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ORIGINAL ARTICLE

Providing Risk Management Model for Mineral Spa Based on International Standards with Safety and Environmental Approach

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ABSTRACT

The aim of this article was to present a model for measuring and managing the risk of using hot mineral spas based on the structural safety with environmental approach. A conceptual model of risk was prepared in four stages: 1) determining the general outline of the model, 2) identifying spa structure safety indicators, 3) evaluating and scoring the indicators, and 4) determining the quantitative and qualitative categories of the model and providing solutions. In the current study, 30 spa structure safety indicators were extracted, and the weight of each indicator was obtained based on the amount of risk for users. Moreover, a questionnaire was prepared by analytic hierarchy process (AHP) analysis method. According to the standard level allowed for each indicator, spa structure safety risk categories were prepared in five ranges for each indicator based on the obtained weights and the opinions of health experts. The results of the risk associated with each spa were obtained by combining 30 spa structure safety indicators. Firstly, to assess the risk of using hot mineral spas by the method invented in this study, the extracted model indicators were scored in six spas of Iran. Then, risk level of the six spas was evaluated. According to the risk scores, hot spas named Gavmishgoli and Qotoursoo had an unacceptable level of risk. Qinarjeh, Shabil, and Sabalan had a high level of risk. Borjloo had a moderate level of risk. The proposed risk model provides a framework for a standard and safe mineral spa.

KEYWORDS: *Balneotherapy; Safety; Risk model; Thermal spring*

INTRODUCTION

Lack of a comprehensive standards and appropriate measures to eliminate the Health hazard by wrong design in the mineral spas as well as the hygienics equipment are among the threats to tourist attractions to hot spas. The annual death of several people in various hot spas in Ardabil province as a result of these threats may ruin the reputation of these important tourist attractions at the national and international levels [1-2]. Studies have indicated that a portion of these fatal threats is related to spa structure and equipment as well as spa safety [3-4]. Providing a risk management model can control the risks of using hot mineral spa based on spa structure safety management system. Mineral hot spas cannot be managed by the standards and requirements of ordinary spas (approved by the Standards Organization, Ministry

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of Health, and Ministry of Labor) due to certain factors such as hazardous gases and high temperatures [5-6]. Previous studies have documented chemical and microbial contamination in these waters. Due to the lack of comprehensive national standards for hot mineral spas, the similar standards used for ordinary spas are also used for these types of spas [7-8]. According to the provisions of National Standard No. 20483 on how to use hydrotherapy centers and hot springs [9], the standard facilities for diving and professional swimming cannot be used by all the people.

National Standard No. 15572 [10], (which is the translation of International Standard No. ISO 17679), first of all, obliges providing qualified welfare and treatment services to customers, generally outlines the issue of ensuring health of the people and only focuses on hot water temperature and how to adjust the temperature through ventilation. Moreover, in National Standards No. 11202 regarding spas [11-7-12], in addition to the current regulations and requirements of the Ministry of Health and the Ministry of Labor, the requirements of public safety and public health are explained in general [13].

Regardless of the international average, the rate of accidents in mineral hot spas of Ardabil province caused by lack of spa structure safety indicators are much higher than the national average [14], indicating the need for preventive programs. There is a large body of research on dangers of using mineral hot spas. In a study conducted in Spanish hot mineral waters, the role of microbial components in water of natural mineral spas was investigated to determine the effect of physical factors on microbial components in mineral spa [15]. In another study on more than 27,000 mineral spas in Japan, used by some people through some traditional health practices, it was found that hot spas as a therapeutic landscape play an important role in maintaining health and well-being of the Japanese people [16]. In another study, quantity and quality of hot spas were studied in Iran and it was found that most of these springs do not have good health and welfare conditions and it was concluded that if proper conditions and basic facilities are provided and upgraded, Iran would be introduced as a worldwide hub of natural tourism and therapy [17].

Isinuka springs in South Africa are traditional spas used by hundreds of people every day. In a study on its physical and chemical properties, it was found that clay sediments of the cave and swimming spa water had a high concentration of calcium and toxic metal of lead [18]. In another study, a quantitative microbial risk assessment (QMRA) model was evaluated for Legionnaires disease. This model was able to estimate colony concentration of the disease agent in different parts of the spa air [19]. In a study, a safe and standard disinfection strategy was evaluated in spas.

Antimicrobial activity was assessed in the water of four different spas. Antibacterial activity of TiO_2 showed an additional effect with a decrease of more than 99% within 2-5 hours [20-6]. Based on the conducted studies and considering incompleteness of the provisions of standards for safe use of hot water and finally, quantitative and spa structure safety development of mineral hot spas, in the current situation, there is a need to define a comprehensive procedure for safe and healthy use of mineral spas in order to boost the tourism industry and the region's economy [21-22].

Comprehensive research recommendations made by Erfurt in their doctoral dissertation were also conducted as a meta-analysis in mineral spas of most countries [23], and also results of a study on providing a risk model [19], showed importance of providing a risk model for mineral spas. Therefore, this research was carried out to present a new concept and solution in the field of presenting a conceptual model based on spa structure safety indicators to deal with various environmental conditions including important indicators in hot mineral spas. In this study, the cases of hydrotherapy accidents in Ardabil Province were aimed to investigate the shortcomings in the safety management system for preventing the occurrence of hazardous accidents. The study was carried out in hot mineral spas in Ardabil, Iran in 2020.

MATERIAL and METHODS

In this study, a risk model of spa was prepared in four stages of planning, identifying, evaluating, managing, and monitoring [24]. In the planning stage, it was determined how to manage the potential risks and the general framework of the model was specified to show the risk of using the mineral spas. In the second stage, the indicators of potential risks in various forms, such as spa structure safety indicators and environmental conditions, were identified. In the third stage, the identified risks were evaluated using criteria identified for spa structure safety indicators and requirements of the current standards, etc. Thus, these criteria were scored based on their probability of occurrence and possible consequences. Based on the risk management model and the spa structure safety indicators, the hot mineral spas were classified into five categories, namely no risk, bearable partial risk, moderate risk, high risk, and unbearable risk. In the fourth stage, which could be called a solution presentation stage, the risk was managed through reducing and eliminating, avoiding, assigning, and accepting the risk. In the last stage, conditions and level of the risk were determined for each spa, and the subsequent management measures were determined by providing the solutions and monitoring of the performance. Afterwards, all the available national and international scientific, research documents, and reports [25] about the risk models for the use of mineral hot spas were applied.

The spa structure safety components of research on contents and requirements of the current standards were identified and selected. Finally, the results of analyzing the accidents of hot mineral spas were obtained by root cause analysis (RCA). By determining the spa structure safety indicators, structure and categories of each component were considered. After analyzing these components and determining their level by the analytic hierarchy process (AHP) method, the ranges of each category were determined. Therefore, the conditions for using the mineral spas were determined by the model output (fourth and fifth stages of ISO standard 31000). The studied mineral spas in Ardabil province have been shown in Figure 1. Spa structure safety indicators of the spas in several cities of the province, including Nir, Sarein, and Meshkinshahr were presented after repeated visits, completing the prepared questionnaires and evaluations by relevant experts and officials.

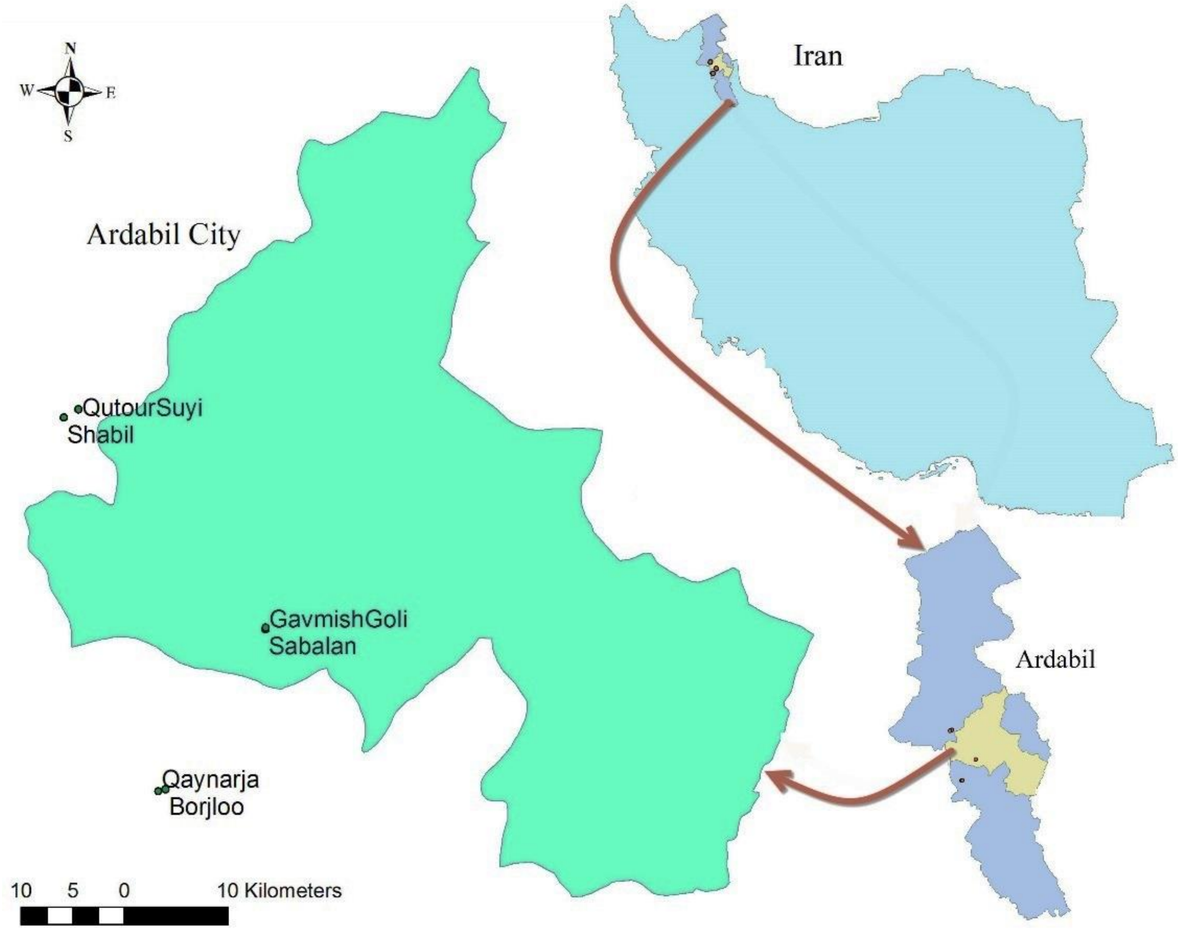

Fig 1. Geographic location of the study area in six spa centers studied in Ardabil, Iran

Flowchart of the modeling method used in this study has been presented in Figure 2 and Figure 3. The indicators related to the areas of spa structure safety of the hot mineral spas were categorized based on the questionnaire and the experts' opinions [26].

The AHP method was employed to quantify the weights of performance indicators. Using the indicators defined in the questionnaire, a checklist was prepared to collect the required information. Then, the indicators were studied and calculated in the field study by the prepared checklist.

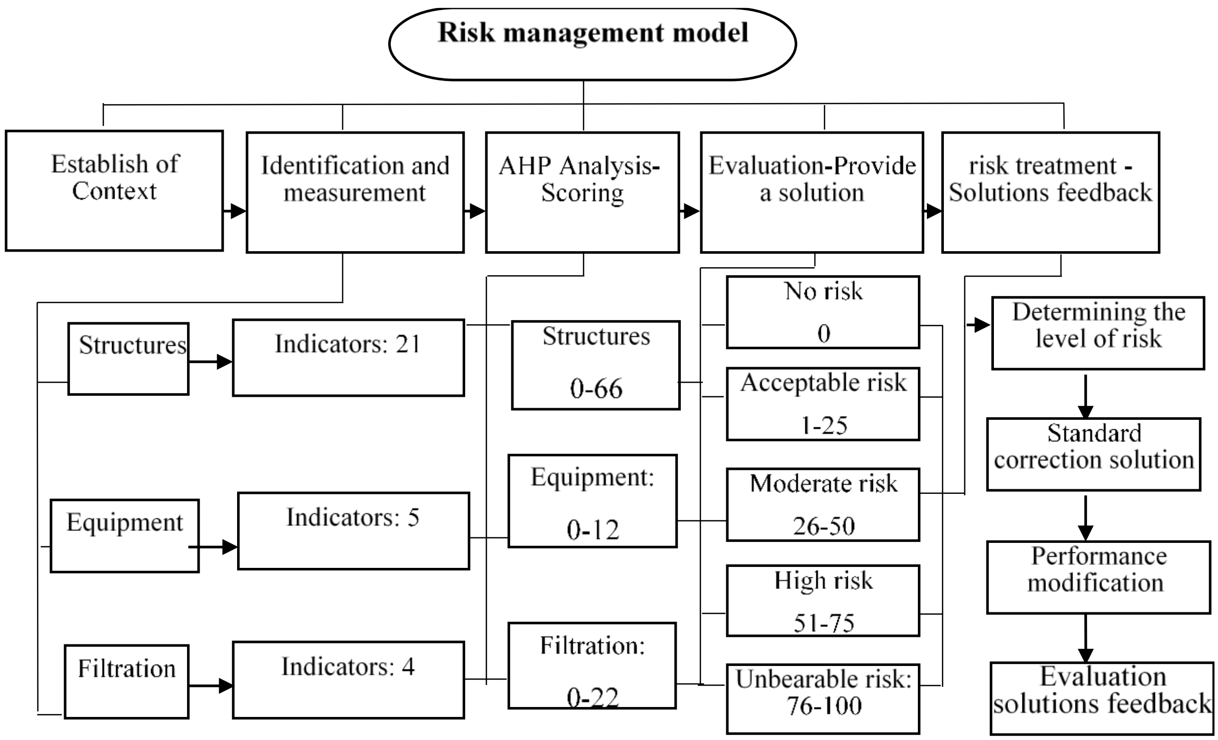

Fig 2. Flowchart of the risk management model steps

First, the prepared spa structure safety information was arranged as input to the conceptual model. Next, using the completed questionnaire covering the current standards for the hot mineral spas, results of accident analysis, statistical tests, and AHP weighting, each component was assigned an appropriate weight. Then in the data analysis section, each component and the weight assigned to the categories were considered based on the quantitative amounts. Finally, the spa structure safety category of the mineral spas was obtained by determining their level of risk based on weighting and scoring of these categories. The process of these steps has been presented in Figure 3.

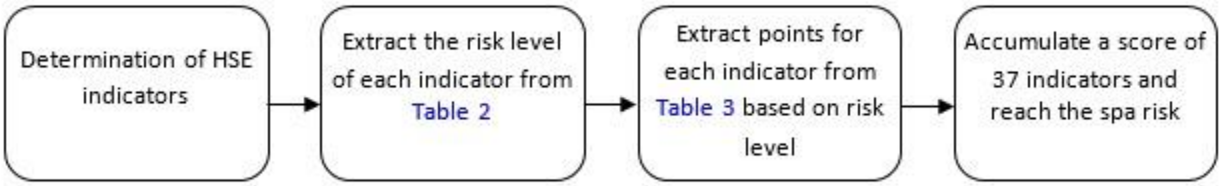

Fig 3. Steps of identification-measurement of indicators and analysis-scoring in the risk model

In the method of risk management, 37 indicators were scored from 0 to 100. The score of each factor was obtained using a questionnaire with a separate table involving the micro-factors with technical details. Finally, a risk number was calculated for each spa and five levels of risk management labeled as no risk, low risk (bearable), moderate risk, high risk, and unbearable risk were considered for the parameters in each spa. The related quantitative score was obtained by equally dividing it by 25 points according to Table 1. If the parameter value was within the range of standard value, the level would have no risk and the other 4 risk levels would be applied according to the classification mentioned in the above section.

Table 1. Spa structure safety category after total ranking values of 30 indicators in the risk management model

Risk class and level	Weighting score
No risk	0
Acceptable risk	1-25
Moderate risk	26-50
High risk	51-75
Intolerable risk	76-100

The spa structure safety indicators used in this method (30 indicators) were classified into three categories of structure, equipment and filtration categories (see Table 2). According to Table 2, the standard amount and risk ranges obtained by opinions of the health experts were used to determine five categories for each parameter based on the five levels of the risk model. The risk level for each parameter obtained from the questionnaire and the experts' opinions has been presented in Tables 2 and 3. Score of the risk level for the parameter was extracted and inserted into Table 4.

The evaluation criterion for determining the risk level of each model indicator was based on the rate of implementation of measures or supply of equipment as described by hydrotherapy standards (INSO, 2019; INSO, 2018; INSO, 2017; INSO 2012). In case of full compliance of the standards with the indicators, the relevant risk level would be assigned to the no risk level. Moreover, levels of low and tolerable risk, medium risk, high risk and unbearable risk would be assigned in case of supplying 76% to 100%, 51% to 75%, 26% to 50%, and 0% to 25% of the indicators, respectively.

Table 2. Spa structure safety indicators with standard range and 5 ranges and risk levels

Risk level/ Agent name	No risk 1 (%)	Acceptable Risk 2 (%)	Medium Risk 3 (%)	High Risk 4 (%)	Unbearable Risk 5 (%)
Area and capacity of water spaces	100	75	50	25	0
Depth of pools in different age groups	100	75	50	25	0
Location and number of Iranian and French health services	100	75	50	25	0
The position of the stairs in the depth of the pool and the height of the platforms	100	75	50	25	0
Condition of doors, windows and railings	100	75	50	25	0
Use of anti-damping materials and sound insulation	100	75	50	25	0
Condition of Normal and disabled locker rooms	100	75	50	25	0
Number, dimensions and placement of showers	100	75	50	25	0
Non-slip and washable floor, sharp edgeless surfaces	100	75	50	25	0
Lobbying status and reception	100	75	50	25	0
Buffet position and distance from the pool	100	75	50	25	0
Condition of dry and wet sauna, how to inject steam	100	75	50	25	0
Smooth and durable surface inside the pool	100	75	50	25	0
Jacuzzi condition	100	75	50	25	0
Two meters of space at the edge of the pool	100	75	50	25	0
The condition of the chlorine pond	100	75	50	25	0
The condition of the chemical chamber and the distance of twenty meters from the pool	100	75	50	25	0
Parking status and fifty percent capacity of swimmers	100	75	50	25	0
Lighting status of various spaces	100	75	50	25	0
Roof condition and no need for a false ceiling	100	75	50	25	0
Bright colors of the walls	100	75	50	25	0
Existence of protected electrical circuits	100	75	50	25	0
Exhaust gas and particulate monitoring system	100	75	50	25	0
Fire alarm and extinguishing systems (manual and automatic)	100	75	50	25	0
Existence of water and environment thermometer	100	75	50	25	0
Periodic maintenance program of boilers	100	75	50	25	0
Wastewater collection system, suitability of canals and water supply pipes	100	75	50	25	0
Existence of natural ventilation	100	75	50	25	0
Existence and function of artificial ventilation and air blowers	100	75	50	25	0
Filtration recirculation flow	100	75	50	25	0

RESULTS

Initially, 30 spa structure safety indicators were weighed according to the experts' opinions and the questionnaires which covered three categories of structure with a total score of 66, equipment with a total score of 12, and filtration aspects with a total score of 22. The results of Table 3 showed that the highest weight was related to one indicator with a value of 12, which were structure component. This indicator was Depth of pools in different age groups. The lowest score was given to one indicator with a value of 1 and included Existence of water and environment thermometer. Figure 4 shows output of the AHP hierarchical analysis method for weighting the 30 indicators studied.

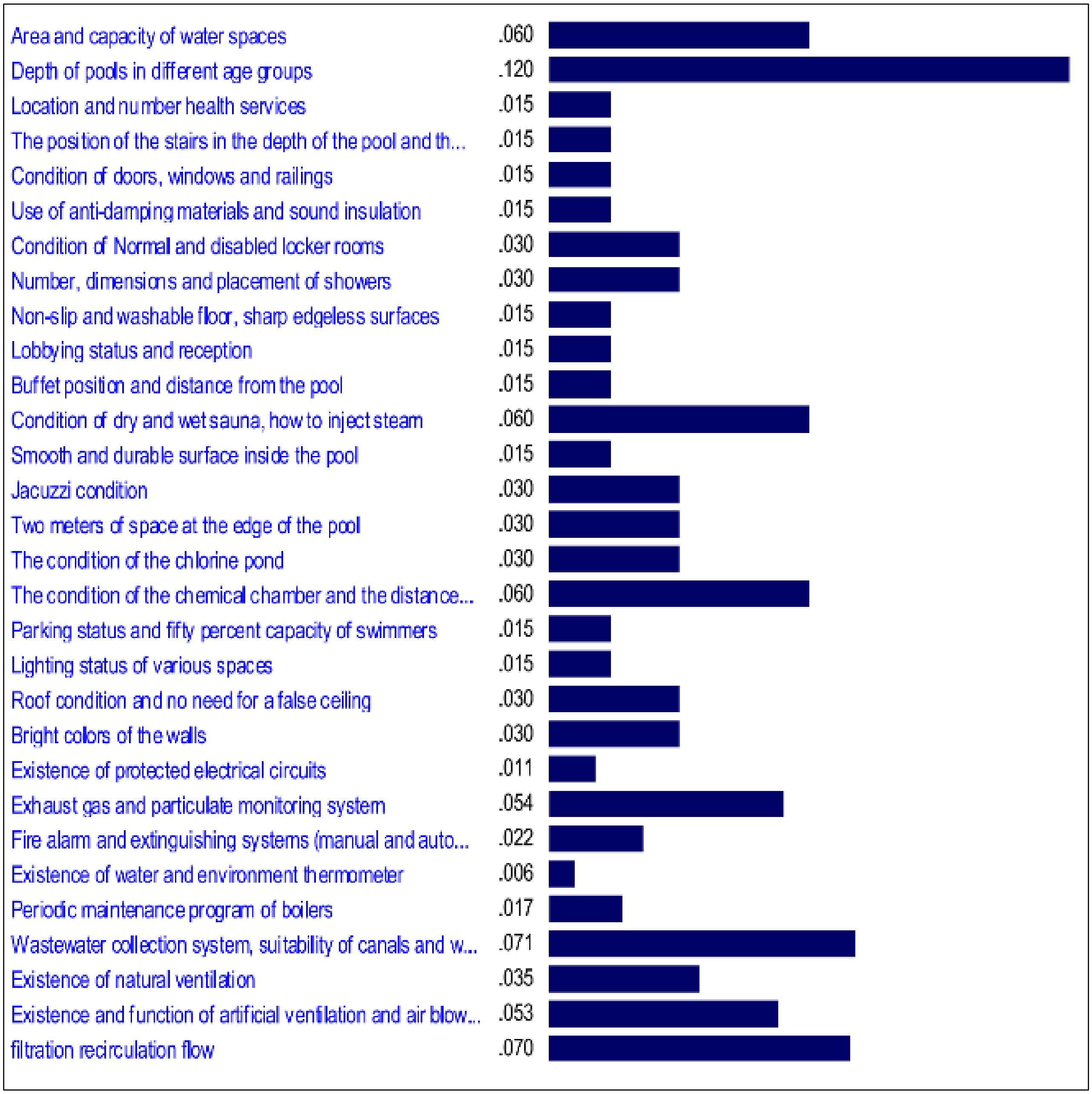

Fig 4. Weighting scores of 30 spa structure safety indicators by AHP hierarchical analysis

According to the results of weighting, the score rang of the indicators was divided into four equal parts as shown in Table 3. Some indicators were rounded off to simplify the scoring process. In this management model, the risk was classified into five categories. The value of an indicator equal to or less than its standard value represented the first category or without risk (zero risk). These five risk levels were determined according to the increase of the standard value. Moreover, the spa water samples received a corresponding score from Table 3 when they were in any level presented in Table 2.

Scores analysis of 30 indicators in the studied hot mineral spas indicated that, in the structure group, Qotoursoo spa with a total score of 59.25 had the highest risk level and Borjloo spas with a total score of 13.12 had the lowest risk level. In the equipment group, Gavmishgoli spa with a total score of 11 had the highest risk and Shabil spa with a total score of 9.5 had the lowest risk. Moreover, in the filtration group, Gavmishgoli spa with a total score of 21.25 had the highest risk score and Shabil, Qinarjeh and Borjloo spas with a total score of 15.5 had the lowest risk score.

According to the results of Table 4, Gavmishgoli spa with a total score of 88.25 and Qotursuyi spa with a total score of 87.25, respectively, were at an unacceptable risk level and had the highest risk compared to the other spas. The other three spas were at a high risk level, so that Shabil spa with a total score of 65.125 ranked the third, Qinarjeh spa with a total score of 61.125 ranked the fourth, Sabalan spa with a total score of 50.375 ranked the fifth and Borjloo spa (which had the lowest risk) with a total score of 68.25 ranked the sixth and were at an moderate risk level. The overall risk level related to each mineral spa was obtained by aggregating their scores of spa structure, equipment and filtration indicators.

Table 3. Weighting scores of quality indicators in 5 risk classes

Indicators		Weighted score	No risk	Acceptable	Medium	High	Unbearable
Area and capacity of water spaces	Structure	6	0	1.5	3	4.5	6
Depth of pools in different age groups	Structure	12	0	3	6	9	12
Location and number of health services	Structure	1.5	0	0.375	0.75	1.125	1.5
The position of the stairs in the depth of the pool and the height of the platforms	Structure	1.5	0	0.375	0.75	1.125	1.5
Condition of doors, windows and railings	Structure	1.5	0	0.375	0.75	1.125	1.5
Use of anti-damping materials and sound insulation	Structure	1.5	0	0.375	0.75	1.125	1.5
Condition of Normal and disabled locker rooms	Structure	3	0	0.75	1.5	2.25	3
Number, dimensions and placement of showers	Structure	3	0	0.75	1.5	2.25	3
Non-slip and washable floor, sharp edgeless surfaces	Structure	1.5	0	0.375	0.75	1.125	1.5
Lobbying status and reception	Structure	1.5	0	0.375	0.75	1.125	1.5
Buffet position and distance from the pool	Structure	1.5	0	0.375	0.75	1.125	1.5
Condition of dry and wet sauna, how to inject steam	Structure	6	0	1.5	3	4.5	6
Smooth and durable surface inside the pool	Structure	1.5	0	0.375	0.75	1.125	1.5
Jacuzzi condition	Structure	3	0	0.75	1.5	2.25	3
Two meters of space at the edge of the pool	Structure	3	0	0.75	1.5	2.25	3
The condition of the chlorine pond	Structure	3	0	0.75	1.5	2.25	3
The condition of the chemical chamber and the distance of twenty meters from the pool	Structure	6	0	1.5	3	4.5	6
Parking status and fifty percent capacity of swimmers	Structure	1.5	0	0.375	0.75	1.125	1.5
Lighting status of various spaces	Structure	1.5	0	0.375	0.75	1.125	1.5
Roof condition and no need for a false ceiling	Structure	3	0	0.75	1.5	2.25	3
Bright colors of the walls	Structure	3	0	0.75	1.5	2.25	3
Existence of protected electrical circuits	Equipment	2	0	0.5	1	1.5	2
Exhaust gas and particulate monitoring system	Equipment	5	0	1.25	2.5	3.75	5
Fire alarm and extinguishing systems (manual and automatic)	Equipment	2	0	0.5	1	1.5	2
Existence of water and environment thermometer	Equipment	1	0	0.25	0.5	0.75	1
Periodic maintenance program of boilers	Equipment	2	0	0.5	1	1.5	2
Wastewater collection system, suitability of canals and water supply pipes	Filtration	7	0	1.75	3.5	5.25	7
Existence of natural ventilation	Filtration	3	0	0.75	1.5	2.25	3
Existence and function of artificial ventilation and air blowers	Filtration	5	0	1.25	2.5	3.75	5
filtration recirculation flow	Filtration	7	0	1.75	3.5	5.25	7

Table 4. Value and level of risk of spa structure safety indicators of the 6 spas studied

Parameter	Borjloo		Qaynarja		Sabalan		Gavmishgoli		shabil		Qotoursoo	
	Risk	**Value**	**Risk**	**Value**	**Risk**	**Value**	**Risk**	**Value**	**Risk**	**Value**	**Risk**	**Value**
Area and capacity of water spaces	0	0	0	0	0	0	3	2	3	2	4.5	3
Depth of pools in different age groups	3	1	3	1	3	1	12	4	6	2	12	4
Location and number of health services	0	0	1.5	4	0	0	1.5	4	1.125	3	1.5	4
The position of the stairs in the depth of the pool and the height of the platforms	0.375	1	1.125	3	0.375	1	1.125	3	0.75	2	1.125	3
Condition of doors, windows and railings	0.375	1	1.5	4	0.75	2	1.5	4	1.5	4	1.5	4
Use of anti-damping materials and sound insulation	0.75	2	1.5	4	0.75	2	1.5	4	0.75	2	1.5	4
Condition of Normal and disabled locker rooms	2.25	3	3	4	2.25	3	3	4	2.25	3	3	4
Number, dimensions and placement of showers	0	0	1.5	2	0	0	1.5	2	1.5	2	3	4
Non-slip and washable floor, sharp edgeless surfaces	0.75	2	1.125	3	0	0	1.125	3	0	0	1.125	3
Lobbying status and reception	0	0	0.75	2	0	0	0.75	2	0.75	2	1.5	4
Buffet position and distance from the pool	0	0	1.5	4	0.75	2	1.5	4	0.75	2	1.5	4
Condition of dry and wet sauna, how to inject steam	1.5	1	3	2	0	0	6	4	3	2	6	4
Smooth and durable surface inside the pool	0	0	1.125	3	0	0	1.5	4	0.75	2	1.5	4
Jacuzzi condition	0	0	1.5	2	0	0	3	4	1.5	2	3	4
Two meters of space at the edge of the pool	0	0	1.5	2	0	0	3	4	1.5	2	3	4
The condition of the chlorine pond	0	0	3	4	2.25	3	3	4	3	4	3	4
The condition of the chemical chamber and the distance of twenty meters from the pool	0	0	6	4	4.5	3	6	4	6	4	6	4
Parking status and fifty percent capacity of swimmers	0.375	1	0.75	2	0.75	2	1.5	4	0.75	2	1.5	4
Lighting status of various spaces	0.75	2	0.75	2	0.75	2	1.125	3	0.75	2	0.75	2
Roof condition and no need for a false ceiling	1.5	2	0	0	1.5	2	0	0	2.25	3	0	0
Bright colors of the walls	1.5	2	1.5	2	1.5	2	2.25	3	2.25	3	2.25	3
Total structure risk	**13.1**		**35.62**		**19.13**		**55.87**		**40.12**		**59.25**	
Existence of protected electrical circuits	1.5	3	1	2	1.5	3	2	4	0.5	1	2	4

Exhaust gas and particulate monitoring system	5	4	5	4	5	4	5	4	5	4	5	4
Fire alarm and extinguishing systems (manual and automatic)	1	2	1	2	1	2	1	2	1	2	2	4
Existence of water and environment thermometer	1	4	1	4	1	4	1	4	1	4	1	4
Periodic maintenance program of boilers	2	4	2	4	2	4	2	4	2	4	2	4
Total equipment risk		**10.5**		**10**		**10.5**		**11**		**9.5**		12
Wastewater collection system, suitability of canals and water supply pipes	7	4	7	4	7	4	7	4	7	4	7	4
Existence of natural ventilation	3	4	3	4	3	4	2.25	3	3	4	2.25	3
Existence and function of artificial ventilation and air blowers	3.75	3	3.75	3	3.75	3	5	4	3.75	3	5	4
filtration recirculation flow	1.75	1	1.75	1	7	4	7	4	1.75	1	1.75	1
Total filtration risk	**15.5**		**15.5**		**20.75**		**21.25**		**15.5**		**16**	
Total	**39.125**		**61.125**		**50.375**		**88.125**		**65.125**		**87.25**	

DISCUSSION

Risks of using spa has been extensively studied by many researchers around the world [27- 28-29]. However, no study has focused on developing a risk management model based on spa structure safety indicators. The results of investigating the hot mineral spas in Japan emphasized that lack of accurate and sufficient standards can cause illness and injury to the users rather than providing well-being and treatment for them [16]. The results confirmed the results of reviewing the forensic documents on this issue. Studies conducted in Serbia, Yemen, and other countries revealed that strict standards and proper risk management of accidents in hot mineral spas, as tourist centers, could significantly contribute to the economy [30-31].

Studies of hot mineral spas in Iran, particularly in Sarein city showed that the spa structure safety indicators were not in standard conditions [8], which was consistent with the results of this study. Investigation of other mineral spas in Ardabil and other provinces of Iran have confirmed the need to pay attention to these resources in order to improve their quality [17]. In this research, this problem was evaluated by providing a comprehensive solution and a standard risk model.

CONCLUSION

The present study was aimed to provide a solution for the risks associated six hot mineral spas in Ardabil province in Iran. Monitoring hot mineral spas based on the obtained scores and the proposed solutions revealed that among six spas, Gavmishgoli spa, with a score of 88.125, QoturSuyi spa, with a score of 87.25 had an unbearable risk and the rest of the spas were at high and moderate risk level. It is due to the results that monitoring and management intervention is of particular importance to improve their quality of services. Forensic records related to deaths and injuries in the spas also showed that majority of the cases were related to Qotursuyi spa, in which there was no written plan to reduce the number of casualties to zero.

In the fourth stage, the risk management model was presented in this research provided a solution according to the nature and origin of problems and risks regarding using hot mineral spas, as well as the results of conceptual model of risk, field visits, review of forensic records, and studies on the standard group ISO 1000 standard. Therefore, it was divided into two categories including defects in the system (standard development) and defects in performance of existing standards.

Based on the findings of this study, the identified cases caused by defects in the system and standardization included the differences in the nature of hot mineral spas with ordinary water pool, leading to some special conditions in mineral hot springs such as the limited view due to vapors emitting from surface of the spa, that overshadow humans' health. This situation leads to the increased severity and recurrence of the accidents among the users of mineral spa. Therefore, it is necessary that the number of lifeguards does not follow the formula for conventional pools as mentioned in Standard No. 20483.

The new standard will include an accident and quasi-accident logging system, an HSE expert and a doctor in charge of the spa. Development of HSE plan and EIA, considerations of passive structural defense issues, site planning in terms of less damage in the event of floods and earthquakes (due to the activity of the area in terms of geological activities) to be applied in the standard. Necessary structural measures in controlling unwanted reflection of sounds in this type of spa should be added to the relevant standard.

Considering inefficiency regarding condition of the defined and implemented ventilation in hot mineral waters, it is necessary to define ventilation requirements in the standard including the need for blowing ventilation mechanism on surface of the water. It is due to the direct relationship between the rate of accidents and the amount of dangerous gases emitting from the water surface of these spas. In this sense, hygienic considerations and protocols related to the infectious diseases including coronavirus disease 2019 (COVID-19) should also be provided in the standard.

The necessary regulatory and governance measures should be defined to control performance of mineral spa managers. On the other hands, the compliance of spas' managers to the national standards should be assessed regularly to control accident cases occurance due to defects in performance. The routine protocols of recirculation, circulation, and discharge of water in hot mineral water spas should be continuously monitored by government officials. Standard discharge and treatment of wastewater should be stipulated in the standard due to occurrence of various diseases caused by chemicals and detergents in the wastewater of mineral spas, but it must be operated properly.

Finally, some solutions derived from spa structure safety components were proposed to deal with the identified risks. It was also recommended to include hygienic considerations and protocols related to the infectious diseases. The used risk model could estimate a high level of risk in the studied spas in Iran, which was consistent with the incidents recorded in forensic medicine. Principle approaches for reducing the risk level in the studied spas should be implemented based on the spa structure safety indicators derived from spa international standards.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest regarding the publication of this manuscript.

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