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Investigating and Prioritizing Factors Affecting Health Literacy in University Students of Yazd Using Artificial Neural Network Technique

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ABSTRACT

Introduction: Current university students are potential and actual parents of future generations. The level of their health literacy affects health and health literacy level of future generations. Therefore, the purpose of the present study was investigating and prioritizing the factors affecting the health literacy of students in Yazd (a city in central Iran) using an artificial neural network technique.

Methods: This study was cross-sectional and descriptive and it was conducted on 400 university students in Yazd during autumn 2018. Data were collected using a questionnaire on health literacy and 14 independent variables. Data were analyzed with SPSS software via descriptive statistics, one sample T-test, and artificial neural network.

Results: The mean of students' health literacy was 80.65±12.21. The most important factors affecting the level of students' health literacy were the grade, college, father's education level, age, and residence.

Conclusion: Since grade had the greatest impact on health literacy of students, it is suggested that university officials consider the campus to hold classes, lectures, workshops and distribute appropriate resources such as brochures, booklets among students and also provide health information stations at locations such as dining room, university entrance, and dormitory to promote students' health literacy in lower grades.

Keywords: Health Literacy, Neural Networks, Students

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Introduction

Health literacy is a concept which emerged in the early 1970s and was considered as a significant issue in public health care very soon (1). The World Health Organization introduced health literacy as an important determinant of health (2). Health literacy is a concept that is related to individuals' capacities to meet the health demands in society (3).

Several definitions of health literacy are presented in different researches. Most health literacy definitions concentrate on functional skills (reading and numeracy) or on basic skills to obtain and process (written and oral) information about health (4). Accordingly, health literacy can be defined as the ability to read, understand, and act on the basis of health recommendations (2).

Health literacy is classified into three main categories including functional health literacy, communication health literacy, and critical health literacy. Functional health literacy includes the ability to understand health issues, medical guidelines, and brochures. Communication health literacy is the ability to extract information and meanings from communication channels. Critical health literacy is the ability to make informed health decisions in everyday life (5).

Some researchers have been conducted on health literacy. MohammadiFarah et al. (6) conducted a survey to identify factors affecting health literacy among Hamadan University of Medical Sciences students. Results showed that health literacy was correlated with age, gender, marital status, and faculty. Bodur et al. (1) investigated factors affecting health literacy in adults in Turkey and concluded that increasing awareness and understanding of health professionals regarding the health literacy level of the addressed individuals could improve health outcomes. Lorini et al. (3) analyzed the relationship between antecedents and consequences of health literacy. Some of the antecedents in this paper were Gini coefficient, unemployment rate, foreign-born population, age, and sex. Some of the consequences in this paper were the prevalence of overweight, life expectancy at birth and total health expenditure. Jansen et al. (4) concluded that higher educational attainment was associated with higher scores on the health literacy.

People with low health literacy do not understand the written and spoken information provided by the health team and do not respond to the recommendations, so they have a poorer health status and suffer more from the costs (2). In people with low levels of health literacy, arbitrary and uncontrolled drug use, lack of compliance with doctor's recommendations, undesirable control of blood glucose, poor health knowledge, lack of health concerns, and inappropriate relationships with doctors are more prevalent (7). Other researches have shown that low health literacy is accompanied by a low level of understanding about health and health care conditions which arethe inability to properly carry out self-care activities, the difficulty in understanding drug and treatment, the increase in hospitalization,health care costs, and mortality, less screen for early detection of illnesses such as cancer, and the inability to receive appropriate and timely care (8).

Health literacy has been considered by policymakers because of its impact on people's decision-making on health, as one of the important issues for improving the health of the community and improving the quality of health care provision (9). This is especially important among university students. The main reason for focusing on this target group is the suitability of the student's age for education. University students are also good patterns for promoting a healthy lifestyle among different groups of society (6).

The findings of researches conducted within the country showed that health literacy among people in our society and especially among university students is not at the standard level. Inadequate health literacy is considered a global threat (9). Also, a review of past studies showed that there had been no study on the health literacy of university students in Yazd. Furthermore, in the researches that investigated the factors affecting health literacy so far, artificial neural network techniques had not been used. To cover this gap and with considering the negative effects of low health literacy among people and consequently health literacy importance

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in the quality of life of present and future generations, this study investigated and prioritized factors affecting health literacy among university students in Yazd.

Methods

This cross-sectional descriptive study was conducted during autumn 2018. The minimum sample size was calculated 385 using Cochran formula taking into account p=0.5, d=0.05, and z=1.96. Finally, the analysis was performed on 400 complete questionnaires. The sampling method was two-stage cluster sampling. At first, a list of all universities in Yazd was prepared. Among these universities, four universities including Shahid Sadoughi University of Medical Sciences, Yazd University, Payame Noor University, and Science and Arts University were randomly selected. Then, from each of these four clusters, some students were selected via available sampling. The sample size chosen from these four universities was selected according to the number of students in each university. To this end, the sample size from each university was 78, 181, 54 and 87, respectively.

Data were collected by questionnaire. Data on the dependent variable, health literacy, was collected via scale developed by Montazeri et al. (10) who reported Cronbach's alpha for different dimensions between 0.72 to 0.89. Borji et al. (11) verified the reliability of the scale, too. Cronbach's alpha of scale in this study was 0.71. Validity of the scale was verified through content validity. This scale consisted of 33 items and five dimensions including reading (4 items), access (6 items), understanding and perception (7 items), assessment (4 items) and decision making and behavior (12 items). In this questionnaire, the five-point Likert scale was used. The minimum, maximum and average of health literacy scores that could be obtained from this questionnaire were 33, 165, and 99, respectively. The research consisted of 14 independent variables extracted from the research literature — data on independent variables was obtained through a closed questionnaire from students.

In order to observe ethical considerations, the participants in the research could abandon cooperation at each stage. Furthermore, questionnaires did not ask for the participants' name. By the way, the researcher also initially described the aim of study for participants and received informed consent from them.

Data analysis included descriptive statistics, one sample T-test and sensitivity analysis by an artificial neural network using SPSS software. An artificial neural network is a data processing system that processes data through various processors that behave in an interconnected way to solve the problem. In artificial neural networks, a data structure is designed using programming knowledge that can act as a neuron. Then, by building up a network between these neurons and applying an educational algorithm to it, the network is trained and then is used for prediction (12). Artificial neural network models can detect the relationships between the data and produce an appropriate output with the least error (13). Therefore, considering the advantages of an artificial neural network technique compared to other similar methods in prediction, this technique was used in this study to prioritize the factors affecting health literacy among university students in Yazd. To this end, it was first necessary to design a neural network. Each neural network includes an input layer, an output layer, and at least a hidden layer. Input layer consists of independent research variables, in which no processing takes place. The hidden layer is a layer that extracts information from the input layer, processes and sends it to the output layer. Network training takes place at this level. The results of the calculations are sent to the output layer. Output layer consists of the final output of the network (14). There are several methods to create a neural network. The Redial Basis Function (RBF) network was used in the present study due to its great advantages. Some of the advantages of the RBF network include being faster, creating better decision areas and easier interpretation of the output layer. RBF is a three-layer network. In order to achieve the research goal and prioritize the health literacy of students, this study was carried out in six stages:

1.Data Preparation: Before the RBF network was implemented, the data were first controlled and

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refined for outliers and missing data.

2.Data Classification: Data was categorized into three groups including 263 cases (65.8% 0) in training group, 91 cases (22.8%) in the test group and 46 cases (11.5% 0) in holdout group.

3.Selecting the number of hidden layers: Automated selection structure was used for identifying the number of hidden layers and units in it.

4.Selecting a training method in the hidden layer: Batch training method and scaled conjugate gradient optimization algorithm was used due to the small sample size and intention to minimize total errors directly. This training method trains all the recorded values in the training group at the same time.

5.Setting the stopping rule: In batch training, it is necessary to update weights several times, and the database should be checked several times to reach one of the stopping rules. Errors convergence rule was used which is an ideal state in the algorithm.

6.Neural Network Implementation: In this stage, according to the settings, the RBF network was implemented.

Results

The descriptive statistics of the independent variables of the study are presented in Table 1.

Table 1. Distribution of participants according to independent variables

Variable	Category	Frequency	Percentage
Gender	Female	198	49.5
	Male	202	50.5
Age	Under 23	180	45.0
	23-30	144	36.0
	31-40	58	14.5
	41 and more	18	4.5
College	Humanities	120	30.0
	Science	104	26.0
	Engineering	62	15.5
	Arts	31	7.8
	Medical science	83	20.8
Marital Status	Single	182	45.5
	Married	218	54.5
Employment Status	Employed	153	38.3
	Unemployed	247	61.8
Grade	Associate	63	15.8
	Bachelor	146	36.5
	Master	102	25.5
	Doctorate/Medicine	89	22.3
Economic Status	Low	79	19.8
	Medium	272	68.0
	High	49	12.3
Father's Education level (in years)	Under 12	51	12.8
	12	171	42.8
	16	139	34.8
	18 and more	39	9.8
Mother's Education level (in years)	Under 12	51	12.8
	12	240	60.0
	16	90	22.5
	18 and more	19	4.8
Residence	Urban	118	29.5
	Rural	282	70.5

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Experience of hospitalization	Yes	166	41.5
	No	234	58.5
Source of information	Health staff	36	9.0
	Internet	172	43.0
	Radio and TV	107	26.8
	Press media	44	11.0
	Friends and relatives	41	10.3
Number of educated people in Family	0	201	50.2
	1	136	34.0
	2	53	13.3
	>3	10	2.5
Health problem	Yes	24	6.0
	No	376	94.0

The descriptive statistics of health literacy are presented in this section. The mean of students' health literacy was 80.65±12.21. Skewness and Kurtosis coefficients were 0.259 and -0.099, respectively. Skewness and Kurtosis Standard Error were 0.122 and 0.243, respectively.

The results of one sample T-test showed that the p-value of the test is 0.000 and the upper and lower limit of confidence interval were -17.1506 and -19.5531, respectively. Since the p-value is less than 0.05 and the limits of confidence interval are negative, it can be concluded that the health literacy level of students is less than average.

The artificial neural network was used to prioritize factors affecting health literacy. The summary of RBF network information is shown in Table 2.

Table 2. RBF Network Information

Input Layer	Factors	1	Gender
		2	Age
		3	College
		4	Marital status
		5	Employment status
		6	Grade
		7	Economic status
		8	Father's education level
		9	Mother's education level
		10	Residence
		11	Experience of hospitalization
		12	Source of information
		13	Number of educated people in the family
		14	Health problem
	Number of Units		51
Hidden Layer	Number of Units		7
	Activation Function		Softmax
	Dependent Variables		Health Literacy
Output Layer	Number of Units		1
	Rescaling Method of Scale Dependents		Standardized
	Activation Function		Identity
	Error Function		Sum of Squares

The importance of independent variables in predicting the health literacy of students can be seen in Figure 1 and Table 3.

It should be mentioned that in both Figure 1 and Table 3, the variables are sorted from most to the least effect.

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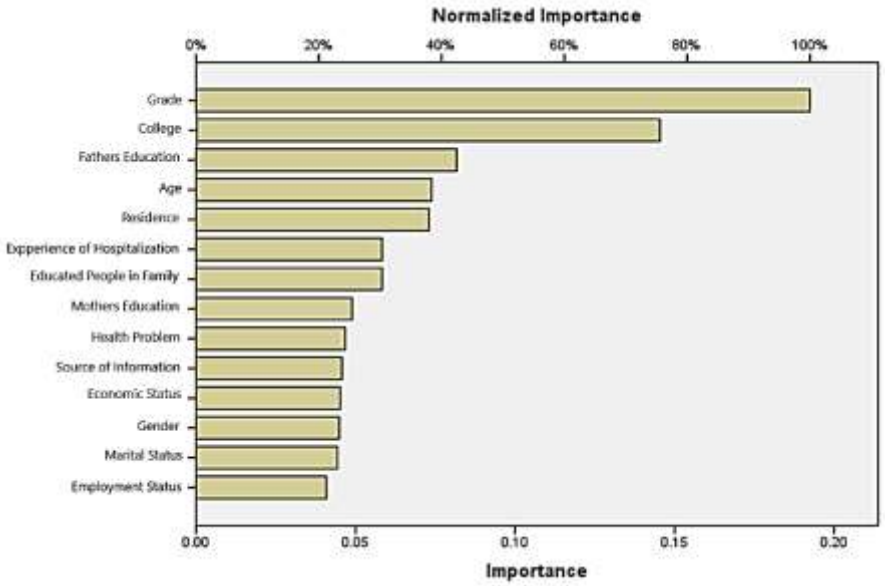

Figure 1. Importance of Independent Variable

Table 3. Independent Variable Importance

Rank	Variable	Importance	Normalized Importance	Rank	Variable	Importance	Normalized Importance
	Grade	0.192	100.00%	8	Mother's Education level	0.049	25.40%
	College	0.145	75.60%	9	Health problem	0.047	24.30%
	Father's Education level	0.082	42.50%	10	Source of information	0.046	23.80%
	Age	0.074	38.40%	11	Economic Status	0.045	23.50%
	Residence	0.073	38.00%	12	Gender	0.044	23.00%
	Experience of hospitalization	0.058	30.30%	13	Marital Status	0.045	23.40%
	No. of educated people in Family	0.058	30.30%	14	Employment Status	0.041	21.20%

As shown in Table 3 and Figure 1, the variables of grade, college and father's Education level had the most effect on health literacy of students, and the variables of gender, marital status, and employment status had the least effect on the level of students' health literacy

Discussion

Health literacy is one of the important issues in public health, and its key role in determining the health level and health system has become increasingly important (15). Due to health literacy's importance in society, this study investigated the health literacy level and prioritized the factors affecting it among Yazd city students.

The results showed the level of students' health literacy is low. This finding is inconsistent with the findings of MohammadiFarah et al. (6). These researchers determined the level of health literacy among Hamadan University of Medical Sciences students and concluded that health literacy is sufficient and at an average level among them. Also, the finding of the present study is inconsistent with the findings of Panahi et al. (16). These researchers assessed health literacy level among dormitory students at Shahid Beheshti University of Medical Sciences and concluded that health literacy is at an average level among them. The finding of the present study is consistent with the findings of Mahmoudi and Taheri (17) who reported insufficient health literacy among students of Ferdowsi University of Mashhad. It seems that one of the reasons for low health literacy among students is that the university is not active in providing related information to students. Universities, with the help of health care centers can provide a variety of appropriate resources such as brochures, booklets, magazines, posters and distribute them among students. Moreover,

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providing health information stations at locations such as dining room, university entrance, dormitory, etc. seems appropriate. The health literacy level among the students in the present study can be compared with the level of health literacy among people in Yazd. The finding of the present study is consistent with the findings of Rezaee Esfahrood et al. (18) who reported that health literacy in 59.3 percent of diabetic patients of Yazd diabetes research center was insufficient.

Sensitivity analysis of independent variables on the RBF network showed that grade had the greatest impact on student health literacy. This finding is consistent with the findings of Rong et al. (19) who stated that grade has a significant impact on health literacy. This finding shows that as long as students' engagement with the university increases, their health literacy increases as well. Therefore, it is recommended that authorities and university officials use this point and use the campus to hold classes, lectures, workshops, etc. to promote students' health literacy in lower grades.

Sensitivity analysis of independent variables also showed that students' college was the second variable that had the great impact on student health literacy. This finding is consistent with the findings of MohammadiFarah et al. (6) who reported that college has a significant impact on health literacy. This finding is also consistent with the findings of Ziapoor and Kianpoor (20) among students of Kermanshah University of Medical Sciences in 2016. They concluded that the average score of health literacy has a significant difference among educational groups, that is, health literacy status is different among students of different colleges. Azimi et al. (21) reported that the level of health literacy among medical students is higher than non-medical students. According to this finding, it is recommended to pay greater attention to non-medical students and focus on conducting health literacy training courses for these students.

Sensitivity analysis of independent variables also showed that father's Education level was the third variable that had a great impact on student health literacy. This finding is consistent with the findings of Rong et al. (19). In their study, regression analysis showed that years in college, the system of education, and father's education level influences the level of health literacy of students of the military college. Students of military college whose father's educational level was high school or university had a higher level of health literacy. Parents' educational level affects children's health knowledge and behavior. Also, Cheng et al. (22) reported that a high level of health literacy in parents could improve the level of health literacy among their children.

Variables including gender, marital status, and employment status had the least effect on the level of students' health literacy. The reason for this little effect seems to be disappearing social, cultural, ethnic, and economic differences that cause differences in awareness on various issues such as health literacy in women and men, unemployed and employed groups, or the single and married groups. This fading out is due to the emergence of phenomena such as the Internet and social networks that balance between groups.

Conclusion

Results showed that health literacy among students is less than average and the variables such as grade, college and father's Education level had the most effect on the students' health literacy. Due to the widespread use of social networks, it is recommended to use this opportunity effectively and to improve the level of health literacy and related behaviors. It is proposed to design health-related interventions, provide programs and information related to illness and health through the Internet and social networks. It is recommended that the universities provide health information stations in appropriate places such as dining room, university entrance, and dormitory for the students.

One of the limitations of this research was that the study was conducted in a group of undergraduate students and the findings cannot be generalized to all students. Also, the available sampling method makes it difficult to generalize the findings of the research. Another limitation of this

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study was the self-report methodology in completing the questionnaire, because the results may not be sufficient in determining the behaviors of the respondent.

For future studies on health literacy, it is suggested that other independent variables affecting health literacy which were not studied in this study be investigated. Determining the importance of independent variables on health literacy in this research has been done by an artificial neural network technique. It is suggested that this determination should be carried out through other prediction techniques such as random forest, genetic algorithm, etc., and the results of these techniques should be compared.

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It should be mentioned that in this study, all of the ethical considerations are in accordance with the Helsinki Treaty.

Conflict of Interest

There are no conflicts of interest to declare.

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