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Full Length Research Paper

Risk analysis in breast cancer disease by using fuzzy logic and effects of stress level on cancer risk

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Every year thousands of human mortality from cancer is due to limitation of medical sources and unable to use the existing sources effectively. Patient losses can be reduced by using the numerical (quantitative) techniques in the system of medical and health. Cancer is a genetic disease which is developed by the abnormal cell increase and cell growth as a result of deoxyribonucleic acid (DNA) damage and cells being out of the program. With this model, as earlier cancer is diagnosed, so the treatment would be that successful. In this study, risk of getting breast cancer of people is going to be deduced and the opportunity to destroy this risk will be suggested to the patient. Effects of stress to cancer are going to be examined after evaluating the risk value of cancer that is going to be evaluated on the basis of self resistance of the person to cancer expectance of risk result and aptitude to stress. In order to resolve the problem, the available figures have been evaluated; leading method and sample have been presented together with fuzzy logic model as a new modality. The reason for selection of fuzzy logic model in this study is that the system uses fuzzy logic model which provide effective results depending on uncertain verbal knowledge just like logic of human being. After receiving good results from the study; our system will make a pre-diagnosis for the people who possibly can have risk of getting cancer by the reason of working conditions or living standards. Therefore, this will enable these people to take precautions to the risk of cancer. Besides, the contribution of fuzzy logic model in the field of health and topics of artificial intelligence will also be examined in this study. Due to this type of study, people will have the chance to take measures against catching cancer and the rate of catching cancer can be decreased. Due to this study, the presentation of strong software is aimed, so that related techniques are used in the health field and sample studies are conducted.

Key words: Fuzzy logic, cancer, risk, analysis, breast cancer, stress, preliminary diagnosis, soft computing.

INTRODUCTION

Fuzzy logic is a logic structure that emerged as a result of an article which was published by Lotfi Zadeh in 1961. Fuzzy logic is based on fuzzy cluster and sub-clusters. In classical approach, an existence is either an element of a cluster or is not. If it is expressed in mathematical terms, when an existence is an element of a cluster in terms of membership relation with the cluster, it takes a value of "1" and when it is not an element of the cluster, it takes a value of "0". Fuzzy logic is an expansion of classical cluster indication. Each existence has a membership degree in fuzzy existence cluster. Membership degree of existences may range between (0, 1 (Klir JG., Yuan B, 1995). Contrary to classical clusters, membership degrees of fuzzy cluster elements [0, 1 interval] may vary at infinite numbers (Ishibuchi et al., 1997). They are getting together with their constant and uninterrupted integrity of their membership degrees. Binary variables such as cold-hot, fast-slow, light-dark in precise clusters are softened by flexible qualifiers such as slightly cold, slightly hot, slightly dark and they are simulated to real world. The most important difference is that there are no precisely defined preconditions of cluster membership,

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which is at the source of information under this umbrella, and there are more problems and random variables. Bit characteristic of fuzzy logic is that the data are taken by sampling and it is assumed that they represent the whole and probability is obtained accordingly.

Every year thousands of human mortality from cancer is due to limitation of medical sources and unable to use the existing sources effectively. Patient losses can be reduced by using the numerical (quantitative) techniques in the system of medical and health (Alvarez MG., 2000). The mathematical models can be used in any place where decision making problem is appeared. Cancer is a genetic disease which is developed by the abnormal cell increase and cell growth as a result of DNA damage and cells being out of the Program. With this model, as earlier cancer is diagnosed, so the treatment would be that successful. If the medical manage to use the techniques such as fuzzy logic in their own field, many diseases like cancer could reach to the condition of treatment owing to early diagnosis or be prevented. So there would not be a necessity for expensive operations. Nowadays, most people who have cancer; apply to hospitals at the stage of disease progression and therefore the disease is not diagnosed earlier. If the treatments are useless as usual, the patient dies at short time. One of the important issues is to focus on prospective cancer disease diagnosis for fit people (Abbod MF et al., 2001).

Breast cancer is the type that appears firstly in the breast cells. After lung cancer, breast cancer is the most frequent type of cancer all over the world. According to the recent researches, occurring one in every eight women will have the breast cancer eventually. Although, males also get caught to breast cancer which are indeed very rare cases. Specifically, women cases are 100 times more than male cases (Temiz, 2007). Since 1970's it has recorded incrimination in breast cancer cases and modern western life-style is considered as the reason for this increase. The frequency of the disease in south-America and Europe is more than any region in the world. Early diagnosis can save the patient with 96% chance of living. Every year 44000 people lose their lives because of breast cancer. The most efficient and protective way against the breast cancer is the early diagnosis (Wolberg et al., 2007).

Stress is some kind of a body straining that is caused by physical or social environment, and does not cause to any disease directly but causes physical or psychological diseases because of the decreasing resistance of body (Elbi, 1991). It is claimed that psychological stress is most especially in forcing immunity system by decreasing the lymphocytes. This decreasing response power of immunity system is increasing the risk of infection diseases and the risk of cancer. Stress is able to cause cancer cells to settle down and spread to whole body by destroying the immunity system. Animal laboratory experiments show this close relation between stress and cancer clearly.

The purpose of this study is to determine the future risk of getting breast cancer that is chosen as pilot cancer type for the study, of people whose disease conditions are not clearly known and to recognize the diagnosis before disease. Therefore, factors that cause breast cancer are going to be determined firstly. After putting forward the results, these factors are going to be used in fuzzy logic model and affiliation degrees of these factors are going to be settled. As a result of this examination risk analyses of the person to the breast cancer are going to be defined and the pre-diagnosis is going to be pointed.

Within this scope, breast cancer has been selected as a pilot cancer type (Yılmaz et al., 2011). The reason for selection of breast cancer is that this cancer is appropriate for this study and frequency of this cancer. In this study, the risks for people who possibly can get cancer will be discovered by applying fuzzy logic model and suggestions will be submitted to persons to eliminate these risks. In order to resolve the problem, the available figures have been evaluated; leading method and sample have been presented together with fuzzy logic model as a new modality. The reason for selection of fuzzy logic model in this study is that the system uses fuzzy logic model which provide effective results depending on uncertain verbal information just like logic of human being. The purpose of this study is to examine the usability of fuzzy logic model in the light of existing figures and to evaluate the obtained results and share.

MATERIALS AND METHODS

Fuzzy logic

Fuzzy logic aims to model human thinking and reasoning and to apply the model to problems according to needs. It tries to equip computers with the ability to process special data of humans and to work by making use of their experiences and insights. When human logic solves problems, it creates verbal rules such as “if <event realized> is this, the <result> is that”. Fuzzy logic tries to adapt these verbal rules and the ability to make decisions of humans to machines/computers. It uses verbal variables and terms together with verbal rules (Ishibuchi et al., 1997).

Verbal rules and terms used in human decision-making process are fuzzy rather than precise. Adapting human logic system to computers/machines will increase problem-solving ability of computers/machines. Verbal terms and variables are expressed mathematically as membership degrees and membership functions. Fuzzy decision-making mechanisms use symbolic verbal phrases instead of numeric values. Transferring these symbolic verbal phrases to computers is based on mathematics. This mathematical basis is fuzzy logic.

Systems that use fuzzy logic are alternatives to the difficulty of mathematical modeling of complex non-linear problems and fuzzy logic meets mathematical modeling requirement of a system. Systems that use fuzzy logic can produce effective results based on indefinite verbal knowledge like humans. In fuzzy logic, information

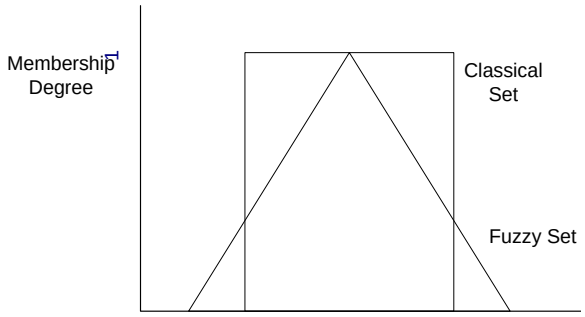
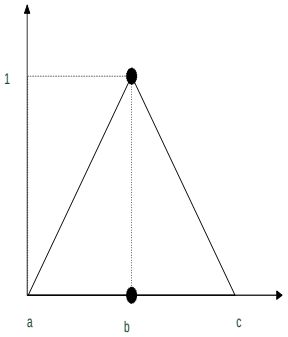


Figure 1. Indication of a classical and fuzzy cluster on coordinate system.



$$if \quad a \le x \le b \Rightarrow \frac{\max' \times [\sin(x) - \sin(a)]}{[\sin(b) - \sin(a)]}$$

$$if \quad b \le x \le c \Rightarrow \frac{\max' \times [\sin(c) - \sin(x)]}{[\sin(c) - \sin(b)]}$$

$$if \quad a > x \,\|\, c < x \Rightarrow 0$$

Figure 2. Triangular membership type and membership degree calculation.

is verbal phrases such as big, small, very, few etc. instead of numeric values. If a system's behavior can be expressed by rules or requires very complex non-linear processes, fuzzy logic approach can be applied in this system.

Fuzzy clusters

Fuzzy cluster concept is an extension of a classical cluster. In classical cluster, an element is either within a cluster (1) or is not within a cluster (0). In fuzzy clusters, an element has any membership value between 0 and 1. (Yalpir et al., 2011) (Figure 1).

In classical clusters, "1" represents being a member while "0" represents not being a member. In fuzzy clusters, "1" represents full membership (full membership degree), degrees between "0" and "1" represent degrees of membership and "0" represents full non-membership (full non-membership) (Klir JG., Yuan B).

Linguistic variables

While variables in mathematics usually take numerical values, in fuzzy logic applications, the non-numeric linguistic variables are often used to facilitate the expression of rules and facts.

A linguistic variable such as age may have a value such as young or its antonym old. However, the great utility of linguistic variables is that they can be modified via linguistic hedges applied to primary terms. The linguistic hedges can be associated with certain functions. For example, Lotfi Zadeh proposed to take the square of the membership function. This model, however, does not work properly (Ishibuchi et al., 1997).

Fuzzy logic method applied

Method applied

Firstly, Mamdani type fuzzy logic models are developed for cancer types specified as pilot within the study and have been used within the application software. Performance measurements of Mamdani type fuzzy logic model have been made for breast cancer type by using various model cases. Since the result produced by the model will be very important for the industry such as health where even the smallest detail has great importance, the requirement to introduce a fuzzy logic model that may have higher performance has arisen. In this respect, a new type of fuzzy logic model approach is introduced by making modifications on the Mamdani type fuzzy logic model and by introducing new methods.

Rating formulas and fuzzification

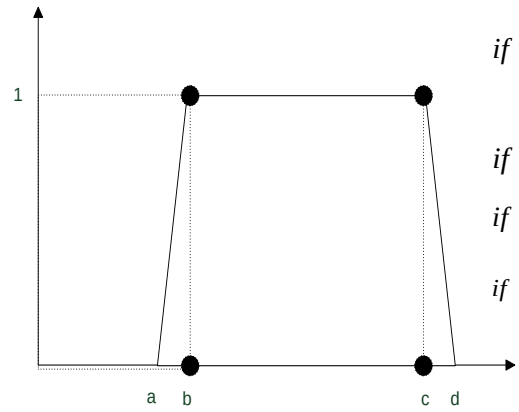
Generally in practice, making the change ranges appearing in classical set form fuzzy is required for fuzzy set, logic, and system procedures (Phuong et al., 2001; Torres et al., 2006). For this, it is considered that all the elements that may be present in a range have various values between 0 and 1, instead of having membership degree equal to 1. In this case, it is accepted that some elements include uncertainty. In case of arising of these uncertainties from non-numerical cases, fuzziness is mentioned. Convenience of fuzzy sets depends on the skill of being able to form membership degree functions appropriate for different concepts. Most frequently used functions are triangle and trapezoid for ease. The display of elements pertaining to any fuzzy set by triangle membership function and trapezoid membership function and the mathematical expression of calculation of membership degrees on new type fuzzy logic approach are displayed in Figures 2 and 3.

Besides functions being in the form of triangle or trapezoid used frequently or being in other appropriate forms, sub sets are required to be in a form that is overlapping with each other.

Rule processing unit

In fuzzy logic, rules are formulated by conditional cases in the form of 'if ... then, let it be'. All input variables are converted to oral variable values, step of producing fuzzy result is applied based on rules for current status and values of oral variables are calculated at output. On the other hand, a fuzzy rule should have oral input and output terms in the form of 'if ... then, let it be' (for example, if X value is A, then let Y value is B). 'If ...' section is named status; '... let B' section b name result or decision section. In the example of 'if X value is A, then let Y value be B', A and B are oral words and they indicate to which status X and Y values pertain to in fuzzy sets X and Y. As rules are processed in order, result found is processed to exits indicated by following formulas and rules for new type fuzzy logic approach within the rules related with entry values made fussy themselves (Yager, 1996).

$$t_1 = \frac{x_1 + x_2 + ... + x_n}{n} \qquad t_2 = (x_1 - t_1)^2 + (x_2 - t_1)^2 + ... + (x_n - t_1)^2$$



$$if \quad a \le x \le b \Rightarrow \frac{\max' \times [\sin(x) - \sin(a)]}{[\sin(b) - \sin(a)]}$$

$$if \quad b \le x \le c \Rightarrow 1$$

$$if \quad c \le x \le d \Rightarrow \frac{\max' \times [\sin(d) - \sin(x)]}{[\sin(d) - \sin(c)]}$$

$$if \quad a > x \,\|\, d < x \Rightarrow 0$$

Figure 3. Trapezoid membership type and membership degree calculation.

	Gender	Age	Menarche Age	Menopause Age	First Birth	Alcohol Consumption	Nutrition Habit	Genetic
1	Female	58	14	52	31	very other da	Oily	Mother
2	Male	60	None	None	None	Fortnightly	Lean	None
3	Female	55	13	None	24	Fortnightly	Lean	Aunt
4	Female	41	14	None	None	Everyday	Lean	Mother-Niece
5	Female	51	14	None	28	Fortnightly	Oily	None
6	Female	49	15	47	21	None	Lean	None
7	Male	58	None	None	None	very other da	Lean	Aunt-Other
8	Female	57	14	49	27	Once a week	Oily	Aunt
9	Female	34	13	None	32	Twice a week	Lean	Other
10	Female	44	14	42	29	Everyday	Oily	None

a)Sample breast cancer dataset

	Type of Cancer	Risk Result	Stress Resistance	Stress Trend
1	Breast	Low Risk	Resistant	Light Inclined
2	Breast	Risky	Flimsy	Inclined
3	Breast	Healthy	Quite Resistant	Light Inclined
4	Breast	Risky	Quite Resistant	Light Inclined
5	Breast	Low Risk	Resistant	Light Inclined
6	Breast	Risky	Flimsy	Resistance
7	Breast	Risky	Inclined	Inclined
8	Breast	Low Risk	Quite Resistant	Resistance
9	Breast	Risky	Flimsy	Very Tendecy
10	Breast	Risky	Resistant	Inclined

b)Sample sample dataset

Figure 4. Sample dataset.

$$t_3 = \frac{t_2}{n} \qquad t_{result} = \sqrt{t_3}$$

If more than one value exists in any of the output values for related rules, the greatest value within these values is selected.

$$\alpha_{ort} = \frac{n}{\frac{1}{\max_1} + \frac{1}{\max_2} + ... + \frac{1}{\max_n}}$$

$$result = \frac{(top_1 \times \alpha_{ort}) + (top_2 \times \alpha_{ort}) + ... + (top_n \times \alpha_{ort})}{\max_1 + \max_2 + .. + \max_n}$$

Defuzzification

In practical applications, especially in engineering plans, projects, and designs, definite numerical values are required for sizing. The implications of the fuzzy variable, set, logic, and systems in artificial intelligence studies, that might be fuzzy, should be converted to definite numbers. All of the procedures made for conversion of fuzzy information into definite results are named defuzzification procedures (Belohlavek et al., 2006; Steimann, 1997).

The defuzzification process will be made by applying the following formula in the new type fuzzy logic approach by using peak values of related output set produced as result and output values calculated within the rules.

Dataset

120 datasets were provided from Şişli Etfal Hospital Oncology services for testing performance measurement of this presented fuzzy logic model (Figure 4). 63 of the used datasets including the people who were diagnosed with breast cancer. Other 57 datasets are including the people who went to the hospital for the examination but were not diagnosed with breast cancer. Model's success status was presented with using both healthy and patient datasets. 30 datasets were provided for calculating the stress' trigger status on breast cancer. 19 of the used datasets including the people who were diagnosed with breast cancer and other 11 datasets are including

the people who went to the hospital for the examination but were not diagnosed with breast cancer.

Cancer

Cancer is a class of diseases in which a group of cell display uncontrolled growth through division beyond normal limits, invasion that intrudes upon and destroys adjacent tissues, and sometimes metastasis, which spreads the cells to other locations in the body via lymph or blood. These three malignant properties of cancers differentiate them from benign tumors, which are self-limited, and do not invade or metastasize (Alvarez MG., 2000).

Cancers are primarily an environmental disease with 90 to 95% of cases due to lifestyle and environmental factors and 5 to 10% of them were due to heredity (Alvarez MG., 2000). Common environmental factors leading to cancer death include: tobacco (25 to 30%), diet and obesity (30 to 35%), infections (15 to 20%), radiation, stress, lack of physical activity, and environmental pollutants. These environmental factors cause abnormalities in the genetic material of cells. Genetic abnormalities found in cancer typically affect two general classes of genes oncogenes and tumor suppressor genes.

Definitive diagnosis requires the examination of a biopsy specimen, although the initial indication of malignancy can be symptomatic or radiographic. Most cancers can be treated and this may include chemotherapy and radiotherapy and/or surgery (Temiz, 2007). The prognosis is most influenced by the type of cancer and the extent of disease. While cancer can affect people of all ages, the risk typically increasing with age. In 2004 cancer caused about 13% of all human deaths (7.6 million).

Breast cancer

Breast cancer is the most common cancer type in the world except skin cancer and it takes the second place after the lung cancer between the deaths of cancer. The frequency of breast cancer changes from country to country (Wolberg et al., 2007). It is argued that the following factors play role in developing of breast cancer (Ravi et al., 2003).

Gender: Being a woman is already a factor for breast cancer. The breast cancer is seen 99% in women, 1% in men.

Age: The risk of breast cancer increases as the age goes by 77% of patients who are just diagnosed by breast cancer, 84% of them who dies from breast cancer; are over 50 years old people.

Having benign and malignant tumour in the breast before: Presence of cancer in the breast increases the cancer risk in the other one as 2-6 times; atopic hyperplasia as 4-5 times.

Genetic: having a history of cancer in the family, mutation in BRCA-1 and BRCA-2 genes and P53 gene increases the cancer risk. While the occurrence risk of cancer in a mother of someone who has a breast cancer is 8.8; this ratio for her sister is 2.7 and for her daughter is 4.6. Only 10 to 15% of breast cancers are based on genetic.

Menarche Age: It is shown that early menarche (period) is a risky factor in development of breast cancer. Regular menstruation starting period is also important following to the menarche. Risk of getting breast cancer for People who have early Menarche (before 12) and go through the regular menstruation in a short time; is 4 times more than others.

Menopause Age: There is a relation between Breast Cancer risk and Menopause Age. Breast cancer risk in women who are in menopause before the age of 45 is as much as half of in women who are in menopause after the age of 55.

Pregnancy age: Never get pregnant and getting pregnant at first time over the age of 30 increases the risk of breast cancer. The cancer risk for women who give birth after the age of 30 is 4 times more than the women before 20.

Nutrition: It is explained that nourishing with higher consumption of oil increases the risk of breast cancer, low consumption from tendon is subject to discussion.

Body Weight: The low body weight in Pre-menopause period and high body weight in post menopause period increase the risk of breast cancer.

Alcohol consumption: Alcohol increases the breast cancer risk.

Exercise: It is explained that exercise made in the period of Adolescence and adulthood by the women under the age of 40 decreases the breast cancer risk

Radiation exposure: Radiation exposure especially under the age of 30 and before puberty increases the breast cancer risk (Aydıner A et al., 2006; DeSilva CJS et al.,1994; Gross RE, 2000).

Risk factors in breast cancer

1) Being a woman
2) Being in old age
3) History of breast cancer in the first degree relative
4) Cancer in the breast before or atopic hyperplasia
5) Mutation in genes of BRCA-1 and BRCA-2
6) Menarche under the age of 12
7) Menopause period over the age of 55
8) Giving first birth over the age of 30
9) Daily Alcohol Usage
10) Fat Diet (Ravi et al, 2003).

The relationship between stress and cancer

Determination of the risk factors that cause cancer is among important protection methods. One of these risk factors is stress. The importance of stress, which is the problem of our era, is increasing each day as a factor that lays the basis for many diseases. Stress is a physiological uneasiness that does not cause direct disease coming from physical or social environment, but that causes physiological and mental diseases as they reduce the resistance of human body. Particularly, it is asserted that mental stresses reduce T lymphocytes and suppress the immune system. This reduction in the response of the immune system increases the frequency of infection diseases and cancer (Elbi, 1991).

Stress breaks down the immune system of the body and may cause the settlement of carcinogen cells and their spreading to all over the body. Animal research has indicated that there is such kind of a relationship between stress and cancer. In a study that lasted for 400 days with mice that had cancer susceptibility, mice were kept in intensely crowded conditions and exposed to stress by people. At the end of this period, cancer was developed in 90% of the mice. However, in only 7% of the mice in the comparison group that were kept in low stress conditions cancer was developed. The studies carried out with human beings also indicated that there is a relationship between life stress and the frequency of cancer. It has been detected that the patients who have got cancer diagnosis went through many life events during the previous year from the diagnosis (Bilge et al, 2008).

There are various life events that cause the emergence of stress. In a study, it has been stated that socioeconomic problems increase the level of stress, thus give rise to breast cancer. In another study, it has been reported that the risk factors, which are considered important were not present in the women that applied to mammography unit; however, there were factors such as intense stress, poverty, and

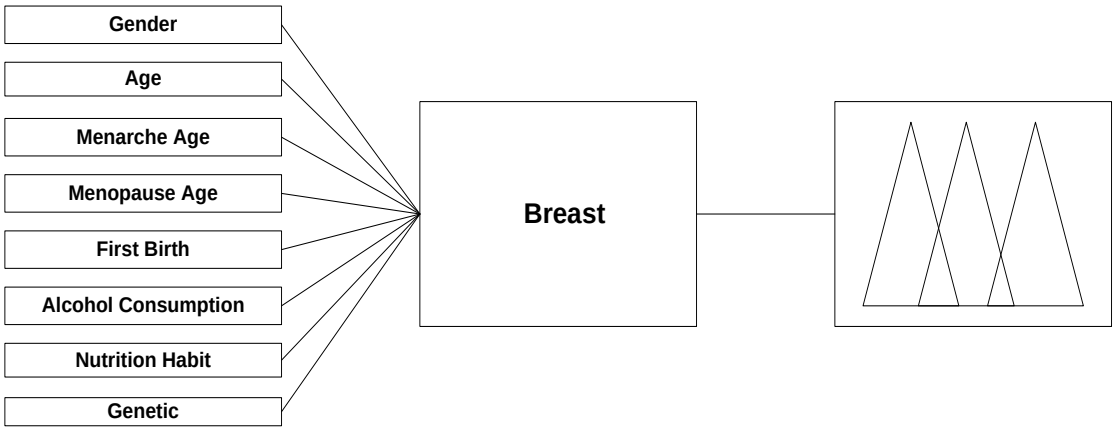


Figure 5. Fuzzy logic breast cancer model.

violence.

In a research published in Mart issue of Biological Chemistry Magazine, it was discovered that the stress hormone called "epinephrine" which is strengthening to cancer cells and extends the life of these cells. According to the research, both stress causes the development and proliferation of cancer cells, and reduces the efficiency of cancer treatments. In the presence of stressful events, epinephrine hormone starts to increase rapidly and in case of long-term discomfort or depression, it is maintained at a high level. When cancer cells are exposed to this hormone, the protein called “BAD” that is required for the death of the cell becomes ineffective (Bilge et al, 2008).

Implementation and results

After the identification of cancer type and risk factors of this cancer; model design has been initiated. The Fuzzy Logic model for Breast Cancer has been developed. Gender, age, genetic status, menarche age, menopause age, first birth age, alcohol consumption and nutrition habit as factors have been identified in the model of Breast Cancer. In accordance with these factors, membership degree of 8 different factors has been determined. As a result of outcome from these 8 factors, the risk status of this person to that type of cancer has been analyzed within the model. (Extremely risky, risky, low risk and healthy) (Figures 5 and 6).

In this model formed, if the degree of membership type of entry is triangular; let the value x be the value given by the person for the related entrance. For the calculation of the level of membership: (Figure 2). In this model formed, if the degree of membership type of entry is trapezoid; let the value x be the value given by the person for the related entrance. For the calculation of the level of membership: (Figure 3).

After the determination of membership functions and degrees, the model principle has been done in the direction of current figures and learned opinion. 115 rules have been formed in the model in total.

After the person completes the entry of related areas and presses Calculate Risk Result, levels of membership are calculated one by one for the entries of Gender, age, genetic status, menarche age, menopause age, first birth age, alcohol consumption, nutrition habit and all of the rules that we determined in the model are controlled (Figure 7) (Çoşkun, 2011).

As a result of the rules, risk condition of the person as Healthy – Under Low Risk - Under Risk or Under High Risk is assigned by taking the minimum value of these membership levels.

After all these rules are applied, in order to calculate the result of the risk condition of the person, a value is calculated by taking the maximum of the value in Healthy – Under Low Risk - Under Risk and Under High Risk group (Figure 8).

If the maximum values produced as a result of the rules are max1 for Healthy, max2 for Under Low Risk, max3 for Under Risk, max4 for Under High Risk; a result is calculated by separately being formulated for 14 different probabilities.

According to the value of obtained result, risk condition of the person is calculated; and the fact that the person belongs to which class with which value is found out. (Healthy, Under Low Risk, Under Risk, Under High Risk) (Figure 9). Stress model was formed in order to calculate the effect of stress on this condition according to the risk result calculated from breast cancer model by using fuzzy logic. In order to calculate the resistance of the person to stress, 16 questioned Stress Resistance Test; and in order to calculate the tendency of the person towards stress, 20 questioned Stress Tendency Test were prepared by Expert psychologists (Türkmen, 1991). In the stress model; risk result, the results of stress resistance test and stress tendency tests and the entries of the model were determined.

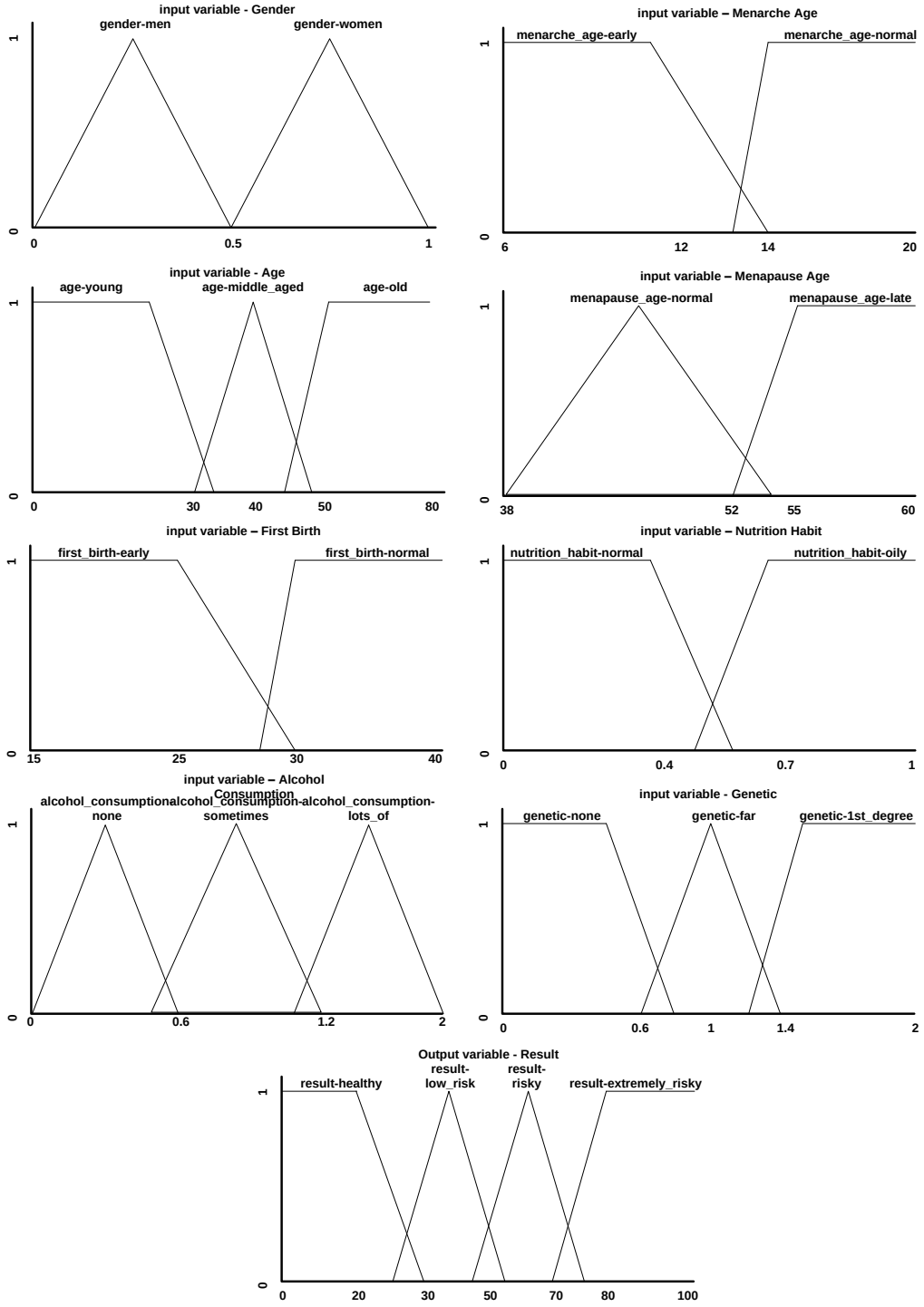


Figure 6. Fuzzy logic breast cancer model inputs and membership degrees.

As a result of outcome from these 3 factors, the risk status of this person to that type of cancer has been analyzed within the model (Extremely risky, risky, low risk and healthy) (Figures 10 and 11).

After the person completes the entries of related areas and presses Calculate Risk Result button, levels of membership are calculated one by one for the entries of stress resistance, stress tendency and all of the 64 rules

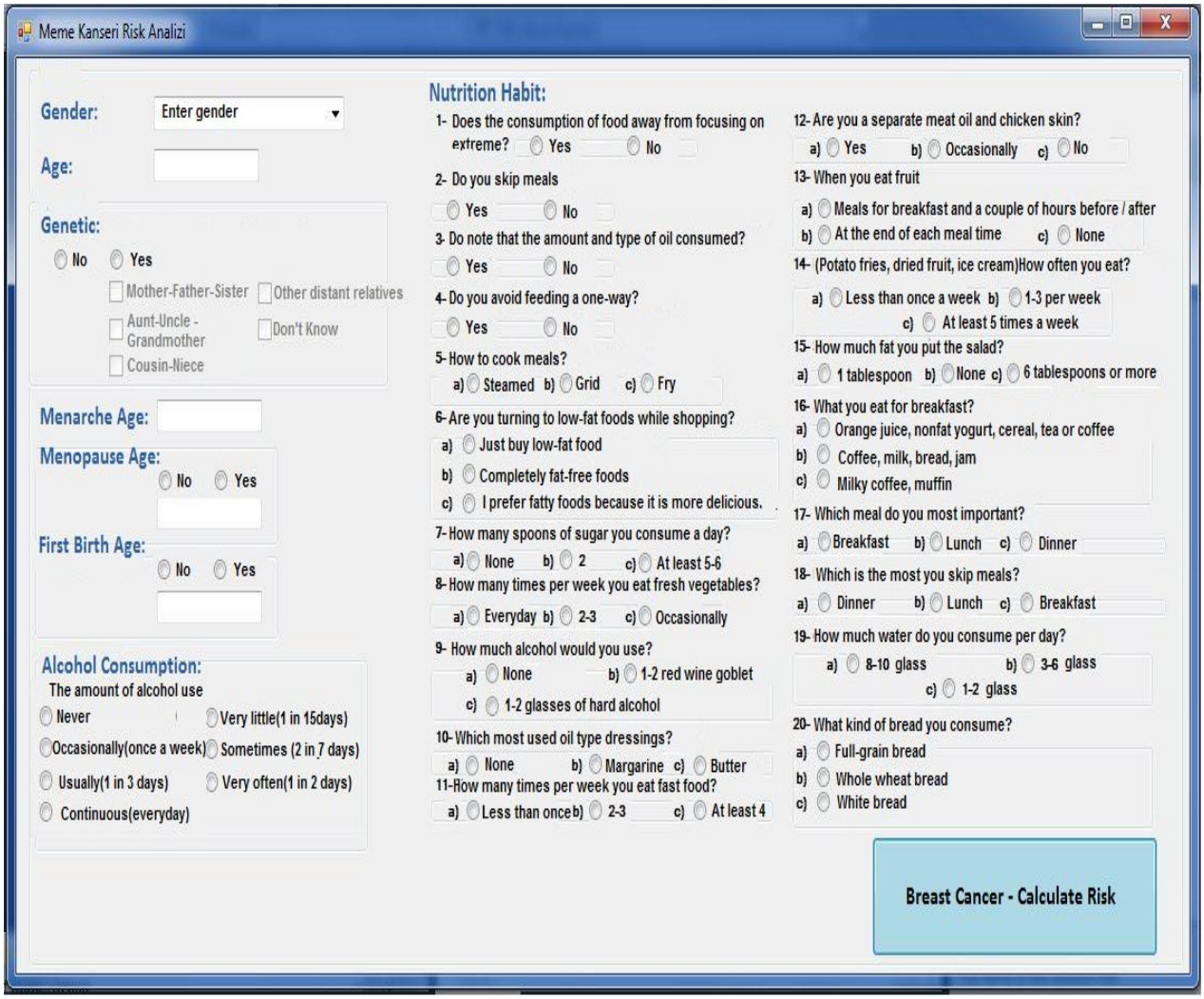


Figure 7. Cancer risk analysis application via fuzzy logic model – breast cancer.

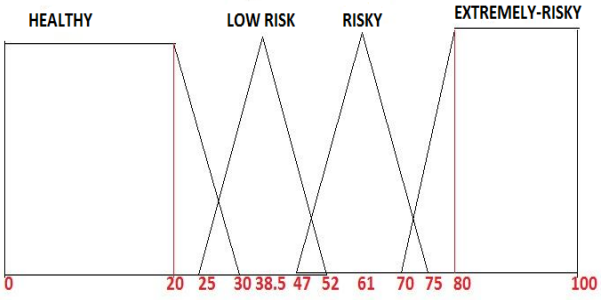


Figure 8. Colon cancer result and membership degrees.

determined in the model are controlled (Figure 12). As a result of the rules, risk condition of the person as Healthy – Under Low Risk - Under Risk or Under High Risk is assigned by taking the minimum value of these membership levels. After all these rules are applied, in order to calculate the result of the effect of stress on cancer condition, a value is calculated by taking the maximum of the value in Healthy – Under Low Risk - Under Risk and Under High Risk group. According to the result value obtained, risk condition of the person is calculated; and the fact that the person belongs to which class with which value is found out. For our model that performs risk analysis with the effect of stress on cancer, our system was tested for the related cancer type with the data of the patients and healthy people we have and it was seen that optimum result was obtained from this model. Performance of the system in this matter has been calculated as 81%. In the direction of risk analysis made to 97 of 120 people in test set, the system has correctly been conducted (Figure 13).

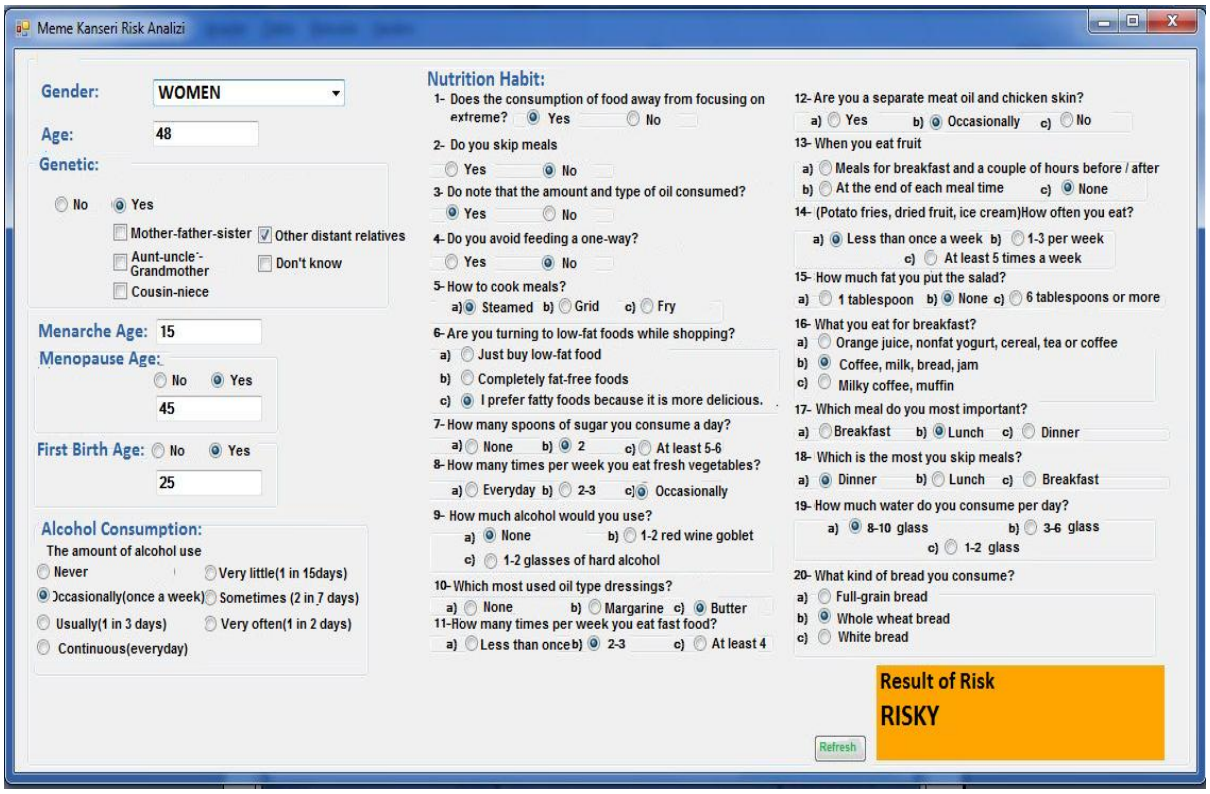


Figure 9. Cancer risk analysis application via fuzzy logic model – breast cancer analysis result.

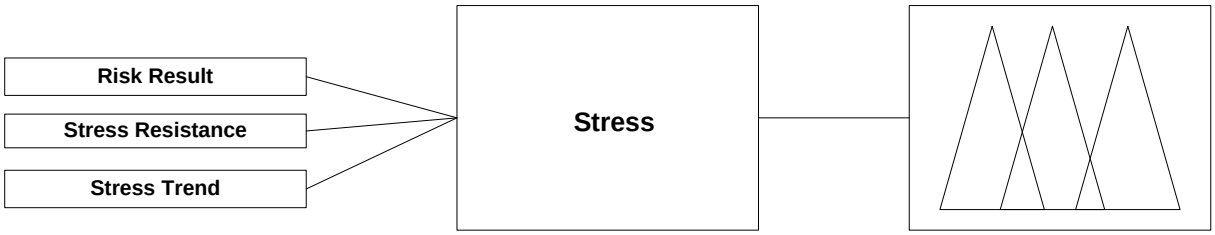


Figure 10. Fuzzy logic stress – cancer model inputs and membership degrees.

DISCUSSION

When studies of Balanica and friends (2011) “Risk Assessment in Breast Cancer by Using Fuzzy Logic Model”, Saleh and friends (2011) “Fuzzy Management Support System in Breast Cancer”, Caramihai and friends (2010) “Breast Cancer Risk Assessment by Fuzzy Logic”, are analyzed in detail, it is observed that artificial intelligence techniques for health sciences are applied to a large extent for diagnosis and identification. The same case also applies for cancer diseases. For methods used in studies reviewed, introductions and clinical findings are emphasized; findings that cannot be known without analysis and taking expert opinion are emphasized in the model as introduction. Besides this, ready-made tools that are held for artificial intelligence by application software such as FuzzyTech or Matlab have been used in studies reviewed. Moreover, a new fuzzy logic model has not been developed within the studies, Mamdani type Fuzzy Logic Model previously used or techniques such as Multi-layer artificial nerve web have been used in the solution of the problem.

In our research, different than studies conducted in literature, not only the difference of performance outcomes of prepared application, producing statistical data, and determination of risk factors affecting breast

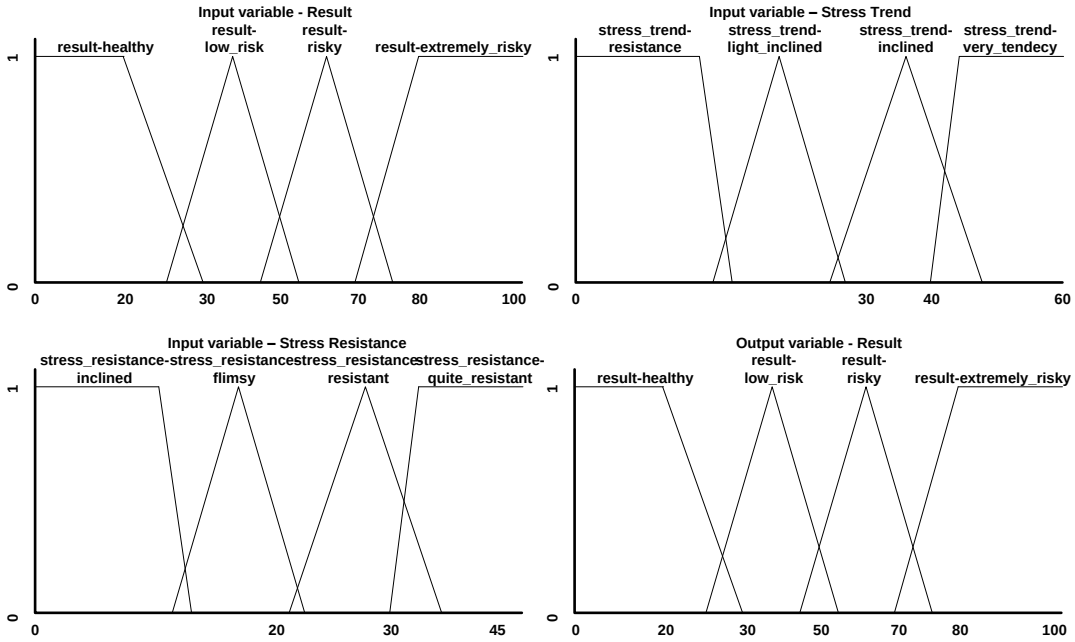


Figure 11. Fuzzy logic stress – cancer model inputs and membership degrees.

Figure 12. Cancer risk analysis application via fuzzy logic model – analysis of the effect of stress on cancer.

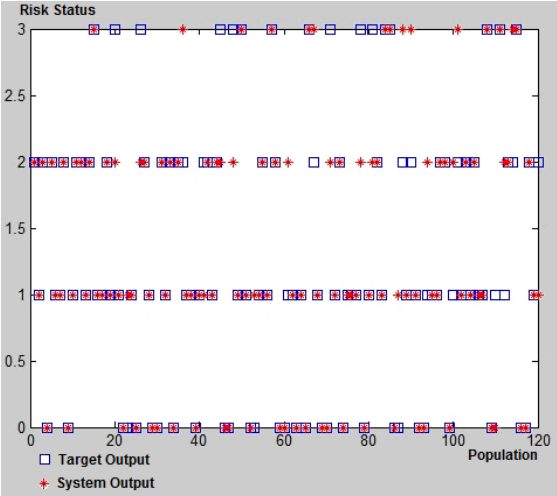


Figure 13. System performance graphic.

cancer, the development of an application to work in every computer system loaded with .NET framework that can be used by doctor or potential patient for people suspected to have or may have breast cancer is aimed. Besides this, another objective is to be able to introduce a fuzzy logic method that can produce more successful results. Moreover, it is aimed that introductions of fuzzy logic model determined for breast cancer from cancer type selected as pilot are composed from findings known without any testing and taking expert opinion. As a result of this, without any analysis or expert, a person can calculate the risk status for any of the 3 cancer types conveniently with the help of software in any computer loaded with .NET framework. Except all these, the effect of stress, as subject having a triggering role in every kind of disease at our age, on cancer types is also tried to be construed within the software, different than other studies. In the study, firstly, performance report is extracted by using mamdani method from fuzzy logic models, afterwards, new fuzzy logic method is introduced and performance differences by the renewed system are brought up. It is observed that fuzzy logic method used produced more successful results in proportion to the amount of its data held

When scientific studies conducted are reviewed, it is observed that artificial intelligence techniques for health sciences are applied for diagnosis and identification to a large extent. The same case also applies for cancers diseases. After catching diseases such as cancer, for diseases with very difficult treatments and recoveries, taking precautions before the initiation of the disease, learning about risk status, or preliminary diagnosis for the disease are important issues. In consideration of this case, the software, that will measure the susceptibility for that cancer type and risk status for specific cancer types at healthy people or at people not diagnosed with the disease, is developed by selecting fuzzy logic model from artificial intelligence techniques in this study. In research conducted, it is understood that cancer disease types are linked to each other. After determination of cancer disease types (breast – lung – colon) selected as pilot in thesis study, the fuzzy logic model from artificial intelligence methods, which is widely used among disciplines and has a mathematical infrastructure, is selected, and even, risks of a healthy person for catching these cancer types in the future are revealed.

In the study, different than studies conducted in literature, not only the difference of performance outcomes of prepared application, producing statistical data, and determination of risk factors affecting breast cancer, an application that will work in every computer system loaded with .NET framework that can be used by doctor or potential patient for people suspected to have or may have breast cancer is developed. Moreover, all introductions of fuzzy logic models determined for breast cancersfrom cancer type selected as pilot are composed from findings that can be known without any testing and taking expert opinion. As a result of this, without any analysis or expert, a person can calculate the risk status for a cancer type conveniently with the help of software in any computer. Except all these, the effect of stress, as subject having a triggering role in every kind of disease at our age, on cancer types has been construed within the software, different than other studies.

The reason for selection of breast cancer as pilot cancer types within the study is the frequency of patient numbers for indicated cancer type and their appropriateness for this type of study. The risks of catching breast colon cancer for people by using a new type of fuzzy logic model within the study have been revealed and the opportunity to offer suggestions to the person to remove this risk has been provided. In the study, data on hand is reviewed with the purpose of solving the problem and fuzzy logic model as a new approach and risk analysis method and sample have been presented. The reason of selection of fuzzy logic model is the effective drawing of conclusion of systems, where fuzzy decision is used, depending on uncertain linguistic information as the human logic can do.

It is observed that the best result is reached by testing our system by data of patients and healthy people on hand for the related cancer type in the fuzzy logic model software that is formed by new method and that is conducting risk analysis for breast cancer. The system's performance in this subject is calculated at 81% rate. In 97 of 120 data on hand for new type fuzzy logic model provided by new method formed, accurate results have been obtained, performance measurement has been ensured at 81% rate.

After completion of the fuzzy logic model software that is conducting risk analysis of people for breast cancer

Table 1. Performance measurement for the Mamdani method and new type fuzzy logic method on cancer types.

Type of cancer	Performance of Mamdani method (%)	Performance of new type fuzzy logic method (%)
Breast cancer	79	81
Effect of stress on breast cancer	73	76

	Gender	Age	Menarche Age	Menopause Age	First Birth	Alcohol Consumption	Nutrition Habit	Genetic	Result of the Model	Real Result
1	Female	33	14	None	27	Once a week	Lean	None	Low Risk	Healthy
2	Female	42	15	None	32	Twice a week	Oily	Niece	Risky	Patient
3	Male	52	None	None	None	Fortnightly	Oily	Aunt	Risky	Healthy
4	Female	25	None	None	None	A three-day	Lean	Other	Low Risk	Healthy
5	Male	37	None	None	None	Every other day	Oily	Mother	Risky	Patient
6	Female	31	15	None	19	None	Lean	None	Healthy	Healthy
7	Female	56	14	45	22	Fortnightly	Lean	None	Risky	Healthy
8	Female	63	13	43	21	None	Oily	Mother	Extremely Risky	Patient
9	Female	39	14	None	None	None	Lean	Don't know	Risky	Healthy
10	Male	42	None	None	None	A three-day	Oily	Don't know	Low Risk	Healthy
11	Female	52	15	46	25	None	Oily	None	Risky	Healthy
12	Female	29	13	None	None	Twice a week	Oily	None	Low Risk	Healthy
13	Female	58	13	48	29	None	Oily	Niece	Extremely Risky	Patient
14	Female	50	14	45	25	Once a week	Lean	Aunt	Risky	Patient
15	Female	46	14	None	28	None	Lean	None	Risky	Healthy
16	Male	50	None	None	None	Once a week	Oily	Mother-Aunt	Risky	Patient
17	Female	48	14	46	23	None	Lean	Other	Risky	Patient
18	Female	39	13	None	30	A three-day	Oily	Don't know	Extremely Risky	Patient
19	Female	61	15	50	18	None	Oily	Grandma	Risky	Patient
20	Female	48	13	45	20	None	Lean	Don't know	Risky	Healthy

	Type of Cancer	Risk Result	Stress Resistance	Stress Trend	Result of the Model	Real Result
1	Breast	Low Risk	Resistant	Light Inclined	Low Risk	Healthy
2	Breast	Risky	Flimsy	Inclined	Extremely Risky	Patient
3	Breast	Healthy	Quite Resistant	Light Inclined	Healthy	Healthy
4	Breast	Risky	Quite Resistant	Light Inclined	Risky	Healthy
5	Breast	Low Risk	Resistant	Light Inclined	Low Risk	Healthy
6	Breast	Risky	Flimsy	Resistance	Risky	Patient
7	Breast	Risky	Inclined	Inclined	Extremely Risky	Patient
8	Breast	Low Risk	Quite Resistant	Resistance	Low Risk	Patient
9	Breast	Risky	Flimsy	Very Tendecy	Extremely Risky	Patient
10	Breast	Risky	Resistant	Inclined	Risky	Healthy
11	Breast	Risky	Inclined	Very Tendecy	Extremely Risky	Patient
12	Breast	Risky	Quite Resistant	Resistance	Risky	Patient
13	Breast	Low Risk	Resistant	Inclined	Low Risk	Patient
14	Breast	Risky	Flimsy	Light Inclined	Extremely Risky	Patient
15	Breast	Low Risk	Quite Resistant	Very Tendecy	Risky	Patient

Performance Breast Cancer	97/120	81&
Performance Breast Cancer&Stress	22/30	76%

Figure 14. Sample data and model performance.

selected as pilot, the effect of stress status on cancer has been investigated and fuzzy logic model has been developed for the triggering status of a cancer type. When test is conducted on fuzzy logic model software formed by new method to 30 people each from healthy people or people with cancer disease, within breast cancer type separately, performance measurements at rates of 76% (22/30) for breast cancer have been ensured (Table 1). (The data set has been gathered from Şişli Etfal Hospital, Oncology Service)

Conclusion

In this prepared study, the people have made risk analysis and pre-diagnosis regarding the breast cancer which is determined as a cancer type by using the fuzzy logic model; developed a system which provides suggestions to persons as a guide to decrease the risk or eliminate the risk on the base of risk status of cancer type. The reason for selection of fuzzy logic model in this study is that the system uses fuzzy logic model which provides effective results depending on uncertain verbal knowledge just like logic of human being. The quality of fuzzy logic model usage here is to reach a general solution by doing only limited experiments. It takes long time to use the other methods for such problem. The fuzzy logic provides the quickest solution to the problem and prevents time loss for other methods. The fuzzy logic model has been designed in this study .As a result of the implementation; system has become successful between the rates of 80 to 85%.

Fuzzy logic system which is used in this study, gets more accurate results than similar mathematical models. With this study, it can be made risk analysis for cancer which is threatening the future of humanity. Because of giving successful performance of this fuzzy logic model, it gives better results than similar systems.

The risk analysis has been tested on the system by using the figures of patient and healthy people in order to measure the performance and acceptability of the study. But, it could not be verified as 100% accurate on the system as the risk status of the person who has the lower risk; may change in the future together with different living conditions and factors. In the direction of risk analysis made to 97 of 120 people in test set, the system has correctly been conducted. At the end of the study, it has achieved up to the success of 81% with the system (Figure 13).

Datasets were taken from Şişli Etfal Hospital Oncology Services. Sample 20 data were shown in Figure 14 that compares the results of 120 datasets which were used in

breast cancer risk analysis and the real results. Similarly, Sample 15 data were shown in Figure 14 that compares the results of 30 datasets which were calculated the effects of stress on breast cancer and the real results. While the model that calculate the breast cancer risk analysis works at 81% accuracy rate, the model that calculate the effects of stress on breast cancer works at 76% accuracy rate.

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