ingegneria sismica
International Journal of Earthquake Engineering
Anno XLIII - Num. 1 - 2026

An analysis of the intervention effect of dance therapy based on embodiment theory on the mental health level of college students

Qiwang Zhang[1,*]

[1] School of Music and Dance, Changsha Normal University, Changsha, Hunan, 410100, China

SUMMARY: *This paper designs a controlled experiment of dance therapy intervention on college students' mental health level under the guidance of theories of embodied cognition and implicit memory. Basic data on positive/negative emotions of the subject students were collected through pre- and post-tests to test the effect of dance therapy based on embodied theory. After that, the students' basic personal and social characteristics were modeled, and quantile regression analysis was used to find out the extent of the dance therapy's impact on college students' mental health, so as to provide the dance therapy intervention based on embodiment theory for the optimal intervention target. At the end of the 6-month controlled experiment, the mean positive mood score of 35 students in the treatment group increased from 37.606 to 83.898, and the mean negative mood score decreased from 86.414 to 29.577. Dance therapy based on embodied theory helps to improve positive thinking ability and reduce negative passivity in students with poor mental health status.*

KEYWORDS: *embodied cognition; dance therapy; mental health; positive/negative emotions; quantile regression*

1 Introduction

The Blue Book on Mental Health “China's National Mental Health Development Report (2019-2020)” released in 2021 shows that in 2020, the proportion of college students with a tendency to severe depression will be 18.5%, 4.2% of college students will have a high-risk tendency to depression, and 8.4% of college students will have a tendency to severe anxiety. College students are affected by many external factors, when in a continuous high-pressure environment may lead to physical and mental exhaustion, a variety of physical and psychological discomforts, which may lead to many mental illnesses, such as agitation, depression, interpersonal tension, emotional imbalance, etc., which may pose a threat to life and health in serious cases [1-5].

Currently, colleges and universities establish mental health education systems and offer mental health education classes in order to enhance college students' mental health awareness and ability. In addition, the state has set up mental health hotlines and psychological counseling service centers to help college students solve their psychological distress, providing counseling services 24 hours a day. However, the lack of accuracy of psychological description, student counseling shame, and the limited number of professional counselors have led to unsatisfactory psychological interventions for college students [6-8]. Dance therapy is an important part of art therapy, through the process of dancing to achieve the role of physical, emotional and cognitive conditioning, dance therapy theory is the product of the integration of art, psychology

*wudao_1217@163.com
https://doi.org/10.65102/is2026026
Published: 30 April, 2026

and medicine, can make up for the shortcomings of traditional psychotherapy [9]. Dance movements to music can stimulate the visual, auditory and kinesthetic senses of the human body, and when the dance movements and the music melody are highly compatible, it can produce physiological pleasure and spiritual pleasure, realizing the perfect fit between the soul and the body, and entering an incomparable wonderful world [10-12]. Therefore, dance therapy is the result of the joint action of physiology and psychology.

In the 1970s, the international academic community proposed the "embodied theory" on the basis of criticism and reflection, and pointed out that traditional humanities and social sciences have obscured the body and completely separated the body and mind. This mechanical and simple "transmission-reception" type of "disembodied theory" has ignored the physical dependence of cognition, thinking, etc., resulting in the loss of the intrinsic value of the body [13]. Literature [14] reported that embodied therapy allows individuals to learn and understand multiple elements of body-related information, self-awareness, emotions, and behaviors, and to acquire skills such as stress management, communication, and health management. Literature [15] argued from the perspective of embodied cognition theory that the body plays a therapeutic role in psychotherapy through emotion regulation, physical communication, therapeutic relationship coordination, promotion of self-growth, and interpersonal interaction. Literature [16] applied a compliant body-cognition approach to understanding dance therapy-based psychiatric disorders and, in conjunction with self-narrative theory, argued that dance therapy facilitates changes in an individual's self-narrative with the help of physical skills and awareness, which improves the individual's sense of self-control and digestion of negative emotions. Literature [17] guided by embodied cognition theory, physical dance instructional programs significantly and positively enhanced students' psychological well-being, promoted the development of healthy interpersonal relationships and personalities, and enhanced academic, musical, and cooperative skills.

Clinical application of dance therapy as a non-pharmacological intervention for psychological problems. Literature [18] meta-analysis emphasized that physical activity helps to improve the mental health of individuals, and compared to other forms of physical activity, dance therapy is more effective in improving memory, social cognition, stress, self-efficacy, and verbal fluency of individuals. Literature [19] arranged dance therapy and conventional therapy twice a week for 10 weeks for adult patients with depression, which effectively improved the physical and mental discomfort indicators of the patients, and dance therapy can improve the improvement effect of conventional therapy. Literature [20] illustrated that dance therapy forms such as mirroring, synchronization, rhythm, and interaction can improve the physical perception and social participation of adult patients with autism spectrum disorders, promote communication, and improve negative symptoms. Literature [21] confirmed the effectiveness of dance therapy, a complementary form of embodied therapy, as an intervention for a borderline personality disorder + PTSD population, improving patients' self-regulation, interpersonal relationships, and self-efficacy. Literature [22] conducted medication- and traditional recreation-based dance therapy for adolescents with schizophrenia, and the dance-additive treatment program significantly improved the adolescents' emotional apathy and social withdrawal, as well as their emotional experience and self-regulation, relative to medication and traditional recreational therapies. Literature [23] analyzed that dance therapy is effective in reducing stress and improving emotional resilience and psychological well-being of individuals in academic settings and emphasized that the specificity of academic settings necessitates the development of individualized dance therapy. Clinical studies in the literature [24] have shown that a creative dance intervention delivered twice a week for 8 months was effective in reducing emotional states and improving somatic symptoms in adolescent girls, and that the effects of the intervention needed to be sustained through long-term engagement.

Among the studies on the mechanisms related to dance therapy, literature [25] revealed that the levels of brain-derived neurotrophic factor are altered in patients with stress-based triggered depression, which in turn affects their mood and cognitive functioning, and that medication and physical activity can optimize the levels of this factor, thus effectively improving depressive symptoms. Literature [26] assessed the hormonal and metabolite changes in the human body under dance activity, dance activity reduced cortisol levels in individuals, and cortisol levels varied across dance types, while chronically high cortisol levels exacerbated anxiety levels in individuals. Literature [27] findings present that dance rhythms of 60 beats/minute and 100 beats/minute increase the heart rate variability index of individuals, which improves the therapeutic effect, whereas dance rhythms of 140 beats/minute decrease the therapeutic effect of dance. Literature [28] reported that HRV is a measure of psychological stress response related to psychological stress, and that linear and nonlinear HRV metrics respond to emotional changes and the nature of stress in terms of an individual's psychological stress. Literature [29] states that dance therapy promotes body-based emotional transmission in individuals through the combined activation of motor areas by movement and accompaniment, and that group dancing in helps to enhance the functioning of mirror neurons in individuals to cope with individual stress.

A study on the efficacy and differences of dance therapy. A study in literature [30] showed that five dance styles, modern, Chinese classical, jazz and ballet, showed differences in the intervention effects on college students suffering from depression, with the highest level of heart rate variability index and the lowest depression index under modern dance intervention. Literature [31] found that dance interventions can improve their positive mood and reduce individuals' anxiety levels such as socialization and body image, while digital dance interventions based on smart fitness goggles have more significant effects than traditional dance interventions. Literature [32] assessed the efficacy of a 3-day dance treatment on depression and anxiety in college students, with immediate efficacy at the beginning of the treatment and sustainability of the efficacy, which continued to be present more than 3 months later and did not show gender differences. In contrast, the results of dance therapy for college students who reported anxiety symptoms in the literature [33] showed that the duration of the treatment was more than one month before the effect of anxiety relief gradually appeared, and the treatment of more than three months significantly reduced the level of anxiety in the students.

Currently there are fewer university psychotherapy systems based on dance therapy in colleges and universities, but sports dance, as a common physical education elective course in colleges and universities, provides a reference for a university psychotherapy system based on dance therapy. Literature [34] found that sports dance can help students overcome psychological barriers and significantly promote the psychological level of college students, as well as self-confidence, communicative ability and the ability of people to cope with stress. Some western colleges and universities offer dance therapy practice courses. Literature [35] studies have confirmed that dance therapy practice courses can reduce anxiety and stress levels of physical therapy students, and enhance students' physical expression and social skills, thus improving students' learning motivation. With the growing effect of dance therapy, most colleges and universities have conducted dance therapy courses and laboratories, as well as organized various dance interventions to promote the mental health of college students.

Knowledge of cognitive science and phenomenology is gradually being applied in student mental health interventions. This paper combines embodiment theory and dance therapy to investigate whether dance therapy based on embodiment theory is effective in college students' mental health interventions through controlled experiments. The effect evaluation was carried out by means of a scale survey, based on the students' positive and negative mood changes, and combined with the ANOVA test to check the difference between the treatment group and the

control group. After the effectiveness of the intervention was verified, in order to improve the accuracy of the mental health intervention of dance therapy, quantile regression modeling and likelihood ratio test were completed on the base data of college students. The mental health status of students with different traits was analyzed to support dance therapy interventions based on embodiment theory for students most likely to have mental health problems.

2 Design of Dance Therapy Method for College Students Based on Embodiment Theory

2.1 Research Program and Subjects

2.1.1 Subjects of intervention

In this study, 70 college students were openly recruited as research subjects through a college mental health center and were grouped into 35 students in a dance therapy group based on embodiment theory and 35 students in a control group based on traditional mental health interventions. The average age of all students was between 18-22 years old, and none of the 70 students who participated in this study had a basic knowledge of dance and volunteered to participate in this research study.

2.1.2 Programming

The dance therapy intervention based on embodied theory was conducted for 150 minutes three times a month for 6 months for the dance therapy group and no intervention for the control group. The dance therapy intervention was divided into 18 activities that included several themes: exploring the relationship between emotions and the individual, the relationship between the body and objects, the relationship between the body and space, the relationship between the body and speed, the relationship between the body and strength, and the relationship between the individual and the group. Intervention content theory is based on Dance Therapy Laban movement analysis, imaginative dance movement, and mirrored and real movement. Warm-up movements are done through cut silk circles to establish body movement awareness and to establish the connection between the individual and the group. The interviewees are guided by the leader's guiding words to do self-exploration of body movement, and through the projection generated in the brain by the guiding words, the interviewees will dominate their limbs to make imaginative movement exploration, and experience the dance therapy method of creative dance.

2.1.3 Measurement methods

In the pre-dance therapy period, the dance therapy group and the control group were given 70 questionnaires on the “Comprehensive Diagnostic Scale for College Students' Mental Health” and “Positive and Negative Affective Scale”, with 35 questionnaires for each group, and 70 questionnaires were recovered with valid information. The recovery rate of the questionnaires reached 100%, and the validity rate reached 100%. Before the intervention study, it was explained to the members of both groups that the purpose of this test was for research purposes only, and the names of the students were omitted to protect their privacy, so as to ensure that the results of the study were objective and true.

First, the data of the students in the dance therapy group were counted and the results were analyzed and tabulated as follows: First, the “Comprehensive Diagnostic Scale for College Students' Mental Health” is a 30-question scale for mental health distress. For each question,

answer "Yes" or "no". An answer of "yes" will be awarded 1.0 point. The answer "No" is worth 0.0 points. The scale assesses multiple dimensions of conversational aspects, friendship aspects, interpersonal relations, and heterosexual interactions. The scores are graded at three levels, with scores ranging from low to high up representing different stages of ability distress from low to high. Secondly, Positive and Negative Affect Scale (PANAS), which is able to effectively investigate the students' emotions, and can effectively distinguish between positive and negative emotions, this test scale is designed with 30 questions on a 5-point scale.

2.2 Theoretical analysis of embodied cognition and implicit memory

Embodiment theory helps people understand the essential role that the body can play in the process of active imagination and psychological healing from a cognitive science and phenomenological perspective. In contrast to traditional epistemological perspectives that advocate the separation of body and mind, embodiment emphasizes subjectivity in the cognitive process. The basic meaning of embodiment is the dependence of cognition on the body. Although there is much debate about how important the role of the body is in cognitive processes, a large body of research has shown that the body is intrinsically involved in cognition, influencing emotions, attitudes, and mental processes such as thinking, judging, remembering, categorizing, and concept formation. According to embodiment theory, cognition and emotion are based on motor-sensory processes, and knowledge and memory also include stimuli and responses from motor-sensory processes. The body carries a variety of memories and potentially traumatic experiences, except that this wisdom is often hidden behind direct conscious awareness. Authentic Movement uses dance as a medium to listen to the body, to break through the blockade of consciousness and channels of communication at the kinesthetic level, and then to influence cognition and emotion through verbal and non-verbal interventions. Movers start from their own problems and use improvisation in authentic movement to explore their attitudes towards external stimuli and their responses on an operational or emotional level. Such embodied experience triggers and reinforces the emotions associated with the problem, allowing the mover to consciously recognize, adjust, and process the associated feelings to form new mental cognitions.

Research on implicit memory confirms the important role of the body in cognitive and other mental processes from another perspective. Implicit memory is formed in the pre-linguistic stage mainly through bodily sensations and kinesthetic experiences, and has a profound impact on the behavioral patterns of individuals in perceiving and responding to the environment in adulthood. Memories associated with strong emotions cross the cerebral cortex and are processed and preserved at the preconscious level by the amygdala in conjunction with the right hippocampus. And the right hippocampus seems to be associated to a higher degree with right-brain-related perceptual experiences, such as body-based, emotionally saturated or symbolized activities. Working at the body level helps in the extraction and recreation of implicit memory. After trauma, for example, some people selectively forget painful experiences, resulting in physical and mental separation and emotional isolation. This is due to shame and fear interfering with cortical memory extraction and impairing the ability to self-reflect. The constant awareness, reflection and communication of bodily sensations and movement patterns during authentic movement prompts the mover to redirect attention to the neglected body. In the empathic holding of the witness, the body can guide the mover to become aware of the information latent in the pre-verbal phase and in coping with danger, to establish new neural pathways, to give a different meaning to the traumatic experience, to develop more advanced coping skills, and to improve mental health.

2.3 Statistical methods based on quantile regression modeling

2.3.1 Quartile-related definitions

The quantile is a number of intervals obtained from the cumulative distribution function of an independent variable according to certain rules. The q-quartile is calculated by dividing a set of data with a sample size of n and q equal parts according to a certain order. That is, if the mth $q-$quantile takes the value z, then the probability that the random variable Z of the sample population is less than z is not greater than m/q, and the probability that the random variable Z is less than or equal to z is not less than m/q. i.e:

$$P(Z<z)\le m/q, P(Z>z)\le 1-m/q \tag{1}$$

where $0<m<q$. The q quantile has a total of $q-1$ quantile points.

Quantile values are not affected by long-tailed density distributions or the presence of outliers, and are therefore a quite useful measure. In reality, the distribution of the number of its density function often does not satisfy the assumption of normal distribution, or the outliers of the data can not be eliminated from the mean, then the use of quantile regression can be used to obtain more accurate descriptive statistics than the mean and other higher-order distance regression. Thus, quantile regression estimation can solve the problem of data distribution that is not normally distributed and contains outliers.

Definition 1: Let the distribution function of a real-valued random variable Z be $F(z)=P(Z\le z)$, then for $\forall 0<\tau<1$, both:

$$F^{-1}(\tau)=\inf\{z:F(z)\ge\tau\} \tag{2}$$

Then equation (2) is the τ th quantile of Z. The median $F^{-1}(1/2)$, which is very important for the study of practical problems. Usually the median and the mean are expressed as the positional characteristics of the data.

Definition 2: For a decision problem: different loss functions correspond to different decision connotations, in the quantile regression model, the loss function is defined as:

$$\rho_\tau(v)=v(\tau-I(v)) \tag{3}$$

where $I(v)=\begin{cases}0.0, & v\ge 0.0\\ 1.0, & v<0.0\end{cases}$, for the schematic function, this loss function is a non-negative segmented linear convex function. Figure 1 shows the loss function visualization.

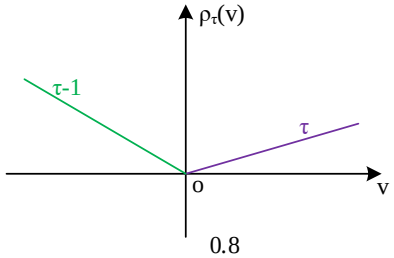

Figure 1: Loss Function

Then $\exists \tau \in (0.0,1.0)$, making the loss function the minimum optimization problem. This problem is posed in the context of investigating the tolerance of the quantile estimator under this loss function. The idea is to make the expectation under the loss function (3) equation, $\exists \hat{\xi}$:

$$E[\rho_\tau(Z-\hat{\xi})] = (\tau-1)\int_{-\infty}^{\hat{\xi}}(z-\hat{\xi})dF(z) + \tau\int_{\hat{\xi}}^{+\infty}(z-\hat{\xi})dF(z) \tag{4}$$

is minimized. Therefore, the first order derivative of $\hat{\xi}$ in the above equation is obtained:

$$0 = (1-\tau)\int_{-\infty}^{\hat{\xi}} dF(z) - \tau\int_{\hat{\xi}}^{+\infty} dF(z) = F(\hat{\xi}) - \tau \tag{5}$$

By the monotonicity of $F(z)$, any left endpoint satisfying the solution interval $\{z : F(z) = \tau\}$ minimizes the expected loss; When there is a unique solution $\hat{\xi} = F^{-1}(\tau)$; When there are multiple solutions, we have a quantile interval of solutions from which we select the smallest element, which mirrors the right continuity of the empirical quantile function. Moreover, a point estimate of the quantile can also be obtained by introducing an asymmetric linear loss function $\rho_\tau(v)$. Examining the sample $\{z_i\}_{i=1}^n$, its empirical distribution function is:

$$F_n(z) = n^{-1}\sum_{i=1}^{n} I(z_i \le z) \tag{6}$$

We replace F with F_n, then there still exists $\hat{\xi}$ which minimizes the expected loss:

$$\int \rho_\tau(z-\hat{\xi})dF_n(z) = n^{-1}\sum_{i=1}^{n}\rho_\tau(z_i-\hat{\xi}) \tag{7}$$

The τ quantile of the sample is then obtained. When τn is taken as an integer, a solution interval $\{z : F_n(z) = \tau\}$ of no practical significance is obtained.

The sample τ quantile that is the solution to the optimization problem is connected to the sample observations in exactly the same order. The problem of finding the τ quantile of a sample Z:

$$\min_{\hat{\xi}\in R}\sum_{i=1}^{n}\rho_\tau(z_i-\hat{\xi}) \tag{8}$$

I.e., begging:

$$\min_{\hat{\xi}}\left[\sum_{z_i\ge\hat{\xi}}\tau\left|z_i-\hat{\xi}\right| + \sum_{z_i<\hat{\xi}}(1-\tau)\left|z_i-\hat{\xi}\right|\right] \tag{9}$$

The problem can be transformed into a linear programming problem with an optimal solution by introducing $2n$ slack variables $\{d_{i+}, d_{i-}; i = 1,\cdots,n\}$ to denote the positive and negative parts of the residual vector $z_i - \hat{\xi}$. Then there are:

$$\min_{(\hat{\xi},d_+,d_-)\in R\times R_+^{2n}} \left\{ \tau 1_n' d_+ + (1-\tau) 1_n' d_- \middle| 1_n \hat{\xi} + d_+ - d_- = z \right\} \tag{10}$$

where 1_n denotes the n-dimensional column vector whose components are all 1.0. From the above equation we see that the optimal solution is obtained on the constraint set $1_n \hat{\xi} + d_+ - d_- = z$, which is a multifaceted constraint set consisting of the intersection of the linear equational constraints and the set of $2n+1$-dimensional hyperplanes determined by the set $R \times R_+^{2n}$. Figure 2 illustrates the case when the median is the optimal solution for linear programming.

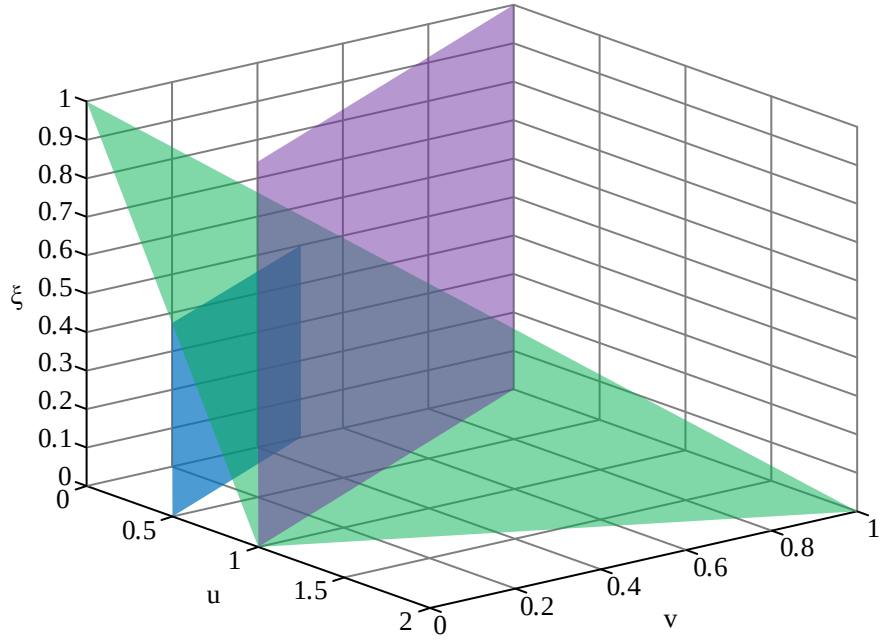

Figure 2: Situation of median serves as the optimal solution for linear programming

As we increase the number of observations, then each observation plays an important role in the optimal solution of the objective function. The solution in Figure 2 can always be obtained by moving $\hat{\xi}$ closer to some sample observation. Many of the characteristics of the optimal solution clearly follow from these simple observations.

2.3.2 Definition of quantile regression

We follow the least squares approach to finding the sample mean: that is, we solve for $\min_{\hat{\xi}\in R} \sum_{i=1}^{n} (z_i - \hat{\xi})^2$ to obtain the sample mean $\hat{\xi}$, generalizing the method used as a solution to a simple optimization problem to a model for estimating a conditional quantile function. When given x, solving: $\min_{\beta\in R} \sum_{i=1}^{n} \rho_\tau (z_i - \beta)$ gives the sample τ-quartiles $\hat{\beta}(\tau)$.

When x is given, the conditional distribution of z is $F_z(z \mid x)$, then its inverse function is $Q_z(\tau|x) = \inf\{z : F_z(z|x) > \tau\}$. Define $Q_z(\tau \mid x) = x'\beta(\tau)$ as the sample conditional τ quantile function, where x is a p-dimensional column vector and $\beta(\tau)$ can be estimated as follows:

$$\min_{\beta \in R^p} \sum_{i=1}^{n} \rho_\tau \left(z_i - x_i' \beta \right) \tag{11}$$

and is obtained.

Definition 3: For $\forall \tau \in (0.0,1.0)$, the resulting parameter coefficients $\beta(\tau)$ are called the τ regression quantiles.

Rewrite equation (11) as:

$$\min_{\beta \in R^p} \left(\sum_{z_i \geq x_i' \beta} \tau \left| z_i - x_i' \beta \right| + \sum_{z_i < x_i' \beta} (1-\tau) \left| z_i - x_i' \beta \right| \right) \tag{12}$$

where $0.0 < \tau < 1.0$ and the coefficient vector β varies with the value of τ. From the principle of analytic geometry, τ indicates the percentage of data above or below the regression plane to the total data. Quantile regression essentially adjusts the position and direction of the regression plane by taking any value between 0.0 and 1.0 for τ, allowing the regression variable to estimate different quantiles of the response variable, which can represent information about all the data to a certain extent but focuses more on data in a specific region.

2.3.3 Estimation of quantile regression and its asymptotic properties

Theorem 1: Consider a linear model:

$$Z_i = x_i' \beta + \mu_i, i = 1, \cdots, n \tag{13}$$

where $\{\mu_i\}$ is independently and identically distributed in F, and the density function f at the point $F^{-1}(\tau)$ is strictly greater than 0.0. Then the density function of $\hat{\beta}(\tau)$ is:

$$g(b) = \sum_{l \in L} P\left\{ \xi_n(b) \in C \middle| X(l) \right\} \prod_{i \in l} f\left(x_i'(b - \beta(l)) + F^{-1}(\tau) \right) \tag{14}$$

where $\xi_l(b) = \sum_{i \in l} \psi_\tau (z_i - x_i b) x_i' X(l)^{-1}$ and C is $[\tau, \tau - 1]^p$.

Let $\hat{\zeta}_n = (\hat{\zeta}_{\tau_1}, \cdots, \hat{\zeta}_{\tau_m})$ be the $\zeta_n = (\zeta_{\tau_1}, \cdots, \zeta_{\tau_m})$ of the estimator, then there are:

$$\sqrt{n}(\hat{\zeta}_n - \zeta_n) \sim (0, \Omega) \tag{15}$$

where Ω is the $m \times m$ variance matrix and consists of the following elements:

$$(\omega_{ij}) = (\tau_i \wedge \tau_j - \tau_i \tau_j) / (f(F^{-1}(\tau_i)) f(F^{-1}(\tau_j))) \tag{16}$$

This is the starting point for the large sample theory of linear combinations of order statistics.

Since the slopes of quantile regression vary greatly under different τ, a fundamental problem in quantile regression is to test whether the slope parameters are equal under different τ. We will only introduce the likelihood ratio test below.

2.3.4 Likelihood ratio test

Linear modeling:

$$z_i = x_i'\beta + \mu_i \tag{17}$$

where μ_i is independently and identically distributed. Consider the median regression test with the original hypothesis: $H_0 : R\beta = r$

Construct the test statistic:

$$T_n = 6(\tilde{V}(1/2) - \hat{V}(1/2)) / s(1/2) \tag{18}$$

where $s(\cdot)$ is the "sparse function", the inverse of the sample density function.

$$\hat{V}(\tau) = \min_{\{\beta \in R^p\}} \sum \rho_\tau \left(z_i - x_i'\beta\right) \tag{19}$$

$$\tilde{V}(\tau) = \min_{\{\beta \in R^p | R\beta = r\}} \sum \rho_\tau \left(z_i - x_i'\beta\right) \tag{20}$$

When the original hypothesis H_0 holds, the statistic T_n asymptotically obeys a χ^2 distribution with q degrees of freedom, where q is the rank of the matrix R. The test statistic T_n is analogous to the likelihood ratio test statistic. For a general τ quantile regression test, construct the corresponding test statistic:

$$T_n(\tau) = \frac{2}{\lambda^2(\tau)s(\tau)}\left[\tilde{V}(\tau) - \hat{V}(\tau)\right] \tag{21}$$

and

$$\hat{\Lambda}_n(\tau) = \frac{2n\hat{\sigma}(\tau)}{\lambda^2(\tau)s(\tau)} \ln\left(\tilde{\sigma}(\tau) - \hat{\sigma}(\tau)\right) \tag{22}$$

where $\lambda^2(\tau) = \tau(1-\tau)$; $s(\tau)$ is the inverse of the density function, known as the "sparse function", denoted by $s(\tau) = [f(F^{-1}(\tau))]^{-1}$, and also referred to as the partition of the density function of quartiles; $\hat{\sigma}(\tau) = n^{-1}\hat{V}(\tau)$, $\tilde{\sigma}(\tau) = n^{-1}\tilde{V}(\tau)$. This test is often referred to as the proposed likelihood ratio test, also known as the ρ test.

3 Experimental and quantile regression analysis of mental health interventions

3.1 Analysis of pre-laboratory test data for both groups of students

3.1.1 Pre-experimental measurement of basic data on positive and negative emotions

Before and after the dance therapy experiment based on embodiment theory, data on positive and negative emotions were collected from 70 students (35 in the dance therapy group and 35 in the control group) using the "Comprehensive Diagnostic Scale for College Students' Mental Health".

Figure 3 shows the basic positive mood scores of the two groups of students before the

experiment. Figure 4 shows the basic situation of negative mood scores of the two groups of students before the experiment. Before the experiment, the positive mood scores of the 35 students in the treatment group ranged from about 31.318 to 44.478, with a mean score of only 37.606; the negative mood scores ranged from 75.670 to 99.526, with a mean score of 86.414. The 35 students in the control group had positive mood scores ranging from about 30.574 to 44.614, with a mean score of only 37.438; negative mood scores ranged from about 75.983 to 99.972, with a mean score of 87.664. Both groups of students had lower positive mood scores and higher negative mood scores.

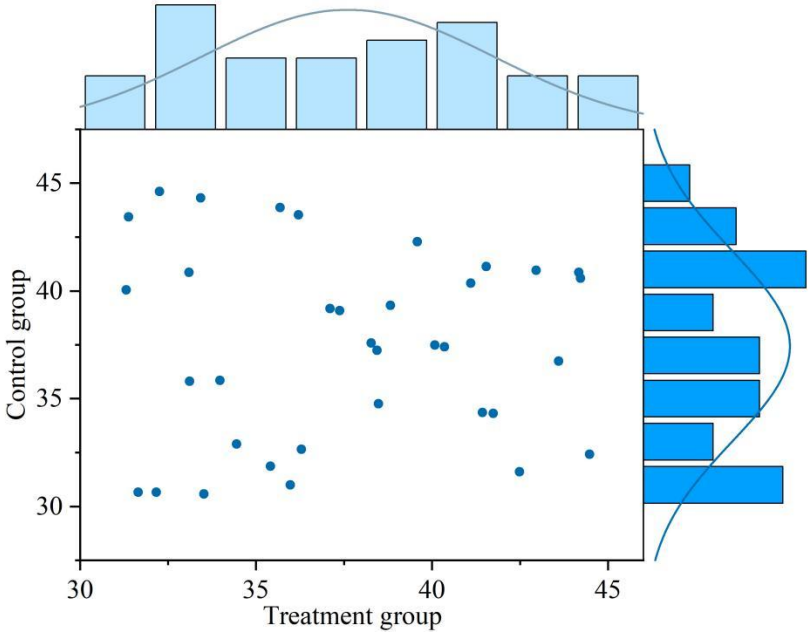

Figure 3: Positive emotion scores of 2 groups of students before experiment

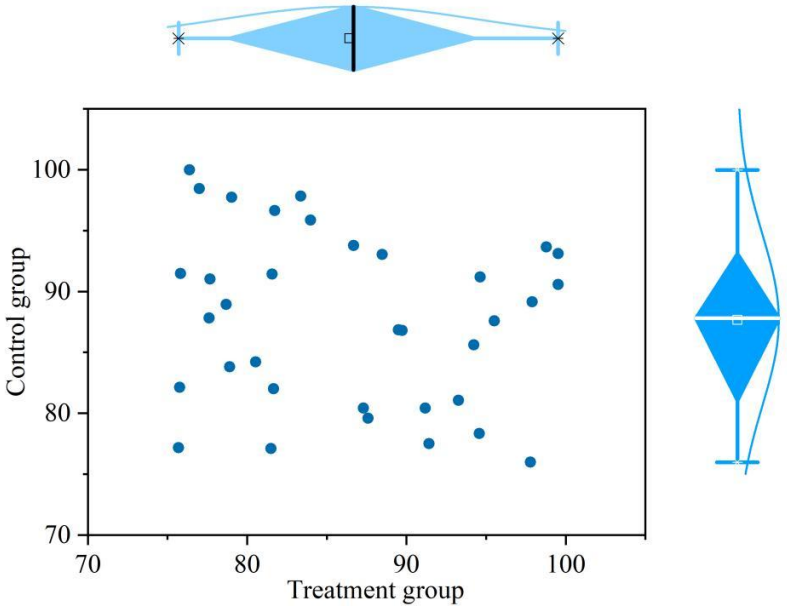

Figure 4: Negative emotion scores of 2 groups of students before experiment

3.1.2 ANOVA of positive and negative emotions on pre-test of the experiment for both groups of students

In order to examine whether there were any between-group differences between the 2 groups in emotional psychology prior to the experiment, an ANOVA was performed. Table 1 shows the ANOVA results of the positive and negative mood pre-tests for the treatment and control groups. The ANOVA chi-square test was performed first, and the results showed that the variance of each group satisfied the chi-square criterion ($p=0.864>0.05$, $p=0.875>0.05$). And there is no significant difference in the pre-test scores of the groups ($p=0.842>0.05$, $p=0.891>0.05$). It indicates that the grouping of experimental subjects is reasonable, which will not affect the experimental results and can carry out the next experimental intervention.

Table 1: Variance of positive and negative emotions among the two groups

Factor Name	Homogeneity of variance test				Analysis of variance results	
	Levene's statistic value	DF1	DF2	P	F	P
Positive emotions	0.037	3	67	0.864	0.053	0.842
Negative emotions	0.005	3	67	0.875	0.009	0.891

3.2 Comparison of mental health scores between the two groups of students before and after the experiment

3.2.1 Comparison of positive and negative mood scores before and after the experiment in the treatment group

Figure 5 compares the changes in positive mood scores and negative mood scores of the treatment group before and after the experiment. The positive mood score of the treatment group increased from 31.318~44.478 to 70.670~93.791 before the experiment, and the mean positive mood score increased from 37.606 to 83.898. Negative mood scores decreased significantly from 75.670~99.526 to 25.325~34.516 before the experiment, and the mean score decreased from 86.414 to 29.577. After a total of 18 sessions of dance therapy experiment based on embodiment theory over a period of 6 months, the positive mood scores of 35 students in the treatment group increased very significantly, and the negative mood scores decreased equally significantly. From the changes in the scores, it can be preliminarily concluded that the dance therapy based on embodiment theory is effective.

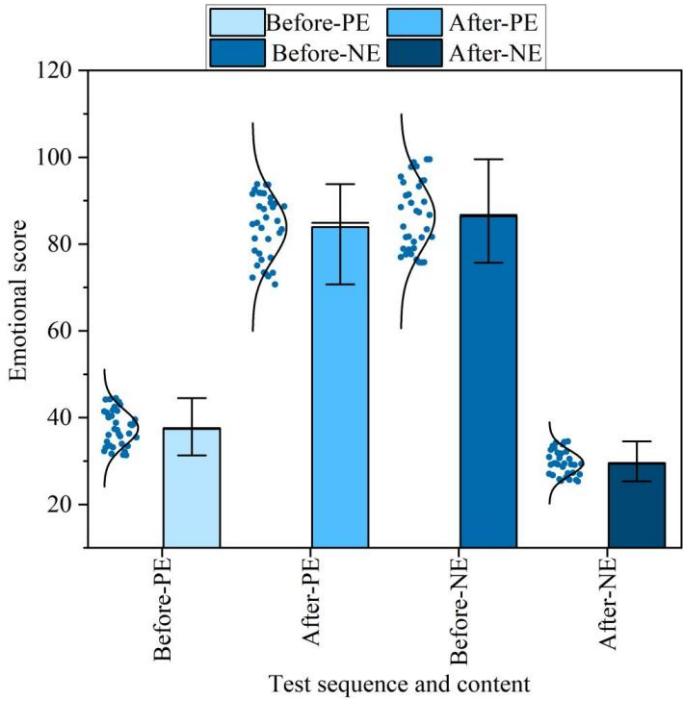

Figure 5: Changes in positive and negative emotional scores of treatment group

3.2.2 Comparison of positive and negative mood scores before and after the experiment in the control group

Figure 6 shows the changes in positive and negative mood scores before and after the experiment for the 35 students in the control group. The positive mood scores of the students in the control group increased slightly from 30.574 to 44.614 before the experiment to 40.725 to 54.512, and the average score increased from 37.438 to 48.565; the negative mood scores decreased from 75.983 to 99.972 to 70.235 to 79.539, and the average score decreased from 87.664 to 74.5059 points. Overall, the control group used traditional mental health intervention methods for the students participating in the experiment, which also helped to improve the students' mental health status, but the positive mood enhancement and negative mood decline were not as obvious as that of the treatment group.

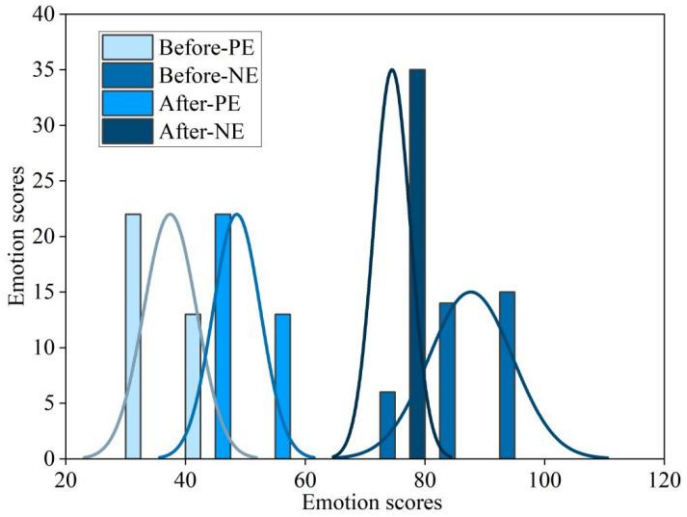

Figure 6: Changes in positive and negative emotional scores of control group

3.2.3 ANOVA of positive and negative emotions measured after the experiment for both groups of students

ANOVA was again performed on the positive and negative emotions of the two groups of students after the experiment to verify whether there were between-group differences. Table 2 shows the results of the ANOVA of positive and negative emotions measured after the experiment for the two groups of students. It was tested that both positive and negative mood scores of the two groups of students after the experiment were significantly different at the level of 0.001 (P all equal to 0.000), and that the positive mood scores of the treatment group were significantly higher than the positive mood scores of the control group, and the negative mood scores of the treatment group were significantly lower than the negative mood scores of the control group. Using dance therapy based on embodiment theory can guide college students with poor mental health to release stress and relieve anxiety through body dancing.

Table 2: Post-experiment variance of positive and negative emotions

Factor Name	Homogeneity of variance test				Analysis of variance results	
	Levene's statistic value	DF1	DF2	P	F	P
Positive emotions	0.044	4	66	0.000	0.005	0.000
Negative emotions	0.002	4	66	0.000	0.001	0.000

3.3 Quartile regression analysis of college students' mental health status

3.3.1 Differences in the mental health of university students of different genders

After proving through controlled experiments that dance therapy based on embodiment theory can effectively intervene in the mental health status of college students, how to accurately identify students with mental health problems in colleges and universities, and how to utilize dance therapy based on embodiment theory to provide help for these students, has become the focus of the next step of research. In this paper, we construct a quantile regression model of college students' mental health by studying the data related to different basic personal characteristics (section 3.3.1 takes gender as an example) and social characteristics (section 3.3.2 takes household registration as an example) of college students to find out the commonalities of college students with poor mental health status.

Figure 7 shows the results of the independent sample t-test for the mental health of college students of different genders. The indicators of college students' mental health contain six aspects: somatization (S), compulsion (C), depression (D), anxiety (A), hostility (H), and fear (F). As can be seen from P=0.001 or P=0.000, there is significant variability between males and females on different mental health indicators and this variability can be extrapolated to the overall, i.e., the difference is statistically significant. Males had higher severity in anxiety (5.021), hostility (5.176), and fear (5.234) than females, while females had higher severity in somatization (4.382), obsessive-compulsive (4.193), and depression (4.675) than males.

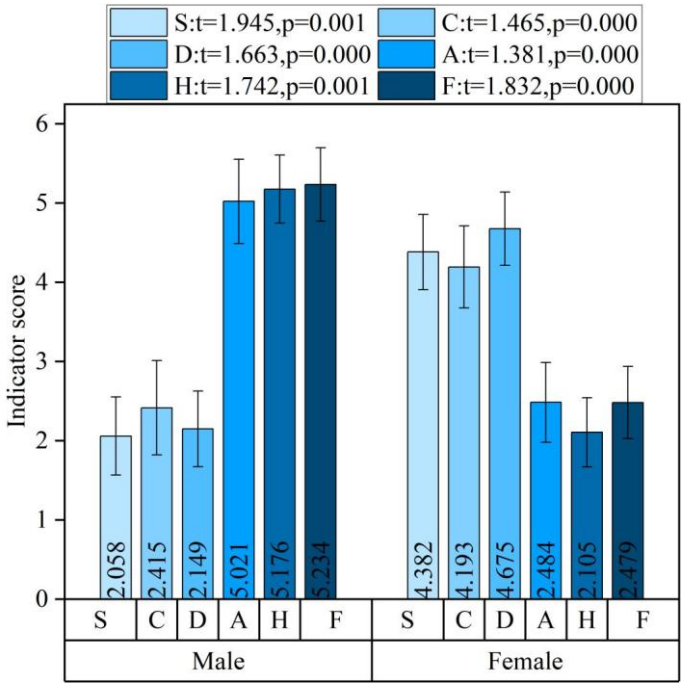

Figure 7: Independent sample t-test for male and female college students

3.3.2 Differences in the mental health of college students from different households

Figure 8 shows the results of the independent samples t-test for the mental health of college students from different households. There is a significant difference between students from agricultural and non-agricultural households on six indicators of mental health (P=0.000/0.001). The mean scores of students from agricultural households were significantly lower and more severe than those of students from non-agricultural households on the five indicators of somatization (2.485), compulsion (3.019), depression (2.567), hostility (3.016), and fear (2.518). The average score on anxiety indicators for students from non-agricultural households was 5.461, higher than that of 2.452 for agricultural households, and students from non-agricultural households had more severe anxiety.

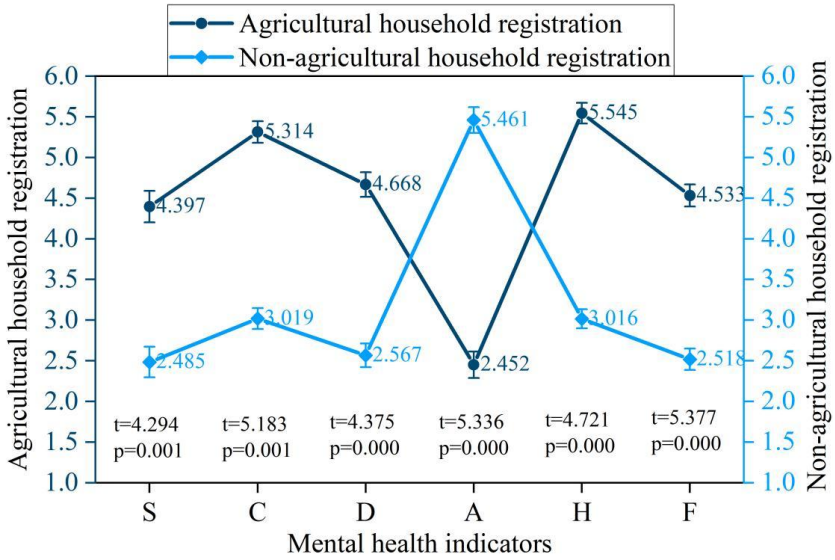

Figure 8: Independent sample t-test for Different household registrations students

3.3.3 Interquartile Regression Analysis of Dance Therapy on College Students' Mental Health

Table 3 shows the results of quantile regression analysis of dance therapy on college students' mental health. The six independent variables, including only child, gender, household registration, ethnicity, parental job stability, and high school school location, all had a significant negative effect on the mental health of college students at the 0.001 level (partial regression coefficient and standardized regression coefficient < 0.000). The mental health of college students during their study in colleges and universities was negatively affected by social traits and personal traits. In contrast, dance therapy based on embodiment theory had a significant positive effect on the mental health of college students at the 0.001 level. This also means that if dance therapy based on embodiment theory is proactively provided at the school level after the enrollment of these students who are prone to mental health problems, it can largely improve the mental health status of the students and prevent them from developing unhealthy behaviors during the college years. At the same time, when using embodiment theory-based dance therapy to intervene in the mental health of college students, schools should also focus on non-only females of agricultural origin, especially those from ethnic minorities, those who attended high school in remote areas, and those whose parents have unstable jobs, and provide them with more personalized dance therapy.

Table 3: Percentile regression analysis of college students' mental health

Independent variable	Partial regression coefficient	Standard error	Standardized regression coefficient	Test value	Sig.
(Constant)	1.942	0.037	--	53.423	0.001
Only child	-0.126	0.012	-0.083	-4.705	0.001
Gender	-0.104	0.015	-0.052	-6.442	0.001
Residence registration	-0.127	0.013	-0.071	-4.071	0.001
Ethnicity	-0.089	0.018	-0.062	-3.164	0.001
Stability of parents' jobs	-0.256	0.021	-0.043	-3.528	0.001
Location of the high school	-0.148	0.022	-0.015	-2.169	0.001
Dance therapy based on embodied theory	0.503	0.045	0.074	5.382	0.001
$R=0.951, R^2=0.384$, Adjusted $R^2=-2.080, F=0.156, P=0.001$					

4 Conclusion

This paper designs a controlled experiment of dance therapy based on embodiment theory to assist college students to improve their mental health status. Before the experiment, the positive mood scores of the treatment group only ranged from 31.318 to 44.478, while the negative mood scores were as high as 75.670 to 99.526, which had more serious mental health problems. After 18 sessions of embodiment theory-based dance therapy in 6 months, the positive mood scores of the students in this group increased dramatically to 70.670~93.791, and the negative mood scores also realized a significant decrease to only 25.325~34.516.

Dance therapy based on embodiment theory showed high application value in providing students with guidance on body rhythmic expression and group healing support. The quantile regression analysis revealed that dance therapy had a significant positive effect on college students' mental health status, and college administrators should pay attention to providing personalized embodiment theory-based dance therapy for mental health interventions in a

timely manner to avoid the deterioration of students' mental health during college.

Funding

This research was supported by the Hunan Provincial Department of Education Scientific Research Youth Project "Empirical Study on Promoting the Development of College Students' Mental Health through Dance Therapy from the Perspective of Embodied Cognition" (Project Number: 24B1195, Hunan Provincial Department of Education).

About the Author

Qiwang Zhang was born in Wuhan, Hubei Province, China in 1986. He holds a Ph.D. in Education and is currently employed at the School of Music and Dance, Changsha Normal University. His main research interests are Dance Education and Dance Science.

References

[1] Porru, F., Robroek, S. J., Bültmann, U., Portoghese, I., Campagna, M., & Burdorf, A. (2021). Mental health among university students: The associations of effort-reward imbalance and overcommitment with psychological distress. Journal of Affective Disorders, 282, 953-961.

[2] Bhujade, V. M. (2017). Depression, anxiety and academic stress among college students: A brief review. Indian Journal of Health & Wellbeing, 8(7).

[3] Karyotaki, E., Cuijpers, P., Albor, Y., Alonso, J., Auerbach, R. P., Bantjes, J., ... & Kessler, R. C. (2020). Sources of stress and their associations with mental disorders among college students: results of the world health organization world mental health surveys international college student initiative. Frontiers in psychology, 11, 1759.

[4] Nobiling, B. D., & Maykrantz, S. A. (2017). Exploring perceptions about and behaviors related to mental illness and mental health service utilization among college students using the health belief model (HBM). American journal of health education, 48(5), 306-319.

[5] Cuijpers, P., Auerbach, R. P., Benjet, C., Bruffaerts, R., Ebert, D., Karyotaki, E., & Kessler, R. C. (2019). The world health organization world mental health international college student initiative: an overview. International journal of methods in psychiatric research, 28(2), e1761.

[6] Cerolini, S., Zagaria, A., Franchini, C., Maniaci, V. G., Fortunato, A., Petrocchi, C., ... & Lombardo, C. (2023). Psychological counseling among university students worldwide: A systematic review. European journal of investigation in health, psychology and education, 13(9), 1831-1849.

[7] Park, S. (2020). A Geographical Study on the Limitations of Campus Student Counselling Centers as Alternative Therapeutic Spaces for Promoting Mental Health: From a Perspective of Counsellors. Journal of the Korean Geographical Society, 55(1), 1-15.

[8] Yin, C., Gao, R., & Ni, X. (2023). Intention of psychological counseling, attitude toward seeking psychological help, and shame among vocational college students: a cross-sectional survey. Alpha Psychiatry, 24(5), 186.

[9] Koch, S. C., Riege, R. F., Tisborn, K., Biondo, J., Martin, L., & Beelmann, A. (2019). Effects of dance movement therapy and dance on health-related psychological outcomes. A meta-analysis update. Frontiers in psychology, 10, 1806.

[10] Lowen, F. (2024). The role and value of pleasure in dance/movement therapy experience: beyond the limits of science. Body, Movement and Dance in Psychotherapy, 19(1), 70-84.

[11] Barrero González, L. F. (2019). Dance as therapy: embodiment, kinesthetic empathy and the case of contact improvisation. Adaptive Behavior, 27(1), 91-100.

[12] Gomes, N., Cochet, S., & Guyon, A. (2021). Dance and embodiment: therapeutic benefits on body-mind health. Journal of Interdisciplinary Methodologies and Issues in Science.

[13] Kosmas, P., & Zaphiris, P. (2018). Embodied cognition and its implications in education: An overview of recent literature. International Journal of Educational and Pedagogical Sciences, 12(7), 970-976.

[14] Fugate, J. M., Macrine, S. L., & Hernandez-Cuevas, E. M. (2024). Therapeutic potential of embodied cognition for clinical psychotherapies: from theory to practice. Cognitive Therapy and Research, 48(4), 574-598.

[15] Lan, W., & Haosheng, Y. (2021). The Roles of the Body in Psychotherapy: an Analysis based on the Embodied Perspective. The Roles of the Body in Psychotherapy: an Analysis based on the Embodied Perspective, 3(1), 33-40.

[16] Kronsted, C. (2020). The self and dance movement therapy–a narrative approach. Phenomenology and the Cognitive Sciences, 19(1), 47-58.

[17] Ma, C. (2024). The influence of college physical education teaching on students' mental health and skill improvement under the embodied cognition Theory. Revista de Psicología del Deporte (Journal of Sport Psychology), 33(2), 366-375.

[18] Fong Yan, A., Nicholson, L. L., Ward, R. E., Hiller, C. E., Dovey, K., Parker, H. M., ... & Chan, C. (2024). The effectiveness of dance interventions on psychological and cognitive health outcomes compared with other forms of physical activity: a systematic review with meta-analysis. Sports Medicine, 54(5), 1179-1205.

[19] Hyvönen, K., Pylvänäinen, P., Muotka, J., & Lappalainen, R. (2020). The effects of dance movement therapy in the treatment of depression: a multicenter, randomized controlled trial in Finland. Frontiers in psychology, 11, 1687.

[20] DeJesus, B. M., Oliveira, R. C., de Carvalho, F. O., de Jesus Mari, J., Arida, R. M., & Teixeira-Machado, L. (2020). Dance promotes positive benefits for negative symptoms in autism spectrum disorder (ASD): A systematic review. Complementary therapies in medicine, 49, 102299.

[21] Harty, E. (2024). “Embodying opposites”—A case illustration of Dance Movement Therapy as an additional intervention in the treatment of co-morbid Borderline Personality Disorder and Complex Post Traumatic Stress Disorder. Journal of Clinical Psychology, 80(4), 900-911.

[22] Xiaolin, L., Meiling, P., & Chao, W. (2024). The Application of the Dance Movement Therapy in the Rehabilitation of Adolescent Patients with Schizophrenia. MEDS Clinical Medicine, 5(1), 49-53.

[23] Dosumu-Lawal, Y., & Azeez, R. O. (2024). Dance Therapy, Stress Reduction, Emotional Resilience and Mental Well-being of Academics at Lagos State University. LASU Postgraduate School Journal (LPSJ), 1(1).

[24] Duberg, A., Jutengren, G., Hagberg, L., & Möller, M. (2020). The effects of a dance intervention on somatic symptoms and emotional distress in adolescent girls: A randomized controlled trial. Journal of international medical research, 48(2), 0300060520902610.

[25] Phillips, C. (2017). Brain-derived neurotrophic factor, depression, and physical activity: making the neuroplastic connection. Neural plasticity, 2017(1), 7260130.

[26] Lopez-Nieves, I., & Jakobsche, C. E. (2022). Biomolecular effects of dance and dance/movement therapy: A review. American Journal of Dance Therapy, 44(2), 241-263.

[27] Zhao, R., Li, J., & Wang, J. (2025). Effect of Different Dance Rhythms on the Recovery Period of the Autonomic Nervous System. Journal of Manipulative and Physiological Therapeutics.

[28] Immanuel, S., Teferra, M. N., Baumert, M., & Bidargaddi, N. (2023). Heart rate variability for evaluating psychological stress changes in healthy adults: a scoping review. Neuropsychobiology, 82(4), 187-202.

[29] Wang, J. (2024). Neural and Psychological Mechanisms of Dance Movement Therapy Efficacy. Critical Debates in Humanities, Science and Global Justice.

[30] Zhao, R., Li, J., & Wang, J. (2025). The effects of different types of dance interventions on the autonomic nervous system of college students with depressed mood. Frontiers in psychology, 16, 1625090.

[31] Qiu, S., Ruan, C., & Wang, Y. (2025). Anxiety relief in the post-pandemic era: a randomized trial on the integration of digital technology into dance art healing. Frontiers in Psychology, 16, 1545461.

[32] Zhang, B., Campiranon, A., & Srisawat, P. (2024). The Effect of Dance Psychotherapy Activities on Stress Reduction for Undergraduate Students. Journal of Multidisciplinary in Humanities and Social Sciences, 7(6), 3160-3175.

[33] Zhang, A., & He, N. (2022). Study on the effect of dance movement therapy on psychiatric rehabilitation of patients with anxiety disorders. Psychiatria Danubina, 34(suppl 2), 660-660.

[34] Tang, J. (2024). The influence of sports modern dance on the psychological health of college students. Revista de Psicología del Deporte (Journal of Sport Psychology), 33(1), 1-12.

[35] Arman, N., & Türkmen, E. (2021). Effect of dance therapy course practice on academic motivation, anxiety, dance-related self-efficiency, stress, and autonomous learning in physiotherapy students. Archives of Health Science and Research, 8(2), 124-130.