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Differential Analysis on Mental Health Level of Physical Education Majors

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Abstract

College students can promote both physical fitness and mental health by taking a suitable amount of physical exercise at the right time. However, few scholars have conducted differential analysis on the mental health level of college students under the intervention of physical exercise, not to mention that of physical education (PE) majors. To fill up the gap, this paper carries out a differential analysis on the mental health level of PE majors. Firstly, the mental health level of PE majors was evaluated in 11 aspects, and a graded response model was established based on the 11 indices. Next, the mental health level of PE majors was subjected to fuzzy comprehensive evaluation (FCE). Finally, the mental health differences between PE majors and college students in other majors were analyzed accurately. The results show that the mental health level of physical education majors varies with genders, ages, grades, school types, durations per physical exercise, weekly frequencies of physical exercise, sports venues, and skill levels. The research findings provide a reference for further research of PE majors and their mental health level.

Keywords: physical exercise; mental health of college students; differential analysis

Introduction

Mental health research in China has made quite significant progress, referring to foreign research results on mental health. For instance, there are already complete systems of research objects, methods, and contents (Guo et al., 2018; Huang, 2021; Sidong, 2013). College students can promote both physical fitness and mental health by taking a suitable amount of physical exercise at the right time (Guo et al., 2014; Zhao & Zhong, 2014). Most scholars demonstrated the relationship between physical exercise and the mental health factors of college students, namely, mood, will, character, conduct, and interpersonal relationship, and verified that physical exercise can significantly ease the mental problems of college students (Deroche et al., 2012; Eccles et al., 2011; Firdausi et al., 2021; Gupta et al., 2019; Holzer, 2020; Nagelli et al., 2019). Facing the research boom of college students' mental health and growing popularity of sports among youngsters, this paper aims to evaluate the mental health level of Chinese college students and identify the mental health features and differences among college students.

The mental health education in colleges is premised on the accurate evaluation of the mental health situation of college students (Cheng et al., 2014; Heazlewood et al., 2011; Lane, 2012; Li, 2013; Li et al., 2013; Ma et al., 2011). Hazarika et al. (2020) analyzed the different features of mental health among higher vocational students against the self-evaluation scale of mental health symptoms, and proved that the students of different genders, grades, family backgrounds, source regions, and majors differ significantly from ordinary Chinese people in mental health issues (e.g., negative emotions, anxiety, and sensitivity). Wu and Huang (2012) fully considered the distribution of mental health indices of normal education students, and combined U test and Moses' test of extreme reactions with data mining technology to analyze the different mental health levels of different types of students. Focusing on the mental problems of rural college students (e.g., high learning stress, anxiety, hostility, and sensitivity to interpersonal communication), Kim et al. (2017) surveyed the mental health differences among 600 poor junior high school students in southeastern rural areas of Guangdong, China, using the Mental Health Scale for High School Students, and concluded that the poor rural students are much more mentally unhealthy than common urban students. Kawata et al. (2017) carried out a meta-analysis on the different mental health situations among high school students with different features and compared the mental health scores of those of different genders, family incomes, and source regions (rural area vs. urban area).

From the existing results on mental health and the participation of physical education (PE) majors in physical exercise, it can be learned that the mental health level of college students has always been tested against mental health scales. However, few scholars have conducted differential analysis on the mental health level of college students under the intervention of physical exercise, not to mention that of PE majors (Heaviside et al., 2018; Ling & Bin, 2010; Min-gang & Dan-dan, 2015; Tan, 2016; Xu & Yao, 2016). Therefore, this paper carries out a differential analysis on the mental health level of PE majors. Section 2 evaluates the mental health level of PE majors in 11 aspects and establishes a graded response model based on the 11 indices. Section 3 performs fuzzy comprehensive evaluation (FCE) (Li et al., 2019; Song et al., 2019; Xu & Peng, 2020) of the mental health level of PE majors. Section 4 analyzes the mental health differences between PE majors and college students in other majors.

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After sorting and analyzing the collected data, this paper evaluates the basic level of mental health among college PE majors, and the examines features and differences of mental health from the perspective of different factors. Based on the mental health levels of college PE majors of different features, the current state of mental health was obtained for college PE majors, and several countermeasures were presented to improve their mental health. The research provides a reference for future research of PE majors and their mental health level and helps stimulate the sports enthusiasm among youngsters.

Evaluation Model

Drawing on the relevant data and teaching experience of college staff, this paper designs a set of 11 impactors for the mental health of PE majors: learning stress MHL1, interpersonal anxiety MHL2, loneliness and sensitivity MHL3, impulsion and irritability MHL4, overconfidence and paranoia MHL5, downcast and depression MHL6, hostility and indifference MHL7, tension and fear MHL8, worry and apprehension MHL9, obsessive thinking and behavior MHL10, and somatization of psychological disorder MHL11. Then, a graded response model was established based on these indices.

Multilevel evaluation is often used to replace the traditional 0-1 evaluation method for effect evaluation. The new approach triggers the research and development of more complex scoring models. Samejima's graded response model breaks through the limit of conventional litem response theory, which only applies to 0-1 items, and applies well to subjective and objective evaluation problems. Extended from 0-1 rating model, Samejima's graded response model uses second-order logistic function and facilitates mathematical processing.

Following Samejima's graded response model, the probability $DV_{i,g}(\varphi)$ for a college student with the mental health level φ to receive a score g for index i can be calculated by:

$$DV_{i,g}(\phi) = DV^*_{i,g}(\phi) - DV^*_{i,g+1}(\phi) \quad (1)$$

where, $DV^*_{i,g}(\varphi)$ is the probability for the said college student to receive a score equal to or greater than g for index i; $DV^*_{i,g+1}(\varphi)$ is the probability for the said college student to receive a score equal to or greater than g+1 for index i. Suppose the full mark n of index i equals 4. Then, there are a total of 5 levels: 0, 1, 2, 3, 4, and 5. If g=4, then formula 1 can compute the probability to receive the score of 4 or 5.

In fact, $DV^*_{i,g}(\varphi)$ indicates whether a college student can receive the score of a level for index i. If the score is equal to or greater than g, then the student can receive the score; otherwise, he/she cannot receive that score. Without considering the level of 0, the difficulty $r_{i,g}$ in receiving the score g for index i satisfies the following inequality:

$$r_{i,1} < r_{i,2} < \cdots r_{i,g} < r_{i,g+1} < \cdots r_{i,n} \quad (2)$$

Formula 2 shows that the difficulty in receiving the same score increases monotonically with increase of the score level. Suppose index i has the same discriminability δ_i across all score levels. Then, $DV^*_{i,g}(\varphi)$ can be described by the two-parameter logistic model as:

$$DV^*_{i,g}(\phi) = \frac{1}{1+exp[-1.7\delta_i(\phi_j - r_{i,g})]} \quad (3)$$

Similarly, $DV^*_{i,g+1}(\varphi)$ can be calculated by:

$$DV^*_{i,g+1}(\phi) = \frac{1}{1+\exp[-1.7\delta_i(\phi_j - r_{i,g+1})]} \quad (4)$$

The probability for a college student to receive the score of g for an index can be calculated by:

$$DV_{i,g}(\phi) = DV^*_{i,g}(\phi) - DV^*_{i,g+1}(\phi) = \frac{1}{1+\exp[-1.7\delta_i(\phi_j - r_{i,g})]} - \frac{1}{1+\exp[-1.7\delta_i(\phi_j - r_{i,g+1})]} \quad (5)$$

Since the full mark is n for each index, we have $DV^*_{i,0}(\varphi)=DV^*_{i,n+1}(\varphi)=0$.

In Samejima's graded response model, $DV^*_{i,0}(\varphi)$ and $DV^*_{i,g}(\varphi)$ is the type of characteristic function and operation characteristic function of evaluation indices, respectively. The two parameters can be illustrated by type and operation characteristic curves, respectively.

Figure 1 shows the type of characteristic curves of $DV^*_{i,0}(\varphi)$, which is consistent with the term characteristic curve of ordinary two parameter models. Without considering the level of 0, the four levels correspond to four curves. The higher the score level, the more right skewed the curve, the greater the difficulty in receiving the same score. Since the discriminability is equal across the levels, all the curves are parallel to each other.

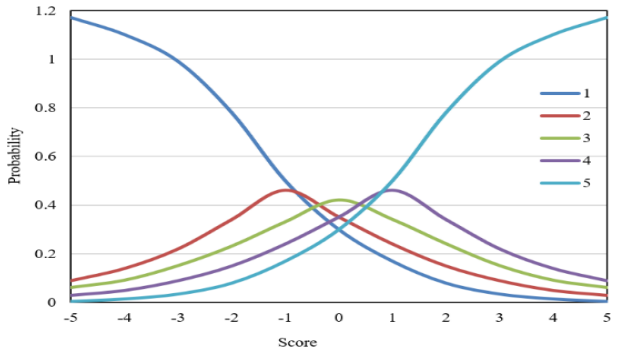

Figure 1. Type characteristic curves of $DV^*_{i,0}(\varphi)$

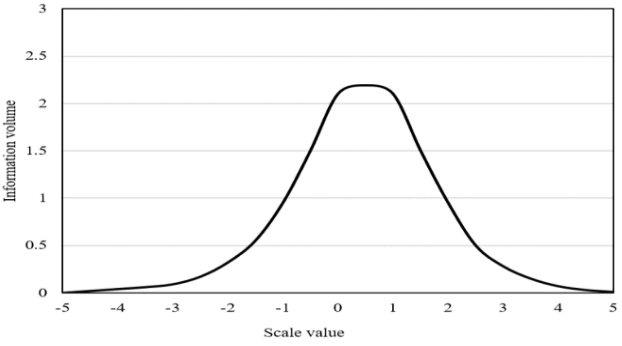

Figure 2. Operation characteristic curves of $DV^*_{i,g}(\varphi)$

Figure 2 presents the operation characteristic curves of $DV^*_{i,g}(\varphi)$. Apparently, these curves do not take the regular s shape. Three of the four curves have only one peak. Therefore, with the growth of φ, the probability of receiving a score does not increase monotonically but increases first to the peak at φ and then decreases. The score of zero is a unique case, in which the probability of receiving the score of zero decreases monotonically with the growth of φ. The morphological features of the operation characteristic curves of $DV^*_{i,g}(\varphi)$ is a visual display of the actual situation of receiving the exact score of each level.

The φ value determines the evaluated and actual scores of mental health level of each college student. In essence, the evaluation of mental health level aims to grasp and determine the actual mental health level of every target college student. Specifically, the student needs to answer questions raised by experts, who will give an objective score according to his/her responses. The score reflects the mental health level of the student.

Neither the weights of evaluation indices nor φ values of the target students were known. Therefore, the maximum likelihood estimation (MLE) was carried out to estimate the parameters of Samejima's graded response model:

$$SR(v|\phi,e,r) = \prod_j^N \prod_i^M DV_{i,j,g}(\phi) =$$

$$\prod_j^N \prod_i^M \left(\frac{1}{1+exp[-1.7\delta_i(\phi_j - r_{i,g})]} - \frac{1}{1+exp[-1.7\delta_i(\phi_j - r_{i,g+1})]} \right) \quad (6)$$

The maximum likelihood function (6) can be solved by Newton-Raphson Iteration.

Moreover, the information function was introduced to evaluate the mental health level of PE majors. The purpose of index quantification and evaluation is to derive the actual mental health level of college students from their answers and responses to each index. Therefore, the importance of each index to the evaluation result, the quality of each question, and the accuracy of the evaluation all depend on how much information is provided in the mental health test on PE majors that objectively reflects the actual mental health of college students. If there is a huge amount of such information, the evaluation will be accurate, reliable, and close to the reality, that is, the evaluation result will be trustworthy. Figure 3 presents the information function curve and the standard error curve.

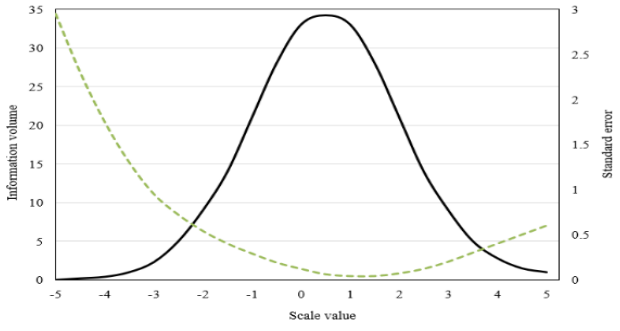

Figure 3. Information function curve and standard error curve

The information function was defined as the opposite number of the expected second-order derivative of the log-likelihood function of the graded response model relative to the φ value of PE majors:

$$CY(\phi) = u(\hat{\phi}|\phi)^{-1} = -H\frac{\partial^2 ln\, CY}{\partial \phi^2} = \sum_{i=1}^m CY_i(\phi) =$$

$$\sum_{i=1}^m \frac{(DV_i')^2}{DV_i w_i} \quad (7)$$

The information function (7) is essentially the actual data of the evaluation scores. As required by the graded response model, the standard error was defined as the reciprocal of the variance of the mental health level of each college student derived through statistical estimation:

$$DG(\phi) = \frac{1}{\sqrt{CY(\phi)}} = \frac{1}{\sqrt{\sum CY_i(\phi)}} \quad (8)$$

FCE

This paper applies FCE to test the mental health of college PE majors. Considering the complexity and fuzziness of psychological problems, a multilevel comprehensive evaluation model was introduced to realize all-round judgement of the mental health state of the college students. The fuzzy transform of evaluation indices is the theoretical basis for the FCE of the mental health level of PE majors. Figure 4 illustrates the process of the fuzzy transform.

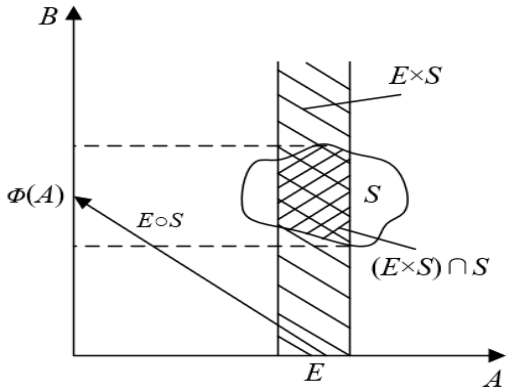

Figure 4. Process of fuzzy transform

Firstly, the set of index data was transformed by:

$$\Phi: D(A) \to D(B)\ E \mapsto \Phi(E) \triangleq R \quad (9)$$

Let Φ be the mapping from index dataset A to index dataset B; R be the projection of E via Φ. Then, the dataset transforms according to any relationship S⊂A×B between evaluation indices can be described by:

$$\Phi: D(A) \to D(B)\ E \mapsto \Phi(E) \triangleq R \triangleq \left((E \times B) \cap S\right)_B \quad (10)$$

Suppose Φ(E)=E∘S. The feature function for the mapping of Φ(E) must satisfy:

$$PQ_{\Phi(E)}(b) = PQ_{((E\times B)\cap S)B}(b) = \bigvee_{a\in A} PQ_{(E\times B)\cap S}(a,b) =$$

$$\bigvee_{a\in A}\left(PQ_{E\times B}(a,b) \wedge PQ_S(a,b)\right) = \bigvee_{a\in A}\left(PQ_E(a) \wedge PQ_S(a,b)\right) \quad (11)$$

The feature function of projection R must satisfy:

$$PQ_R(b) = \bigvee_{a\in A}\left(PQ_E(a) \wedge PQ_S(a,b)\right), \forall b \in B \quad (12)$$

If A= {a_1, a_2, …, a_m} and B= {b_1, b_2, …, b_n} 时, the relationship (12) can be converted into:

$$PQ_R(b_i) = U_{i=1}^{m}\left(PQ_E(a_i) \wedge PQ_S(a_i,b_i)\right), j = 1,2,\dots,n \quad (13)$$

Assuming that:

$$r_j \stackrel{\Delta}{=} PQ_R(b_i), e_i = PQ_E(a_i), s_{ij} = PQ_R(a_i,b_i) \quad (14)$$

Then:

$$r_j = \overset{i=1}{\underset{m}{\vee}}\left(e_i \wedge s_{ij}\right), j = 1,2,\dots,n \quad (15)$$

Then, the fuzzy transform from A to B can be defined as any mapping from D(A) to D(B):

$$\tilde{E} \mapsto \tilde{\Phi}\left(\tilde{E}\right)\Delta\tilde{R} \quad (16)$$

The basic idea of the FCE of mental health level among PE majors is to construct an evaluation model based on the principles of F linear transform and all indices of mental health level, and comprehensively evaluate the mental health level of PE majors, following the maximum membership principle.

There are three elements of FCE: factor set, comment set, and single factor evaluation:

(1) The factor set is the set of evaluation indices V= {v_1, v_2, …, v_F}. It is assumed that a total of F factors is related to the mental health level of PE majors.

(2) The comment set is the set of the levels of each index U= {u_1, u_2, …, u_C}. It is assumed that an index could be assigned to a total of C levels.

(3) Single factor evaluation aims to obtain a set of D judgements on U by evaluating every single index, i.e., to obtain (s_{i1}, s_{i2}, …, s_{iC}) by evaluating v_i (i=1, …, F). Hence, single factor evaluation can be viewed as a D mapping from V to U:

$$d: V \to D(U)\ v_i \mapsto (s_{s1}, s_{s2}, \dots, s_{iF}) \quad (17)$$

where, mapping d can determine a D relationship. Then, S∈$\lambda_{F\times C}$ can be defined as the judgement matrix:

$$S = \begin{bmatrix} s_{11} & s_{12} & \cdots & s_{1C} \\ s_{21} & s_{22} & \cdots & s_{2C} \\ \vdots & \vdots & & \vdots \\ s_{F1} & s_{F2} & \cdots & s_{FC} \end{bmatrix} \quad (18)$$

In other words, the judgement matrix S can be established from the fuzzy set for single factor evaluation.

During the evaluation, different indices have different importance relative to the final evaluation result and should be assigned different weights to reflect the difference. The weights assigned to the indices V on set D can be described as a dataset E= (e_1, e_2, …, e_F). Then, the weight coefficients were synthetized with the judgement matrix S to obtain the FCE set R= (r_1, r_2, …, r_C). Then, E○S satisfies:

$$E \circ S = R = (r_1, r_2, \dots, r_C) \quad (19)$$

were,

$$E = (e_1, e_2, \dots, e_F)\ S = \left(s_{ij}\right)_{F\times C}, s_{ij} \in [0,1]\ r_j = \overset{i=1}{\underset{n}{\vee}}\left(e_i \wedge s_{ij}\right), j = 1,2,\dots,C \quad (20)$$

The FCE set R= (r_1, r_2, …, r_C) is the comprehensive evaluations of all indices. To judge the mental health level of PE majors, the final result of FCE was determined by the principle of maximum membership: the level u_j corresponding to the maximum r_j in the FCE set R is the result of FCE. The resulting FCE model can be denoted as CY or CY (∧, ∨).

From the FCE process, when only index v_i is considered, the membership of v_i score to level u_j can be expressed as s_{ij}(j=1, 2, …, C). Based on D relationship, the compositional operation can be implemented:

$$r_j = \overset{i=1}{\underset{F}{\vee}}\left(e_i \wedge s_{ij}\right), j = 1,2,\dots,C \quad (21)$$

During the overall consideration of various indices, it is necessary to adjust s_{ij} according to the degree of influence e_i of v_i on the overall evaluation of mental health level of PE majors: First, calculate the membership of v_i score to level u_i; Second, carry out compositional operation based on D relationship; Third, rank the indices by membership.

Definition: Suppose the function d of C levels meets the following four conditions:

(1) d (0, 0, …, 0) =0, and d (1, 1, …, 1) =1.

(2) If a_i<a'_i, then d (a_1, a_2, …, a_C) ≤d (a'_1, a'_2, …, a'_C).

(3) $\lim_{ai\to ai0}$d (a'_1, a'_2, …, a'F) =d (a'_{10}, a'_{20}, …, a_{F0}).

(4) 4d (a_1+a'_1, a_2+a'_2, …, a_m+a'm) =d (a'_1, …, a_m) +β (a'_1, …, a'_m).

Then, function d can be called the judgement matrix, with β: $[0, 1]^C$→ [0, 1].

From the evaluation index system (EIS) for mental health level of PE majors, the final evaluation result is determined by multiple factors. Therefore, a simple evaluation model cannot truthfully reflect the actual mental health level of PE majors and have difficulty in assigning suitable weights to the evaluation indices. This calls for a complex multilevel evaluation model.

Due to the sheer number of indices for mental health level of PE majors, it is necessary to perform single factor evaluation with the primary indices, and then carry out secondary comprehensive evaluation. Let R_i be the score of a class i index: PQ be the comprehensive evaluation result between different classes of indices. Then, the secondary comprehensive evaluation needs to assign weights to all F classes:

$$PQ = E \circ R = E \circ \begin{bmatrix} E_1 \circ S_1 \\ E_2 \circ S_2 \\ \dots \\ E_F \circ S_F \end{bmatrix} = E \circ \begin{bmatrix} R_1 \\ R_2 \\ \dots \\ R_F \end{bmatrix} = E \circ \left(r_{ij}\right)_{4\times F} \quad (22)$$

The number of indices in each class determines the division and number of indices on each level of the multilevel evaluation model.

Experiments and Results Analysis

The mental health data were collected from grade 1 PE majors of the target colleges in recent two years. Out of thousands of files, 200 copies were selected from the age group of 19-20. Among them, 70 are about females, and 130 about males. The data were rated against the EIS scale and used to establish our mathematical model.

Relevant studies have analyzed the mental health levels of young golfers and ordinary youth in Shanghai. The analysis covers the following aspects: mental health level evaluation of young golfers, mental health level evaluation of ordinary youth, mental health level analysis of different groups, difference between young golfers and ordinary youth in mental health level. Our experiments were designed in reference to the above contents.

During our mental health survey on PE majors, relevant experts held that Chinese college students have a poor psychological quality, many of whom are poor in psychological endurance, stamina, and anti-frustration awareness. In particular, PE majors are generally short-tempered and mentally burdened under the huge learning stress. This paper designs a comparative experiment on the mental health level of PE majors (test group) and college students in other majors (control group). Table 1 shows the results of differential analysis.

Table 1

Results of differential analysis on the mental health level of PE majors and other majors

Index number	Group	Mean	Good (%)	Slightly poor (%)	Moderately poor (%)	Strongly poor (%)	Extremely poor (%)	Z-score	P value
MHL1	Test	1.82	67.2	25.7	7.1	0.6	1.1	-2.735	0.010
	Control	1.73	54.8	38.1	7.2	0.7	0		
MHL2	Test	1.56	81.2	15.9	2.9	1.0	0.6	-2.767	0.008
	Control	1.92	68.5	24.6	6.6	0.8	0		
MHL3	Test	1.56	81.2	12.3	7.1	0.6	0.7	-2.871	0.003
	Control	1.67	69.7	23.6	6.0	0.7	0		
MHL4	Test	1.56	80.1	13.4	5.3	0.8	0.6	-3.579	0
	Control	1.73	70.6	24.7	3.7	1.3	0		
MHL5	Test	1.62	77.5	15.1	6.6	1.0	0.6	-2.574	0.013
	Control	1.69	74.9	20.3	4.2	1.3	0		
MHL6	Test	1.58	73.2	16.8	8.0	2.4	0.6	-3.372	0.002
	Control	1.83	64.1	26.7	8.4	0.7	0.7		
MHL7	Test	1.89	58.9	24.9	8.6	4.3	1.0	-1.898	0.08
	Control	1.87	80.7	25.2	12.5	3.1	0		
MHL8	Test	1.54	69.5	14.3	4.9	0	0.6	-3.372	0.002
	Control	1.66	68.7	26.1	4.2	0	0		
MHL9	Test	1.72	71.1	20.3	8.9	0.6	0.7	-2.967	0.005
	Control	1.83	60.8	29.8	9.0	0	0.6		
MHL10	Test	1.54	81.2	15.0	4.3	0.6	0.6	-2.869	0.007
	Control	1.63	73.1	22.6	4.2	0.8	0		
MHL11	Test	1.85	76.9	18.7	3.5	0	0.6	-3.35	0.002
	Control	1.72	67.2	21.0	2.6	0.7	0		

Table 2

Normality test on evaluation indices

Index number	Kolmogorov-Smirnov			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
MHL1	0.142	216	0.000	0.872	216	0.000
MHL2	0.213	216	0.000	0.763	216	0.000
MHL3	0.225	216	0.000	0.762	216	0.000
MHL4	0.219	216	0.000	0.785	216	0.000
MHL5	0.218	216	0.000	0.756	216	0.000
MHL6	0.215	216	0.000	0.843	216	0.000
MHL7	0.172	216	0.000	0.762	216	0.000
MHL8	0.213	216	0.000	0.852	216	0.000
MHL9	0.194	216	0.000	0.775	216	0.000
MHL10	0.223	216	0.000	0.764	216	0.000
MHL11	0.168	216	0.000	0.823	216	0.000

As shown in Table 1, PE majors had lower scores on all mental health indices, expect for learning stress, than other majors. However, there were more PE majors with good mental health level than other majors. Through the differential analysis, the P values of the 11 mental health indices for both PE majors and other majors were smaller than 0.05. Therefore, there are no significant difference between PE majors and other majors in 9 mental health indices: MHL1, MHL2, MHL3, MHL4, MHL5, MHL6, MHL8, MHL9, and MHL11.

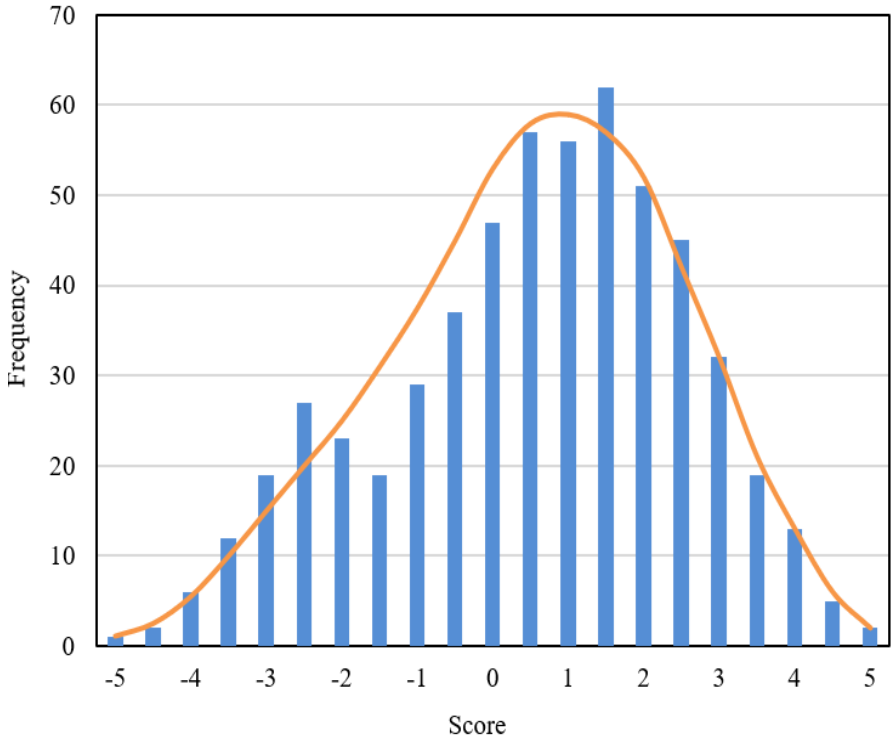

Figure 5. Histogram of evaluation indices for mental health level

The differential analysis on the mental health level between PE majors and other majors focuses on the disparity between index data in terms of classes or directions. Table 2 shows the results of normality test on the indices, and Figure 5 presents the histogram of the indices. It can be seen that the P values of all index data were smaller than 0.05, indicating that the indices do not obey normal distribution. Therefore, two nonparametric analysis tools of SPSS were adopted, namely, Mann-Whitney U test and Kruslcal-Walli's test.

Firstly, a U test was carried out to analyze the mental health level of PE majors of different genders. As shown in Table 3, the P values of differential analysis on PE majors were greater than 0.05 on the composite score, MHL1, MHL2, MHL4, MHL5, MHL6, MHL7, MHL8, MHL9, and MHL11, and smaller than 0.05 on MHL3 and MHL10. Except for MHL3 and MHL10, PE majors of different genders have no significant difference in mental health level on nine indices. The gender difference in MHL3 and MHL10 is that male PE majors are much poorer than their female counterparts, possibly because male college students are more outgoing, optimistic, and unconstrained.

Next, a Kruskal-Walli test was carried out to analyze the mental health level of PE majors of different ages. As shown in Table 4, the P values of differential analysis on PE majors were greater than 0.05 on the composite score, and all 11 indices. Therefore, PE majors of different ages have no significant difference in overall mental health level or any of the 11 indices. Despite their age difference, PE majors face similar environmental pressures from learning, life, economy, and society during their stay on campus. PE majors of different ages might differ slightly on the mean of mental health level, but the difference is by no means significant.

Table 3

Mental health level of PE majors of different genders

Index number	Mean		U test	
	Male	Female	Z score	P value
MHL1	1.782	1.8205	-0.372	0.723
MHL2	1.5426	1.4875	-0.165	0.872
MHL3	1.6239	1.3796	-2.478	0.023
MHL4	1.5874	1.4878	-0.635	0.531
MHL5	1.5862	1.6184	-0.342	0.734
MHL6	1.8705	1.7203	-0.169	0.854
MHL7	1.5139	1.8674	-0.232	0.823
MHL8	1.7642	1.4857	-0.251	0.761
MHL9	1.7658	1.6732	-0.027	0.982
MHL10	1.5369	1.4725	-0.734	0.047
MHL11	1.6541	1.5845	-0.312	0.765
Composite score	98.7632	95.7413	-0.312	0.765

Table 4

Differential analysis on mental health level of PE majors of different ages

Index number	Mean				Kruslcal-Walli's test	
	<18	18-19	19-20	>20	Chi-square	P value
MHL1	1.6318	1.8529	1.7982	1.8142	2.752	0.42
MHL2	1.4752	1.5342	1.5341	1.6721	0.614	0.884
MHL3	1.5732	1.5617	1.5249	1.4324	0.721	0.862
MHL4	1.4079	1.5541	1.5732	1.5328	1.03	0.795
MHL5	1.5238	1.5934	1.6731	1.4682	0.407	0.921
MHL6	1.4372	136845	1.7655	1.5321	2.572	0.462
MHL7	1.6356	1.9632	1.7762	2.1213	3.442	0.324
MHL8	1.4215	1.4795	1.5582	1.6835	2.023	0.563
MHL9	1.6735	1.7631	1.6986	1.6235	0.192	0.971
MHL10	1.5203	1.5872	1.4576	1.4785	4.037	0.258
MHL11	1.5483	1.6549	1.6724	1.624	0.952	0.807
Composite score	91.8415	99.373	97.9862	97.6	0.952	0.807

Kruskal-Walli test was also adopted to analyze the mental health level of PE majors of different grades. As shown in Table 5, the P values of differential analysis on PE majors were greater than 0.05 on the composite score, MHL3, MHL4, MHL5, MHL6, MHL7, MHL8, MHL9, MHL10, and MHL11. Therefore, PE majors of different grades have no significant difference in overall mental health level or the 9 indices. On MHL1 and MHL2, grade 1 PE majors were much poorer than those in grades 2-4, for they need to adapt to an entirely new living and learning environment.

Table 5

Differential analysis on mental health level of PE majors of different grades

Index number	Mean				Kruslcal-Walli's test	
	Grade 1	Grade 2	Grade 3	Grade 4	Chi-square	P value
MHL1	1.8435	1.6532	1.6212	1.7635	10.712	0.051
MHL2	1.5321	1.4723	1.4325	1.7	4.072	0.563
MHL3	1.5632	1.4554	1.5613	1.6325	2.321	0.867
MHL4	1.5472	1.4732	1.3721	1.59	8.025	0.156
MHL5	1.5735	1.5212	1.4874	1.7321	5.63	0.352
MHL6	1.6539	1.5332	1.4527	1.76	8.563	0.129
MHL7	1.1327	1.9243	1.7813	1.5254	2.775	0.765
MHL8	1.4323	1.3864	1.5623	1.5823	6.321	0.283
MHL9	1.6435	1.8329	1.6321	1.7276	1.903	0.868
MHL10	1.5802	1.4352	1.5732	1.4235	2.762	0.743
MHL11	1.6315	1.5736	1.5463	1.6723	3.402	0.632
Composite score	98.23	94.3215	92.0725	100.32	3.402	0.632

Table 6

Differential analysis on mental health level of PE majors of different types of colleges

Index number	Mean			Kruslcal-Walli's test	
	Domestic colleges	Domestic higher vocational colleges	Foreign colleges	Chi-square	P value
MHL1	1.8572	1.4654	1.6532	3.795	0.12
MHL2	1.5423	1.3621	1.6	0.756	0.673
MHL3	1.5431	1.6	1.5439	0.095	0.956
MHL4	1.593	1.37	1.4252	3.572	0.168
MHL5	1.6632	13896	1.4136	5.053	0.09
MHL6	1.7352	1.4252	1.4923	1.762	0.402
MHL7	1.8755	1.7463	1.8752	1.293	0.524
MHL8	1.6	1.6251	1.4735	0.912	0.637
MHL9	1.7032	1.6372	1.7631	0.17	0.925
MHL10	1.5342	1.6	1.4739	0.085	0.953
MHL11	1.6533	1.5127	1.5672	0.412	0.814
Composite score	99.3782	90.6	93.8413	0.412	0.814

Besides, Kruskal-Walli test was performed on the mental health level of PE majors of different types of colleges. As shown in Table 6, the P values of differential analysis on PE majors were greater than 0.05 on the composite score and all 11 indices. Therefore, PE majors of different types of colleges have no significant difference in overall mental health level or any of the 11 indices. Three types of colleges were considered in the test: domestic colleges, domestic higher vocational colleges, and foreign colleges. On average, the PE majors receiving education domestically are only slightly poorer than those learning in foreign colleges.

Table 7

Differential analysis on mental health level of PE majors with different durations per physical exercise

Index number	Mean				Kruslcal-Walli's test	
	<1h	1-2h	2-3h	>3h	Chi-square	P value
MHL1	1.9923	1.6276	1.6312	1.8064	13.065	0.006
MHL2	1.6108	1.4135	1.4329	1.4325	3.58	0.312
MHL3	1.5972	1.4352	1.4764	1.5238	6.75	0.082
MHL4	1.6639	1.4796	1.4645	1.462	5.513	0.132
MHL5	1.75	1.4612	1.4621	1.7	6.802	0.075
MHL6	1.8	1.465	1.467	1.7	10.385	0.013
MHL7	2.0647	1.6791	1.6637	1.8623	5.743	0.127
MHL8	1.6685	1.603	1.4321	1.549	3.774	0.018
MHL9	1.8061	1.413	1.605	1.6653	1.776	0.063
MHL10	1.6492	1.4512	1.413	1.4732	5.189	0.152
MHL11	1.7623	1.4895	1.4851	1.6849	6.623	0.033
Composite score	106.7234	89.4232	89.7629	94.8643	6.623	0.083

Table 8

Differential analysis on mental health level of PE majors with different weekly frequencies of physical exercise

Index number	Mean						Kruslcal-Walli's test	
	≤Once	Twice	Three times	Four times	Five times	>Six times	Chi-square	P value
MHL1	1.8721	1.8947	1.6246	1.6745	1.67	1.7542	12.632	0.025
MHL2	1.8226	1.7723	1.5132	1.2417	1.4961	1.3759	12.673	0.024
MHL3	1.8723	1.6231	1.2761	1.3452	1.2963	1.3973	11.735	0.035
MHL4	1.672	1.7935	1.2243	1.4	1.4316	1.6312	8.953	0.113
MHL5	1.6539	1.8563	1.5064	1.4352	1.4929	1.7231	19.342	0.003
MHL6	1.7085	1.9632	1.5463	1.2263	1.2593	1.4233	12.165	0.035
MHL7	1.9534	2.0327	1.6	1.1445	1.4592	1.4398	9.306	0.092
MHL8	1.7593	1.3952	1.5132	1.5426	1.7588	1.7982	5.6	0.384
MHL9	1.7512	1.9323	1.5964	1.4563	1.8462	1.6522	15.131	0.02
MHL10	1.8923	1.8952	1.2489	1.2594	1.4653	1.4526	12.772	0.027
MHL11	1.667	1.8208	1.5195	1.85	1.67	1.672	12.853	0.026
Composite score	99.7853	109.1932	81.196	80.3	95.7	99.322	12.853	0.026

Another Kruskal-Walli test was conducted to see if the mental health level of PE majors varies with the duration per physical exercise. Here, the duration is divided into 4 types: <1h, 1-2h, 2-3h, and >3h. As shown in Table 7, the P values of differential analysis on PE majors were greater than 0.05 on the composite score, MHL2, MHL3, MHL4, MHL5, MHL6, MHL7, MHL9, and MHL10, and smaller than 0.04 on MHL1, MHL8, and MHL11. Except for MHL1, MHL8, and MHL11, PE college students with different durations per physical exercise have no significant difference on the remaining 8 indices. The main reason is that physical exercise promotes their physical fitness and professional literacy, eases the stress and tension brought by professional learning, and slows down the somatization of psychological disorder.

With the aid of Kruskal-Walli test, this paper also analyzes the mental health level of PE majors with different weekly frequencies of physical exercise. As shown in Table 8, the P values of differential analysis on PE majors were greater than 5 on MHL4, MHL7, and MHL8, and smaller than 0.05 on the remaining 8 indices. Therefore, PE majors with different frequencies of physical exercise do not have

significant differences on MHL4, MHL7, and MHL8. The most prominent difference lies in the fact that the PE majors doing physical exercise 3-5 times per week received better composite score and scores on MHL1, MHL2, MHL3, MHL5, MHL6, MHL9, MHL10, and MHL11. This means a moderate frequency of physical exercise promotes the mental health of PE majors. But the positive effect would be reduced, if the frequency of physical exercise is too high or too low.

Table 9

Differential analysis on mental health level of PE majors using different types of sports venues

Index number	Mean				Kruslcal-Walli's test	
	Campus road	Gym	Stadium	Dorm	Chi-square	P value
MHL1	1.8022	1.7915	1.7132	1.8162	0.873	0.834
MHL2	1.6153	1.6563	1.4829	1.845	2.15	0.536
MHL3	1.664	1.5195	1.492	1.6051	0.267	0.965
MHL4	1.643	1.5502	1.492	1.8912	0.95	0.812
MHL5	1.792	1.6897	1.4866	1.6235	1.395	0.723
MHL6	1.9152	1.685	1.5819	1.4257	2.062	0.57
MHL7	1.9513	1.8516	1.8617	1.6131	0.953	0.812
MHL8	1.4582	1.4562	1.4714	1.8343	2.374	0.6
MHL9	1.7035	1.7562	1.6178	1.4984	0.892	0.823
MHL10	1.6721	1.6856	1.4653	1.4532	2.375	0.495
MHL11	1.6632	1.6489	1.6472	1.6534	0.603	0.892
Composite score	99.6251	97.1325	99.4891	98.4563	0.603	0.892

Furthermore, a Kruskal-Walli's test was performed to analyze the mental health level of PE majors using different sports venues. As shown in Table 9, the P values of differential analysis on PE majors were greater than 0.05 on the composite score and all 11 indices. Therefore, PE majors using different sports venues have no significant difference in overall mental health level or any of the 11 indices. That is, the type of sports venue does not greatly affect the overall mental health of PE majors, or their mental health measured by any index. Note that the gym and stadium provide training grounds for basketball, football, badminton, and tennis. Dorm and campus road are not good venues for physical exercise. But neither of them affects the evaluation of mental health level of college students.

Table 10

Differential analysis on mental health level of PE majors with different skill levels

Index number	Mean						Kruslcal-Walli's test	
	None	≥100	90-99	80-89	72-79	<72	Chi-square	P value
MHL1	1.8513	1.7257	1.682	1.7052	1.8516	1.8056	0.823	0.973
MHL2	1.6847	1.5235	1.4753	1.5486	1.1532	1.6175	1.192	0.945
MHL3	1.6512	1.5013	1.5861	1.4563	1.6	1.7491	2.384	0.792
MHL4	1.6841	1.6516	1.4589	1.4815	1.751	1.1656	1.26	0.96
MHL5	1.6729	1.7613	1.1432	1.5571	1.6516	1.4383	3.07	0.692
MHL6	1.7511	1.7052	1.2754	1.6423	1.5632	2.2489	0.213	0.981
MHL7	1.823	1.8813	1.8156	1.9616	1.7411	1.4651	3.295	0.657
MHL8	1.4284	1.6548	1.4332	1.4252	1.3284	1.4489	6.856	0.235
MHL9	1.6841	1.765	1.4489	1.6486	1.65	1.4487	6.504	0.28
MHL10	1.6413	1.6712	1.6753	1.2817	1.4862	1.6541	4.32	0.487
MHL11	1.628	1.6489	1.6481	1.5156	1.6518	1.6846	0.603	0.985
Composite score	97.5156	99.8056	95.5632	93	103.2512	97.5212	0.603	0.985

Finally, Kruskal-Walli's test was employed to analyze the mental health level of PE majors with different skill levels. As shown in Figure 10, the P values of differential analysis on PE majors were greater than 0.05 on the composite score and all 11 indices. Therefore, PE majors with different skill levels have no significant difference in overall mental health level or any of the 11 indices.

Conclusions

This paper carries out a thorough differential analysis on the mental health level of PE majors. The mental health level of PE majors was firstly evaluated from 11 aspects, and the relevant indices were used to build a graded response model. Then, an FCE was performed on the mental health

level of PE majors. After that, the normality of the indices was tested, and two data analysis tools of SPSS were selected for the differential analysis on index data. Specifically, the mental health level of PE majors was analyzed under the conditions of different genders, different ages, different grades, different types of schools, different durations per physical exercise, different weekly frequency of physical exercise, different sports venues, and different skill levels. The research results provide a reference for the research of PE majors and mental health. Starting with mental evaluation and measurement methods, this paper firstly explores the mental health state of college PE majors, and briefly analyzes the possible causes of mental health problems. Drawing on domestic and foreign studies, the authors put forward solutions to the existing mental health problems, trying to simplify the actual work of mental test. In addition, feasible operation method and crisis intervention approach were developed to detect mental abnormality of students, provide them with guidance, and minimize the degree of damage.

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