

The Study of Obesity in Children Using Fuzzy Logic

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Abstract— The paper comprises of a case study which is done on children in the age group of 4 to 6years. The study includes the Body Mass Index and physical activity which are taken into account for the analysis of obesity in children. MATLAB Tool box is used for the analysis along with the concept of Fuzzy Logic.

Keywords- Body Mass Index, Fuzzy Logic, linguistic variables, membership functions, obesity

I. INTRODUCTION

Background

In the past most of the studies about the obesity of the children have been based on data collected from schools [1] for various health problems such as cholesterol, blood Pressure diabetes etc . It has been established that how on the basis of overweight and obesity [2] these diseases appear in the children. However, no study has been made for the children from nucleus families with good income with either one/ both the parents working or who have not sufficient time to devote for their children with respect to diet, habits and physical activities. On the other hand, these children consume more of junk food, which affect their obesity. Obesity [1] has been a major health issue and is of major concern for the parents when it is with respect to their children. Studies of obesity and overweight in urban schools [1] have been made in the past, which have shown a high prevalence of obesity in the children. The reasons of obesity can be due to many, like diet [7], amount of physical activity [8], age, gender, genetic factors etc. Obesity raises various health issues [2] such as diabetics, high blood pressure, and cholesterol. To analyze whether the child is obese requires certain factors based on which Percentile Body Mass Index is calculated [4], [9]. If Percentile Body Mass Index (PBMI) is greater than the 95th percentile then the child is said to be obese [2]. To calculate obesity in children the height, weight, age and gender [9] are to be taken into account before we calculate the PBMI.

Studies have been made on the maternal employment, in general [9] with respect to overweight but there has been no study that has been made for nuclear families with good financial background and either or both the parents working. These parents do not have sufficient time to take care of their Childs' diet, physical activities and eating habits.

In the present study we have taken into account a sample of school children staying in metropolitan cities in India and in nucleus families. Based on the data collected , calculation of PBMI is derived [9] of the samples which has been collected with only prime percentile ranges taken into account [4] and classifying whether the child is underweight, healthy, overweight or obese.

For application of Fuzzy logic for drawing the conclusion of the data, which is not well defined, MATLAB was used with Fuzzy logic Tool Box. Using the Fuzzy Logic Tool Box of MATLAB [6] with the details, whether the child is involved in physical activities [8], keeping the carbohydrate intake [10] normal for all children, graph is plotted and conclusions drawn.

II. NEED FOR STUDY

The study of obesity in children has been gaining utmost importance because of the diseases such as diabetes, high blood pressure, cholesterol which are of high prevalence in children at a very young age. Due to these diseases; it has become very important for the parents to become aware of their Child's health before they are affected by serious health issues.

It has been seen that since both the parents are working they are not have able to provide sufficient time to monitor their child food habits, physical activity etc. Due to all these reasons it is very important to analyze what percentage of total activities contribution comes from physical activities and how increasing and decreasing of these activities would lead them to a normal, overweight or obesity condition.

III. METHODS AND TOOLS

In the present study, the children, in the age group of 4-6 years have been taken and analysis done on the data collected. The PBMI [3] has been calculated [4] with respect to their age, height and weight and sex. The method applied for the study was used on the data collected, which has been in

approximations. Therefore, Fuzzy rules [5] were applied which suites well for such studies. While calculating [4] the PBMI first age was taken, whereas height and weight of the child taken subsequently, calculation for the PBMI done [9] for each child for totaling to 30 samples in total. Around four prime samples are taken which lie in a particular range of values as shown in the Table 1[4] below:

Table 1: Clinical guidelines on identification of obesity in children

Classification	Percentile of BMI
Underweight	<5
Normal weight	>=5 and <85
Overweight	>=85 and <95
Obesity	>=95

The classification for children is on the percentile BMI [3] rather than just BMI as in the case of adults. In the methods that have been used previously was that on the basis of these calculations and conclusion were drawn that the child whose percentile lies in the above range of >=95th percentile are obese.

The method applied draws to a conclusion that when a child , does some amount of physical activity how the weight tends to drift away from obesity to the overweight or if he reduces the exercise how from overweight he may tend to drift towards obesity.

Using the Fuzzy Logic Toolbox [6] of MATLAB along with the standard values of percentile [4] and the amount of physical activity done the Graphs are plotted and conclusions drawn.

The Fuzzy Logic approach is based on the linguistic information [5] acquired, which is a sub field of intelligent systems. Since the data in these areas is incomplete and insufficient therefore this approach is used. The Fuzzy Inference System (FIS) simulation tools which along with fuzzy logic and fuzzy rules [11] act on the input crisp data.

IV. FUZZY LOGIC MODELING

In the traditional approach of the set theory either some value belongs to a set or it does not. For example let us consider that a child with > 95th percentile value will be obese and a child with the percentile range of 85th to 95th will be considered overweight. But there may be some values which will lie in both the cases. That is where the fuzzy logic approach becomes applicable. In the fuzzy set, a value for the variable can partially belong to a set and can have membership function [12] value in the range of 0 and 1 ($0 \leq \mu \leq 1$).

The inputs are percentile BMI and physical activity. Each of these input are fuzzified and the universe of discourse [12] of the input variable PBMI are classified as underweight, normal weight, overweight, obese. The second input variable is physical activity which is Classified as fewer_activity, middle_activity, greater_activity. Figure 1 [11] shows how the crisp input are applied to the fuzzifier and then to the Inference Engine. The Inference Engine applies the Mamdani Method or the Sugeno method of evaluation.

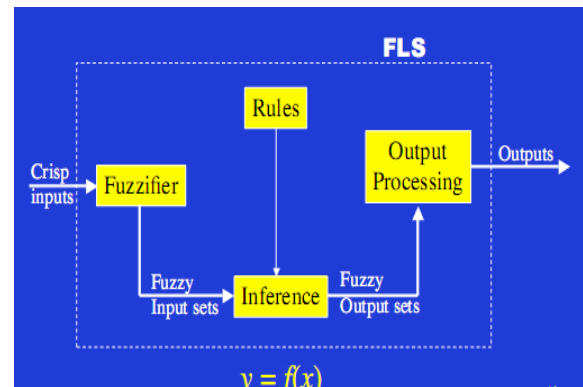


Fig. 1. Fuzzy Logic Block Diagram

V. SIMULATION USING MATLAB

The MATLAB simulation results are shown Figure 2 shows the crisp inputs which are converted to fuzzy input and passed to the Inference Engine which applies the Mamdani method of evaluating the fuzzy input. The crisp inputs are physical activity and weight.

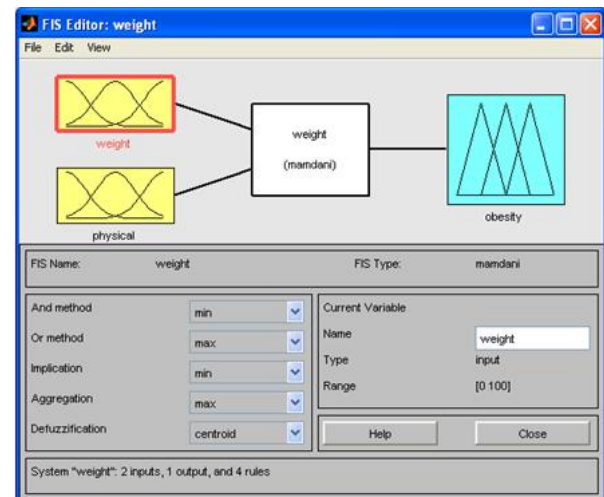


Figure 2: Show the input membership functions

Figure 3 shows the fuzzified inputs for weight crisp input which are applied to the Inference engine

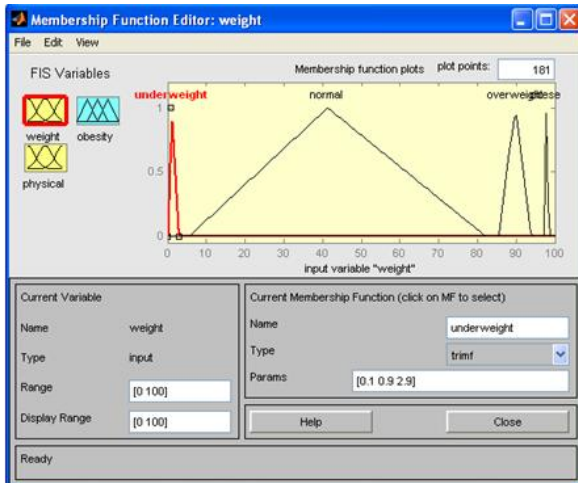


Figure 3: Shows the membership function of input weight

The inputs are split into different range of values based on which the membership function is plotted. The range of inputs refers Table 1 values.

They are classified as underweight, normal, and overweight, obese. Figure 4 shows the crisp input for physical

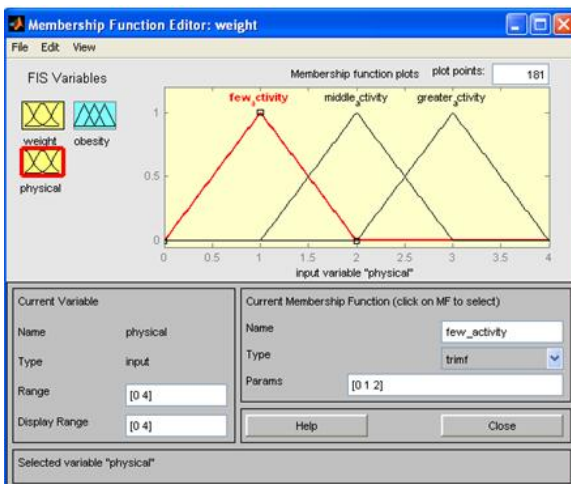


Figure 4: Shows the membership function of input physical.

The input physical range of values [8] is classified into membership functions which lie in the range as shown. They are classified as few_activity, middle_activity, greater_activity. Figure 5 shows the rules which are applied to the Inference Engine which uses the Mamdani method of evaluation.

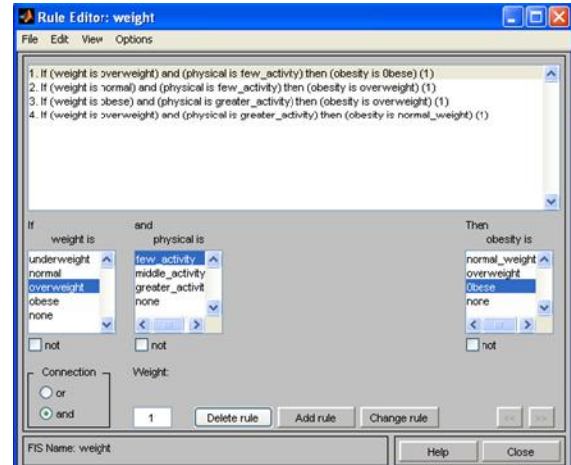


Figure 5: Shows Fuzzy Rules applied to Mamdani method of Evaluation

Based on these rules the following output is generated. Figure 6 shows the output membership

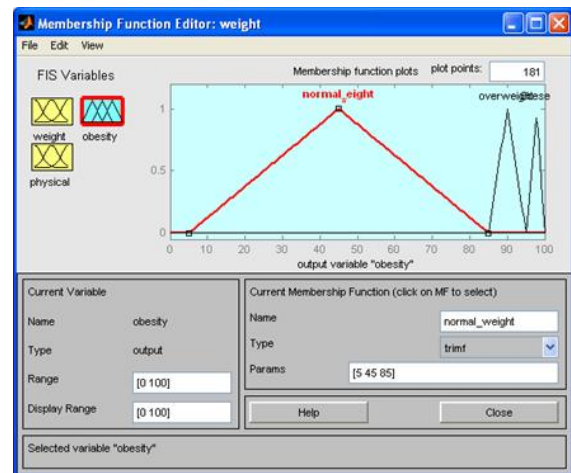


Figure 6: Range of values of Output membership function.

Figure 7 shows the output when a particular Rule is applied to the Inference Engine

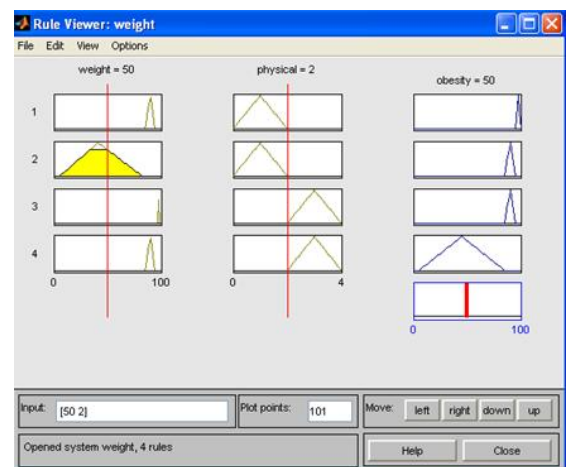


Figure 7: Output rule viewer

Figure 8 shows the final surface view in three dimensions when the respective rules are applied.

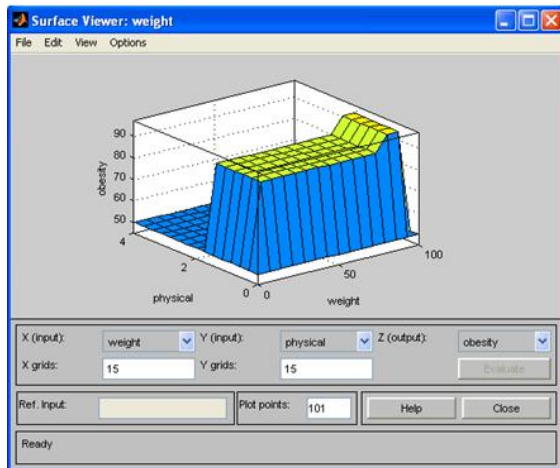


Figure 8: Shows surface view of the output.

From the above plots shows that definitive conclusions can be drawn and parents advised to modify activities of their children along with their diet pattern.

VI. CONCLUSION

Conclusions drawn were on the basis of inference derived in consultation with a dietitian. The conclusions drawn can be used for advice to the parents for the healthy development of their children.

The study shall be useful for children living in the Megacities, such as Bangalore, Chennai, Bombay, and Delhi.

A further analysis of the data can be carried out by taking into account of probability pattern of the information provided by the parents. This shall need application of Type-2 Fuzzy Logic based inference engine. [14] by incorporating more linguistic variable [13].

VII. REFERENCES

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