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Generating a Novel Artificial Intelligence-Based Decision-Making Model for Determining Priority Strategies for Improving Community Health

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ABSTRACT

Improving public health affects society in many ways. Improved public health can lead to a longer and healthier life. Policymakers cannot address all these criteria at the same time due to both time and budget constraints. Therefore, priority strategies need to be formulated by determining the importance weights of these criteria. Accordingly, the purpose of this study is to evaluate the significance of the strategies determined for the development of public health. For this purpose, the analytic hierarchy process (AHP) method is considered to define the importance of the strategies. Within this scope, artificial intelligence methodology is integrated with spherical fuzzy sets. In this framework, the decision matrix of AHP is obtained by the artificial intelligence system. Next, the steps of spherical fuzzy sets are implemented. The main contribution of this manuscript is considering artificial intelligence methodology to create the decision matrix. Hence, the weights of the experts can be computed based on their qualifications. With the help of this approach, it may be possible for the opinions of experts with better qualifications to be taken into consideration with a higher coefficient. This situation has a positive contribution to increasing the accuracy of the findings. The findings indicate that accessibility is the most important strategy to improve public health. Similarly, vaccination and preventive services also play a significant role in this regard.

1. Introduction

Public health is a discipline that aims to protect, improve, and develop the health of individuals and communities. Accordingly, many strategies are implemented within the scope of public health. First, methods such as vaccinations, preventive health services and healthy living campaigns are applied to prevent diseases. In addition, it aims to promote healthy lifestyles by promoting practices such as healthy eating, smoking cessation, and regular exercise. In other words, reducing health

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inequalities between socio-economic groups is one of the main objectives. The protection of factors such as clean air, soil and water is within the scope of public health practices as they positively affect the health of individuals. Apart from these, increasing health literacy and being prepared for emergencies are important for public health. In cases where such practices fail, it is possible to talk about many negativities. Cost increases due to increased disease burden put the relevant units in a difficult situation. In this regard, it is also possible to experience negative situations such as increasing health inequalities and decreasing trust in decision-makers [1].

There are many ways to improve public health. In particular, facilitating access to health services is an ideal tool for improving public health. In addition, preventive health services and vaccination practices aim to intervene in diseases before they emerge. Raising public awareness by increasing the level of education and health literacy is one of the important practices that will improve public health. In addition, studies indicate that one of the biggest health problems in the future will be obesity. To prevent this, it is important to develop policies to promote healthy nutrition and physical activity. Social connections and socializing also affect individuals' mental health. Accordingly, steps to be taken to improve the mental health of societies are becoming more important. Environmental factors such as climate change, noise pollution, and the amount of green space are also factors that add to the shaping of community health. It is possible to contribute to the improvement of public health by reducing noise pollution, increasing the amount of green space, and fighting against climate change in the right way [2].

Improving public health affects society in many ways. Improved public health can lead to a longer and healthier life. In addition, the reduction of diseases provides both health and economic benefits. The participation of healthy individuals in the labor force ensures productivity and contributes to the development of the country. Thus, given that good public health affects individuals at this level, it can be said that this issue has been extensively studied in the literature. However, there are very few studies that aim to produce strategies to improve public health. In this context, education level and health literacy, economic status, access to health services, environmental factors, social connections, healthy eating and physical activity, tobacco and alcohol use, and immunizations and preventive health services are found as factors affecting the improvement of community health. Decision-makers and policymakers cannot address all these criteria at the same time due to both time and budget constraints. Therefore, priority strategies need to be formulated by determining the importance weights of these criteria [3].

Accordingly, in this study, it is aimed to evaluate the importance of the strategies determined for the development of public health. For this purpose, AHP method is considered to define the importance of the strategies. In this process, artificial intelligence methodology is integrated with the Spherical fuzzy sets. Within this framework, the decision matrix of AHP is obtained by artificial intelligence system. After that, the steps of Spherical fuzzy sets are implemented. The main contributions of this manuscript are given below. (i) By considering artificial intelligence methodology to create decision matrix, the weights of the experts can be computed based on their qualifications. With the help of this issue, it may be possible for the opinion of experts with better qualifications to be taken into account with a higher coefficient. This situation has a positive contribution to increase the accuracy of the findings. (ii) Owing to the use of spherical fuzzy sets in the analysis process, evaluation can be made with a more comprehensive data set. This can significantly reduce the uncertainty in the process. Preferring the AHP technique in the analysis process also provides some advantages. AHP allows prioritization of different criteria and sub criteria. In this way, it helps decision makers better understand their priorities and values. This helps manage complex decision-making processes more successfully.

Literature review is conducted in the second part. Proposed methodology is explained in the third part. Analysis results are presented in the following part. The final part includes discussion and conclusion.

2. Literature Review

Accessibility to health services is one of the most important factors for improving public health. Access to health services increases participation in preventive health services. In addition, it enables early diagnosis and treatment. It also makes it possible to reduce health inequalities. Rapid access to health services also facilitates emergency interventions [4]. Fitzpatrick [5] examined the impact of stocks in the public health sector on private sector prices and access to health services. The results of the study conducted in Uganda show that access problems in health services lead to less equitable health outcomes. Fu et al. [6] analyzed access to healthcare for vulnerable migrants during the COVID-19 pandemic in the United Kingdom. It is stated that access to health services is an important factor in improving people's health. Tasci and Ahmed [7] identified the barriers to refugees' access to health services during the COVID-19 pandemic. It is reported that refugees have problems accessing health services and this situation negatively affects public health.

Vaccination and preventive health services are another important issue to be considered for improving public health. Vaccination and preventive health services aim to protect individuals from diseases and reduce risk factors. Accordingly, practices such as vaccinations and screening tests enable early diagnosis of diseases. In addition, increasing the health awareness of society and making more use of preventive health services is also one of the practices [8]. Taylor et al. [9] conducted a review study examining the cost-effectiveness of preventive health services. Data from 2005-2022 from four different electronic databases are analyzed. It is emphasized that preventive health services are important for public health. Rimoldi and Terzera [10] investigated the use of preventive health services by immigrants in Italy. While it is stated that the utilization of preventive health services differs among migrants, it is underlined that these services are important for public health.

The economic status of individuals is another issue that affects public health. Having a good economic situation makes it easier for individuals to access health services. In addition, nutrition and healthy living activities are more likely to be emphasized. Better economic conditions also affect working conditions and stress levels, thus contributing to improved public health. The development of health infrastructures is also associated with economic development [11]. Pangallo et al. [12] examined the relationship between health and economy during the COVID-19 pandemic. It is stated that economically better-off individuals are less affected by health problems. Apart from this, another important factor affecting public health is healthy nutrition and physical activities. In particular, nutrition and physical activity practices are needed for weight control and obesity prevention. Healthy nutrition and physical activity also empower individuals to prevent cardiovascular diseases. Pippi et al. [13] evaluated physical activity and nutrition status in terms of public health. It is mentioned that regular physical activity and healthy nutrition are important factors affecting health status.

Environmental factors such as air and water quality, food security, climate change, and industrial waste are some of the factors that affect public health. Air pollution triggers respiratory diseases, while water quality has an impact on the general health of the community. The use of chemical fertilizers and pesticides endangers food security and has negative impacts on human health. In addition, industrial wastes harm air, water, and soil quality, which in turn affects public health [14]. Wang et al. [15] examined the role of environmental factors in future public health emergencies based on the COVID-19 pandemic. It is stated that the effects of environmental factors on health are more clearly understood in the COVID-19 pandemic. Bezuidenhout et al. [16] investigated the role of

environmental factors on health status and quality of life in individuals with spinal cord injury in South Africa. According to the results of the study, which has a cross-sectional research design, it is understood that environmental factors have a significant impact on public health.

A review of the literature reveals that there are several issues affecting public health. Public health affects a country's productivity and labor force performance. Consequently, it also supports economic development. A healthy population leads to lower labor loss and health expenditures. In addition, a healthy population can increase a country's military and defense power. Therefore, it can be said that decision-makers aim to improve public health. However, many factors affect public health. These factors include education level and health literacy, economic status, access to health services, environmental factors, social connections, healthy eating and physical activity, tobacco and alcohol use, and immunizations and preventive health services. Considering the studies conducted, it can be said that these factors have been examined separately. However, there is a need in the literature for a study that aims to develop a prioritized strategy to improve community health. Accordingly, this study aims to create a list of criteria affecting public health and to develop a strategy by weighting these criteria according to their importance.

3. Proposed Methodology

The aim of this study is to determine the importance of the strategies determined for the development of public health. AHP method is used to determine the importance of the strategies determined by researching the literature. In the methods based on expert opinion, the equal evaluation of experts is criticized. The decision matrix of AHP is obtained by artificial intelligence system. Thus, solutions are produced for criticism. In addition, uncertainty is included in linguistic expressions. Fuzzy numbers are recommended to include it in this uncertainty. In this study, Spherical Fuzzy sets are taken into consideration in a wide area of uncertainty [17]. The steps of the method are summarized in Figure 1.

The mathematical formulas and details of the stages in Figure 1 are given under subtitles.

3.1. Artificial Intelligence-based Decision Matrix

Creating a decision matrix without considering the years and experience of experts is criticized in the studies in the literature. In this study, it is suggested to create a decision matrix with an artificial intelligence system in response to criticism. In Step 1, the mathematical structure of the artificial intelligence system is created. For this, Keras and Tensorflow libraries are used in Python. With the help of these libraries, a structure with a total of 9 layers, 7 of which consist of hidden layers, is created. The Sigmoid function in Equation (1) is integrated as the activation function of the neurons in these layers. The number e here is the Euler Number.

$$S(x) = \frac{1}{1+e^{-ax}} \tag{1}$$

Thanks to the Sigmoid function, it is ensured that the output of the model complies with the definition of the Spherical Fuzzy set. In addition, the Adam algorithm is preferred for calculating the parameters of artificial intelligence. This is because the Adam algorithm provides high performance on small data. The mathematical formulation of the Adam algorithm is presented in Equations (2)-(6).

$$W_{t+1} = W_t - \frac{a}{\sqrt{\hat{S}_t+\epsilon}}\hat{V}_t \tag{2}$$

$$\hat{V}_t = \frac{V_t}{1-\beta_1^t} \tag{3}$$

$$\hat{S}_t = \frac{S_t}{1-\beta_2^t} \tag{4}$$

$$V_t = \beta_1 V_{t-1} + (1-\beta_1)\frac{\partial L}{\partial w_t} \tag{5}$$

$$S_t = \beta_2 S_{t-1} + (1-\beta_2)\left[\frac{\partial L}{\partial w_t}\right]^2 \tag{6}$$

In this context, a demonstrates learning coefficient, w gives information about the weight, β indicates the degree to which past gradients are involved in the process and ∂L/(∂w_t) refers to the gradient. V and S are initial values of algorithm. Step 2 involves machine learning of artificial intelligence. In order for the mathematical model to learn, the data set is obtained by simulation. Randomly generated expert opinions and years of experience are used as input variables. The output variable of the model is created using Equations (7) and (8).

$$SFWGM_W(\widetilde{D}_1, \widetilde{D}_2, \dots \widetilde{D}_n) = \begin{Bmatrix} \prod_{i=1}^n \mu_{D_i}^w, \\ \left[1-\prod_{i=1}^n (1-v_{D_i}^2)^w\right]^{\frac{1}{2}}, \\ \left[\prod_{i=1}^n (1-v_{D_i}^2)^w - \prod_{i=1}^n (1-v_{D_i}^2-\pi_{D_i}^2)^w\right]^{\frac{1}{2}} \end{Bmatrix} \tag{7}$$

$$w_i = \frac{d_i}{\sum_{i=1}^n d_i} \tag{8}$$

In Equations (7) and (8), the variable d represents the expert's years of experience, while μ, v, and π values signify the membership degree, non-membership degree, and hesitancy degree of the Spherical fuzzy number, respectively. Membership, non-membership and hesitancy values in Equation (7) are calculated from Table 1.

Table 1
Linguistic Scales

Scale	μ	v	π
9	0.9	0.1	0
8	0.85	0.15	0.05
7	0.8	0.2	0.1
6	0.75	0.25	0.15
5	0.7	0.3	0.2
4	0.65	0.35	0.25
3	0.6	0.4	0.3
2	0.55	0.45	0.4
1	0.5	0.5	0.5
0.5	0.45	0.55	0.4
0.333	0.4	0.6	0.3
0.25	0.35	0.65	0.25
0.2	0.3	0.7	0.2
0.167	0.25	0.75	0.15
0.143	0.2	0.8	0.1
0.125	0.15	0.85	0.05
0.111	0.1	0.9	0

The learning is an iterative process. This situation is achieved for 100 Epochs. In this way, learning is reinforced. For learning success, Equation (9) is considered. A mean squared error (MSE) value close to 0 indicates high success.

$$MSE = \frac{1}{m}\sum_{i=1}^m (Y_i - \hat{Y}_i)^2 \tag{9}$$

Where, Y represents the actual value and Y` is the output value of the model. m is number of data.

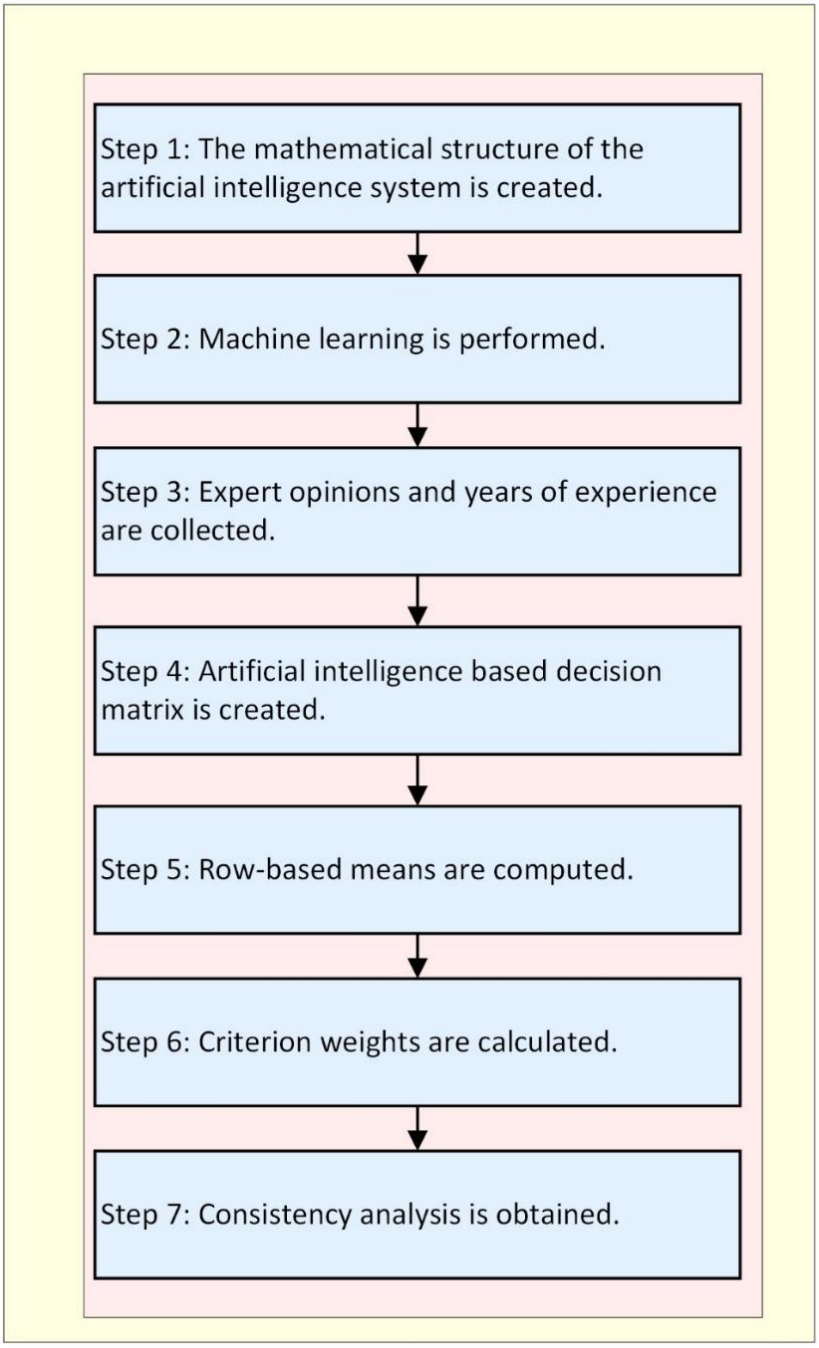

Fig. 1. Flowchart

3.2. Spherical Fuzzy AHP

The AHP method is a classical weighting method based on expert opinion in multi-criteria decision making [18]. The version of the AHP method integrated with Spherical Fuzzy numbers is presented below.

Step 3 is about collecting expert opinions. A team consisting of people who are experienced in their fields and have academic studies is created. Then, opinions are collected with the scale in Table 1. Additionally, the years of experience of the members of the team are noted. In Step 4, the decision matrix is defined. The opinions and years of experience of the expert team are given as input to the artificial intelligence system. A spherical fuzzy decision matrix (D) in Equation (10) is obtained through the system.

$$D = \begin{bmatrix} (0.5,0.5,0.5) & \cdots & (\mu_{1n}, v_{1n}, \pi_{1n}) \\ \vdots & \ddots & \vdots \\ (\mu_{n1}, v_{n1}, \pi_{n1}) & \cdots & (0.5,0.5,0.5) \end{bmatrix} \quad (10)$$

In Step 5, row-based means are computed with the help of Equation (11).

$$SFWAM_W(\widetilde{D}_1, \widetilde{D}_2, \dots \widetilde{D}_k) = \begin{Bmatrix} \left[1 - \prod_{i=1}^{k}(1-\mu_{D_i}^2)^{\frac{1}{n}}\right]^{\frac{1}{2}}, \\ \prod_{i=1}^{k} v_{D_i}^{\frac{1}{n}}, \\ \left[\prod_{i=1}^{k}(1-\mu_{D_i}^2)^{\frac{1}{n}} - \prod_{i=1}^{k}(1-\mu_{D_i}^2-\pi_{D_i}^2)^{\frac{1}{n}}\right]^{\frac{1}{2}} \end{Bmatrix} \quad (11)$$

Step 6 is about calculating the criterion weights. First, row averages are defuzzied with Equation (12). Finally, the weights are normalized with Equation (13).

$$S(\widetilde{w}_j^s) = \sqrt{\left|100 * \left[(3\mu_{\bar{A}_s} - \frac{\pi_{\bar{A}_s}}{2})^2 - (\frac{v_{\bar{A}_s}}{2} - \pi_{\bar{A}_s})^2\right]\right|} \quad (12)$$

$$W_j = \frac{S(\widetilde{w}_j^s)}{\sum S(\widetilde{w}_j^s)} \quad (13)$$

In ***Step 7***, consistency analysis is performed. With the help of Equations (14)-(15), Consistency Index is calculated. Then, the Consistency index (*CI*) value is divided by the random index (*RI)* value. With equation (16), Consistency Ratio (*CR*) is computed.

$$CI = \frac{\lambda_{max} - n}{n-1} \quad (14)$$

$$\lambda_{max} = \frac{1}{n}\sum_{i=1}^{n} \frac{d_{ij} W_j}{W_i} \quad (15)$$

$$CR = \frac{CI}{RI} \quad (16)$$

CR value of less than 0.1 indicates that the matrix is consistent [19].

4. Analysis Results

It is important to determine strategies to improve public health. For this purpose, eight strategies were determined as a result of the literature review. These strategies are given in Table 2.

Table 2
Strategies to Improve Public Health

Criteria	Codes
Education Level and Health Literacy	Education
Economic Situation	Economic
Access to Health Services	Accessibility
Environmental Factors	Environment
Social Factors	Social
Healthy Nutrition and Physical Activity	Nutrition
Tobacco and Alcohol Use	Alcohol
Vaccines and Preventive Health Services	Vaccination

In Step 1, a system for the AI-based decision matrix is created. The mathematical structure of artificial intelligence is coded in Python. The Sigmoid activation function in Equation (1) and the Adam

algorithm in Equations (2)-(6) are integrated into the system. For Step 2, a data set is produced to enable machine learning. 1000 pieces of data are used in the machine learning process. The output variable is obtained from the data obtained by simulation with Equations (7) and (8). Machine learning is performed in 100 Epochs. For learning success, it is calculated with Equation (9). The MSE value of the system is found to be 0.034. Since this value is close to zero, it is stated that learning is successful. In Step 3, the expert team is created. This team consists of three people and includes people who have academic studies in the field of public health. Expert opinions of the experts are given in Table 3.

Table 3
Expert Opinions

				Expert 1				
	Education	Economic	Accessibility	Environment	Social	Nutrition	Alcohol	Vaccination
Education	1.000	2.000	3.000	2.000	2.000	3.000	3.000	0.167
Economic	0.500	1.000	3.000	3.000	3.000	4.000	2.000	0.167
Accessibility	0.333	0.333	1.000	9.000	9.000	8.000	9.000	9.000
Environment	0.500	0.333	0.111	1.000	4.000	4.000	4.000	0.143
Social	0.500	0.333	0.111	0.250	1.000	5.000	5.000	0.200
Nutrition	0.333	0.250	0.125	0.250	0.200	1.000	7.000	0.500
Alcohol	0.333	0.500	0.111	0.250	0.200	0.143	1.000	0.167
Vaccination	6.000	6.000	0.111	7.000	5.000	2.000	6.000	1.000
				Expert 2				
	Education	Economic	Accessibility	Environment	Social	Nutrition	Alcohol	Vaccination
Education	1.000	2.000	2.000	3.000	3.000	2.000	3.000	0.167
Economic	0.500	1.000	3.000	3.000	4.000	4.000	3.000	0.167
Accessibility	0.500	0.333	1.000	9.000	9.000	9.000	8.000	8.000
Environment	0.333	0.333	0.111	1.000	4.000	4.000	5.000	0.143
Social	0.333	0.250	0.111	0.250	1.000	4.000	5.000	0.200
Nutrition	0.500	0.250	0.111	0.250	0.250	1.000	8.000	0.500
Alcohol	0.333	0.333	0.125	0.200	0.200	0.125	1.000	0.167
Vaccination	6.000	6.000	0.125	7.000	5.000	2.000	6.000	1.000
				Expert 3				
	Education	Economic	Accessibility	Environment	Social	Nutrition	Alcohol	Vaccination
Education	1.000	2.000	3.000	3.000	3.000	3.000	2.000	0.167
Economic	0.500	1.000	3.000	4.000	3.000	4.000	4.000	0.167
Accessibility	0.333	0.333	1.000	9.000	8.000	9.000	9.000	7.000
Environment	0.333	0.250	0.111	1.000	4.000	5.000	5.000	0.143
Social	0.333	0.333	0.125	0.250	1.000	5.000	6.000	0.200
Nutrition	0.333	0.250	0.111	0.200	0.200	1.000	7.000	0.500
Alcohol	0.500	0.250	0.111	0.200	0.167	0.143	1.000	0.167
Vaccination	6.000	6.000	0.143	7.000	5.000	2.000	6.000	1.000

Step 4 involves obtaining the spherical fuzzy decision matrix (D) with the artificial intelligence system. The decision matrix illustrated by Equation (10) is expressed in Table 4.

Table 4
Decision Matrix

	Education			Economic			Accessibility			Environment		
Education	.50	.50	.50	.55	.45	.40	.58	.42	.34	.59	.41	.33
Economic	.45	.55	.40	.50	.50	.50	.60	.40	.30	.62	.38	.28
Accessibility	.42	.58	.34	.40	.60	.30	.50	.50	.50	.90	.10	.00
Environment	.41	.59	.33	.38	.62	.28	.10	.90	.00	.50	.50	.50
Social	.41	.59	.33	.38	.62	.28	.12	.88	.03	.35	.65	.25
Nutrition	.42	.58	.34	.35	.65	.25	.11	.89	.02	.33	.67	.23
Alcohol	.42	.58	.34	.39	.61	.31	.11	.89	.03	.31	.69	.21
Vaccination	.75	.25	.15	.75	.25	.15	.15	.85	.06	.80	.20	.10
	Social			Nutrition			Alcohol			Vaccination		
Education	.59	.41	.33	.58	.42	.34	.58	.42	.35	.25	.75	.15
Economic	.62	.38	.29	.65	.35	.25	.60	.40	.32	.25	.75	.15
Accessibility	.88	.12	.03	.89	.12	.03	.88	.12	.03	.84	.16	.07
Environment	.65	.35	.25	.67	.33	.23	.69	.31	.22	.20	.80	.10
Social	.50	.50	.50	.68	.32	.22	.72	.28	.18	.30	.70	.20
Nutrition	.32	.68	.22	.50	.50	.50	.82	.18	.09	.45	.55	.40
Alcohol	.28	.72	.18	.18	.82	.08	.50	.50	.50	.25	.75	.15
Vaccination	.70	.30	.20	.55	.45	.40	.75	.25	.15	.50	.50	.50

In Step 5, the mean of each row is computed with Equation (11). In Step 6, the fuzzy importance weights of the strategies are first defuzzied with the help of Equation (12). Then, the weights of the strategies are calculated using Equation (13). The results obtained are presented in Table 5.

Table 5
Weights of Strategies

Strategies	w			s(w)	W
Education	0.5429	0.4634	0.3616	14.4208	0.1197
Economic	0.5585	0.4499	0.3293	15.0731	0.1251
Accessibility	0.7977	0.2162	0.1738	23.0512	0.1913
Environment	0.5146	0.5129	0.2885	13.9908	0.1161
Social	0.4931	0.5330	0.2881	13.3510	0.1108
Nutrition	0.4869	0.5459	0.2978	13.1160	0.1088
Alcohol	0.3334	0.6837	0.2908	8.5327	0.0708
Vaccination	0.6740	0.3402	0.2457	18.9774	0.1575

Step 7 involves determining the consistency of the decision matrix. CR value is calculated with the help of Equations (14) - (16). CI, RI and CR values are 0.08, 1.41 and 0.06, respectively. Since the CR value is less than 0.1, the matrix is seen to be consistent. In other words, the calculated weights are interpretable. In this case, the ranking of the weights of the strategies is given in Figure 2.

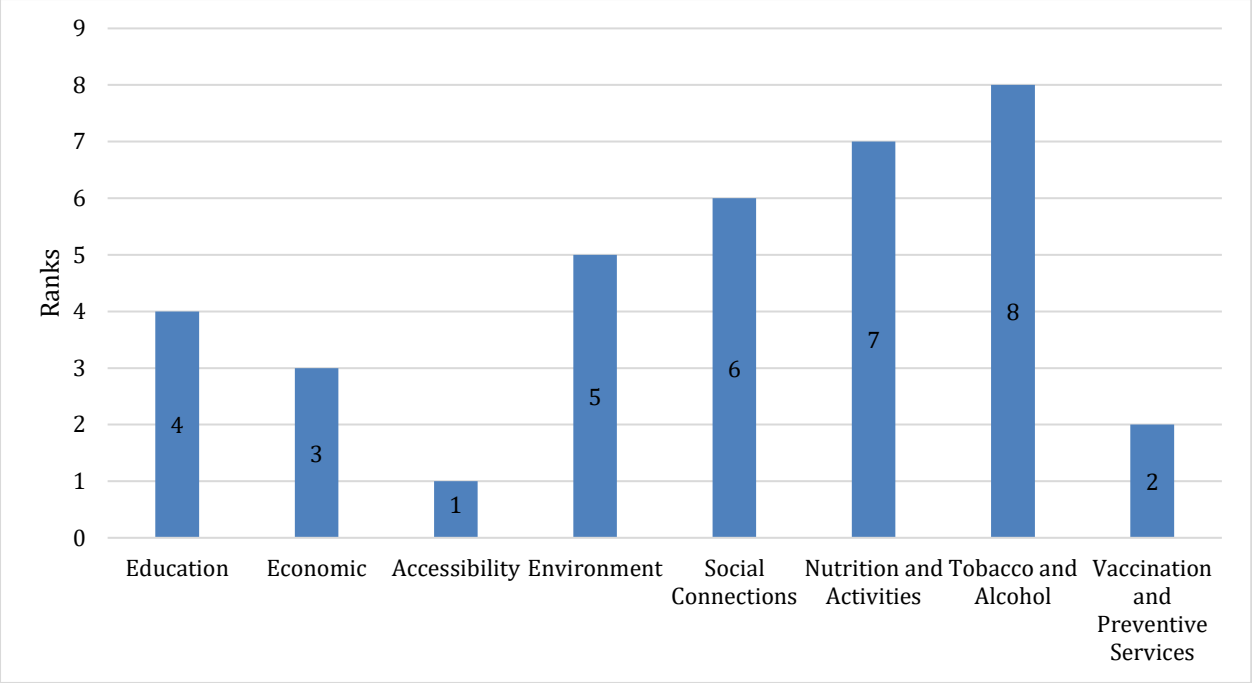

Fig. 2. Ranking of Strategies

According to Figure 2, accessibility is the most important strategy as it has the highest weight value. The second important strategy is vaccination and preventive services. The importance weight of this criterion is found to be 0.1575.

5. Discussion and Conclusion

This study examines the significance of the strategies determined for the development of public health. For this purpose, AHP method is considered to define the importance of the strategies. Within this scope, artificial intelligence methodology is integrated with the Spherical fuzzy sets. In this framework, the decision matrix of AHP is obtained by artificial intelligence system. Next, the steps of Spherical fuzzy sets are implemented. It is found that accessibility is the most important strategy to improve public health. Similarly, vaccination and preventive services also play a key role for this situation.

The analysis revealed that the most important criterion for improving public health is access to health services. Access to health services is especially crucial for facilitating early diagnosis and treatment [20]. Another significant issue is that access to health services should be easy to control and manage chronic diseases [21]. In addition, being able to respond to emergencies such as natural disasters is vital [22]. Therefore, easy access to health services increases response effectiveness. Stennett and Tsakos (2022) [23] examined the impact of the COVID-19 pandemic on access to oral health services in the UK. While it is stated that the pandemic restricted access to oral health services, it is seen that the oral health level of the community improved after ease of access is provided. Vieira et al. (2023) [24] aimed to improve access to radiotherapy in the Brazilian public system. For this purpose, 124 patients were retrospectively evaluated within the scope of the study. The importance of access to health services for individuals to be healthy is mentioned. Abdallah et al. (2022) analyzed access and fees for public health services for the poor in Bangladesh. It is emphasized that access to health services should be improved to improve public health.

Preventive health services play an important role in improving public health. As a result of the analysis, preventive health services are found to be another important criterion affecting this process. Preventive health services aim to improve the health of individuals by intervening before

diseases occur [25]. In this context, early diagnosis and treatment are provided through regular health checks and screenings. It also includes programs to raise health awareness [26]. In addition, birth control and family planning activities are considered within the scope of preventive health services [27]. Kang et al. (2023) [28] examined disparities in the use of preventive health services among Asian young adults in the United States. The National Health Interview Survey data emphasizes the impact of preventive health services on public health. de Oliveira et al. (2022) [29] investigated the impact of the COVID-19 pandemic on preventive health services in Brazil. The study is conducted by comparing the preventive and treatment services provided between 2017 and 2019 with the services provided in 2020. It is stated that preventive health services are important to prevent the emergence of vaccine-preventable diseases and complications arising from non-communicable, chronic health conditions.

The main contribution of this manuscript is considering artificial intelligence methodology to create decision matrix. Hence, the weights of the experts can be computed based on their qualifications. By the help of this condition, it may be possible for the opinion of experts with better qualifications to be taken into account with a higher coefficient. This situation has a positive contribution to increase the accuracy of the findings. Additionally, owing to the use of spherical fuzzy sets in the analysis process, evaluation can be made with a more comprehensive data set. This can significantly reduce the uncertainty in the process. The main limitation of this study is only preferring the AHP technique in the analysis process to compute the weights of the criteria. In spite of some advantages, this methodology cannot consider the causal directions among the items. Therefore, in the future studies, impact relation map can be created by using different decision-making techniques, such as DEMATEL.

Author Contributions

Conceptualization, Y.G. and H.D.; methodology, S.Y.; software, S.E.; validation, Y.G., H.D. and S.E.; formal analysis, S.Y.; investigation, Y.G.; resources, S.Y.; data curation, S.E.; writing—original draft preparation, S.Y.; writing—review and editing, H.D.; visualization, S.E.; supervision, Y.G.; project administration, Y.G.; funding acquisition, S.E. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement

There is no data in this study.

Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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