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Article

Bayesian Network Model-Based Assessment of the Role of Music Intervention in Volleyball Players' Physical Recovery

Dan Lv [1], Li Zhou [2,*], Wei Li [2] and Yan Wang [2]

[1] School of Physical Education, Inner Mongolia University, Hohhot, Inner Mongolia, 012000, China
[2] School of Art and New Media, Shijiazhuang Institute of Technology, Shijiazhuang, Hebei, 050228, China
* Correspondence author: bingshanlanhu@163.com

Abstract: This paper proposes to explore the mechanism of music therapy's influence on volleyball players' physical recovery under the acquisition of music therapy's extensive mechanism of action. Relevant factors affecting volleyball players' physical recovery are pointed out, including physics, biology, training and psychology. Analyze the composition of Bayesian network and the analysis process, and establish the Bayesian network model of volleyball players' physical recovery. Analyze the role of each influencing factor on the physical recovery of volleyball players, and get the size of the mechanism of music therapy in the physical recovery of volleyball players. Functional music for sports was selected to analyze the effect of music therapy on special intervention for volleyball players. The two-factor repeated measures variance was used to analyze the physical fatigue test data of the experimental group and the control group, and the results showed that the music regulation method has a significant effect on relieving volleyball players' fatigue. Music therapy can act on volleyball players by regulating psychological states, as well as positively affecting them through the body's biological response to vibrating music.

Keywords: bayesian network; music therapy; sport functional music; volleyball players

1. Introduction

As society continues to evolve, sports competitions have made significant progress, with athletes' physical fitness increasingly coming under scrutiny. Physical fitness refers to the skills and capabilities of the human body's organs and systems, as well as the abilities demonstrated during sports activities. It encompasses basic physical qualities such as strength, speed, endurance, and flexibility, as well as the fundamental motor skills exhibited in physical movements [1]. For volleyball athletes, physical fitness is the key to mastering and improving athletic techniques. Good physical fitness serves as the foundation and guarantee for enhancing volleyball performance capabilities [2]. During competitions, volleyball athletes repeatedly pass the ball, resulting in a significantly elevated heart rate per minute. Following intense competition, lactic acid levels in muscles do not undergo noticeable changes, leading to a cyclical alternation in neural system control within muscles. This process causes substantial physical exertion, accumulating micro-damage in muscles and impairing the ability to participate in consecutive matches [3-6]. As sports competitions become increasingly intense, athletes' actual training intensity gradually increases. Utilizing reasonable recovery techniques can effectively restore athletes' physical strength, reduce fatigue, enhance overall physical skills, and improve athletes' comprehensive physical fitness [7-9]. If fatigue and reduced physical performance caused by overexertion are not promptly addressed, they may exacerbate fatigue and muscle weakness, directly impairing athletic performance and potentially leading to sports injuries, thereby threatening athletes' health [10-11].

In modern society, as attention to mental and physical health continues to grow, various innovative intervention methods have emerged, with music intervention being one of the most prominent and uniquely compelling approaches. Music intervention is not simply listening to music but a purposeful, planned, and structured intervention process aimed at improving people's physiological, psychological, cognitive, and social functions through the power of music [12]. The application of music therapy is

extremely broad. In the medical field, for patients with neurological disorders such as Parkinson's disease and Alzheimer's disease, music therapy can help improve motor coordination, attention, and memory [13-14]. For children with autism, music can serve as a bridge for communication with the outside world, helping them express emotions and enhance social interaction skills [15]. In psychological therapy, music therapy can help patients with anxiety and depression alleviate tension, release inner stress, and regain inner peace and tranquility [16-17]. Gradually, music intervention has been introduced into the field of sports, where it plays a unique role in providing effective assistance to athletes.

Study [18] found that listening to fast-paced, uplifting music during the recovery phase after high-intensity exercise can increase athletes' sense of well-being and promote psychological comfort. Study [19] summarized multiple studies showing that listening to music before, during, and after exercise can effectively improve direct negative emotions, alleviate pain, and reduce associated negative emotions. Literature [20] mentions that listening to music can regulate athletes' physiological phenomena such as heart rate, adrenaline, and muscle activity, thereby enhancing athletic performance, while athletes' music preferences can influence their energy metabolism and psychophysiological responses. Literature [21] reports that music intervention has no effect on alleviating subjective fatigue or improving average power during high-intensity interval training, but it is effective in increasing peak power, emphasizing that the selection of music and timing of intervention are extremely important. Literature [22] tested that slow-tempo music intervention after intense exercise helps restore athletes' heart rate and heart rate variability balance, aiding in the prevention and reduction of arrhythmia and sudden cardiac death risks. Literature [23] conducted music intervention during a sports test, which enhanced athletes' exercise motivation, alleviated fatigue duration, and promoted continued exercise, while slow-tempo music reduced heart rate. It is evident that music intervention methods have a positive impact during athletes' recovery periods and are widely utilized.

In volleyball, literature [24] reviews that post-match recovery strategies relying on nutrition and sleep supplementation are effective, while cold water immersion and laser therapy have certain limitations. Effective recovery strategies can also prevent injuries. Literature [25] conducted music intervention on athletes under a fixed nutrition strategy, which helped improve athletes' physical performance and recovery, with the most significant effect within 10 minutes post-exercise. The results of study [26] indicate that meditation-based cognitive training and music training interventions help alleviate mental fatigue in volleyball athletes, though they have no significant effect on physical fatigue relief. Study [27] confirms that combining aerobic fitness exercises with music enhances volleyball athletes' specialized performance and promotes recovery, with this method showing more significant effects in female athletes. While there is limited research on the role of music intervention in physical recovery in volleyball, music intervention is widely recognized as a low-cost measure that aids athlete recovery. Therefore, assessing the role of music intervention in physical recovery in volleyball is important for helping athletes develop training plans and prevent injuries.

Bayesian networks are graphical models used to represent and reason about uncertainty. They use directed acyclic graphs to represent dependencies between variables and probability distributions to represent the joint distribution of variables, clearly illustrating the relationships between these variables and enabling accurate analysis and evaluation of the overall system. This provides support for assessing the physical recovery of volleyball athletes under music intervention [28-29].

In this paper, we understand the action mechanism of music therapy from four dimensions, combined with the influencing factors of volleyball players' physical recovery, and constructed the volleyball players' physical recovery model using Bayesian network model. Combining the Bayesian network related theorem and the Bayesian network process and parameter learning method, using 1~7 to measure and obtain the intensity of the influence of each influencing factor on the volleyball player's physical recovery. Bring in music therapy factors to clarify the degree of influence of music therapy on volleyball players' physical recovery. To analyze the effect of sport functional music on the physical fitness specific intervention of volleyball varsity players in the experimental group using a comparative test. Compare the degree of volleyball players' fatigue recovery in the baseline, mid-test, and post-test, and analyze the effect of music intervention on alleviating volleyball players' physical fatigue.

2. Music Therapy, Physical Training for Athletes

2.1. Importance of Athletes' Physical Training for Modern Volleyball

Modern volleyball is characterized by technological and comprehensive, and the technical system is more perfect, which puts higher requirements on athletes' physical fitness. So it is necessary to strengthen the training in order to be better engaged in the game. Combining modern volleyball and the athletes' own characteristics, a scientific and reasonable training program is formulated after in-depth analysis to ensure that the ideal effect is achieved. Effective training can enhance the athletes' physical fitness, so

that they can play their best in the game and achieve the final victory.

Physical training refers to the use of specialized training to enhance the overall quality of the athlete, can better adapt to the game, effectively improve their own competitive level. Athletes' physical fitness can be affected by genetic factors, but it can be improved through acquired training, and great potential can be tapped.

With the development of modern volleyball, the level of athletes from all over the world has been greatly improved, and it is very difficult to win in the competition, which requires athletes to deal with the relationship between physical fitness, skills, and mental ability to ensure that they can play their best in the game. Among them, physical fitness is the foundation, only with good physical fitness, in order to persist in the high-intensity competition. Through scientific research, it has been shown that only athletes with good physical fitness can give full play to their tactics in the game, so as to gain an advantage.

Good physical fitness can allow athletes to withstand greater loads, avoiding injuries during the game, thus extending the life of the sport. Modern volleyball games are more intense confrontation, requiring athletes to have good physical fitness, so in daily life to strengthen the training. The analysis of the athlete's own characteristics and the competition environment, as the basis for the development of training programs, reflecting the scientific and personalized characteristics, to further enhance the physical fitness of the athletes, and to achieve more excellent results in the competition [30].

2.2. Mechanisms of Action of Music Therapy

2.2.1. Regulation of Physiological Rhythms and Homeostasis through the Neuroendocrine System

Music activates neurons in the relevant areas of the cerebral cortex through the auditory pathway, and subsequently transmits these nerve signals to the auditory cortex and other relevant areas of the brain for processing. It also affects endocrine structures such as the hypothalamus and pituitary gland through the nerve conduction pathway, stimulating the release of a variety of biologically active substances, which in turn regulates local blood flow, increases the supply of oxygen and nutrients to the tissues, enhances cellular excitability, improves nerve conduction and information processing, and strengthens cardiovascular function, promoting blood circulation and heart health. It also enhances digestion and absorption, regulates hormone secretion, and maintains homeostasis in the body, thus maintaining normal physiological rhythms and psychological balance and promoting overall health. In addition, music therapy may regulate the balance of neurotransmitters in the brain by promoting brain tissue regeneration and neurotransmitter release.

2.2.2. Regulation of Physiological Functions by Acoustic Vibration

Music, as a complex and harmonious sonic vibration, may trigger resonance phenomena in the cranial, thoracic and abdominal cavities and their internal organs and tissues once it enters the human body. This resonance phenomenon may have an effect on the physiological functions of the body, covering aspects such as brain electrical activity, heart and respiratory rhythms. In addition, musical sound waves may also produce effects by modulating the vibrational state of the body's cells. This modulation results in a more harmonized cellular vibration, similar to a cellular massage, and helps to regulate the level of cellular excitation or inhibition, thereby promoting improved body functions.

2.2.3. Maintaining Physical and Mental Health by Regulating Mental States

On the physiological level, music affects anxiety-related physiological responses, such as heart rate and blood pressure, and can calm or stimulate a sense of arousal in patients. On the psychological level, music can prompt clients to consciously or unconsciously engage in self-reflection or introspection while listening intently. In the process of enjoying music, people often feel the passage or change of time and space, thus getting rid of the disturbance of daily life. This effect has a positive impact on mental health, helping to heal and maintain physical and mental health.

Overall, emotional inhibition leads to an imbalanced mental state, and effective expression of emotions is key to reducing stress. Music provides an outlet for emotional catharsis, which can effectively regulate psychological states and have a positive effect on physical and mental health.

2.2.4. Influence through the Body's Biological Response to Vibrational Music

Somatosensory vibration music therapy, also known as vibration acoustic therapy, is a music therapy technology, through the way of "the body perceives music", the low-frequency signal in the music is amplified and physically transduced, and the "bone conduction mode" and psychological and physiological dual stimulation are used to act on the patient's body and mind. The therapy converts

low-frequency sound waves into mechanical vibrations that act directly on the body, producing physiological and psychological effects. Low-frequency vibrations can penetrate tissues, promote local blood circulation, increase oxygen and nutrient supply, and reduce muscle tension and pain.

3. Analysis of the Effect of Music Therapy on the Physical Recovery of Volleyball Players

3.1. Bayesian Networks

A Bayesian network is a probabilistic graphical model. Since Bayesian networks can compute the conditional probability of any set of random variables, they are often used to discover potential probabilistic relationships between variables. Thanks to its intuitive graphical approach, simple and easy-to-understand probabilistic theoretical foundations, and a variety of effective network structure learning and parameter learning methods, Bayesian networks have become one of the dominant methods for the study of uncertainty and inference techniques in the field of artificial intelligence today, and have been applied in various fields. For example, pathology diagnosis, space technology, fault dispute in communication networks, decision support, etc. [31].

3.1.1. Bayes' Theorem

Bayes' theorem is the foundation of Bayesian networks and mainly portrays the relationship between conditional probabilities. The specific relationships are as follows:

$$P(A \mid B) = \frac{P(B) \times P(B \mid A)}{P(B)} \tag{1}$$

In the Bayesian formula:

$P(A)$ is the prior probability (marginal probability) of the event A denoting the probability that event A occurs.

$P(A \mid B)$ is the conditional probability of the event A after the occurrence of the known event B, called the posterior probability of A.

$P(B \mid A)$ is the conditional probability of the event B after the occurrence of the known event A, called the posterior probability of B.

$P(B)$ denotes the probability of event B occurring and is the prior probability (marginal probability) of event B.

The Bayesian formula also applies to the more general case. Event B contains the set of events $\{B_1, \cdots, B_m\}$, and to study the probability of event A occurring if event B occurs, the posterior probability of event A is calculated by applying Bayes' formula:

$$P(A \mid B_1, \cdots, B_m) = \frac{P(B_1, \cdots, B_m \mid A) P(A)}{P(B_1, \cdots, B_m)} \tag{2}$$

In this paper, A represents the degree of physical recovery of volleyball players, and B represents a series of influencing factors, which are material therapy factors, music therapy factors, and so on.

3.1.2. Components of Bayesian Networks

Definition 1: A Bayesian network B is a three-dimensional array (X, A, P) where:

(a) X is a collection of nodes including variables such as light, electricity, temperature physical therapy, etc.

(b) is a series of directed connected line segments pointing out the interaction between variables, which together with the set of nodes X form the directed connected graph of a Bayesian network, i.e. $G = (X, A)$.

(c) The conditional probability between each child node and its parent node is:

$$P = \{P(x \mid pa(x)) : x \in X\} \tag{3}$$

where $Pa(X)$ is some parent of node X, denoted here by $pa(x)$, and P represents the probability.

Definition 2: The prior joint probability P_B of a Bayesian network B is defined as follows:

$$P_B(X) = \prod_{x \in X} P(x \mid pa(x)) \tag{4}$$

Then the prior joint probability of the Bayesian network B is:

$$P_B(X) = P(A) \times P(B) \times P(C \mid A, B) \times P(D \mid C) \tag{5}$$

Definition 3: If y_j represents the j th state of a child node, and x_{ij} represents the j th state of the parent node for any parent node $X_i = (x_{i1}, \cdots, x_{im})$, then the joint probability $P(Y = y_j, X_i = x_{ij})$ is:

$$P(Y = y_j, X_i = x_{ij}) = P(X_i = x_{ij}) \times P(Y = y_j \mid X_i = x_{ij}) \tag{6}$$

In a Bayesian network, $P(X_i = x_{ij})$ is the prior probability of the parent node. $P(Y = y_j \mid X_i = x_{ij})$ is the prior conditional probability under this condition, which can be calculated from the conditional probability table.

Take a Bayesian network as an example to explain the process of calculating this conditional probability. Assuming that all the nodes of the Bayesian network have only two states, occurrence and non-occurrence, it is necessary to know the probability that node A occurs when node C occurs, i.e., to find the probability $P(C \mid A)$. Since node C has another parent node B, the extension of $P(C \mid A)$ is obtained:

$$P(C \mid A) = P(C, B \mid A) + P(C, \overline{B} \mid A) \tag{7}$$

Expand the first term, get:

$$\begin{aligned} P(C, B \mid A) &= \frac{P(C, B, A)}{P(A)} = \frac{P(C \mid B, A) P(B, A)}{P(A)} \\ &= P(C \mid B, A) P(B \mid A) = P(C \mid B, A) P(B) \end{aligned} \tag{8}$$

Id:

$$P(C, \overline{B} \mid A) = P(C \mid \overline{B}, A) P(\overline{B}) \tag{9}$$

Bringing in can be obtained:

$$P(C \mid A) = P(C \mid B, A) P(B) + P(C \mid \overline{B}, A) P(\overline{B}) \tag{10}$$

where the probability values at the right end of the equation are given in the conditional probability table, i.e., they are all known.

Definition 4: The prior edge probability $P(Y = y_i)$ of a child node is defined as:

$$P(Y = y_i) = \sum_{j}^{m} P(X_i = x_{ij}) \times P\left(Y = y_j \mid X_i = x_{ij}\right) \tag{11}$$

Definition 5: The posterior probability $P(X_i = x_{ij} \mid Y = y_i)$ is defined as follows:

$$P\left(X_i = x_{ij} \mid Y = y_i\right) = \frac{P(Y = y_i, X_i = x_{ij})}{P(Y = y_i)} = \frac{P(X_i = x_{ij}) \times P(Y = y_j \mid X_i = x_{ij})}{P(Y = y_i)} \tag{12}$$

In this paper, x_{ij} represents a certain state of some influencing factor. y_j represents a certain level of physical recovery.

Since a Bayesian network is a graphical tool, it can be understood both qualitatively and theoretically. From a qualitative point of view, i.e., looking at the topology of a Bayesian network, one can see the dependence and independence between individual random variables. If two nodes are connected by a directed line segment, then there is a dependency between these two, if not, then these two are independent. On a quantitative level, the Bayesian network portrays the degree of probabilistic dependence between nodes as it allows for the calculation of a conditional probability distribution table for each node.

3.2. Bayesian Network Modeling for Volleyball Players' Physical Recovery

3.2.1. Factors Affecting Physical Recovery in Volleyball Players

The purpose of constructing the index system of factors affecting volleyball players' physical recovery is as follows:

(1) To provide a basic set of factors for the construction process of Bayesian network.

(2) Improve the efficiency of Bayesian network structure learning.

(3) To clarify the interrelationship between music intervention and volleyball players' physical recovery.

The summary of factors affecting volleyball players' physical recovery is shown below:

(1) Training science method: mainly refers to the rational arrangement of the rhythm of training in arranging physical training for many years, throughout the year and in each unit.

(2) Physical methods: mainly the use of physical methods, mainly the use of light, electricity, temperature, pressure and other physical stimulation, in order to accelerate the microcirculation of the body in order to achieve the effect of blood circulation and dissipation of stagnation.

(3) Medical and biological methods: mainly according to the project characteristics of the athlete after training in a timely manner to replenish the organism's consumption.

(4) Psychological methods: coaches can consider using language tips, hints, induction and other psychological training methods to regulate the function of the athlete's cerebral cortex and accelerate the elimination of fatigue. The main methods are natural suggestion, relaxation training and biofeedback and music therapy.

3.2.2. Bayesian Network Process

The process of building a Bayesian network can be divided into three steps as follows:

(1) Define the network variables and their values: network variables can be divided into three types, which are query variables, evidence variables and intermediate variables. Query variables are variables that need to be solved. Evidence variables are variables that need to be asserted as evidence. Intermediate variables are neither query nor evidence and are intended to aid in modeling by detailing the relationship between evidence and query variables. Query and evidence variables can usually be identified from the statement of the problem. Intermediate variables are less easy to identify and may depend on modeling decisions. Nodal variables can be subdivided into continuous and discrete variables, and variables with continuous values are discretized in the study.

(2) Define the network structure: this indicates the need to determine the edges connecting the network, the determination of the network structure is determined by the causal relationships between the variables in the network, therefore the determination of the network structure can be reduced to answering the question about each network variable X.

(3) Define the conditional probability table: based on the final structure of the obtained Bayesian network, the conditional probability table of each node in the topology of the Bayesian network is determined through the learning of the training data, and after completing the learning of the topology and parameters of the Bayesian network, the learning process of a complete Bayesian network that can be used for predictive inference is finished.

The specific construction process of the Bayesian network is shown in Figure 1.

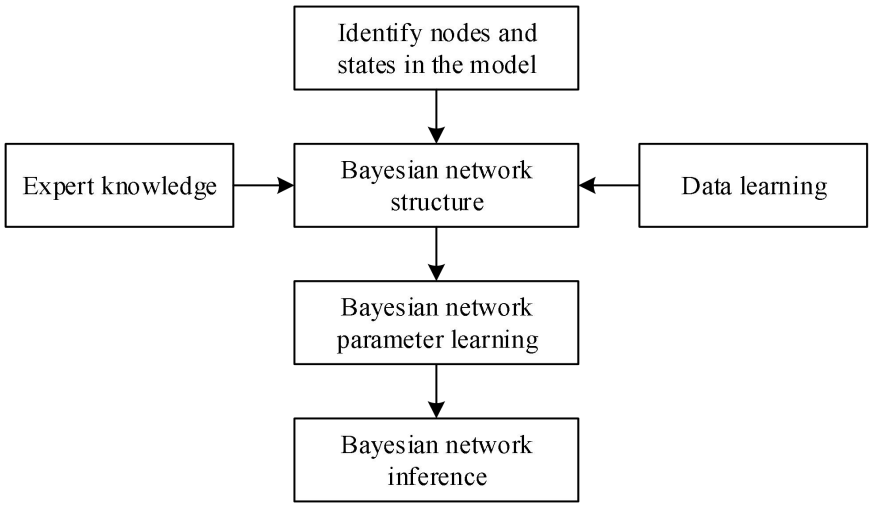

Figure 1. The specific construction process of the beeses network.

3.2.3. Bayesian Network Parameter Learning

Due to the evaluation of each index has a certain degree of subjectivity, and it is difficult to give a precise expression. Therefore, this paper describes the random variables with the help of the concept of fuzzy set, and introduces seven linguistic variables "very low, low, low, medium, high, high, very high" to represent the factor measurement results of the input layer variables. This part of the data is obtained from the questionnaire, and in order to facilitate parameter learning and knowledge inference, the linguistic results and the triangular fuzzy number correspond to each other, and the results of the risk measurement are converted into specific triangular fuzzy number.

The correspondence between the evaluation level and the triangular fuzzy number is shown in Table 1.

Table 1. The evaluation level corresponds to the triangle fuzzy number.

Risk level	Triangular ambiguity	Corresponding questionnaire evaluation level
Very low (VL)	(0.0,0.0,0.1)	1
Low (L)	(0.0,0.1,0.25)	2
(FL)	(0.1,0.25,0.5)	3
Medium (M)	(0.25,0.5,0.7)	4
(FH)	(0.5,0.7,0.9)	5
High (H)	(0.7,0.9,1.0)	6
Very high (VH)	(0.9,1.0,1.0)	7

In this paper, through the form of questionnaire survey, we take 1~7 to measure and obtain the intensity of the influence of each influence factor on the physical recovery of volleyball players.

In this paper, it is assumed that each state node of volleyball player's physical recovery is a fuzzy measure, the affiliation function is A, the value of affiliation is m when the affiliation degree is 1, the upper limit and the lower limit are a and b respectively, $b-a$ indicates the fuzzy degree of the node, and the larger the value is, the larger the fuzzy degree is. Then the whole risk system affiliation set A is denoted as $A \cong (a,m,b)$ and the affiliation function is:

$$\tilde{A}(x)=\begin{cases}0, & x<a \text{ Or } x>b \\ \dfrac{x-a}{m-a}, & a\le x\le m \\ \dfrac{b-x}{b-m}, & m\le x\le b\end{cases} \tag{13}$$

In order to obtain the a priori probability value of each state node, the triangular fuzzy numbers corresponding to the questionnaire data are processed, which mainly includes homogenization, defuzzification and normalization.

(1) Homogenization

Homogenization applies the method of arithmetic averaging, in which the results of the acquired measures are arithmetically averaged. Adopting this process mainly cleans the data in the training set, removes individual outliers and invalid values, so that the fuzzy probability of each node can converge to a reasonable range. The specific formula is:

$$\tilde{p} = \frac{p_1 + p_2 + \cdots + p_n}{n} = \left(\tilde{a}, \tilde{m}, \tilde{b}\right) \tag{14}$$

The triangular fuzzy number of x_i is averaged separately, and the result after node averaging follows the form of fuzzy set consisting of upper, lower and intermediate values. The statistics of the mean value of the triangular fuzzy number of each input node x_i is shown in Table 2.

X1-X10 are X1 Physical Basic Training, X2 Physical Specialized Training, X3 Electrotherapy, X4 Phototherapy, X5 Temperature Therapy, X6 Medical and Biological Methods, X7 Psychological Methods, X8 Relaxation Training, X9 Biofeedback, and X10 Music Therapy, respectively.

Table 2. The triangle fuzzy number mean statistics.

Node	The mean of the triangle	Node	The mean of the triangle
X1	(0.15,0.39,0.47)	X6	(0.21,0.36,0.64)
X2	(0.18,0.35,0.52)	X7	(0.25,0.31,0.66)
X3	(0.12,0.28,0.41)	X8	(0.13,0.25,0.57)
X4	(0.26,0.22,0.68)	X9	(0.11,0.25,0.38)
X5	(0.18,0.26,0.55)	X10	(0.26,0.38,0.62)

(2) Defuzzification and normalization

In the process of averaging calculation, the result calculated after averaging each state node consists of fuzzy data, which needs to be processed to determine the probability value in order to obtain the probability measure of the Bayesian network. Through the method of averaging area, the triangular fuzzy number after taking the mean value is defuzzified to obtain the exact probability value of the node P'. The specific formula is expressed as:

$$P'' = \frac{\tilde{a} + 2\tilde{m} + \tilde{b}}{4} \tag{15}$$

The probability value of the corresponding state of each node has been obtained after the completion of homogenization and defuzzification, but in order to satisfy the condition that the sum of the probability value of the occurrence of each state of the node is 1, i.e., normalization, the probability value of each node state is normalized so as to obtain the a priori probability value of the node of each state. The normalization process is shown in the following equation:

$$P_i = \frac{P'}{\sum_{i=1}^{2} P'} \tag{16}$$

In accordance with the above principle, the defuzzification and normalization processes are completed sequentially by the triangular fuzzy number mean statistics, and the results of the above table are brought into Eq. (16) to obtain the a priori probability of each node, respectively.

The a priori probabilities of the state nodes are shown in Table 3.

Table 3. Prior probability of state nodes.

Node	Low	High	Node	Low	High
X1	0.61	0.32	X6	0.78	0.22
X2	0.69	0.26	X7	0.63	0.35
X3	0.76	0.31	X8	0.75	0.21
X4	0.71	0.27	X9	0.79	0.26
X5	0.63	0.30	X10	0.72	0.34

The implied nodes other than the state nodes can be calculated according to the Bayesian formula, which is given as:

$$P(Y_1, Y_2, \ldots, Y_5, H) = \frac{\prod_j P(Y_j \mid parent(Y_j)) \prod_i P(X_i \mid parent(X_i))}{\prod_i P(X_i)} \quad (17)$$

According to the questionnaire to obtain the data and the results of processing the data after defuzzification are calculated, combined with the expert experience knowledge, probability correction and other processes as the initial parameter state of the Bayesian network, which provides the basis for the subsequent risk evaluation. Among them, the a priori probability value of the occurrence of X10 node is higher, and it can be known that music intervention is a high influence factor.

3.3. Analysis of the Effectiveness of Functional Music for Sports on Volleyball-Specific Interventions

This paper takes the effect of sports functional music on volleyball players' physical fitness as the research object of this paper. After designing intervention experiments and questionnaires, combined with the objective analysis of volleyball-specific physical fitness test indexes and the subjective evaluation of questionnaire aspects, so as to verify the scientificity and feasibility of the application of sports functional music in volleyball-specific physical fitness training.

The questionnaire was initially distributed 20 copies, 20 copies were recovered, with a recovery rate of 100%. 14 days later, the re-test questionnaire was distributed 20 copies, 20 copies were recovered, with a recovery rate of 100%. The expert initial screening questionnaire was initially distributed 6 copies, 6 copies were recovered, with a recovery rate of 100%. 14 days later, the retesting questionnaire was distributed 6 copies, with 6 copies recovered, with a recovery rate of 100%.

This time, a university group of volleyball varsity players in Guangzhou City was used as the experimental group, whose age stage was 18~23 years old, who had received professional volleyball training for a long time and had a high volleyball literacy. According to the opinion of the volleyball coach of the school department, they were divided into experimental group and control group. The experimental group added music therapy to the physical recovery training of volleyball players.

In accordance with the scope of application of the T-test and related regulations, the data obtained before and after the experiment were subjected to descriptive statistical analysis normality test, mainly using the Shapiro-wilk test, and the significance level was set at P>0.05.

The normal distribution test of the results of the specialized physical fitness test of the experimental class is shown in Table 4.

Table 4. Test results of the test results of the experimental class.

Group	Tertiary index	Premeasurement			Posttest		
		Statistics	Freedom	Significance	Statistics	Freedom	Significance
Experimental group	Height	0.915	32	0.315	-	-	-
	Weight	0.960	32	0.745	-	-	-
	Body mass index	0.901	32	0.513	-	-	-
	TRX-left	0.975	32	0.987	0.945	32	0.834
	TRX-right	0.925	32	0.733	0.971	32	0.912
	Jump test	0.964	32	0.647	0.898	32	0.364
	30 meters fast	0.972	32	0.901	0.903	32	0.337
	10m start running	0.988	32	0.781	0.912	32	0.856
	Arrow run - left	0.966	32	0.825	0.987	32	0.451
	Arrow run - right	0.829	32	0.246	0.922	32	0.673
	Preflexion	0.896	32	0.839	0.971	32	0.881

The normal distribution test of the results of the specialized physical fitness test of the control group is shown in Table 5. Combined with Table 4 and Table 5 in the analysis can be seen, the experimental

group, the control group body shape, sports quality indicators before and after the experimental data Shapiro-wilk test P-value is greater than 0.05, the data is normally distributed, can be analyzed by T-test.

Table 5. The control group's special fitness test results were tested by normal distribution.

Group	Tertiary index	Premeasurement			Posttest		
		Statistics	Freedom	Significance	Statistics	Freedom	Significance
Control group	Height	0.871	32	0.812	-	-	-
	Weight	0.814	32	0.241	-	-	-
	Body mass index	0.924	32	0.362	-	-	-
	TRX-left	0.757	32	0.925	0.924	32	0.724
	TRX-right	0.912	32	0.933	0.973	32	0.912
	Jump test	0.926	32	0.954	0.968	32	0.933
	30 meters fast	0.934	32	0.961	0.942	32	0.524
	10m start running	0.953	32	0.925	0.952	32	0.754
	Arrow run - left	0.924	32	0.947	0.965	32	0.652
	Arrow run - right	0.911	32	0.923	0.924	32	0.683
	Preflexion	0.921	32	0.358	0.933	32	0.235

3.4. Analysis of the Intervention Effect of Music Intervention on Volleyball Physical Recovery

The statistical analysis of the fatigue index test data of the experimental group and the control group is shown in Table 6. The fatigue test data of the experimental group and the control group were analyzed using two-factor repeated measures of variance, and the results showed that the music conditioning method had a significant effect on relieving volleyball players' fatigue.

Table 6. The results of fatigue index of the experimental group and the control group.

Index	N=20	Base line(M+SD)	Medium survey(M+SD)	Posttest (M+SD)
Reduced sense of accomplishment	Experimental group	10.23±2.14	10.24±1.25	9.72±2.54
	Control group	11.09±2.01	10.94±1.38	11.24±0.97
Emotional/physical exhaustion	Experimental group	16.84±2.35	16.75±2.49	13.58±3.39
	Control group	17.13±2.01	17.81±1.76	17.12±4.25
Motion negative evaluation	Experimental group	15.24±2.09	14.72±1.33	12.24±2.32
	Control group	14.53±2.61	15.86±1.21	15.65±1.18
Simple response	Experimental group	0.192±0.01	0.181±0.05	0.105±0.03
	Control group	0.183±0.09	0.176±0.07	0.175±0.08
General reaction	Experimental group	0.351±0.03	0.364±0.02	0.236±0.01
	Control group	0.331±0.29	0.319±0.04	0.315±0.02
Dorsal muscle	Experimental group	131.25±7.51	141.25±13.26	158.62±16.24
	Control group	124.21±6.04	136.54±7.41	148.24±14.68
Flash fusion	Experimental group	26.21±2.07	26.54±2.67	29.64±4.03
	Control group	25.57±2.19	23.27±2.38	25.87±2.54
Motor center rate	Experimental group	189.34±4.16	185.64±3.54	180.63±4.12

	Control group	188.76±3.87	183.18±4.03	183.77±3.54
Kinematic primary	Experimental group	94.68±4.24	92.36±3.58	89.87±4.84
	Control group	90.96±3.85	94.01±1.27	92.34±2.21
One-minute punch test	Experimental group	28.63±3.21	29.64±3.56	30.57±3.34
	Control group	27.87±2.29	27.88±2.03	28.91±1.08

4. Conclusion

Based on the importance of athletes' physical training for modern volleyball, this paper uses Bayesian network to construct volleyball physical recovery model and analyze the importance of music therapy for volleyball players' physical recovery. It also analyzes the effect of volleyball special intervention by combining sports functional music.

The factors affecting volleyball players' physical recovery include training methods, medical methods, physical methods and psychological methods. By analyzing the intensity of the influence of each influence factor on the physical recovery of volleyball players, it was obtained that music therapy has a high influence on the physical recovery of volleyball players. The members of volleyball varsity team of university group were selected to analyze the effect of sport functional music on volleyball-specific intervention. The analysis showed that music intervention has significant effect on volleyball players' physical recovery.

References

1. Zhang, Z. (2022). Fitness activities based on the physical fitness of sports athletes. Revista Brasileira de Medicina do Esporte, 29, e2022_0325.
2. Jariono, G., Indarto, P., Sistiasih, V. S., Nugroho, H., & Maslikah, U. (2024). Physical Activity Training Methods to Improve the Physical Condition of Volleyball Players: A Systematic Review. Physical Education Theory and Methodology, 24(1), 118-129.
3. Kilic, O., Maas, M., Verhagen, E., Zwerver, J., & Gouttebarge, V. (2017). Incidence, aetiology and prevention of musculoskeletal injuries in volleyball: A systematic review of the literature. European journal of sport science, 17(6), 765-793.
4. de Freitas, V. H., Ramos, S. P., Bara-Filho, M. G., Freitas, D. G., Coimbra, D. R., Cecchini, R., ... & Nakamura, F. Y. (2019). Effect of cold water immersion performed on successive days on physical performance, muscle damage, and inflammatory, hormonal, and oxidative stress markers in volleyball players. The Journal of Strength & Conditioning Research, 33(2), 502-513.
5. Pechlivanidou, E., Livanou, M. E., Papadopetraki, A., Zambelis, T., & Philippou, A. (2024). Performance characteristics and lower limb muscle reflex properties in female volleyball athletes and non-athletes. Sport Sciences for Health, 20(4), 1317-1323.
6. Karahan, M., & Çolak, M. (2022). Changes in physical performance characteristics of female volleyball players during regional division competitions. SPORT TK-Revista EuroAmericana de Ciencias del Deporte, 11, 12-12.
7. Andrade, D. M., Fernandes, G., Miranda, R., Coimbra, D. R., & Bara Filho, M. G. (2021). Training load and recovery in volleyball during a competitive season. The Journal of Strength & Conditioning Research, 35(4), 1082-1088.
8. Vanyuk, A., Vindyk, A., Zakharina, I., Hrybovska, I., Pityn, M., Danylevych, M., & Hrybovskyy, R. (2020). Improving the functional preparedness of volleyball players aged 18–22 using recovery measures. Journal of Physical Education and Sport, 20, 2086-2093.
9. Widowati, A., Decheline, G., Diana, F., Suhartini, S., & Anjanika, Y. (2025). Physical impact of volleyball matches on adolescent athletes: Insights into fatigue and recovery. Journal Sport Area, 10(1), 37-46.
10. Praveen, R. (2024). Injury, Training Intensity, and Physical & Mental Exhaustion: Indicators of Overtraining Syndrome Among College Athletes--A Cross-Sectional Study. Malaysian Journal of Medicine & Health Sciences, 20.
11. Moseid, C. H., Myklebust, G., Slaastuen, M. K., Bar-Yaacov, J. B., Kristiansen, A. H., Fagerland, M. W., & Bahr, R. (2019). The association between physical fitness level and number and severity of injury and illness in youth elite athletes. Scandinavian journal of medicine & science in sports, 29(11), 1736-1748.
12. Robb, S. L., Hanson-Abromeit, D., May, L., Hernandez-Ruiz, E., Allison, M., Beloat, A., ... & Wolf, E. (2018). Reporting quality of music intervention research in healthcare: A systematic review. Complementary therapies in medicine, 38, 24-41.
13. Leggieri, M., Thaut, M. H., Fornazzari, L., Schweizer, T. A., Barfett, J., Munoz, D. G., & Fischer, C. E. (2019). Music intervention approaches for Alzheimer's disease: A review of the literature. Frontiers in neuroscience, 13, 132.
14. García-Casares, N., Martín-Colom, J. E., & García-Arnés, J. A. (2018). Music therapy in Parkinson's disease. Journal of the American Medical Directors Association, 19(12), 1054-1062.

15. Broder-Fingert, S., Feinberg, E., & Silverstein, M. (2017). Music therapy for children with autism spectrum disorder. Jama, 318(6), 523-524.
16. Lu, G., Jia, R., Liang, D., Yu, J., Wu, Z., & Chen, C. (2021). Effects of music therapy on anxiety: A meta-analysis of randomized controlled trials. Psychiatry research, 304, 114137.
17. Leubner, D., & Hinterberger, T. (2017). Reviewing the effectiveness of music interventions in treating depression. Frontiers in psychology, 8, 1109.
18. Jones, L., Tiller, N. B., & Karageorghis, C. I. (2017). Psychophysiological effects of music on acute recovery from high-intensity interval training. Physiology & Behavior, 170, 106-114.
19. Kuan, G. (2023). The Effect of Music Listening on Athletes' Anxiety, Depression, and Pain: A Mini Review. The Asian Journal of Kinesiology, 25(2), 19-25.
20. Ballmann, C. G. (2021). The influence of music preference on exercise responses and performance: a review. Journal of Functional Morphology and Kinesiology, 6(2), 33.
21. Marques, M., Henrique, N., Takito, M., & Franchini, E. (2024). Effects of music on perceptive and performance responses during high-intensity exercise: a systematic review. Sport Sciences for Health, 20(3), 727-738.
22. Niu, M., Zhao, R., & Wang, J. (2024). The effects of a music intervention on the autonomic nervous system during recovery from strenuous exercise. Annals of Noninvasive Electrocardiology, 29(1), e13096.
23. Torkamandi, P., Akbarnejad, A., Gaeini, A. A., & Gharecheshmei Ghahremanloo, A. (2020). The effects of music intensity on performance and cardiovascular responses in athletes. Sport Sciences and Health Research, 12(1), 93-100.
24. Closs, B., Burkett, C., Trojan, J. D., Brown, S. M., & Mulcahey, M. K. (2020). Recovery after volleyball: a narrative review. The Physician and sportsmedicine, 48(1), 8-16.
25. Zhou, N. (2021). Improvement and Recovery of Athletes' Physical Fitness by Music Regulation Combined with Sports Nutrition. Art and Performance Letters, 2(6), 52-62.
26. Coimbra, D. R., Bevilacqua, G. G., Pereira, F. S., & Andrade, A. (2021). Effect of mindfulness training on fatigue and recovery in elite volleyball athletes: a randomized controlled follow-up study. Journal of Sports Science & Medicine, 20(1), 1.
27. Kozina, Z., Sobko, I., Ulaeva, L., Safronov, D., Boichuk, Y., Polianskyi, A., & Protsevskiy, V. (2019). The impact of fitness aerobics on the special performance and recovery processes of boys and girls 16-17 years old engaged in volleyball. International journal of applied exercise physiology, 8(1), 98-113.
28. Cai, B., Kong, X., Liu, Y., Lin, J., Yuan, X., Xu, H., & Ji, R. (2018). Application of Bayesian networks in reliability evaluation. IEEE Transactions on Industrial Informatics, 15(4), 2146-2157.
29. D'Urso, P., De Giovanni, L., & Vitale, V. (2023). A Bayesian network to analyse basketball players' performances: a multivariate copula-based approach. Annals of Operations Research, 325(1), 419-440.
30. Rahmonovich Haydarov Muhammad,Mamurov B.,Mamanazarov A.,Abdullaev K,Davronov I,Bakhodir Mamurov... & Samarova Sh. R.. (2022). Planning general and special physical training of young volleyball players during training. ACADEMICIA: An International Multidisciplinary Research Journal,12(8),82-86.
31. Bowen Gu,Hao Liu,Tong Zhang,Yuan Gao,Wen Chen,Zhigang Liu... & Chonggan Liang. (2025). Hydrogen leakage risk analysis of hydrogen fuel emergency power vehicle multi-scenario based on dynamic Bayesian network. International Journal of Hydrogen Energy,136,173-185.