ISSN : 0974 - 7435 Volume 10 Issue 24

BioTechnology

An Indian Journal

FULL PAPER

BTAIJ, 10(24), 2014 [15401-15406]

Research on the evaluation of the physical quality of adolescents with intuitionistic fuzzy information

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ABSTRACT

Several years' monitoring showed a consistent drop of adolescents' physical activity in China, which brings widespread social concern. If we don't do anything about it, there will not enough talents and arms in the future, which inevitably affect Chinese's boom and strong. Especially recent ten years, after some policy for intervention, but it didn't work very obviously. Therefore, studying the factors and putting forward the corresponding countermeasures have important theoretical and practical significance.. In this paper, we utilize the intuitionistic fuzzy Einstein weighted average (IFEWA) operator for evaluating the physical quality of adolescents to aggregate the intuitionistic fuzzy information corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s) according to the score function and accuracy function of the overall value of the alternatives. Finally, an illustrative example is given.

KEYWORDS

Evaluation;
Intuitionistic fuzzy numbers;
Intuitionistic fuzzy einstein weighted average (IFEWA) operator;
Physical quality.

INTRODUCTION

Several years' monitoring showed a consistent drop of adolescents' physical activity in China, which brings widespread social concern. If we don't do anything about it, there will no enough talents and arms in the future, which inevitably affect Chinese's boom and strong. Especially recent ten years, after some policy for intervention, but it didn't work very obviously. Therefore, studying the factors and putting forward the corresponding countermeasures have important theoretical and practical significance. From the angle of gene and nutrition: gene is the precondition of development of body, which let its formation and development possible; either poor nutrition or too much nutrition makes physical quality decreased, so, the prevalence of overweight and obesity of Chinese adolescents is a cause of physical quality decline of adolescents. From the impact of environmental factors: primary and high school sports area reduced gradually; the teacher shortage of primary and middle school is rather serious, and the university teachers decreased ceaselessly; exam-oriented education had enormouse influence on school sports and adolescent physical quality. Interviews displayed that the most fundamental factor of the decline is the occupied their time and resources in sports. Ado-

lescent behavior and lifestyle factors associated with physical activity reduced which is the direct cause of decline in physical quality. Through the survey we found adolescent physical activity changes: PE intensity was reduced; the extracurricular sports activity for undergraduate was reduced; the proportion of undergraduate and middle school students who used positive way to and from school was reduced; labor time was reduced; high school students' extracurricular physical exercise was reduced; students' spring, summer camp and other outdoor activities were reduced. In accordance with the use and disuse theory: as the amount of physical activity reduce, the utilization rate of the skeletal muscle and other organs about the activity will reduce, leading to organ function degradation, then the decline of physical quality. To raise adolescents' physical quality, we need coordination of every main body. Government: strengthen the enforcement of related policies, regulations and laws; increase the investment of school sports; give full play to the government in education outside of school in the development of the leading responsibility; continue to promote the sports test system; pay attention to the issues related security. Society: initiative health style; to enhance education for all-around development and strive to create youth sports environment; to increase physical exercise on the mental influnces research and advocacy; to strengthen safety education. School: to strengthen and improve the work of school sports; to expand the duty and function of school plays; to bring school into play a main role in improving students' physical qualities; to control weight of adolescents. Parents: establish correct concept of talent and pay attention to the overall development of students; have an exercise habit which make good examples for children, or attend exercise; should cooperate with school, so that students establish healthy lifestyle, improving the level of physical activity; should actively participate in activities such as "walking school bus' volunteer work. Adolescents: should establish lofty ideals and long-term goal, attach importance to all-round development in particular physical quality enhancement, put aside for the future competitive advantage; establish "sports life" concept; participate in other activities to increase the amount of daily physical activity.

The aim of this paper is to investigate the problems for evaluating the physical quality of adolescents with intuitionistic fuzzy information. We utilize the intuitionistic fuzzy Einstein weighted average (IFEWA) operator to aggregate the intuitionistic fuzzy information corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s) according to the score function and accuracy function of the overall value of the alternatives. The remainder of this paper is set out as follows. In the next section, we introduce some basic concepts related to intuitionistic fuzzy sets. In Section 3 we introduce the problems to evaluate the physical quality of adolescents with intuitionistic fuzzy information. Then, we utilize the intuitionistic fuzzy Einstein weighted average (IFEWA) operator to aggregate the intuitionistic fuzzy information corresponding to each alternative for evaluating the physical quality of adolescents and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s) according to the score function and accuracy function of the overall value of the alternatives. In Section 4, an illustrative example is pointed out. In Section 5 we conclude the paper and give some remarks.

PRELIMINARIES

Based on the intuitionistic fuzzy sets[7-10], Xu &Yager[11] and Xu[12] gave some intuitionistic fuzzy aggregation operators as listed below:

For a collection of IFVs $\tilde{a}_j = \left(\mu_j, \nu_j\right)\left(j = 1, 2, \cdots, n\right)$, then

(1) The intuitionistic fuzzy weighted averaging (IFWA) operator[12]:

$$\mathrm{IFWA}_{\omega}\left(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n\right) = \overset{n}{\underset{j=1}{\oplus}}\left(\omega_j \tilde{a}_j\right) = \left(1 - \prod_{j=1}^{n}\left(1-\mu_j\right)^{\omega_j}, \prod_{j=1}^{n}\nu_j^{\omega_j}\right) \quad (1)$$

where $\omega = \left(\omega_1, \omega_2, \cdots, \omega_n\right)^T$ be the weight vector of $\tilde{a}_j\left(j = 1, 2, \cdots, n\right)$, and $\omega_j > 0$, $\sum_{j=1}^{n}\omega_j = 1$.

(2) The intuitionistic fuzzy ordered weighted averaging (IFOWA) operator[12]:

$$\mathrm{IFOWA}_{w}\left(\tilde{a}_1, \tilde{a}_2, \cdots, \tilde{a}_n\right) = \overset{n}{\underset{j=1}{\oplus}}\left(w_j \tilde{a}_{\sigma(j)}\right) = \left(1 - \prod_{j=1}^{n}\left(1-\mu_{\sigma(j)}\right)^{w_j}, \prod_{j=1}^{n}\nu_{\sigma(j)}^{w_j}\right) \quad (2)$$

where $\left(\sigma(1), \sigma(2), \cdots, \sigma(n)\right)$ is a permutation of

$(1,2,\cdots,n)$, such that $\tilde{\alpha}_{\sigma(j-1)} \geq \tilde{\alpha}_{\sigma(j)}$ for all $j=2,\cdots,n$ and $w=(w_1,w_2,\cdots,w_n)^T$ is the aggregation-associated vector such that $w_j \in [0,1]$, $\sum_{j=1}^{n} w_j = 1$.

In the following, we shall introduce the Einstein operations on intuitionistic fuzzy sets and analyze some desirable properties of these operations. Motivated by Einstein operations, let the t-norm T and t-conorm S be Einstein product T" and Einstein sum S" respectively, then the generalised intersection and union on two IFSs A and B become the Einstein product (denoted by $\tilde{a}_1 \otimes_\varepsilon \tilde{a}_2$) and Einstein sum (denoted by $\tilde{a}_1 \oplus_\varepsilon \tilde{a}_2$) on two IVIFSs $\tilde{a}_1$ and $\tilde{a}_2$, respectively, as follows[13,14].

$$\tilde{a}_1 \otimes_\varepsilon \tilde{a}_2 = \left(\frac{\mu_1\mu_2}{1+(1-\mu_1)(1-\mu_2)}, \frac{\nu_1+\nu_2}{1+\nu_1\nu_2} \right) \quad (3)$$

$$\tilde{a}_1 \oplus_\varepsilon \tilde{a}_2 = \left(\frac{\mu_1+\mu_2}{1+\mu_1\mu_2}, \frac{\nu_1\nu_2}{1+(1-\nu_1)(1-\nu_2)} \right) \quad (4)$$

$$\lambda\tilde{a}_1 = \left(\frac{(1+\mu_1)^\lambda - (1-\mu_1)^\lambda}{(1+\mu_1)^\lambda + (1-\mu_1)^\lambda}, \frac{2\nu_1^\lambda}{(2-\nu_1)^\lambda + \nu_1^\lambda} \right), \lambda > 0; \quad (5)$$

$$(\tilde{a}_1)^\lambda = \left(\frac{2\mu_1^\lambda}{(2-\mu_1)^\lambda + \mu_1^\lambda}, \frac{(1+\nu_1)^\lambda - (1-\nu_1)^\lambda}{(1+\nu_1)^\lambda + (1-\nu_1)^\lambda} \right), \lambda > 0. \quad (6)$$

Definition 4.[13] Let $\tilde{a}_j = (\mu_j, \nu_j)(j=1,2,\cdots,n)$ be a collection of intuitionistic fuzzy values, and let IFEWA: $Q^n \to Q$, if

$$\begin{aligned} &\text{IFEWA}_\omega(\tilde{a}_1,\tilde{a}_2,\cdots,\tilde{a}_n) \\ &= \oplus_{j=1}^{n}(\omega_j\tilde{a}_j) \\ &= \left(\frac{\prod_{j=1}^{n}(1+\mu_j)^{\omega_j} - \prod_{j=1}^{n}(1-\mu_j)^{\omega_j}}{\prod_{j=1}^{n}(1+\mu_j)^{\omega_j} + \prod_{j=1}^{n}(1-\mu_j)^{\omega_j}}, \frac{2\prod_{j=1}^{n}\nu_j^{\omega_j}}{\prod_{j=1}^{n}(2-\nu_j)^{\omega_j} + \prod_{j=1}^{n}\nu_j^{\omega_j}} \right) \end{aligned} \quad (7)$$

where $\omega=(\omega_1,\omega_2,\cdots,\omega_n)^T$ be the weight vector of $\tilde{a}_j(j=1,2,\cdots,n)$, and $\omega_j > 0$, $\sum_{j=1}^{n}\omega_j = 1$, then IFEWA is called the intuitionistic fuzzy Einstein weighted averaging (IFEWA) operator.

It can be easily proved that the IFEWA operator has the following properties[13].

Theorem 1. (Idempotency) If all $\tilde{a}_j(j=1,2,\cdots,n)$ are equal, i.e. $\tilde{a}_j = \tilde{a}$ for all j, then

$$\text{IFEWA}_\omega(\tilde{a}_1,\tilde{a}_2,\cdots,\tilde{a}_n) = \tilde{a} \quad (8)$$

Theorem 2. (Boundedness) Let $\tilde{a}_j(j=1,2,\cdots,n)$ be a collection of IFVN, and let

$$\tilde{a}^- = \min_j \tilde{a}_j, \quad \tilde{a}^+ = \max_j \tilde{a}_j$$

Then

$$\tilde{a}^- \leq \text{IFEWA}_\omega(\tilde{a}_1,\tilde{a}_2,\cdots,\tilde{a}_n) \leq \tilde{a}^+ \quad (9)$$

Theorem 3. (Monotonicity) Let $\tilde{a}_j(j=1,2,\cdots,n)$ and $\tilde{a}'_j(j=1,2,\cdots,n)$ be two set of IFVNs, if $\tilde{a}_j \leq \tilde{a}'_j$, for all j, then

$$\text{IFEWA}_\omega(\tilde{a}_1,\tilde{a}_2,\cdots,\tilde{a}_n) \leq \text{IFEWA}_\omega(\tilde{a}'_1,\tilde{a}'_2,\cdots,\tilde{a}'_n) \quad (10)$$

RESEARCH ON THE EVALUATION OF THE PHYSICAL QUALITY OF ADOLESCENTS WITH INTUITIONISTIC FUZZY INFORMATION

The following assumptions or notations are used to represent the problems for evaluating the physical quality of adolescents with intuitionistic fuzzy information. Let $T=\{S_1,S_2,\cdots,S_m\}$ be a discrete set of alternatives. Let $G=\{G_1,G_2,\cdots,G_n\}$ be a set of attributes. The information about attribute weights is completely known. Let $\omega=(\omega_1,\omega_2,\cdots,\omega_n)$ be the weight vector of attributes, where $\omega_j \geq 0$, $j=1,2,\cdots,n$. Suppose that $\tilde{R}=(\tilde{r}_{ij})_{n\times m}=(\mu_{ij},\nu_{ij})_{n\times m}$ is the intuitionistic fuzzy decision matrix, where μ_{ij} indicates the degree that the alternative A_i satisfies the attribute G_j given by the decision maker, ν_{ij} indicates the degree that the alternative

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A_i doesn't satisfy the attribute G_j given by the decision maker D_k, $\mu_{ij} \subset [0,1]$, $\nu_{ij} \subset [0,1]$, $\mu_{ij} + \nu_{ij} \le 1$, $i = 1,2,\cdots,m$, $j = 1,2,\cdots,n$, $k = 1,2,\cdots,t$.

In the following, we apply the IFEWA operator to MADM for for evaluating the physical quality of adolescents with intuitionistic fuzzy information.

Step 1. Utilize the decision information given in matrix $\tilde{R}$, and the IFEWA operator

$$\tilde{r}_i = (\mu_i, \nu_i) = \text{IFEWA}_\omega(\tilde{r}_{i1}, \tilde{r}_{i2}, \cdots, \tilde{r}_{in}),\ i = 1,2,\cdots,m. \quad (11)$$

to derive the overall preference values $\tilde{r}_i (i = 1,2,\cdots,m)$ of the alternative S_i, where $\omega = (\omega_1, \omega_2, \cdots, \omega_n)^T$ is the weighting vector of the attributes.

Step 2. Calculate the scores $S(\tilde{r}_i)(i = 1,2,\cdots,m)$ of the overall intuitionistic fuzzy preference values $\tilde{r}_i\ (i = 1,2,\cdots,m)$ to rank all the alternatives $S_i\ (i = 1,2,\cdots,m)$ and then to select the best one (s).

Step 3. Rank all the alternatives $S_i\ (i = 1,2,\cdots,m)$ and select the best one (s) in accordance with $S(\tilde{r}_i)$ and $H(\tilde{r}_i)\ (i = 1,2,\cdots,m)$.

Step 4. End.

NUMERICAL EXAMPLE

This section presents a numerical example to evaluate the physical quality of adolescents with intuitionistic fuzzy information to illustrate the method proposed in this paper. There are five adolescents $A_i\ (i = 1,2,3,4,5)$ for four attributes $G_j\ (j = 1,2,3,4)$. The four attributes include endurance (G_1), movement speed (G_2), sports power (G_3) and flexibility and sensitivity of the movement (G_4), respectively. The physical quality of five adolescents $A_i (i = 1,2,\cdots,5)$ are to be evaluated using the intuitionistic fuzzy information by the decision maker under the above four attributes, as listed in the following matrix.

$$\tilde{A} = \begin{array}{c} \\ A_1 \\ A_2 \\ A_3 \\ A_4 \\ A_5 \end{array} \begin{array}{c} \begin{array}{cccc} G_1 & G_2 & G_3 & G_4 \end{array} \\ \begin{bmatrix} (0.6,0.4) & (0.5,0.3) & (0.8,0.1) & (0.5,0.2) \\ (0.5,0.3) & (0.7,0.3) & (0.5,0.2) & (0.6,0.2) \\ (0.5,0.5) & (0.6,0.3) & (0.8,0.2) & (0.3,0.3) \\ (0.7,0.2) & (0.6,0.4) & (0.5,0.3) & (0.6,0.2) \\ (0.5,0.4) & (0.5,0.3) & (0.4,0.4) & (0.8,0.2) \end{bmatrix} \end{array}$$

Then, we utilize the approach developed to evaluate the physical quality of adolescents in order to learn the physical quality of adolescents.

Step 1. Utilize the IFEWA operator, we obtain the overall preference values $\tilde{r}_i$ of the physical quality of adolescents $A_i\ (i = 1,2,3,4,5)$.

$$\tilde{r}_1 = (0.56,0.37), \tilde{r}_2 = (0.46,0.32), \tilde{r}_3 = (0.59,0.35)$$
$$\tilde{r}_4 = (0.67,0.38), \tilde{r}_5 = (0.48,0.21)$$

Step 2. Calculate the scores $S(\tilde{r}_i)\ (i = 1,2,3,4,5)$ of the overall intuitionistic fuzzy values

$\tilde{r}_i\ (i = 1,2,3,4,5)$

$$S(\tilde{r}_1) = 0.19, S(\tilde{r}_2) = 0.14, S(\tilde{r}_3) = 0.24$$
$$S(\tilde{r}_4) = 0.29, S(\tilde{r}_5) = 0.27$$

Step 3. Rank all the physical quality of adolescents in accordance $A_i\ (i = 1,2,3,4,5)$ with the scores $S(\tilde{r}_i)\ (i = 1,2,3,4,5)$ of the overall intuitionistic fuzzy values $\tilde{r}_i\ (i = 1,2,3,4,5)$: $A_2 \succ A_4 \succ A_5 \succ A_3 \succ A_1$, and thus the most desirable physical quality of adolescents is A_2

CONCLUSION

Several years' monitoring showed a consistent drop of adolescents' physical activity in China, which brings widespread social concern. If we don't do any-

thing about it, there will not enough talents and arms in the future, which inevitably affect Chinese's boom and strong. Especially recent ten years, after some policy for intervention, but it didn't work very obviously. Therefore, studying the factors and putting forward the corresponding countermeasures have important theoretical and practical significance.. In this paper, we utilize the intuitionistic fuzzy Einstein weighted average (IFEWA) operator for evaluating the physical quality of adolescents to aggregate the intuitionistic fuzzy information corresponding to each alternative and get the overall value of the alternatives, then rank the alternatives and select the most desirable one (s) according to the score function and accuracy function of the overall value of the alternatives. Finally, an illustrative example is given.

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