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A study of mental health and behavioral habits of college students based on biomechanical analysis: the effects of anxiety and depression on gait, electromyography and balance control and the effects of exercise intervention

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Abstract In order to enhance college students' behavioral patterns and mental health, this study suggests a novel program that combines biomechanical and behavioral activation approaches. According to their levels of anxiety and depression, 120 undergraduate students—60 men and 60 women—were chosen for the study and divided into three groups: the experimental group, which had mild anxiety and depression, the control group, which had no discernible anxiety or depression, and the intervention group, which had anxiety and depression but was receiving exercise intervention. The intervention group underwent 8 weeks of exercise training, including aerobic exercise, strength training and yoga, while the other groups were used for the assessment of baseline biomechanical parameters. Before and after the experiment, a three-dimensional motion capture system (VICON) was used for gait analysis, surface electromyography (Noraxon) for EMG signal acquisition, and a dynamic balance measurement system (Bertec Force Plate) to assess postural stability. Mental health was also assessed using standardized scales (PHQ-9 depression scale and GAD-7 anxiety scale). Results showed that anxiety and depression negatively affected gait parameters, muscle activation and postural stability, with the experimental group having a slower gait, poor symmetry and low levels of muscle activation. In contrast, the intervention group showed improved gait symmetry, increased stride length, and muscle activation levels returned to near control levels after the 8-week exercise intervention, demonstrating that the exercise intervention significantly improved these biomechanical indices.

Index Terms biomechanics, behavioral activation interventions, mental health, gait analysis, electromyographic signals, postural stability, exercise interventions, anxiety, depression

I. Introduction

In recent years, the mental health problems of college students have become increasingly prominent, and the incidence of psychological disorders such as depression and anxiety has been on the rise in the college population [1]. A variety of factors influence the mental health of college students, including academic stress, social expectations, and lifestyle. However, an often overlooked but crucial aspect is the role of biomechanics. [2], [3] Biomechanics, which focuses on the mechanics of biological systems, has traditionally been applied in sports science and rehabilitation medicine, but is equally valuable in the field of mental health. Biomechanics can help us understand the physical manifestations of mental disorders and provide innovative intervention strategies to improve the mental health and behavior of college students [4].

From a biomechanical perspective, mental health problems such as depression and anxiety are not just at the cognitive or emotional level; they are also reflected in biomechanical characteristics such as muscle activity, postural control, movement patterns, and neuromuscular coordination [5]. Studies have shown that depressed individuals typically exhibit slow gait, shortened stride length, increased body sway, and decreased postural control [6], [7]. Similarly, patients with anxiety disorders are often characterized by increased muscle tension, erratic motor responses, and hypersensitivity of the startle reflex, all of which can affect daily behavior and exacerbate psychological burden. These biomechanical indicators not only serve as an objective measure of mental health, but also reveal a strong connection between the mind and the body [8].

Behavioral Activation (BA) interventions are one of the most widely used psychotherapies for depression and anxiety today, with the core idea being to improve emotional states by increasing positive behavioral activity and breaking the vicious cycle of avoidance behaviors [9]. In this intervention system, biomechanics can play an important role in helping to optimize movement patterns, increase neuromuscular efficiency, and improve ergonomic posture, thereby enhancing mental toughness and physical health [10]. For example, interventions such as postural training, proprioceptive training, and motor control training for college students can not only alleviate the physical tensions associated with anxiety and depression, but also reinforce positive behavioral patterns and improve their resilience in the face of stress [11], [12].

In addition, integrating biomechanics into behavioral education for college students is also an effective way to promote mental health. Colleges and universities can provide more scientific and rational mental health support for college students by optimizing campus ergonomic environments, establishing structured exercise courses, and promoting intervention programs based on postural adjustment [13]. It has been shown that regular physical activity, especially motor-control-based practices such as yoga, tai chi, and aerobic exercise, can regulate neurotransmitter levels, reduce cortisol (stress hormone) secretion, and enhance psychological adaptability. When these interventions are combined with biomechanical assessments, they can be precisely tailored to individual differences, thereby increasing the effectiveness of psychological interventions [14].

Additionally, biomechanical gender differences targeting depression and anxiety are of interest. It has been found that male students often tend to be emotionally depressed in the face of stress, and their biomechanical manifestations may include increased muscle rigidity and gait asymmetry, whereas female students may exhibit smoother movement patterns but are more prone to muscle stiffness due to emotional stress. Understanding these gender differences can help to develop more individualized biomechanical interventions that can improve the effectiveness of mental health management [15], [16].

In summary, biomechanics provides a unique and scientific perspective for understanding and improving mental health issues in college students. By analyzing movement mechanics characteristics, postural control, and neuromuscular function, more effective mental health intervention programs can be developed. Integrating biomechanics into behavioral education and mental health strategies not only helps to enhance college students' self-regulation and reduce physical load due to anxiety and depression, but also promotes their long-term mental resilience. In the process of exploring innovative mental health support systems in colleges and universities, the introduction of biomechanical methods will become an important means of promoting the physical and mental health of college students.

II. Biomechanical Perspectives on Student Mental Health and Behavioral Habits

Biomechanics, as an important discipline for studying the movement patterns of living organisms and their force mechanisms, also has a wide range of applications in the field of mental health. In recent years, the problems of depression and anxiety among college students have become increasingly serious, and studies have shown that these psychological states not only affect students' cognitive and emotional regulation abilities, but also profoundly influence their behavioral habits, and may even change their muscle activity patterns, body postures, and motor control abilities [17]. Therefore, adopting a biomechanical approach to study the behavioral characteristics of college students in the state of depression and anxiety can help to understand the interaction between mental health and motor function and provide a scientific basis for intervention [18].

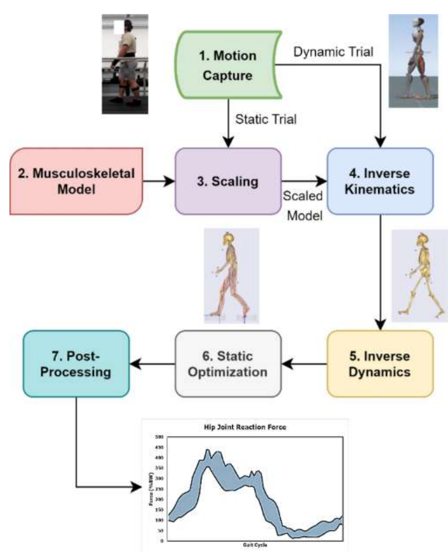

Figure 1: Model of the relationship between students' mental health and behavioral habits from a biomechanical perspective

Figure 1 visually illustrates how biomechanical parameters (e.g., muscle activity, postural stability, gait patterns) interact with mental health factors (depression, anxiety) and behavioral habits (exercise participation, social interactions). The diagram uses a system dynamics framework in conjunction with biomechanical measurements to construct multi-level interactions.

Figure 1 consists of four key modules: mental health status (depression/anxiety), which influences an individual's neuromuscular control, motor coordination, and postural stability [19]. The biomechanical feedback system includes parameters such as electromyographic signals (EMG), gait analysis, postural conditioning (COP: change in plantar center of pressure), and body balance. Behavioral habit modifiers such as exercise participation, daily activity level, and frequency of social interactions are factors that are both influenced by psychological state and can be fed back to modulate mental health through biomechanical pathways.

This chapter will explore the effects of depressive-anxious states on college students' behavioral habits in terms of postural control, gait analysis, muscle activity patterns, and motor coordination, and quantitatively describe these changes through biomechanical models and formulas.

II. A.Attitude control and stability analysis

Depression and anxiety often lead to changes in body posture, such as forward head tilt, shoulder collapse, and slow gait. These changes can be described using the Stability Boundary model:

$$S = \frac{M \cdot g \cdot h}{I + M \cdot h^2} \tag{1}$$

where, S is the stability index, with lower values indicating poorer postural control; M is the mass of the individual; g is the acceleration of gravity; h is the height of the center of mass; and I is the rotational inertia of the trunk.

It has been found that individuals who are chronically depressed and anxious have lower h values (due to habitual postures such as hunching and slumping of the shoulders), which leads to a decrease in S, thus increasing the risk of falling [20].

Individuals in a state of depression and anxiety show abnormal Plantar Pressure Distribution (PD), for example, when standing the pressure is concentrated in the forefoot or hindfoot, which can be described by the following equation:

$$P(x,y) = \frac{F}{A} \tag{2}$$

where $P(x,y)$ is the pressure at a point of the plantar foot; F is the force; A is the contact area.

Through the plantar pressure diagram (Figure 2), the plantar force of college students in different mental states can be visualized.

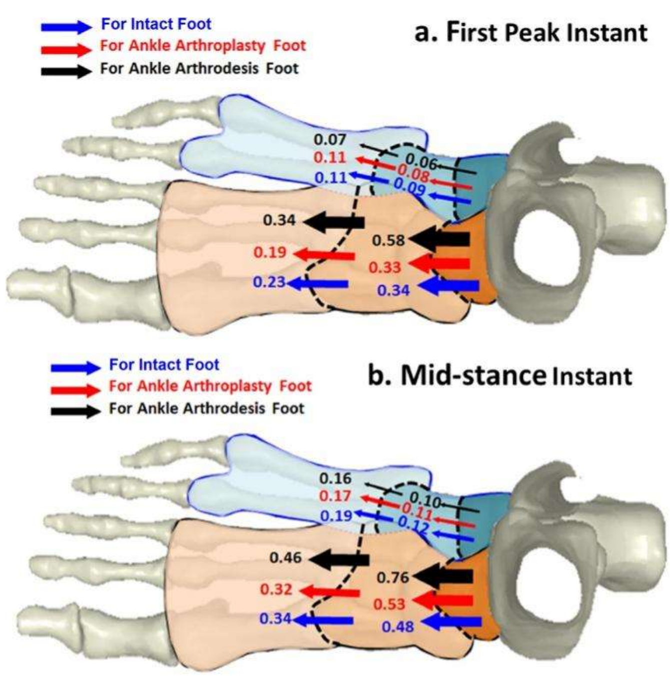

Figure 2: Distribution of plantar pressure in normal (a) and depressed (b) students

II. B.Gait analysis and movement patterns

Depression and anxiety states affect the gait characteristics of an individual, usually in the form of shortened stride length, decreased stride frequency, and gait asymmetry. These changes can be represented by the Gait Cycle parameter:

$$G = \frac{d}{T} \tag{3}$$

where, G is the gait speed; d is the stride length; and T is the gait period. Anxious individuals typically exhibit shorter stride lengths (smaller d) and longer gait cycles (increased T), resulting in a decrease in G. The gait asymmetry can be assessed by the Symmetry Index (SI).

Gait asymmetry can be assessed by the Symmetry Index (SI):

$$SI = \left|\frac{X_L - X_R}{0.5(X_L + X_R)}\right| \times 100\% \tag{4}$$

where, X_L and X_R are left and right leg gait parameters (e.g., step length or step speed), respectively. SISI was usually higher than normal in depressed and anxious students, indicating poor gait coordination.

II. C.Analysis of muscle activity patterns

Changes in muscle activity patterns can be measured by surface electromyography (sEMG). The characterization of EMG signals can be expressed in terms of root mean square (RMS) and mean power frequency (MPF):

$$RMS = \sqrt{\frac{1}{N}\sum_{i=1}^{N} x_i^2} \tag{5}$$

$$MPF = \frac{\sum f_i P(f_i)}{\sum P(f_i)} \tag{6}$$

where, x_i is the sampled EMG signal value; fi is the frequency component; $P(f_i)$ is the power spectral density.

The study showed that depressed and anxious students had lower RMS values and MPF favored low frequencies, indicating reduced muscle activity and reduced motor ability.

II. D.Motor coordination and rehabilitation interventions

Motor coordination in depressed anxious individuals can be described by the rate of change of Joint Angular Velocity (ω):

$$\alpha = \frac{d\omega}{dt} \tag{7}$$

where, α is joint angular acceleration; ω is angular velocity; and t is time. Anxious individuals usually have larger α values, indicating increased motor instability.

For depressed and anxious individuals, the following biomechanical intervention strategies can be used: postural training to improve postural stability through core muscle group training; gait adjustment to improve motor coordination through gait correction and dynamic balance training; muscle strengthening to enhance muscle activity using electromyographic biofeedback techniques; and orthomolecular exercises, such as yoga and tai chi, which are used in conjunction with biomechanical control strategies to improve psychological and motor coordination.

III. Methods

Guided by moral and behavioral norms, this education develops good behaviors in college students through a series of trainings, so that they can develop stable personal habits and further improve their personal moral qualities under the effect of moral practices [21]. Independent samples t-test with control group analysis was used in order to explore the effects of behavioral activation intervention on individuals' behavioral activation level, depression level, coping style and reinforcement sensitivity.

Correlation and regression analyses were conducted on 77 questionnaire data to explore the mediating and moderating roles of coping styles and reinforcement sensitivity in the process of behavioral activation levels affecting depression. Different psychological scales are applicable to specific groups and cultural contexts for assessing psychological states and can be categorized in Table 1.

Table 1: Classification of mental health scales

Type	Features	Representative Scales
Committed to pupils	Created to accommodate kids' physical attributes	University Student Personality Inventory (UPI); Mental Health Scale for Secondary School Students (MSSMHS); and Mental Health Diagnostic Test for Primary and Secondary School Students (MHT)

No particular status limitations	Broad range of applications, provided the test subject's age satisfies the necessary standards	Symptom Self-Measurement Scale SCL90
Evaluates particular psychological symptoms	Focused on assessing the intensity of symptoms associated with specific mental illnesses	Depression Self-Rating Scale SDS

College students' mental health maturity is greatly influenced by social environment and life practice, and school education and life environment are the key factors. Song Delu and Zhang Xiaoxu summarized the characteristics of their psychological development as: 1) rapid intellectual advancement but one-sided thinking; 2) emotional richness but instability; 3) increased self-consciousness but immaturity; 4) desire for interaction but prone to show psychological closure; and 5) development of sexual awareness but prone to imbalance. In addition, because psychological questionnaire data are mostly hierarchical in structure, when identifying groups with poorer psychological status, psychologists need to compare statistical results from different perspectives and analyze them with the help of grouping, data slicing and score statistics. Figure 3 shows an example of traditional software used to analyze the impact of gender and the one-child factor on students' mental health.

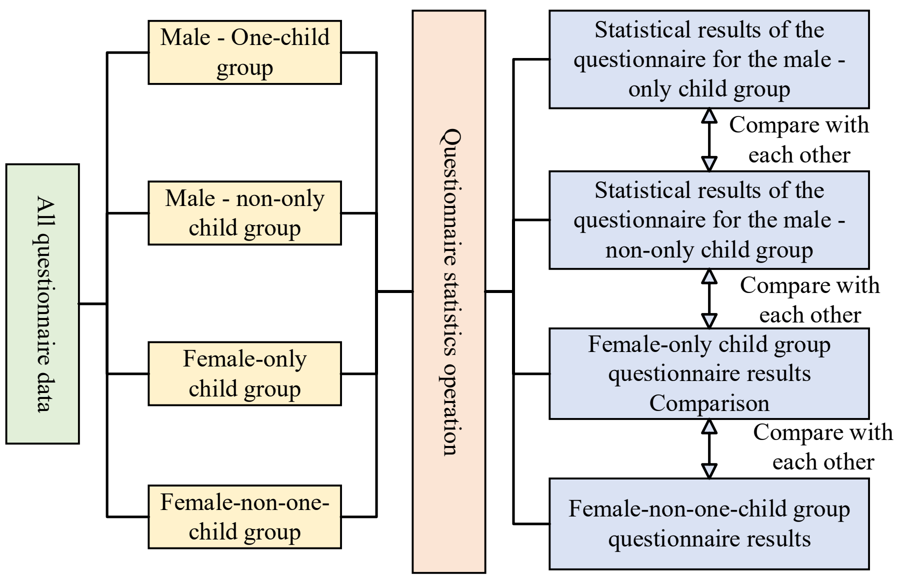

Figure 3: Effect of gender and only-child status on students' psychological status using traditional software

Mental health problems refer to psychological factors or states that affect an individual's normal behavior and activities. Common problems of college students include life adaptation, learning, interpersonal relationship, self-development, career planning, stress and emotion, sexual psychology and cyberpsychological problems, which can be categorized into two types: developmental and obstructive. The former covers learning, emotion, interpersonal relationship, personal growth and psychological crisis, while the latter involves cognitive disorders, emotional disorders, behavioral abnormalities and impaired social functioning. Information visualization is used to parse abstract, unstructured data and reveal hidden patterns through visual views. Its reference model improves the linear pipeline structure as a cyclic interaction pattern, as shown in Figure 4.

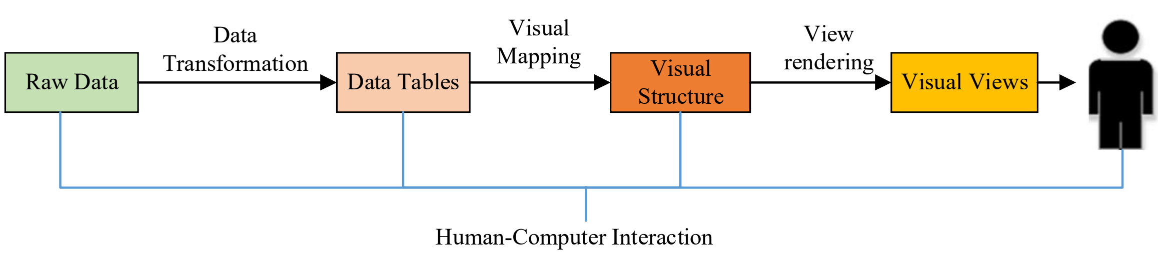

Figure 4: Enhancement of the reference model for information visualization on anxiety and sadness

IV. Results

IV. A. Biomechanics in the mental health and behavioral habits of college students

IV. A. 1) Experimental design and methods

In this study, 120 undergraduates (60 males and 60 females) from a university in Shenyang were divided into three groups according to the level of anxiety and depression:

Experimental group (mild anxiety/depression): 40 people (20 men, 20 women); control group (no significant anxiety/depression): 40 people (20 men, 20 women); intervention group (anxiety/depression but receiving exercise intervention): 40 people (20 men, 20 women).

All subjects were free of neurological diseases or serious sports injuries, and prohibited from strenuous exercise one week before the experiment to ensure the accuracy of the experimental data.

IV. A. 2) Experimental Procedures

The experiment was divided into two phases:

Phase 1: Basic biomechanical measurements

Gait analysis: recording gait parameters including step length, step frequency, gait symmetry, ground reaction force (GRF), etc. using a 3D motion capture system (VICON).

Electromyographic Signal Acquisition (EMG): The electromyographic activation of quadriceps, gastrocnemius, and tibialis anterior muscles was measured using a surface electromyograph (Noraxon) to analyze muscle activity patterns.

Postural stability test: center of gravity fluctuation (COP) was assessed using a dynamic balance measurement system (Bertec Force Plate) to calculate the magnitude and speed of center of gravity change when the subject was standing.

Psychological state assessment: Standardized scales (PHQ-9 Depression Scale, GAD-7 Anxiety Scale) were used to assess the mental health state of the students.

Phase 2: Exercise intervention (intervention group specific)

Subjects in the intervention group were assigned 8 weeks of exercise training, including aerobic exercise (running, cycling), strength training (core stability), and yoga, 3 times per week for 45 minutes.

Repeat the same biomechanical measurements before and after the intervention to compare data changes.

IV. A. 3) Experimental data and analysis

Table 2 demonstrates the means and standard deviations of the gait parameters for the three groups of subjects.

Table 2: Comparison of gait parameters of each group (unit: cm, step frequency unit: step/min)

Group	Step size (left)	Step size (right)	Stride frequency	Symmetry index	Ground reaction force (GRF, N)
Experimental group	62.4±3.2	63.1±2.8	108.3±5.2	0.92±0.04	940±50
Control group	68.2±2.9	68.5±3.1	115.2±4.6	0.98±0.03	980±45
After intervention	67.5±3.0	67.9±2.8	113.9±4.8	0.96±0.03	975±48

The results in Table 2 analyze that the experimental group students have shorter stride length and lower stride frequency, indicating that their walking rhythm is affected by their psychological state and may be characterized by motor retardation. The control group had a more stable gait and higher symmetry of stride length, indicating that those with good mental health status have better motor control. After the exercise intervention, the gait parameters of the students in the intervention group improved, with an increase in stride length and symmetry, suggesting that exercise helps to optimize gait patterns. Table 2 presents the gait parameters of three groups of university students—those with mild anxiety and depression (experimental group), those without significant psychological distress (control group), and those who received an exercise intervention. The data highlight significant differences in motor coordination between individuals with and without anxiety and depression, as well as the positive effects of exercise intervention on gait performance. The experimental group demonstrated shorter step lengths (left: 62.4±3.2 cm, right: 63.1±2.8 cm) and a lower step frequency (108.3±5.2 steps/min) compared to the control group (left: 68.2±2.9 cm, right: 68.5±3.1 cm, step frequency: 115.2±4.6 steps/min). The reduced step length and frequency suggest that anxiety and depression impair motor coordination and may be associated with motor retardation, characterized by slower and less stable movements. Additionally, the lower symmetry index (0.92±0.04) and decreased ground reaction force (GRF: 940±50 N) in the experimental group indicate weaker balance control and reduced lower limb strength. After the eight-week exercise intervention, gait parameters improved significantly. The intervention group exhibited an increased step length (left: 67.5±3.0 cm, right: 67.9±2.8 cm) and a higher step frequency (113.9±4.8 steps/min), approaching the values of the control group. The symmetry index also increased

(0.96±0.03), suggesting improved bilateral coordination and postural control. Furthermore, the GRF increased to 975±48 N, indicating enhanced lower limb strength and improved walking dynamics. These results support the hypothesis that targeted exercise interventions, such as aerobic training, core stability exercises, and yoga, can effectively enhance motor coordination, balance, and overall physical function in individuals experiencing anxiety and depression.

Table 3 demonstrates the mean EMG values of quadriceps and gastrocnemius muscles in the three groups of subjects.

Table 3: EMG RMS values of each group (unit: mV)

Group	Quadriceps (RMS)	Gastrocnemius (RMS)
Experimental group	0.35±0.07	0.28±0.06
Control group	0.41±0.05	0.32±0.05
After intervention	0.40±0.06	0.31±0.05

The results analyzed in Table 3 show that the EMG activation level of the experimental group was lower than that of the control group, indicating that anxiety and depression affect the muscle contraction ability, leading to a decrease in muscle activity. After the exercise intervention, the EMG signal of the intervention group was elevated and close to the level of the control group, indicating that exercise training improved muscle function. Table 3 primarily presents the electromyographic root mean square (RMS) values of the quadriceps and gastrocnemius muscles in university students with different psychological states, analyzing the impact of depression and anxiety on muscle activity levels. The experimental group exhibited lower RMS values (quadriceps: 0.35±0.07 mV, gastrocnemius: 0.28±0.06 mV) compared to the control group (0.41±0.05 mV and 0.32±0.05 mV, respectively). This result indicates that individuals with anxiety and depression have reduced muscle contraction ability, likely due to impaired neuromuscular control caused by prolonged negative emotional states, which subsequently affects motor function and postural stability.

After an eight-week exercise intervention, the RMS values in the intervention group significantly increased (quadriceps: 0.40±0.06 mV, gastrocnemius: 0.31±0.05 mV), approaching the levels observed in the control group. This suggests that exercise intervention effectively restores muscle activity and enhances neuromuscular coordination. Specifically, core strength training, gait adjustment, and dynamic balance exercises may improve muscle recruitment patterns, resulting in better posture control during walking and standing. Additionally, exercise may alleviate anxiety and depression by reducing cortisol levels and improving neurotransmitter function (e.g., increasing serotonin and dopamine secretion), indirectly enhancing muscle function. These findings provide empirical support for optimizing mental health interventions from a biomechanical perspective.

Figure 5 illustrates the comparison of the COP trajectories of the three groups of subjects in the dynamic balance test.

Figure 5 shows that the COP trajectory of the experimental group was more scattered, and the range of fluctuation of the center of gravity was larger, indicating that the balance control ability of individuals in the state of anxiety/depression was poor. After the exercise intervention, the COP trajectory of the intervention group converged, indicating that the training of plantar core muscles effectively enhanced the stability. This reflects the profound influence of mental health status on biomechanical control. Exercise intervention can effectively enhance gait stability, improve muscle activation level, and enhance balance control, providing empirical support for psychological intervention from a biomechanical perspective.

IV. B. Psychological verification

Grasping the nature of college students' behavioral habit education requires focusing on behavioral norms and habit development to ensure that educators shape good habits according to the norms. Therefore, BA interventions or studies should emphasize behavioral avoidance and activation, respectively, and increase the content of related activities.

The depression model parameters include 13 fixed parameters and 31 regression coefficients, and the results are shown in Table 4.

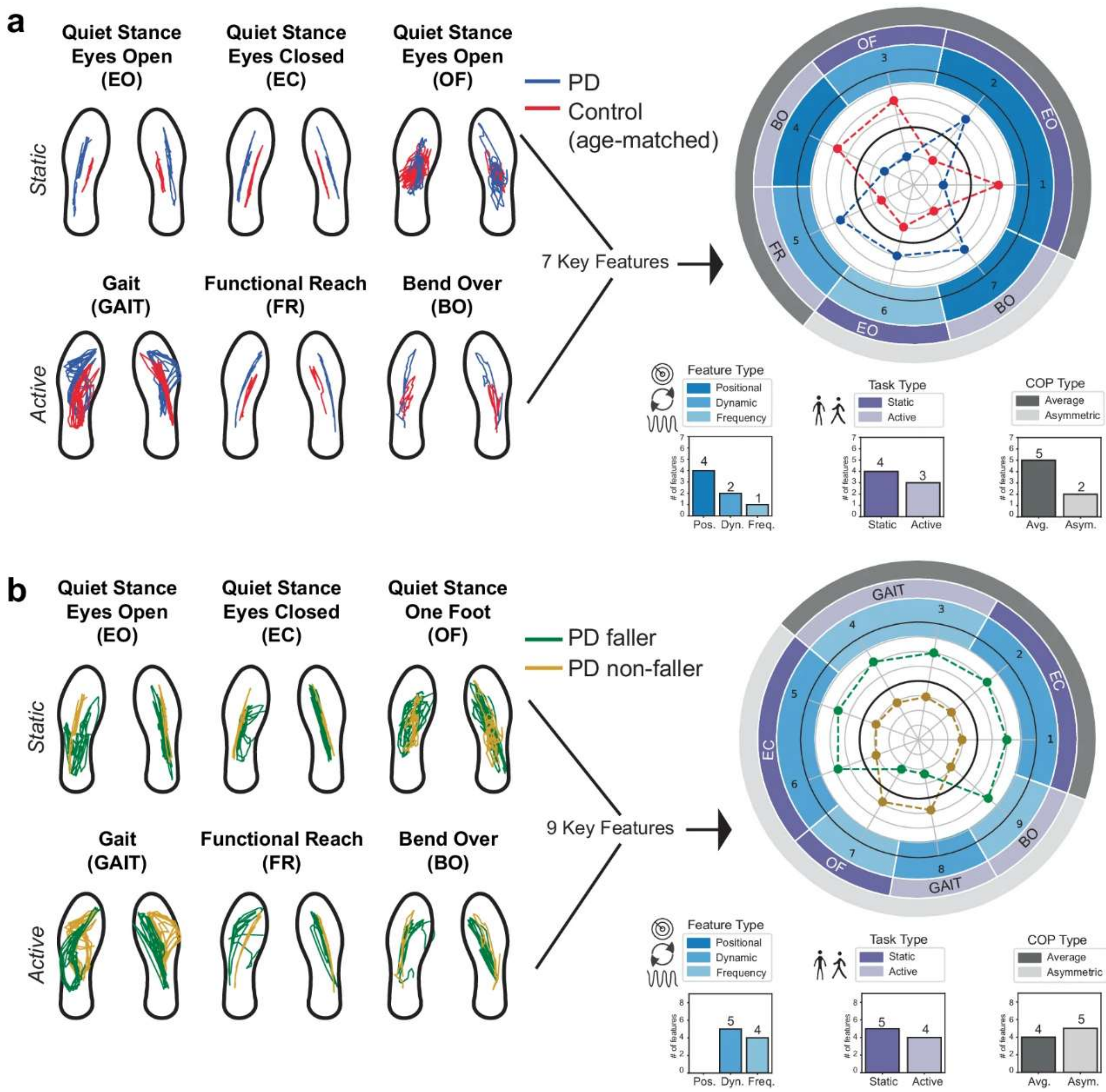

Figure 5: Distribution of COP trajectories for each group(a: experimental group, b: post-intervention)

Table 4: Depression model parameter classes table

	Weights	Covariances	Variances	Means	Intercepts	Total
Fixed	13	0	6	0	0	19
Labeled	0	0	0	0	0	0
Unlabeled	18	10	8	0	0	36
Total	31	10	14	0	0	55

Machine learning is usually divided into two stages. In the first stage, training samples are inputted to emphasize the importance of the psychological development of the “five types of education” and their internal logical relationships in the context of the “moral education” parenting strategy. As Sukhomlinsky said, “Physical, moral and aesthetic cultivation is inconceivable without psychological cultivation.” In the second stage test samples were entered to assess the ability of the model to generalize (see Figure 6).

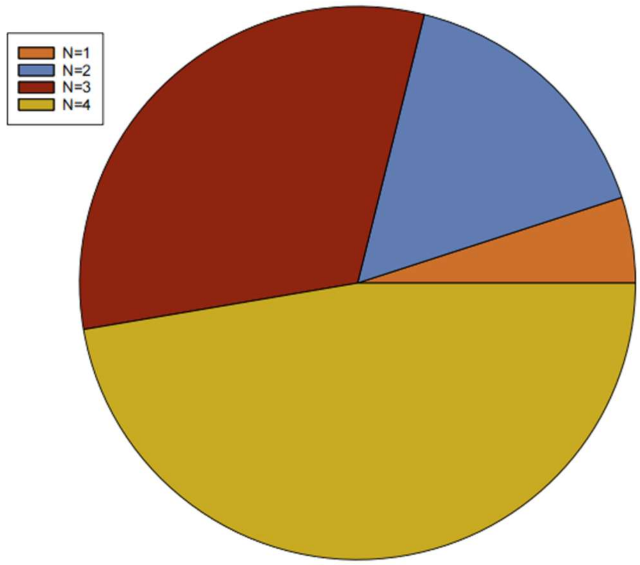

Figure 6: Percentage of every mental state

In addition to the standardized and practical features of general education, the education of contemporary college students' behavioral habits is also targeted, and the cultivation of habits is strengthened by combining the characteristics of the times. A survey of 1,892 undergraduates from 15 universities in China showed that the positive anxiety and stress detection rate of male students was higher than that of female students. Conventional wisdom suggests that male students are subject to greater social and family pressures, and that gender differences lead to different ways of coping with psychological problems. Male students tend to be more silent, while female students are more emotional and willing to talk and express themselves.

V. Discussion

The findings of this study emphasize the profound relationship between mental health and motor coordination, demonstrating that anxiety and depression significantly affect biomechanical performance. The results of gait analysis (Table 2) indicate that students with anxiety and depression exhibit shorter step lengths, lower step frequencies, and reduced symmetry in their gait. These observations suggest that psychological distress influences motor function, leading to movement patterns characterized by instability and reduced efficiency. The lower ground reaction force (GRF) further supports this conclusion, indicating diminished lower limb strength and impaired neuromuscular control in individuals experiencing anxiety and depression. These impairments align with previous research suggesting that heightened psychological stress contributes to reduced motor efficiency and increased postural instability.

The electromyographic (EMG) analysis (Table 3) further reinforces the notion that mental health disorders negatively impact muscle activation levels. The lower root mean square (RMS) values observed in the quadriceps and gastrocnemius muscles of the experimental group highlight a decrease in muscle contraction ability, which may contribute to difficulties in movement execution and postural control. The reduced muscle activation suggests that individuals with anxiety and depression may experience neuromuscular inefficiencies, potentially due to altered central nervous system processing and increased cognitive load associated with their mental health conditions. These findings support the hypothesis that psychological distress is linked to reduced motor coordination and muscular engagement, ultimately affecting functional movement patterns.

The intervention results provide strong empirical evidence for the effectiveness of targeted exercise programs in improving motor function in individuals with anxiety and depression. Following an eight-week intervention consisting of aerobic exercise, strength training, and yoga, the intervention group exhibited significant improvements in gait parameters, muscle activation levels, and postural stability. Increased step length, step frequency, and gait symmetry suggest enhanced motor control and coordination. Additionally, the elevated GRF indicates improved lower limb strength, contributing to more stable and efficient movement patterns. The EMG data further show that muscle activation levels in the intervention group approached those of the control group, signifying enhanced neuromuscular efficiency and improved motor function.

The postural stability results, illustrated by the changes in center of pressure (COP) trajectory (Figure 5), confirm that anxiety and depression negatively impact balance control. The more scattered COP distribution in the experimental group reflects instability, whereas the post-intervention group exhibited a more concentrated COP trajectory, indicating enhanced balance and postural control. These findings are consistent with the understanding that core muscle training and dynamic balance exercises contribute to improved proprioception and neuromuscular control, ultimately reducing the risk of falls and enhancing overall movement stability.

Beyond the biomechanical improvements, the psychological benefits of exercise intervention should also be considered. Physical activity has been widely recognized as a non-pharmacological strategy to alleviate symptoms of anxiety and depression by promoting neurochemical changes, such as increased endorphin and serotonin levels. Moreover, structured exercise routines provide individuals with a sense of accomplishment and routine, which can contribute to improved mental well-being. The results of this study reinforce the importance of incorporating exercise-based interventions into mental health treatment strategies for university students experiencing psychological distress.

In conclusion, this study demonstrates that anxiety and depression have a substantial impact on motor coordination, balance, and muscle function. The results highlight the need for integrating physical activity as part of a holistic approach to mental health care. Exercise interventions, particularly those incorporating aerobic training, strength exercises, and balance-focused activities, can significantly improve motor function and psychological well-being. Future research should explore the long-term effects of such interventions and examine how different types of exercise programs influence mental health and biomechanical performance across diverse populations.

VI. Conclusion

In this study, we investigated the effects of an exercise intervention on the mental health of college students by incorporating a biomechanical approach, particularly its mitigating effects on anxiety and depression levels. Through gait analysis, EMG signal acquisition and postural stability testing, we found that anxiety and depression states significantly impacted the biomechanical performance of individuals in the form of unstable gait, reduced EMG activity levels, and decreased balance control. However, after 8 weeks of exercise intervention, students in the intervention group showed improvements in gait parameters, muscle activation levels, and balance control, suggesting that exercise intervention has a positive effect on psychological well-being at the biomechanical level.

Further statistical analyses revealed a deeper association between mental health and biomechanical control. The exercise intervention not only optimized gait patterns and muscle function, but also enhanced individual postural stability, providing empirical support for mental health interventions from a biomechanical perspective. This finding provides a new theoretical basis for the development of psychological intervention programs, especially in the college student population, where the application of biomechanical methods can be used as an effective complementary tool for mental health management.

Therefore, the results of this study highlight the importance of biomechanics in mental health research, and the biomechanical mechanisms of exercise interventions can be further explored in the future to deepen the multidimensional understanding of mental health improvement and to provide a scientific basis for the development of more individualized intervention programs.

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