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ORIGINAL

THE APPROPRIATE CHOICE OF PHYSICAL EXERCISE MEASURES TO PROMOTE MENTAL HEALTH OF ADOLESCENTS

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ABSTRACT

Adolescence marks a critical phase in the developmental journey of life, with mental health being a state of persistent psychological well-being and positivity. Engaging in sports actively contributes to enhancing the mental health status of teenagers, regulating their emotional states, dismantling psychological barriers, and bolstering their social adaptability. Within the scope of this study, a clustering algorithm is employed to conduct an empirical analysis on the impact of physical exercise on the mental health levels of adolescents, as well as to investigate the intermediary mechanisms at play. At the beginning of the outbreak of the epidemic, the overall level of teenagers' mental health decreased, and negative emotions such as depression and anxiety increased. In addition to emotional problems of different degrees, teenagers also showed physical and behavioral responses such as insomnia and fatigue, chest tightness and headache, and loss of appetite. Some studies also found that home-based teenagers did not have obvious anxiety, but had a high level of perceived stress, and perceived stress was positively correlated with anxiety. The normalization of epidemic prevention and control has had a great impact on teenagers' thoughts and behaviors, and even greater impact on teenagers with psychological problems. The research shows that in the face of the multi-point epidemic, the closed or semi closed management of the campus, and the continuous epidemic prevention and control work of the school, teenagers cannot travel freely and can only move in the campus every day. Some teenagers have bad emotions such as boredom, panic and anxiety, which bring many new problems and new situations to the physical and mental progress of

teenagers and school management.

KEYWORDS: Physical Exercise, Mental health, Adolescence

1. INTRODUCTION

The fundamental purpose of sports is twofold: to enhance physical fitness and to bolster mental strength. Engaging in physical activities has a direct impact on the human body, enhancing its capabilities. Moderate exercise is known to stimulate cognitive activities and behavior, fostering psychological balance, self-awareness, and positive emotional states (Li et al., 2020; Song et al., 2022; Zhao et al., 2022). Students in primary and secondary schools are at a pivotal phase of personal growth and development, and issues surrounding their mental health have emerged as significant societal concerns in China. As the future of the nation and society, the physical and mental well-being of teenagers is crucial for the country's development. Amid intensifying social competition, the psychological pressure on teenagers is on the rise, making mental health a subject of increasing concern. The quality of mental health in teenagers is shaped by a combination of genetic and environmental factors, forming an internal and relatively stable psychological attribute that influences their mental health. Sports activities aim to directly improve both physical and mental conditions. Moderate sports activities can promote psychological balance and enhance self-awareness and positive emotions. Zhu and Zhu define mental health as a sustained and positive state of mental function where individuals can continuously adjust their mental structures to maintain mental and social normalcy or good adaptation in interaction with various environments, within the limits allowed by internal and external conditions. Similarly, Williams et al. view mental health as a state that enables individuals to maintain mental and social normalcy or good adaptation in their interactions with diverse environments (Zhu & Zhu, 2021). The evolving understanding of health has led to a new appreciation of the functions of physical activities and exercises, which are now recognized for their dual benefits of fitness and the enhancement of physical and mental health. However, Tortosa-Martínez et al. noted that there was no significant change in anxiety, tension, and depression following physical exercise (PE) (Hsu et al., 2021; Li et al., 2021; Winkie & Kinnebrew, 2021). Numerous studies have demonstrated that PE has a certain influence on and can promote mental health, but there is no consensus on the differential impact of various PE activities on mental health, as noted in (Wang et al., 2019). Currently, the prevalent mental health issues among college students in China have impacted the quality of talent development. Previous research on teenagers' mental health was primarily theoretical and investigative, providing significant theoretical guidance. The effects of PE on mental health are influenced by numerous factors, and there is no consensus among researchers regarding the specifics of aerobic and anaerobic exercises, exercise intensity, frequency, and duration. Enjoyment and happiness derived from sports

activities are prerequisites for the mental health benefits of teenagers, as enjoyment is likely related to the persistence of exercise, which in turn affects the long-term success of using physical exercise to improve self-perception. In light of these issues, this paper presents an empirical analysis of the impact of PE on the mental health level of teenagers and its intermediary mechanisms, aiming to contribute to a deeper understanding of PE psychology and to inform the development and reform of school health education and fitness programs.

2. Related Work

The multi-dimensional, multi-level and multi-way research on mental health education in universities emerging in recent years shows that the research on mental health education in universities has attracted the attention of practitioners, universities and relevant management departments, and also indicates the vigorous progress of this research (Perez et al., 2017). At the same time, it should also be noted that the research on mental health education in universities is far from that in public universities in terms of depth, breadth, systematization and standardization, which requires the continuous efforts of practitioners and relevant departments (Cattaneo et al., 2020). According to the investigation of Wang et al., teenagers with psychological confusion are more common. And psychological diseases will seriously affect their physical and mental health and comprehensive progress, and even cause malignant events (Wang & Liang, 2020). De et al. Found that the screening, evaluation, diagnosis of the universal mental health scale and the routine and patterned psychological crisis counseling can help improve teenagers' ability to deal with psychological crisis, and the two systems can effectively reduce teenagers' potential psychological crisis (De Vries et al., 2019). Yang et al. Found that Taiji exercise has a very obvious self-healing effect on teenagers' physical and mental health in physical exercise, and suggested long-term exercise (Li et al., 2019). Hua et al. Used SCL-90 psychological symptom checklist as the main measuring tool, through the comparative test on the mental health status of teenagers in universities and ordinary public universities, found that the positive detection rate of teenagers in universities was higher than that in public universities, that is, the overall level of mental health status of teenagers in universities was low, which attracted high attention from universities and all aspects of society (Hua et al., 2018). Achebak et al. Conducted a comparative study on the mental health status of teenagers and the national norm. They believed that among teenagers, the symptoms of interpersonal relationship, anxiety and depression were more prominent, and suggested that university psychological counseling should be focused on this (Achebak et al., 2021). Ahmad et al. Focused on the mental health education work of universities, combined with the characteristics of universities, to improve the common problems commonly existing in the student population, and carried out mental health education from the aspects of inferiority complex, environmental adaptation and interpersonal communication (Ahmad et al., 2020). Watkins et al. Used the sees self-harmony

scale as the main measuring tool to conduct a comparative study on the mental health status of new undergraduate teenagers in universities and ordinary public universities. It is found that in terms of self-harmony, the general public universities are better, and the universities are mainly characterized by high paranoia and other emotions. It is analyzed that the reason may be related to the inappropriate expectations of parents for their children (Watkins et al., 2015). Chen et al. found that universities did not pay enough attention to the mental health problems existing in the student population, could not grasp the mental health status of teenagers in real time and effectively, and did not intervene in time for the existing psychological symptoms (Chen et al., 2016). Gould et al. Studied the influence of self-harmony on teenagers' mental health. He conducted group experiment research on teenagers according to the test results of self-harmony level. The self-harmony level is positively related to teenagers' psychology of coping with problems (Gould et al., 2016). The theoretical level of mental health research in universities has improved rapidly, but there are still unavoidable limitations. The scientific research level in the field of teenagers' mental health in the academic community is relatively backward, the theoretical basis and practical experience are relatively insufficient, and there is still a lot of space in the research system.

3. Methodology

3.1 Cluster analysis is used to analyze teenagers' mental health

K-means arithmetic is a commonly used clustering arithmetic based on partition. This arithmetic considers that the closer the distance between two objects, the greater their similarity. In order to achieve global optimization, partition-based clustering requires all possible partitions. The main steps of K-means arithmetic are described as follows:

(1) k objects are arbitrarily selected as the initial cluster center $m_i(i = 1,2,\ldots,k)$ from the entire sample n.

(2) The distance $d(p,m)$ between the centers of each p and k clusters can be obtained from the following formula:

$$\mathrm{d(i,j)} = \sqrt{(\mathrm{x_{i1}} - \mathrm{y_{j1}})^2 + (\mathrm{x_{i2}} - \mathrm{y_{j2}})^2 + \ldots + (\mathrm{x_{in}} - \mathrm{y_{jn}})^2} \quad (1)$$

Where $i = (x_{i1}, x_{i2}, \ldots, x_{in})$ and $j = (y_{j1}, y_{j2}, \ldots, y_{jn})$ respectively represent two n dimensional data objects.

(3) The minimum distance $d(p,m)$ of each object p is found and p is classified into the same cluster as m_i.

(4) After traversing all the objects, recalculate the value of 88 using

formula (2) as a new cluster center, namely:

$$m_k = \sum_{i=1}^{N} x_i / N \quad (2)$$

Where m_k represents the k cluster center and N represents the number of data objects in the k cluster. Re assign the objects in the entire data set to the most similar cluster. Repeat (2) to (4) until the following square error E is minimum:

$$E = \sum_{i=1}^{k} \sum_{p \in c_i} |p - m_i|^2 \quad (3)$$

In the above formula, E represents the sum of the square errors of all objects, p represents the objects in space, and m_i represents the average value of c_i. The basic flow chart of K-means clustering arithmetic is shown in Fig. 1.

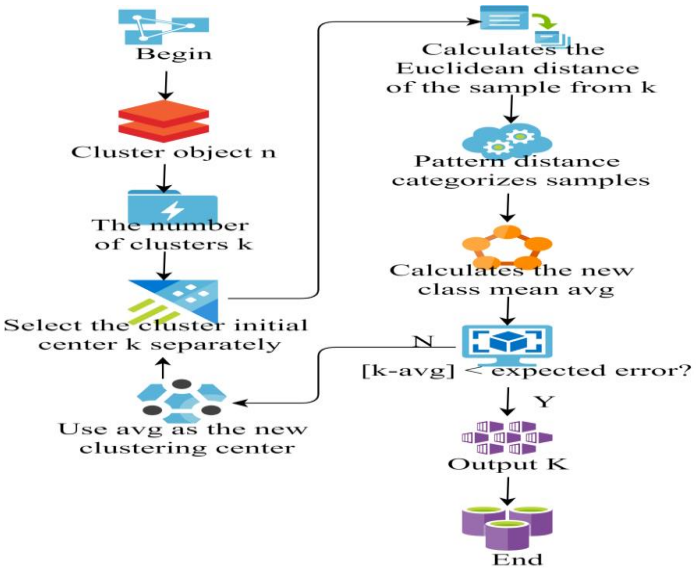

Figure 1: K-means clustering analysis arithmetic flowchart

3.2 Optimization design of mental health research based on Data Mining Technology

The outbreak of COVID-19 has had a significant impact on the mental health of teenagers. Since the outbreak of the epidemic, the mental health of teenagers has shown dynamic changes. At the beginning of the outbreak of the epidemic, the overall level of teenagers' mental health decreased, and negative emotions such as depression and anxiety increased. In addition to emotional problems of different degrees, teenagers also showed physical and behavioral responses such as insomnia and fatigue, chest tightness and headache, and loss of appetite. Some studies also found that home-based teenagers did not have obvious anxiety, but had a high level of perceived stress, and perceived stress was positively correlated with anxiety. The normalization of epidemic

prevention and control has had a great impact on teenagers' thoughts and behaviors, and even greater impact on teenagers with psychological problems. The research shows that in the face of the multi-point epidemic, the closed or semi closed management of the campus, and the continuous epidemic prevention and control work of the school, teenagers cannot travel freely and can only move in the campus every day. Some teenagers have bad emotions such as boredom, panic and anxiety, which bring many new problems and new situations to the physical and mental progress of teenagers and school management. Therefore, combined with the normalization of epidemic prevention and control and the psychological characteristics of teenagers, teenagers' mental health education should be more systematic, institutionalized and scientific. At present, the prediction of teenagers' mental health in universities is mainly focused on the annual Freshmen's psychological census, which focuses on data collection and statistics, without further mining deeper information and summarizing progress laws, resulting in low accuracy of problem prediction. In big data mining, we will discover the regular relationships in key relationship information or attribute categories, and mine the potential information. Through association rule analysis, we will further find out the occurrence of events and lead to the formation of other events in sequence or time. The previous research shows that the mental health status of teenagers has its group characteristics, and the interpersonal problems are obvious. Meanwhile, the effects of different majors, places of origin and social support on mental health are compared and analyzed. The results show that there is a significant correlation between them, with different attribute characteristics. Through data mining technology, useful information is extracted from a large number of teenagers' mental health assessment databases, which can be used as a reference for the prediction of psychological problems of higher vocational teenagers. The specific flow chart of figure 2 is as follows:

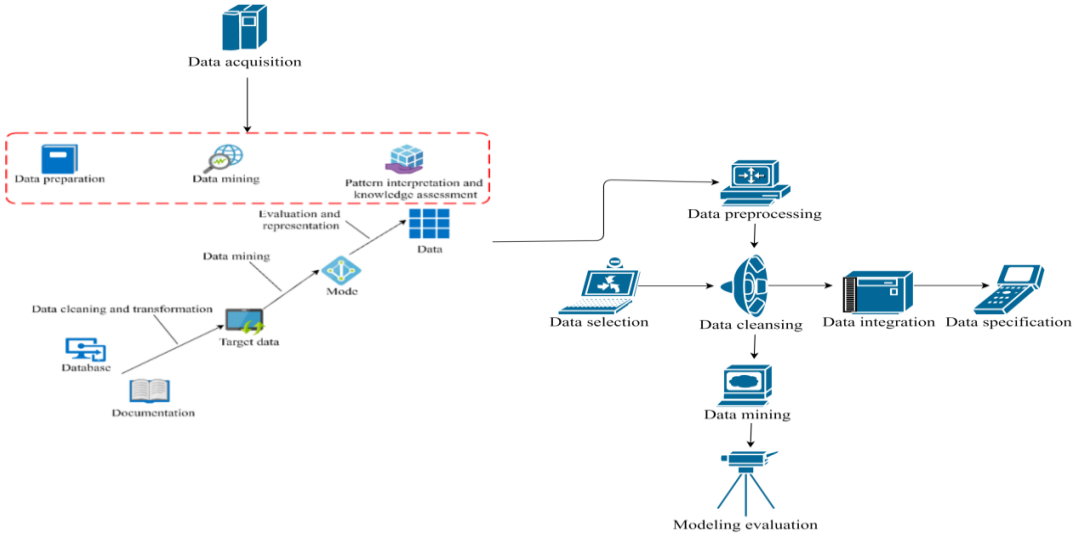

Figure 2: Data mining flow chart of student mental health assessment

Association rules mainly include Apriori arithmetic, FP Tree arithmetic,

grey association way and Eclat arithmetic, among which Apriori arithmetic has a great influence in the application of association rules:

3.2.1. Association Rules and Frequent Item Sets

(1) The probability that both the item set A and the item set B, the representation of association rules, appear together, is called the support degree of association rules, also called the relative support degree:

$$\text{Support}(\text{A} \Rightarrow \text{B}) = \text{P}(\text{A} \cap \text{B}) \tag{4}$$

When the itemset A appears, the probability that the itemset B also appears is the confidence of the association rule:

$$\text{Confidence}(\text{A} \Rightarrow \text{B}) = \text{P}(\text{A}|\text{B}) \tag{5}$$

(2) Minimum support and minimum confidence, we usually call the threshold used to measure support the minimum support, which represents the lowest importance standard of the item set in data statistics. Item sets refer to collections with multiple items. A k item set is composed of k items. For example, the set {table tennis racket, table tennis, sports shoes, badminton} is a 4-item set. Occurrence frequency of itemsets (also known as support count) refers to the number of transactions of all itemsets.

(4) Support count, If the support count of the itemset is known, the support and confidence of the rule $A \Rightarrow B$ can be calculated from the support counts of all transactions, itemset A and itemset $A \cap B$:

$$Support(A \Rightarrow B) = \frac{A, B\ The\ number\ of\ transactions\ that\ accurred\ simultaneously}{The\ number\ of\ all\ transactions}$$
$$= \frac{Support\_count(A \cap B)}{Total\_count(A)} \tag{6}$$

$$Confidence\ (A \Rightarrow B)$$
$$= P(B|A) = \frac{Support(A \cap B)}{Support(A)}$$
$$= \frac{Support\_count(A \cap B)}{Total\_count(A)} \tag{7}$$

As long as the number of all transactions and the support counts of the three item sets of A, B and $A \cap B$ are obtained, the corresponding association rules $A \Rightarrow B$ and $B \Rightarrow A$ can be generated, and finally whether they are strong association rules can be determined.

3.2.2. Apriori Arithmetic: Use Candidates to Generate Frequent Itemsets

(1) Apriori's property all non-empty subsets of frequent itemsets are also

frequent itemsets.

(2) Apriori arithmetic implementation process: By searching all the frequent itemsets, the support cannot be less than the set minimum support threshold. In the search process, the connection step and the pruning step are connected and the largest frequent itemsets can be obtained after multiple cyclic operations.

Connection step: the main purpose of the connection step is to find K item sets. For the set minimum support threshold, the one item frequent set L_1 is obtained by removing the value less than from the one item candidate set C_1; Next, two candidate sets C_2 are generated through L_1 connection, and two frequent sets L_2 are obtained by keeping the item sets that meet the restriction conditions inC_2; In the next step, three candidate sets C_3 are generated by connecting L_2 and L_1, and three frequent sets L_3 can be obtained by saving the item sets in C_3 that meet the restriction conditions. The maximum frequent item set L_k can be generated by continuing the above loop operation.

Pruning step: The operation after the connection step is the pruning step, which mainly reduces the search range in the process of generating the candidate items C_k. Since L_{k-1} and L_1 are connected to generate candidate items C_k, due to the nature of the Apriori arithmetic of association rules, all non-empty subsets of the frequent item set must also be frequent item sets. The item set that does not conform to the arithmetic property will not be saved in the candidate item C_k, thus completing the pruning operation. Strong association rules generated by frequent itemsets: it can be known from process 1 that itemsets not greater than the preset minimum support threshold have been removed.

4. Result Analysis and Discussion

According to the latest findings of the coronavirus pneumonia survey, about 99.65% of teenagers can understand the cause, basic situation and severity of the epidemic through mobile network media. However, due to the multi-channel spread of the epidemic, some teenagers have panic, anxiety, depression and other negative emotions. The psychological crisis caused by the epidemic cannot be eliminated immediately and the infectious disease cannot be ended in time. The repair of mental health problems is a slow process. Teenagers' psychological performance also includes lack of thinking, weak will and psychological fatigue. The deep-seated reasons are mainly teenagers' lack of understanding, weak social consciousness, inaccurate self-positioning, immature psychology, unclear and inadequate career planning, and their addiction to the virtual world to escape from reality. At the same time, it is also related to the social environment. Sex is subdivided into categories, and then the teenagers' mental health is objectively and rationally analyzed through the

systematic data analysis function and thus establish a management mechanism with practical reference value. The cluster analysis is used to determine the classification of the student health data. In this example, the best number is 3 categories. The cluster distribution table shows the frequency of each category. According to the 1000 teenagers in the existing spot check database, 525 teenagers are divided into cluster 1 and 456 teenagers in cluster 2. Among them, 19 teenagers are excluded from the system due to lack of data. The two-dimensional distribution map of clustering analysis obtained from the data is shown in Fig. 3.

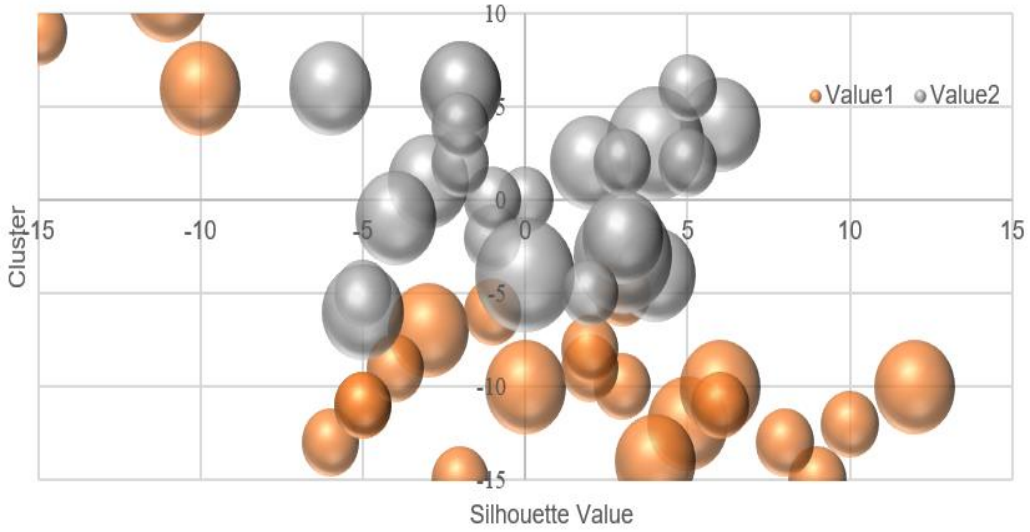

Figure 3: Cluster analysis of teenagers' mental health

From the outline map, there are a few teenagers in the first-class group and the second-class group who are close to each other. Some teenagers in the second-class group are disturbed by the data of the first class, and some points fall into the first-class group. Because of the introduction of inspection indicators to delete association rules, this article uses iris data set to verify. Figure 2 shows the support, confidence, three test indicators and their weight indicators of some rules.

The error rate of the rule is generally large, and the larger the error rate, the greater the probability of error in the prediction of the rule. Therefore, in the weight analysis, the influence of the error rate should be reduced, and the proportion should be placed on the correlation coefficient and the leverage ratio. It can be seen from Fig. 4 that the error rate of rule29 is large, but the comprehensive weight analysis is not affected by the error rate and becomes large but very low. This shows that rule29 is a redundant rule and will be identified and deleted. The error rate of rule21 is very low, the correlation coefficient reaches 3, and the confidence is the highest, indicating that this is a strong rule.

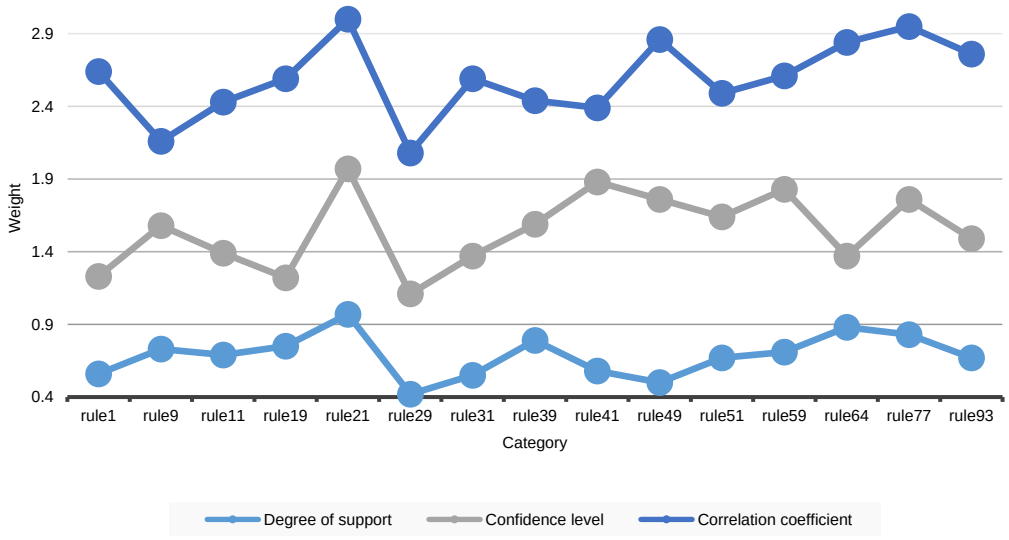

Figure 4: Three detection indexes and their weight indexes of partial rules

The classical Apriori arithmetic traverses the database many times, resulting in a large number of intermediate process sets and a large load on the I / O of the system. Therefore, by deleting the unsatisfied item sets in advance in the above way, the number of candidates item sets is reduced as much as possible, and the improved Apriori arithmetic is proposed. The databases of different levels are introduced, and the number of data records is 20-300. Put the same transaction data set into the two arithmetic scripts to run. The running time (in milliseconds) obtained is shown in Figure 5:

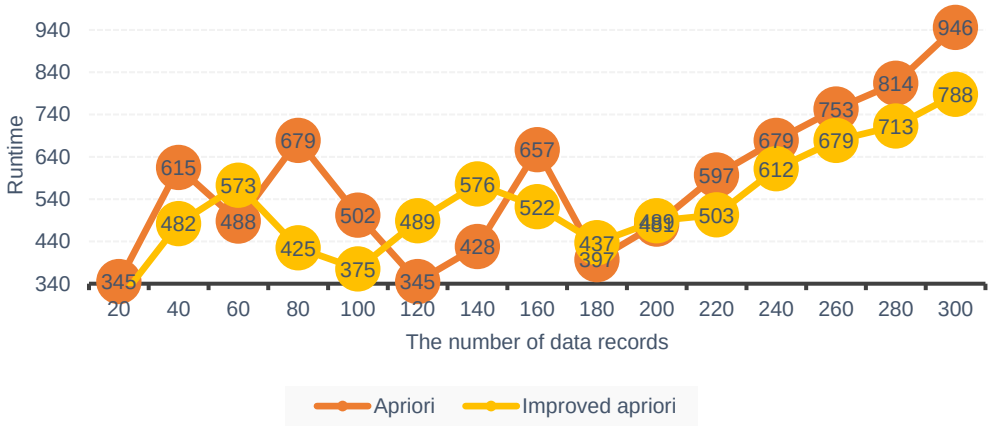

Figure 5: running time of classical and improved Apriori arithmetic under different record numbers

It can be observed that the improved arithmetic does perform better and more efficient than the original arithmetic in terms of running time. With the continuous increase of the number of records in the data set, the improvement effect is more obvious. In addition, setting different support levels also has a certain impact on the running time of the arithmetic. Generally, we set the

minimum standard of support level to 0.05, which can basically meet the requirements of mental health monitoring. However, according to the actual conditions of different times and different objects, we can set the support level to higher or lower. In this article, the reliability is maintained at 0.8. When we adjust the support level threshold to 0.05-0.8, The execution time is also different. It can be observed that the lower the support, the longer the arithmetic execution time, as shown in Figure 6 below:

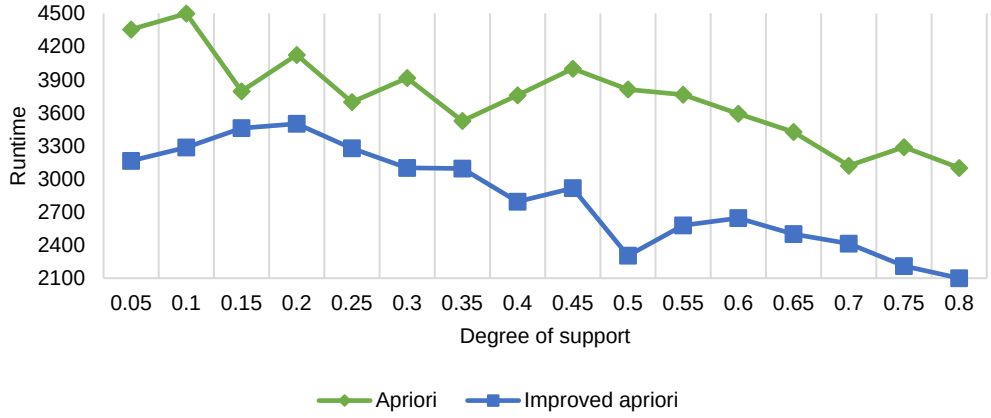

Figure 6: Running time of classical and improved Apriori arithmetic under different support

Similarly, we speculate that setting different confidence levels will also have some impact on the running time of the arithmetic. In general, we set the minimum standard of confidence level to 0.8, and we can adjust the confidence level threshold according to actual needs. In this case, the support level is maintained at 0.4. When we adjust the confidence level threshold to 0.5-10, the execution time also has slight differences. However, there is no obvious trend, and the running time of the two arithmetic's is basically stable. Therefore, setting different confidence levels will not have a great impact on the arithmetic, as shown in the following figure:

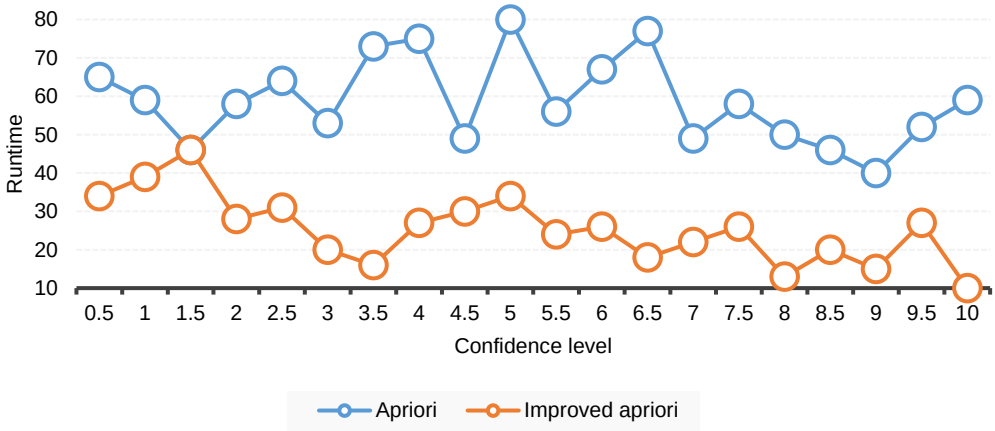

Figure 7: Running time of classical and improved Apriori arithmetic under different confidence levels

5. Conclusions

Physical Education (PE) is pivotal in enhancing the stress resilience, mental health, and interpersonal relationships of teenagers. This study conducts an analysis and tests the impact of PE duration on the mental health levels of adolescents, as well as other intermediary mechanisms. The findings indicate that social support significantly mediates the relationship between PE and resilience. This suggests that social support might be an external protective factor that enables teenagers to obtain peer support, social psychological resources, and develop resilience during their engagement in PE activities. This article proposes an optimized design scheme for the exploration of the mental health education of teenagers under the background of the normalization of epidemic prevention and control, classifies all the mental health problems of teenagers under the influence of the epidemic through cluster analysis, mines valuable information hidden in the psychological problems of teenagers through data mining technology, Provide scientific basis for the prevention and solution of teenagers' mental health, and finally conduct simulation test and analysis.

The simulation results show that the proposed arithmetic has a certain accuracy, which is 10.25% higher than the traditional arithmetic. This result fully shows that the mental health evaluation system of teenagers is designed on the basis of cluster analysis, and the data mining technology is applied to the psychological system, which realizes the automation of the collection of information of teenagers and psychological evaluation information. Through the application of data mining technology, the depth of data analysis of psychological problems is increased, and the feasibility of using data mining technology in mental health assessment system is verified.

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