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An Analysis of Obesity in School Children during the Pandemic COVID-19 Using Plithogenic Single Valued Fuzzy Sets

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Abstract: The objective of this research is to examine the perception that school children with obesity, when excluded from organized academic performance and constrained to their residences during the coronavirus epidemic 2019 will reveal negative consequences in health behaviors. To meet the objective, the concept of Plithogenic Single valued fuzzy sets (PSFS) and their aggregation operators were introduced. Based on the proposed theory, an analysis is presented with the case study to highlight its practicality and preciseness.

Keywords: Fuzzy Set; Plithogenic Set; Plithogenic Single Valued Fuzzy Set; PSFS Operators.

1. Introduction

Global health analysts predict that school closures have worsened the epidemic of childhood obesity rates due to the COVID-19 pandemic. Analysts believe that school shutdowns associated with COVID-19 will double out-of-school time for several children worldwide the previous year and could increase hazard factors involved with a summer break for gaining weight [1-3].

Plithogeny which was introduced in 2017 by Florentine Smarandache [4, 5, 6] is the origination, existence, development, growth, and emergence of various entities from technologies and organic combinations of old objects that are conflicting and/or neutral and/or non-contradictory. A plithogenic set P is a set whose members are characterized by one or more attributes and there may be several values for each attribute. Moreover, it is the generalization of Crisp, Fuzzy, Intuitionistic fuzzy, and Neutrosophic sets.

In this research work, we study how the Plithogenic Single valued fuzzy sets (PSFS) [7-10] and their aggregation operators help in analyzing the main factors for an increase in obesity among school children during the pandemic COVID-19 lockdown with the analyst's fuzzy degree.

The uniqueness of this technique is its effectiveness, as the learner does not have to engage with complex operators based on lengthy calculations. The proposed method also has a realistic approach to the need for a broad spectrum that can penetrate alterations according to the need for the social structure provided.

2. Plithogenic Single valued fuzzy sets and its Operators

Definition 3.1: Let U be a universal set and P is the subset and $x \in P$ be an element. P is called a Plithogenic set which has the form $(P, A, \Lambda, D_F, C_F)$ where A is the attribute Values, Λ is the set of all attributes values that helps in solving an application, D_F is the degree of appurtenance and C_F is the dissimilarity degree.

Let us assume two Analyst A & B each evaluating the PSFS degree of appurtenance of Λ of x to the Plithogenic set P with some given constraints

$D^F{}_A(\lambda) = \alpha \in [0,1]$ and $D^F{}_B(\lambda) = \beta \in [0,1]$.

Also $\wedge_f$ *be the fuzzy* τ_{norm} *and* $\vee_f$ *be the fuzzy* τ_{conorm} *correspondingly*

3.1.1 PSFS Intersection

$$\alpha \wedge_p \beta = C_O * (\alpha \vee_f \beta) + (1 - C_O) * (\alpha \wedge_f \beta) \qquad (1)$$

3.1.2 PSFS Union

$$\alpha \vee_p \beta = C_O * (\alpha \wedge_f \beta) + (1 - C_O) * (\alpha \vee_f \beta) \qquad (2)$$

3.1.3 PSFS Negation

Denying the attribute Value

$\neg_p(\lambda) = anti(\lambda)$, i.e. the opposite of λ, where $anti(\lambda) \in \Lambda$ **or** $anti(\lambda) \in \text{Re}\ fined\ \Lambda(refined\ set\ of\ \Lambda)$.

So we get $D^f{}_X(anti(\lambda)) = x$.

Results:

(i) When more emphasis is allocated to $\tau_{norm}(\alpha,\beta) = \alpha \wedge_f \beta$ when compared to $\tau_{conorm}(\alpha,\beta) = \alpha \vee_f \beta$ for $C(\lambda_d, \lambda) = C_O \in [0, 0.5)$ is called an accurate plithogenic intersection.

(ii) When more emphasis is allocated to $\tau_{conorm}(\alpha,\beta) = \alpha \vee_f \beta$ when compared to $\tau_{norm}(\alpha,\beta) = \alpha \wedge_f \beta$ for $C(\lambda_d, \lambda) = C_O \in [0, 0.5)$ is called an accurate plithogenic union.

(iii) When more emphasis is allocated to $\tau_{norm}(\alpha,\beta) = \alpha \wedge_f \beta$ when compared to $\tau_{conorm}(\alpha,\beta) = \alpha \vee_f \beta$ for $C(\lambda_d, \lambda) = C_O \in (0.5, 1]$ is called an inaccurate plithogenic union.

(iv) When more emphasis is allocated to $\tau_{conorm}(\alpha,\beta) = \alpha \vee_f \beta$ when compared to $\tau_{norm}(\alpha,\beta) = \alpha \wedge_f \beta$ for $C(\lambda_d, \lambda) = C_O \in (0.5, 1]$ is called an inaccurate plithogenic intersection.

(v) $\tau_{conorm}(\alpha,\beta) = \alpha \wedge_f \beta$ and $\tau_{norm}(\alpha,\beta) = \alpha \vee_f \beta$ has allocated the same emphasis 0.5 for $C(\lambda_d, \lambda) = C_O \in 0.5$

3. Proposed Method to Find the Optimum Solution Using PSFS Operators.

Step 1: Classify the problem with the attributes and its corresponding values of attribute.
Step 2: Find the dissimilarity degree according to the Experts X and Y fuzzy degrees.
Step 3: Compute the optimum solution using Eq. (1).
Note: We have used the intersection operator. But the alternative is free for the reader to work with other operators also.

4. Application

Consider the primary attribute "Reason for obesity in school children during lockdown" which has the attribute values.

Food Habits- whose refined values are- less vegetable intake, sugary drinks, junk food and meat consumption which is represented by $\{g_1, g_2, g_3, g_4\}$.

Screen time - whose refined values are-mobile, television and computer which is symbolized by $\{t_1, t_2, t_3\}$.

Sleeping pattern - whose refined values are- increase in day time sleep and decrease in night time sleep which is denoted by $\{h_1, h_2\}$.

Sports- whose refined values are- More Indoor games and lack of outdoor games which is signified by $\{r_1, r_2\}$.

The multi attribute of dimension 4 is,

$R_4 = \{(g_i, t_j, h_k, r_l), \text{ for all } 1 \le i \le 4, 1 \le j \le 3, 1 \le k \le 2, 1 \le l \le 2\}$

The dominant attribute values are g_3, t_1, h_1, r_2 respectively for each corresponding uni-dimensional attribute.

The unit dimensional attribute contradiction degrees are:

$$C(g_1, g_2) = \frac{1}{3}, C(g_2, g_3) = \frac{2}{3}, C(g_1, g_3) = 1,$$

$$C(t_1, t_2) = \frac{1}{2}, C(t_1, t_3) = 1$$

$$C(h_1, h_2) = 1 \text{ and } C(l_1, l_2) = 1 \text{ .}$$

Let us use $fuzzy\,\tau_{norm} = a \wedge_F b = ab$ & $fuzzy\ \tau_{conorm} = a \vee_F b = a + b - ab$

- ***Four-dimensional PSFS Intersection***

Let $x_A = \{d_A(x, g_i, t_j, h_k, r_l) \text{ for all } 1 \le i \le 4, 1 \le j \le 3, 1 \le k \le 2, 1 \le l \le 2\}$

and $x_B = \{d_B(x, g_i, t_j, h_k, r_l) \text{ for all } 1 \le i \le 4, 1 \le j \le 3, 1 \le k \le 2, 1 \le l \le 2\}$

Then

$$\begin{aligned}
& x_A(g_i, t_j, h_k, r_l) \wedge_p x_B(g_i, t_j, h_k, r_l) = \\
& \{c(g_D, g_i) * [d_A(x, g_D) \vee_f d_B(x, g_i) + (1 - c(g_D, g_i)) * [d_A(x, g_D) \wedge_f d_B(x, g_i)] 1 \le i \le 4; \\
& c(t_D, t_j) * [d_A(x, t_D) \vee_f d_B(x, t_j) + (1 - c(t_D, t_j)) * [d_A(x, t_D) \wedge_f d_B(x, t_j)] 1 \le j \le 3; \\
& c(h_D, h_k) * [d_A(x, h_D) \vee_f d_B(x, h_k) + (1 - c(h_D, h_k)) * [d_A(x, h_D) \wedge_f d_B(x, h_k)] 1 \le k \le 2; \\
& c(r_D, r_l) * [d_A(x, r_D) \vee_f d_B(x, r_l) + (1 - c(r_D, r_l)) * [d_A(x, r_D) \wedge_f d_B(x, r_l)] 1 \le l \le 2\}.
\end{aligned}$$

According to Analyst (A & B) fuzzy degrees the following Table 1 and Figure 1 represents the optimum solution.

Table 1. Analysis Table for obesity in school children during pandemic Covid-19 lockdown using PSFS.

Attribute	**Food Habits**				**Screen time**			**Sleeping Pattern**		**Sports**	
values of Attribute	Lack of Vegetable intake	Sugary drinks	Junk food	Meat consumption	Mobile	Television	Computer	More Day time sleep	Less Night time sleep	More of Indoor games	Lack of Outdoor games
Dissimilarity degree	0	1/3	2/3	1	0	1/2	1	0	1	0	1
Analyst A Fuzzy degree	0.4	0.4	0.8	0.6	0.8	0.6	0.5	0.7	0.8	0.3	0.8
Analyst B Fuzzy degree	0.5	0.7	0.9	0.7	0.6	0.5	0.7	0.6	0.7	0.4	0.9
$x_A \wedge_p x_B$	0.7	0.7	0.8	0.4	0.9	0.6	0.4	0.9	0.6	0.6	0.7

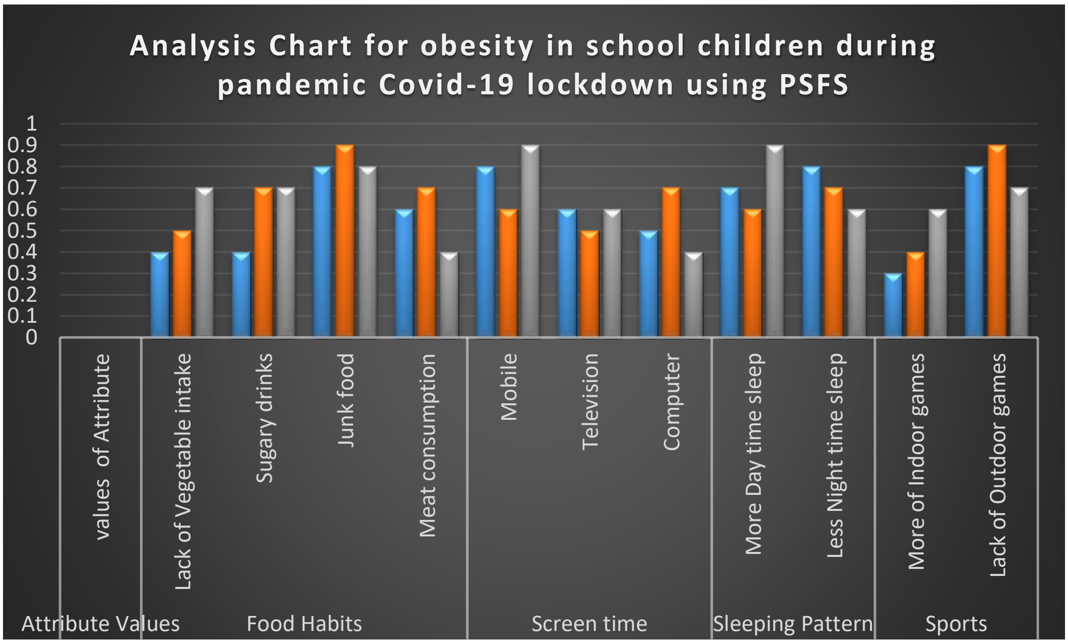

Figure 1. Analysis chart for obesity in school children during the pandemic Covid-19 lockdown using PSFS.

5. Conclusion

Based on the fuzzy degrees of Analyst's (A & B) it is clearly shown that the major reasons for the obesity in children during Covid-19 lockdown is the consumption of more junk food and the time spending on using mobile phones, more day time sleep along with the lack of outdoor sports which reduces all their physical activities and in turn results in the obesity. In future, we can extend this PSFS concept to interval valued and also learn its applications in decision making.

Data availability

The datasets generated during and/or analyzed during the current study are not publicly available due to the privacy-preserving nature of the data but are available from the corresponding author upon reasonable request.

Conflict of interest

The authors declare that there is no conflict of interest in the research.

Ethical approval

This article does not contain any studies with human participants or animals performed by any of the authors.

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