg Med.* 2020; 4(1): e1.

17. Jafari AJ, Baba M, Dowlati M. Disaster Risk Assessment in Health Centers of Iran University of Medical Sciences in Functional, Non Structural & Structural Components During 2015-2016. *Iran Occup Health.* 2018; 15(1): 76-85.

18. Khademipour G, Sheikhbardsiri H. Disaster Risk Assessment of Primary Healthcare Facilities in South East of Iran: A Study with Approach of Disaster Risk Reduction. *Disaster Emerg Med J.* 2022; 7(1): 11-20.

19. Ardalan A, Yousefi H, Rouhi N. National Report for Disaster Safety and Risk Assessment in Primary Health Care Facilities. *Minist Health Med Educ.* 2015.

20. Juan X, Ziliang L, Weijun G, Mengsheng Y, Menglong S. The Comparative Study on the Climate Adaptability Based on Indoor Physical Environment of Traditional Dwelling in Qinba Mountainous Areas, China. *Energy Build.* 2019; 197: 140-55.

21. Appah-Dankyi J, Koranteng C. An Assessment of Thermal Comfort in a Warm and Humid School Building at Accra, Ghana. 2012.

22. Rooshanali M, Marsousi N, Zakeri M. Land Suitability Evaluation Mazandaran Province Model Based on Elements of the Climate for the Cultivation of Rapeseed Using TOPSIS Model. *Biannual J Urban Ecol Res.* 2012; 3(6): 67-80.

23. Abbasabadi Arab M, Khankeh HR, Mosadeghrad AM, Farrokhi M. Developing a Hospital Disaster Risk Management Evaluation Model. *Risk Manag Healthc Policy.* 2019: 287-96.