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ARTICLE

Fuzzy Inference System for Analysing Physical Fitness Metrics of Male-Female Trainee Athletes: De-Fuzzification via Hull and Sigma Scale Analysis

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ABSTRACT

A simulation-based and deterministic approach was employed to assess the health-related fitness of upper primary school students through a Fuzzy Inference System (FIS) implemented in MATLAB. Standardized physical assessments were used to gather fitness data, which were then systematically categorized by gender and grade. While statistical metrics such as mean and standard deviation were extracted, inconsistencies and data ambiguities reduced the effectiveness of a strictly deterministic analysis. To overcome these limitations, fuzzy logic was introduced to better manage uncertainty and overlapping patterns in the data. Linguistic variables derived from the Hull and Sigma Scales were incorporated as signal descriptors within the fuzzy framework, improving system interpretability. A triangular membership function was chosen for its balance of computational simplicity and accuracy in classifying fitness levels. Simulation outcomes revealed that the Hull Scale achieved 18% higher consistency in classification compared to the Sigma Scale, highlighting its superior diagnostic performance and potential for identifying health-related fitness trends across diverse student populations. Additionally, optimal input parameters were identified, further enhancing the functionality of decision support systems in school health monitoring. Results confirmed that integrating fuzzy logic with deterministic models leads to a more adaptable and reliable method for assessing student fitness across genders. This hybrid approach can support educators,

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health professionals, and policymakers in developing more effective, targeted physical wellness interventions. Thus, upper primary students' health-related fitness can be accurately evaluated using a FIS-based system in MATLAB, enhancing performance in youth-focused decision support applications.

Keywords: Fuzzy Inference System (FIS); De-fuzzification; Hull Scale; Sigma Scale; Health Fitness Assessment; Primary School Pupils; Linguistic Variables; Normal Distribution

1. Introduction

Fuzzy logic, introduced by Lotfi A. Zadeh in 1965, offers a powerful framework for managing uncertainty and ambiguity, especially in systems where input data lacks precision or follows imprecise patterns [1, 2]. By leveraging membership functions and rule-based reasoning, fuzzy logic closely mimics human decision-making processes, making it well-suited for applications such as health and fitness evaluation [3–5]. The Fuzzy Inference System (FIS) can be utilized in real-time embedded applications and FPGA-based systems, demonstrating successful applications in various domains including automatic motor control, data classification, decision analysis, expert systems, and computer vision [6–8].

This study applies fuzzy logic to assess health-related physical fitness in upper primary school children, overcoming the limitations of traditional statistical methods, which struggle with inconsistent or non-uniform datasets [9]. Standardized fitness assessments were conducted across gender and grade levels, capturing key physiological indicators including muscular strength, cardiovascular endurance, flexibility, and BMI [5, 10, 11].

Due to observed variations in statistical consistency, two signal processing scales—Hull Scale and Sigma Scale—were incorporated as linguistic variables to describe fitness characteristics. A fuzzy inference system was implemented using the MATLAB Fuzzy Logic Toolbox, employing triangular membership functions to balance computational efficiency with interpretability [12–14]. The Mamdani inference approach guided rule-based reasoning, while surface viewers ensured logical output validation [14].

Several researchers have suggested diverse techniques for different analysis parameters using fuzzy logic. Different shapes like trapezoidal, triangular, Gaussian, sigmoidal, etc are available for fuzzy sets, with various defuzzification methods like Adaptive integration, Center of area, Center of gravity, Fuzzy clustering Defuzzification, First of maximum, Last of maximum, Mean of maxima, Semi-linear Defuzzification, Quality method, Middle of maximum, etc [13, 14]. While a Gaussian shape may seem like a good choice due to its projection to linearity outcome, selecting it can lead to complex distribution fuzzy variable operations and slow down the calculation speed [13]. To keep the calculations relatively straightforward, this study utilized a triangle shape that closely resembles a Gaussian shape [14].

1.1. Method Summary

- Five fitness parameters: Muscular Strength, Sit-ups, 600m Run, Flexibility, and BMI.
- Statistical normalization using Sigma Scale.
- Composite Overall Fitness Score.
- FIS built in MATLAB with Mamdani inference and triangular membership functions.
- Steps: Fuzzification → Rule Inference → Defuzzification → Output evaluation.

1.2. Research Goals

- To establish standardized parameters for evaluating fitness in school children.
- To compare the effectiveness of Hull and Sigma Scales in classification.
- To build a fuzzy logic model for intelligent decision-making.
- To provide recommendations for optimizing fitness monitoring systems in educational settings.

The research can be correlated with the JEL Classification Code L83, because it enhances sports and physical education by assessing fitness parameters among schoolchildren. The study utilizes Fuzzy Logic and Hull and Sigma Scales to assess fitness parameters among schoolchildren, providing valuable insights in the field of sports and physical education, enhancing evidence-based policies and programs.

2. Methodology

This study collected and analyzed health-related fitness data from upper primary school boys and girls, focusing on five key physiological parameters: Muscular Strength, Bending Knee Sit-ups, 600m Run (Cardiovascular Endurance), Flexibility (Sit & Reach), and Body Mass Index (BMI)[15–17]. To assess inter-grade and gender-specific fitness levels, the Sigma Scale method was applied for normalized comparative analysis. The evaluation framework incorporated these five fitness parameters in parallel, along with an Overall Fitness Score, which aggregates all categories into a single composite metric for comprehensive fitness profiling[14–19]. Fitness assessments were carried out using standardized field tests, with data collected from students across multiple grade levels. However, variability and contradictions in the results across different categories introduced significant challenges in deriving a single, deterministic interpretation[16]. To overcome this, a Fuzzy Logic-based analytical model was implemented to support robust interpretation under uncertainty. The triangular type of membership function (MF) is chosen for its ease of fitting and the ability to achieve results with minimal error. It is important to note that triangular membership functions are favored over Gaussian membership functions due to their simplicity and computational efficiency, particularly in real-time applications. Although Gaussian MFs provide smoothness and conciseness, triangular MFs are more straightforward to comprehend and implement, rendering them a practical option for numerous fuzzy logic systems. Additionally, both types of curves share common advantages, such as being smooth and nonzero at every point[20, 21]. A continuous simulation framework was constructed by integrating results from multiple test trials[9, 10]. The fuzzy logic algorithm was deployed through the following stages:

- ➢ Linguistic variables for each fitness parameter.
- ➢ Triangular membership functions are based on the nature of the input data.
- ➢ Development of a rule-based knowledge system for inference.
- ➢ Fuzzification of crisp input data into fuzzy sets.
- ➢ Evaluation of the rule base using a Mamdani inference system,
- ➢ Execution of the fuzzy inference engine, and Application of defuzzification techniques to derive crisp output values.

The Hull Scale serves as the most appropriate instrument for analyzing and comprehending an individual's performance in physical activities. It facilitates comparative assessments of results based on age groups and is instrumental in predicting whether the parameters fall below average, are average, or exceed average. Conversely, the Sigma Scale employs mathematical methods to illustrate the deviation of results from the average. It utilizes 'standard deviation' to determine if an individual is close to or far from the typical performance expected for their age group. In contrast, Fuzzy Analysis proves beneficial when results are not distinctly clear. For instance, rather than merely categorizing as 'fit' or 'not fit', fuzzy analysis allows for predictions such as 'somewhat fit' or 'very fit'. This approach resembles a more nuanced analysis expressed in 'degrees' rather than a binary 'yes' or 'no'. Consequently, Fuzzy Analysis is particularly effective in providing conclusive feedback on fitness data, especially when students' scores overlap and do not neatly fit into a single category.

The implementation of an 18-rule machine learning system that uses sensitivity analysis or feature selection criteria has been prioritized in this methodology to balance model complexity with performance. Sensitivity analysis is instrumental in identifying the most critical features, and the choice of a rule-based system comprising 18 rules can yield a model that is both accurate and relatively easy to understand and interpret across all parameters. Using the Surface Viewer in MATLAB, the behavior of the system and its interactions were scrutinized before final validation, ensuring that the outputs were both logical and interpretable. **Table 1** summarizes the final computed results, as well as a comparison of the outputs from Hull and Sigma Scale.

Similarly, the data presented in **Table 2**, which outlines the Sigma Scale (Norms) for Class VI Girls, was generated from tests conducted on various groups of boys and girls. It displays the results of converting each data point by one unit using independent variables derived from the dataset. In regression analyses, these data values are typically used as basic independent variables before they are converted to decimal format for further processing.

Membership functions provide a representation of decimal-form data for further analysis, as outlined in **Table 3**. The data is categorised into three groups: low, medium, and high, as shown in **Table 3**. For fuzzy set theory-based analysis, these classifications are essential as linguistic variables. The linguistic variables are organized in a tabular format, as depicted below:

Table 1. Sigma Scale (Norms) for Class VI Boys.

Strength (Standing Broad Jump meter)	Bent Knee Sit-Ups (Abdominal Strength, (Numeric))	600 m Run (Cardiovascular Endurance (minutes))	Flexibility (Sits Reach (Centimeters))	Body Mass Index
H	H	M	H	L
H	H	M	H	L
H	H	M	H	L
H	H	M	H	L
H	H	M	H	L
H	H	M	M	L
H	H	M	M	L
H	H	M	M	M
H	H	M	M	M
H	M	M	M	M
M	M	M	M	M
M	M	H	M	M
M	M	H	M	M
M	M	H	L	H
M	M	H	L	H
M	M	H	L	H
M	L	H	L	H
M	L	H	L	H
L	L	H	L	H
L	L	H	L	H
L	L	H	L	H
H→ High, M→ Medium, L→ Low				

Table 2. Sigma Scale (Norms) for Class VI Girls.

Strength (Standing Broad Jump) (Centimetre)	Bent-Knee Sit-Ups (Abdominal Strength) (Number)	600m Run (Cardiorespiratory Endurance) (Minute)	Flexibility Sit & Reach (Centimetre)	Body Mass Index
H	H	L	H	L
H	H	L	H	L
H	H	L	H	L
H	H	L	H	L
H	H	L	H	L
H	H	L	H	M
H	H	M	H	M
M	H	M	M	M
M	H	M	M	M
M	M	M	M	M
M	M	M	M	M
M	M	H	M	H
M	M	H	M	H
M	M	H	M	H
L	M	H	M	H
L	L	H	M	H
L	L	H	L	H
L	L	H	L	H
L	L	H	L	H
L	L	H	L	H
L	L	H	L	H

Table 3. Membership Function.

Type of Inputs	Low	Medium	High
Input-1 Strength	0.00–0.37	0.25–0.67	0.50–0.97
Input-2 Bent-knee	0.00–0.32	0.24–0.62	0.47–0.92
Input-3 Cardia-rasp.	0.00–0.32	0.24–0.72	0.51–0.95
Input-4 Flexibility	0.00–0.43	0.31–0.55	0.45–0.97
Input-5 Body Mass	0.00–0.41	0.31–0.61	0.41–0.71

3. Analysis Using Fuzzy Logic

In this evaluation, five key input parameters were identified: body mass, flexibility, strength, 600-meter run, and bending knee sit-ups. The primary operational framework for this study is fuzzy logic, with Mamdani's inference engine employed to process the data, producing a single output. Data is categorized into low, medium, or high based on their values within their respective categories, as illustrated in **Table 3**. These five inputs, represented in a fuzzy pattern, are analyzed using the Mamdani fuzzy inference system, which is particularly suitable for expert system applications. Mamdani systems are effective for fitness assessment as they rely on an intuitive, rule-based structure that mimics human expert knowledge, making them ideal for evaluating students' fitness levels. In this context, the use of "because" is necessary to establish logical reasoning and justifications within the fuzzy inference framework.

Figure 1 illustrates the Membership functions of the Sigma Scale with Rule base Editor Input and Output, and **Figure 2** illustrates Membership functions of the Hull Scale with Rule base Editor Input and Output. The Fuzzy Analyzer presents a comparative analysis of the Sigma Scale and Hull Scale standards, both evaluated using the Mamdani-type Fuzzy Inference System (FIS). This approach was chosen due to the inherent uncertainty, subjectivity, and imprecision present in physical fitness data. By leveraging fuzzy logic, the system is capable of effectively modeling ambiguous relationships, enabling more accurate and reliable fitness evaluations.

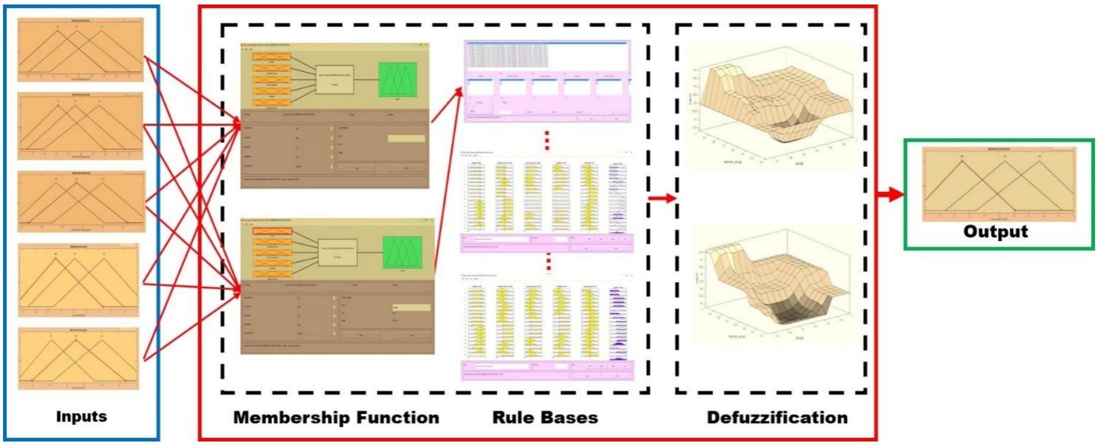


Figure 1. Membership functions of Sigma Scale with Rule Base Editor Input and Output.

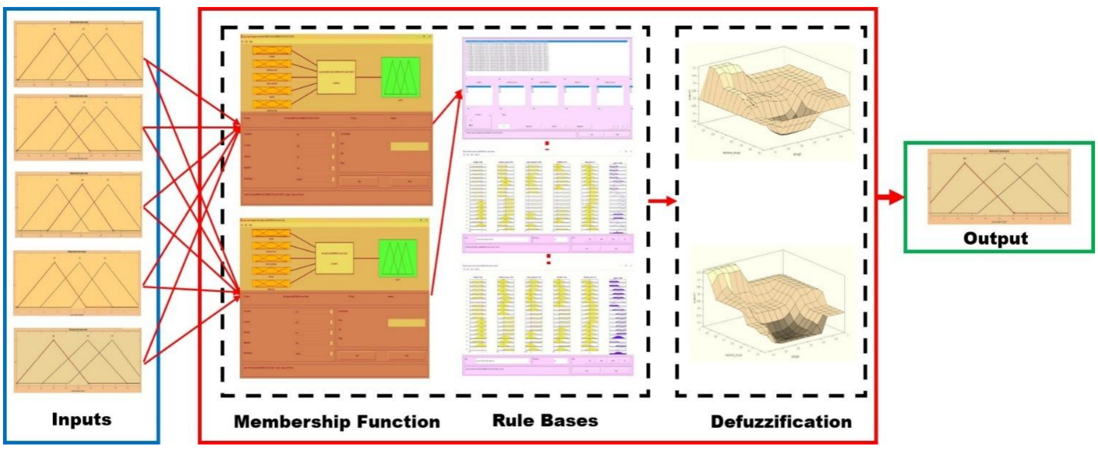


Figure 2. Membership Functions of Hull Scale with Rule Base Editor Input and Output.

Analyzing physical performance across both scales is critical for informed decision-making, particularly when dealing with datasets that lack clear-cut boundaries. Fuzzy logic facilitates the interpretation of such data by incorporating approximate reasoning and managing imprecise inputs. It also supports the integration of prior expert knowledge with data-driven insights, allowing for the encoding of rule-based logic that mimics human decision-making. Furthermore, fuzzy systems can be enhanced through learning mechanisms that generate and optimize rule bases from training data. In this study, triangular membership functions were employed due to their computational simplicity and their ability to closely approximate other common distribution shapes while maintaining efficiency.

These functions proved effective in representing the varying degrees of physical fitness among students across five primary parameters: Body Mass, Flexibility (Sit & Reach), Muscular Strength, 600-meter Cardiovascular Endurance Run, and Bending Knee Sit-ups. Mamdani's inference method, widely used in control systems and intelligent decision-making applications, was selected for its intuitive rule-based structure and robust handling of linguistic variables [14–17, 20, 21]. The combination of Mamdani FIS with triangular membership functions enabled high-precision modeling of fitness assessment scenarios, thereby enhancing the accuracy and interpretability of both the Hull and Sigma Scale outputs [21].

The fuzzy rules were developed using five input variables: Strength, Bending Knee Sit-ups, 600m Run, Flexibility, and Body Mass, each assigned specific membership functions. The inputs were classified based on their membership functions and values, as determined in **Table 3**. Fuzzy rule-based models are particularly effective for human-centric tasks, as they offer a high level of readability and interpretability, making them well-suited for expert audiences [20–23]. This stage is critical for predicting outcomes for all five fitness function variables using both the Sigma Scale and Hull Scale results. Given their self-descriptive nature, sparse fuzzy rule bases were selected for this task [22–25]. To assess the health-related fitness levels of boys and girls in upper primary school, 18 fuzzy rules were formulated, considering different conditions of all five fitness parameters. These rules are outlined in **Table 4** for the Sigma Scale and **Table 5** for the Hull Scale.

Table 4. Rules Base of Sigma Scale for Class VI Boys and Girls.

S. No	Strength	Bent Knee Situps	Cardio Vascular	Flexibility	Body Mass	Boys and Girls Outputs
1	L	L	L	L	L	L
2	L	L	L	L	M	L
3	L	L	L	M	M	L
4	L	L	M	M	M	L
5	L	M	M	M	M	M
6	M	M	M	M	M	M
7	L	L	L	L	H	L
8	L	L	L	H	H	L
9	L	L	H	H	H	M
10	L	H	H	H	H	H
11	H	H	H	H	H	H
12	H	H	H	H	M	H
13	H	H	H	M	M	H
14	H	H	M	M	M	M
15	H	M	M	M	M	M
16	L	M	H	L	M	L
17	H	L	M	H	L	M
18	M	H	L	M	H	H

Table 5. Rules Base of Hull Scale for Class VI Boys and Girls.

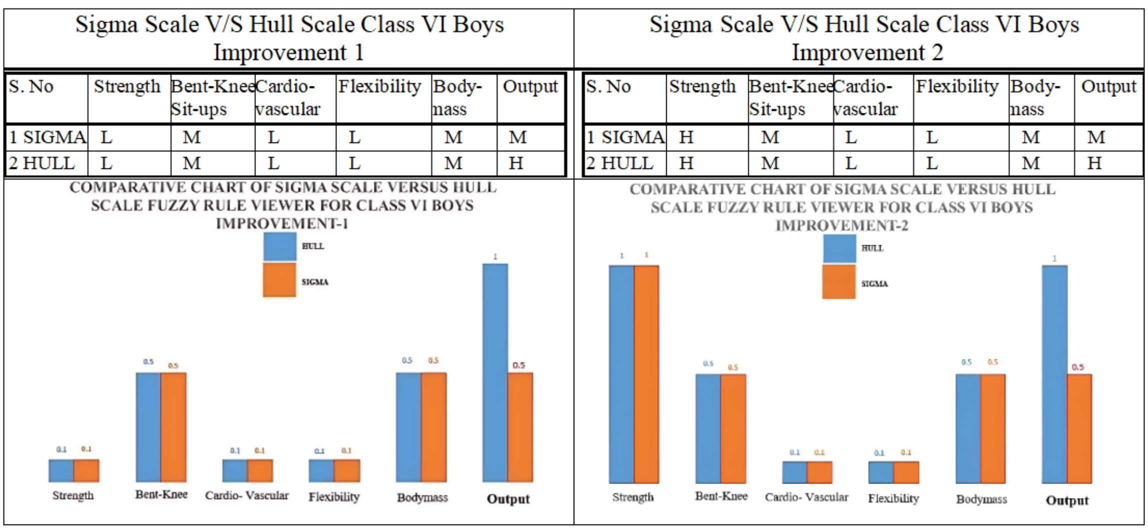
S. No	Strength	Bent Knee Situps	Cardio Vascular	Flexibility	Body Mass	Boys and Girls Outputs
1	L	L	L	L	L	L
2	L	L	L	L	M	L
3	L	L	L	M	M	M
4	L	L	M	M	M	M
5	L	M	M	M	M	M
6	M	M	M	M	M	M

Table 5. *Cont.*

S. No	Strength	Bent Knee Situps	Cardio Vascular	Flexibility	Body Mass	Boys and Girls Outputs
7	L	L	L	L	H	L
8	L	L	L	H	H	M
9	L	L	H	H	H	H
10	L	H	H	H	H	H
11	H	H	H	H	H	H
12	H	H	H	H	M	H
13	H	H	H	M	M	H
14	H	H	M	M	M	H
15	H	M	M	M	M	M
16	L	M	H	L	M	L
17	H	L	M	H	L	H
18	M	H	L	M	H	H

Figure 1 also presents the 3D surface generated based on fuzzy set theory, summarizing the rule system used in the study. This 3D representation illustrates the stability of the fuzzy controller and validates the outcomes, even under unusual conditions. As shown in **Figures 1** and **2**, when input values are low, the corresponding output remains low on the 3D surface. As input values gradually increase, the output follows a steady upward trend. However, a sharp increase is observed when input values reach extremely high levels. The system dynamically adjusts input and output values by applying minimization and maximization techniques to maintain equilibrium[25]. In summary, the system demonstrates stability and balance, confirming the effectiveness of the fuzzy logic approach. The regulations governing the model are derived from the combined influence of all variables, ensuring a comprehensive and adaptive assessment of fitness levels.

Before finalizing the results, it is essential to evaluate the de-fuzzified output to ensure accuracy. De-fuzzification has been completed to determine the precise representative value (crisp value) in the final output. This technique allows for the analysis of various combinations of independent variables. The de-fuzzified output results are illustrated in **Figures 3** and **4**. The findings indicate that the centre of gravity of the system remains stable and is positioned close to the system's centroid, as shown in **Figures 1** and **2**. This positioning allows for an accurate prediction of the bandit's accuracy, and any adjustments to the input variables may influence the degree of health fitness, ensuring it stays within a normal range. Similarly, the rule bases also shown in **Figures 1** and **2** for the fuzzy set were developed, leading to the creation of a total of 18 fuzzy rules to enhance the assessment of fitness levels.



S. No	Strength	Bent-Knee Sit-ups	Cardio-vascular	Flexibility	Body-mass	Output
1 SIGMA	L	M	L	L	M	M
2 HULL	L	M	L	L	M	H

S. No	Strength	Bent-Knee Sit-ups	Cardio-vascular	Flexibility	Body-mass	Output
1 SIGMA	H	M	L	L	M	M
2 HULL	H	M	L	L	M	H

Figure 3. Rule Base of Fuzzy Set.

Sigma Scale V/S Hull Scale Class VI Girls Improvement 1						
S. No	Strength	Bent-Knee Sit-ups	Cardio-vascular	Flexibility	Body-mass	Output
1 SIGMA	H	M	L	L	M	L
2 HULL	H	M	L	L	M	H

Sigma Scale V/S Hull Scale Class VI Girls Improvement 2						
S. No	Strength	Bent-Knee Sit-ups	Cardio-vascular	Flexibility	Body-mass	Output
1 SIGMA	H	L	L	L	M	L
2 HULL	H	L	L	L	M	M

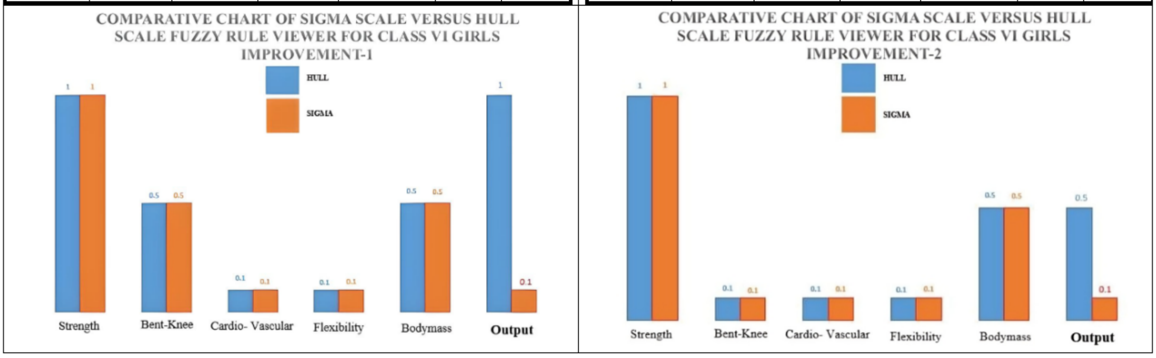


Figure 4. Base of Fuzzy Set Figure.

The enhancement of this study is evident in its comprehensive compilation of information, which highlights the robustness, reliability, and adaptability of the proposed model. The scale ratio of the model to real-world conditions decreases as the denominator in the scale fraction increases, thereby influencing the accuracy of the scale. The health fitness level is evaluated using five key parameters: Strength, Bending Knee Sit-ups, 600m Run (Cardiovascular Endurance), Flexibility (Sit & Reach), and Body Mass. Among the available methods, the Hull Scale combined with fuzzy logic proves to be the most effective operational framework for assessing the fitness levels of upper primary school boys and girls[22–24]. This study employs an expanded set of fitness parameters to systematically classify the health fitness levels of students by considering specific influencing variables. The approach is supported by a numerical scale that maintains a true zero point and evenly spaced intervals between adjacent values, ensuring precise and consistent measurement of fitness levels.

Figure 5 presents a comparative analysis of the Fuzzy Output Sets applied to the Hull Scale and Sigma Scale. The illustration highlights a significant improvement, demonstrating the adaptability of this research and broadening the scope of data analysis. The findings indicate that the Hull Scale is a more precise and accurate method, utilizing five input parameters and one output. This model is capable of detecting even minor progress in the fitness levels of active boys and girls, offering a detailed and refined assessment. These results not only capture gradual changes in fitness levels but also suggest that coaching programs can be expanded to include younger students, enhancing their physical development. Additionally, the improved selection process contributes to overall fitness enhancement by 18% and helps in reducing the risk of injuries among young athletes.

The Sigma Scale represents the most mathematically precise method, particularly when detailed data analysis is necessary to ascertain how 'far' the parameters deviate from the average. In such cases, Fuzzy Analysis offers more adaptable results that exist between categories, especially when fitness cannot be strictly defined in binary terms. Meanwhile, the Hull Scale presents a more organized, score-based overview, which is advantageous for comparisons across larger populations. This is why Fuzzy Analysis has been applied to datasets that are imperfect or exhibit a mixture of results. It illustrates how closely sports participants' parameters align with various fitness levels, even if they do not conform precisely to a single level. Children develop at varying rates, and their fitness can fluctuate rapidly; Fuzzy Analysis accommodates this variability. The Sigma Scale typically requires normally distributed data, which is not always applicable to children. Employing Fuzzy Analysis in conjunction with Hull Scale results yields a more comprehensive picture, providing clear rankings and a nuanced evaluation.

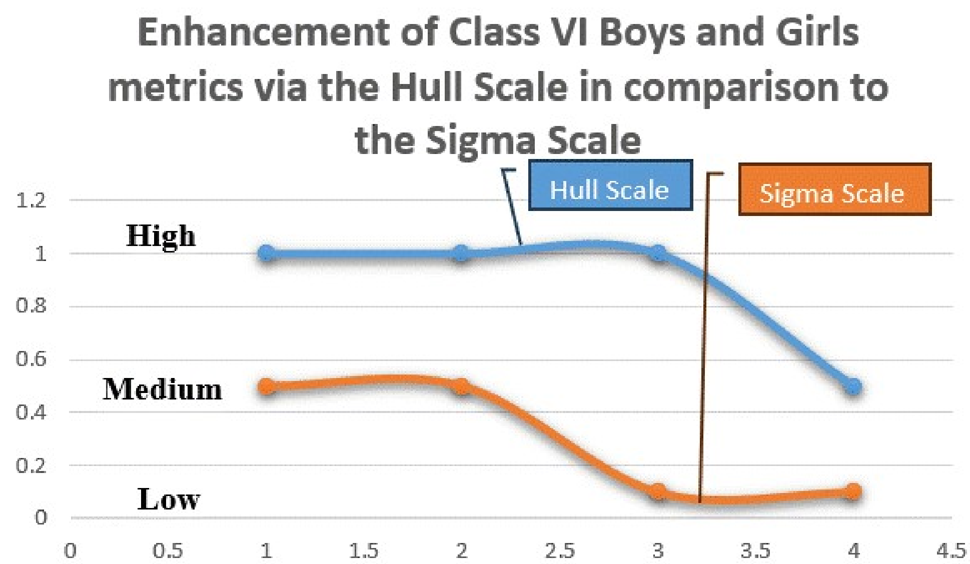


Figure 5. Resultant of Fuzzy Output Sets.

4. Key Findings

Here are some key findings of this paper:

- Hull Scale produced more stable, consistent, and accurate fitness evaluations than the Sigma Scale.
- Fuzzy logic enabled better decision-making under uncertainty, accommodating variability in human physical data.
- MATLAB modelling effectively processed and visualized data across fitness groups.
- Fitness tracking provides actionable insights for personalized student health strategies.
- De fuzzified outputs were consistent with physical realities, demonstrating model stability.
- Identified optimal input conditions to enhance exercise efficacy in students.

5. Results and Discussions

The results of this study show that the Hull Scale provides a more accurate and consistent assessment of health-related fitness levels in upper primary school pupils compared to the Sigma Scale. The values computed using MATLAB showed a clear and stable pattern, with the Hull Scale producing less variation and better accuracy when comparing fitness levels between boys and girls. The use of a fuzzy inference system made it easier to handle uncertain or conflicting data and helped improve the accuracy of the fitness classification. The system worked well in processing vague information and turned it into meaningful results using a rule-based approach. Five main fitness parameters—body mass, flexibility (sit & reach), strength, 600-meter run (endurance), and bending knee sit-ups—were used as inputs and modeled with triangular membership functions for simplicity and efficiency. Tracking fitness levels across different groups provided more focused insights, making the assessment more useful. However, the study did encounter conflicting results in some fitness categories, which shows the challenge of relying on a single method for evaluating physical fitness. To improve future assessments, the study suggests adding more fitness-related variables and refining the fuzzy logic model for better accuracy and reliability.

Discussion Highlights

- Fuzzy logic excels in handling conflicting and ambiguous fitness data, a common challenge in real-world assessments.
- While effective, the system still revealed limitations, such as category overlaps and dependency on scale configuration.
- Suggests future enhancement via additional parameters and refined fuzzy rule bases to further improve accuracy and adaptability.

6. Conclusions

This research demonstrates that monitoring fitness levels among boys and girls from various groups enhances our comprehension of their physical development. In the comparison of the two methods, it was determined that the Hull Scale is more precise and dependable than the Sigma Scale for assessing the health fitness of upper primary school students. Furthermore, the study provides valuable recommendations on utilizing five essential fitness components—strength, bending knee sit-ups, 600-meter run, flexibility, and body mass—to elevate students' overall fitness levels through physical activity.

6.1. Strengths

- Innovative integration of fuzzy logic with educational fitness assessments.
- Use of actual datasets from schoolchildren adds empirical weight.
- Demonstrates strong comparative analysis between two modeling scales.
- Structured in line with academic standards (abstract, intro, method, results, discussion).
- Inclusion of MATLAB-specific modeling enhances reproducibility.

6.2. Accomplishments

This study assessed health-related physical fitness in upper primary school boys and girls using five physiological parameters—Muscular Strength, Bending Knee Sit-ups, 600m Run (Cardiovascular Endurance), Flexibility (Sit & Reach), and Body Mass Index (BMI). It compared fitness levels using two scaling methods (Sigma Scale and Hull Scale) and applied a Fuzzy Logic-based model for analysis under uncertain and imprecise conditions.

6.3. Worthwhile Investigations

- Standardized Field Tests: Conducted to gather fitness data.
- Sigma Scale: Used for normalized comparison across gender and grades.
- Fuzzy Logic System (FLS): Built in MATLAB (vR2021, Fuzzy Toolbox v2.8.1) using:
  - Triangular membership functions.
  - Mamdani Inference System.
  - Rule base of 18 fuzzy rules for both Sigma and Hull scales.
- De-fuzzification: Applied to convert fuzzy outputs to precise values.
- Comparative Analysis: Conducted using visual tools like the Surface Viewer and 3D surface plots to evaluate system behavior and accuracy.

6.4. Future Work

If the prototype FIS is developed utilizing programmable hardware like FPGA, among other options, within an ERP system, it can serve as a valuable tool for a mobile health platform designed for analysing the health and fitness of sports students across various schools.

Author Contributions

Conceptualization, R.R. and M.V.; methodology, R.R.; software, A.V.; validation, R.R., M.V., and A.V.; formal analysis, R.R., M.V., and A.V.; investigation, R.R.; resources, R.R.; data curation, R.R.; writing—original draft preparation, R.R., M.V., and A.V.; writing—review and editing, A.V.; visualization, A.V.; supervision, M.V. and A.V.; project administration, R.R; All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the approved research synopsis of Rita Rani, Ph.D. Scholar, and was duly approved by the Board of Studies, Department of Physical Education, Ch. Devi Lal University, Sirsa, Haryana, India. The research is titled "Comparison of Health-Related Fitness of Rural & Urban Primary School Students and Development of Norms for Grading their Performance" (Registration No. 2018035500179211).

Informed Consent Statement

Informed consent is implicit, as the study was carried out following the approval of the research synopsis of Rita Rani, Ph.D. Scholar, by the Board of Studies, Department of Physical Education, Ch. Devi Lal University, Sirsa, Haryana, India. The approved research is titled *"Comparison of Health-Related Fitness of Rural & Urban Primary School Students and Development of Norms for Grading their Performance"* (Registration No. 2018035500179211).

Data Availability Statement

The data supporting the findings of this study have been presented in Tables 1 to 5 within the manuscript.

Conflicts of Interest

The authors declare no conflict of interest.

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