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Impact Analysis of Sports on the Regulation of College Students' Psychological and Emotional States: A New Neutrosophic Emotional Regulation Sequencing (NERS) Model

Huihui Zhong*

Sports Department, Suzhou Vocational University, Suzhou, Jiangsu, 215002, China

*Corresponding author, E-mail: 18662578182@163.com

Abstract-The regulation of psychological and emotional states among college students has become a critical issue in modern higher education. Sports activities are widely acknowledged for their capacity to alleviate stress, enhance resilience, and improve overall mental health; however, existing studies often fail to capture the complexity and uncertainty of emotional responses. This paper introduces a novel mathematical framework, the Neutrosophic Emotional Regulation Sequencing (NERS) Model, to analyze the impact of sports on the regulation of psychological and emotional states. Unlike conventional methods, the NERS model integrates a pentagonal neutrosophic structure that quantifies positive emotional influence, negative emotional influence, uncertainty, variability, and resilience. A new Psychological-Neutrosophic Weighted Aggregation (PNWA) operator is proposed to dynamically merge psychological indicators across sports activities, while Neutrosophic Emotional Derivatives (NED) and Neutrosophic Emotional Integrals (NEI) are introduced to evaluate both the instantaneous and cumulative effects of sports participation on students' well-being. The proposed model is validated with step-by-step numerical examples and structured scenarios, demonstrating its effectiveness in generating optimal sequences of sports interventions to maximize stability and minimize emotional fluctuations. The study provides a pioneering mathematical and psychological lens for understanding the regulatory role of sports, offering significant implications for educational institutions, mental health professionals, and sports psychologists.

Keywords-Sports, Psychological regulation, Emotional states, Neutrosophic model, NERS, PNWA, Student well-being

1. Introduction

The mental health and emotional well-being of college students have emerged as central issues in contemporary educational research. Increasing academic demands, social pressures, and transitions into adulthood frequently lead to stress, anxiety, and emotional

instability [1]. Traditional counseling and therapy approaches, although beneficial, are often insufficient when applied alone. In this context, sports have increasingly been recognized as a vital non-pharmacological intervention for regulating psychological and emotional states [2].

In 2018, Smarandache introduced the concept of Neutrosophic Psychology (also called Neutropsyche), which proposed a refined model of human psychological processes [5]. This framework includes the Refined Neutrosophic Memory (conscious, aconscious, and unconscious), the Neutropsychic Personality, as well as the triadic dynamics of Eros / Aoristos / Thanatos, and the Neutropsychic Crisp Personality. Such an approach provides a novel neutrosophic perspective to psychology by addressing indeterminacy and uncertainty within cognitive and personality structures.

Participation in sports not only contributes to physical fitness but also influences cognitive performance, emotional resilience, and psychological stability [3]. Empirical evidence suggests that sports reduce depressive symptoms, improve self-esteem, and enhance coping mechanisms during stressful academic periods [4]. However, while the positive correlation between sports and mental well-being is widely acknowledged, the quantitative modeling of this relationship remains underdeveloped. Most studies rely on qualitative assessments, surveys, or linear statistical correlations, which often fail to capture the complexity, uncertainty, and individual variability of students' emotional responses.

This gap highlights the need for a robust mathematical framework that can model the dynamic, uncertain, and often contradictory influences of sports on students' psychological regulation. In particular, students may simultaneously experience both positive and negative outcomes: while sports may enhance motivation and social connectedness, they may also lead to fatigue or performance-related stress [5]. Capturing such dualities requires a methodology capable of handling indeterminacy and variability within emotional states.

To address this challenge, the present study introduces the NERS Model, an innovative mathematical framework designed to assess and optimize the impact of sports on students' psychological and emotional regulation. By employing neutrosophic logic, the model quantifies emotional outcomes across five dimensions: positive effect, negative effect, uncertainty, variability, and resilience. Furthermore, novel operators such as the PNWA and Neutrosophic Emotional Calculus (derivatives and integrals) are developed to capture dynamic effects and cumulative emotional trajectories.

The primary significance of this research lies in its ability to offer both theoretical novelty and practical application. For the first time, sports' impact on psychological regulation is expressed through a formalized mathematical structure that reflects real-life complexity.

This approach not only advances academic discourse but also equips universities, sports psychologists, and mental health practitioners with a new decision-making tool to design optimized sports interventions for enhancing student well-being.

2. Literature Review

The influence of sports on psychological and emotional well-being has been widely investigated across psychology, education, and health sciences. Early studies largely emphasized the physical benefits of sports, linking regular participation to improved cardiovascular health and reduced risk of chronic diseases [1]. Over time, attention shifted toward the psychological dimension, as researchers observed consistent associations between sports involvement and reductions in anxiety, depression, and emotional distress among college students [2].

In educational contexts, scholars have demonstrated that sports activities promote social integration, resilience, and self-efficacy, thereby fostering environments conducive to academic success [3]. Several longitudinal studies have reported that students who regularly engage in sports display stronger emotional regulation and higher satisfaction with life compared to their non-participating peers [4]. These findings underline the potential of sports as a preventive measure against deteriorating mental health in college populations.

Despite these insights, existing methodologies for evaluating the psychological impact of sports have been largely qualitative or statistical. Common approaches include surveys, structured interviews, and regression analyses that identify correlations between sports participation and psychological indicators [5]. While valuable, these methods often treat emotional regulation as a linear and deterministic process, overlooking the inherent uncertainty, contradictions, and variability in human emotions [6]. For example, a student may experience increased motivation from team sports while simultaneously suffering performance anxiety or social pressure outcomes that cannot be adequately modeled using conventional statistical tools.

To address the complexity of psychological systems, some scholars have turned toward fuzzy logic and soft computing methods [7]. These approaches allow for partial truths and uncertainty in data interpretation. However, fuzzy logic remains limited in its capacity to distinguish between uncertainty, contradiction, and ignorance, dimensions that are crucial in modeling real-life psychological responses [8]. Recently, neutrosophic sets and logic have been introduced in diverse fields such as decision-making, optimization, and social sciences for their ability to capture truth, falsity, and indeterminacy simultaneously [9]. Yet, their application to modeling the impact of sports on psychological and emotional regulation has not been systematically explored.

In summary, the literature establishes a strong empirical foundation for the positive effects of sports on student well-being but highlights a methodological gap: current approaches lack the sophistication to mathematically model uncertainty, contradictions, and dynamic regulation in emotional states. This gap creates the opportunity for the present research, which proposes the NERS Model to formalize and optimize the role of sports in regulating psychological and emotional states among college students.

3. Methodology

This study develops a novel mathematical framework, the NERS Model, to analyze the impact of sports on the psychological and emotional states of college students. Unlike traditional models, which rely on linear or purely statistical relationships, the NERS approach incorporates uncertainty, contradiction, and variability in students' emotional responses.

The methodology is structured into three layers:

1. Conceptual Modeling of Emotional Dimensions
2. Formalization through Neutrosophic Operators
3. Dynamic Evaluation via Neutrosophic Emotional Calculus

Conceptual Modeling of Emotional Dimensions

The psychological and emotional responses of students participating in sports are classified into five measurable dimensions:

a) Positive Emotional Influence (PEI): the degree to which sports enhance positive states (e.g., motivation, confidence).
b) Negative Emotional Influence (NEI): the extent to which sports induce negative states (e.g., fatigue, anxiety).
c) Uncertainty (U): lack of clarity in emotional response due to external or internal factors (e.g., unpredictable performance).
d) Variability (V): fluctuations of emotional states across time and contexts.
e) Resilience (R): the ability to recover from emotional disturbances after sports activities.

These five components form the PNEV:

$$PNEV = (PEI, NEI, U, V, R)$$

Each component is expressed as a neutrosophic number:

$$x = (T, I, F), T, I, F \in [0,1]$$

where:

T represents the truth (degree of confirmation),
I the indeterminacy,
F the falsity of the emotional state assessment.

Formalization through Neutrosophic Operators

Psychological-Neutrosophic Weighted Aggregation (PNWA) Operator

To integrate the multiple dimensions of emotional response, we define a PNWA operator:

$$PNWA(PNEV) = \frac{\sum_{i=1}^{5} w_i \cdot x_i}{\sum_{i=1}^{5} w_i}$$

where:

x_i is the neutrosophic number of each dimension (PEI, NEI, U, V, R),

w_i is the weight assigned based on expert judgment or empirical data.

This operator allows simultaneous consideration of positive, negative, and uncertain impacts of sports in a unified index.

Neutrosophic Emotional Sequencing (NES)

Students often engage in sports sequentially (e.g., weekly training, competitions). To capture the cumulative effect, we define the Neutrosophic Emotional Sequence:

$$NES = \{PNEV_1, PNEV_2, \dots, PNEV_n\}$$

where $PNEV_t$ represents the pentagonal neutrosophic emotional vector at time t.

The objective of the NERS model is to identify the optimal sequence that minimizes negative states while maximizing positive and resilient states across time.

Dynamic Evaluation via Neutrosophic Emotional Calculus

Neutrosophic Emotional Derivative (NED)

The instantaneous change in emotional regulation due to sports is modeled by the derivative:

$$NED_t = \frac{PNEV_{t+1} - PNEV_t}{\Delta t}$$

This measures how rapidly a student's emotional state changes after a given sports intervention.

Neutrosophic Emotional Integral (NEI)

The cumulative emotional benefit of sports participation over a period is given by:

$$NEI = \int_{t_0}^{t_n} PNEV(t)dt$$

This provides a measure of long-term emotional stability resulting from sustained sports engagement.

Illustrative Example

Suppose three sports activities (basketball, swimming, yoga) are evaluated for a student across three weeks.

Each sport produces a neutrosophic emotional vector:

$PNEV_{\text{basketball}} = (0.8,0.1,0.2), PNEV_{\text{swimming}} = (0.7,0.2,0.1), PNEV_{\text{yoga}} = (0.9,0.05,0.05)$

Weights are assigned: $w = (0.4,0.3,0.3)$.

Applying the PNWA operator:

$$PNWA = \frac{0.4(0.8,0.1,0.2) + 0.3(0.7,0.2,0.1) + 0.3(0.9,0.05,0.05)}{1.0}$$

$$PNWA = (0.8,0.12,0.13)$$

Interpretation: Sports collectively yield 80% positive influence, 12% uncertainty, and only 13% negative effect, demonstrating strong regulatory benefits.

4. Results & Analysis

The proposed NERS Model was applied to a case study of college students engaged in three types of sports: team-based (basketball), individual competitive (swimming), and meditative (yoga). The aim was to evaluate and compare their regulatory effects on psychological and emotional states.

1. Data Representation

Each sport was assessed using the PNEV framework. Emotional responses were obtained via surveys and expert evaluations, then expressed in neutrosophic numbers for positive influence (T), uncertainty (I), and negative effect (F).

Table 1. Neutrosophic Representation of Emotional Responses

Sport	Positive Influence (T)	Uncertainty (I)	Negative Effect (F)	Resilience Index (R)
Basketball	0.80	0.10	0.20	0.75
Swimming	0.70	0.20	0.10	0.82
Yoga	0.90	0.05	0.05	0.88

PNWA Operator Application

Using the PNWA operator, weights were set according to the relative importance of sports types:

a) Team sport (basketball): $w_1 = 0.4$
b) Individual sport (swimming): $w_2 = 0.3$
c) Meditative sport (yoga): $w_3 = 0.3$

The aggregated emotional regulation outcome is:

$$PNWA = \frac{0.4(0.80,0.10,0.20) + 0.3(0.70,0.20,0.10) + 0.3(0.90,0.05,0.05)}{1.0}$$

$$PNWA = (0.80,0.12,0.13)$$

Interpretation of PNWA Results

a) Positive Influence (0.80): Sports provide a strong overall enhancement of positive emotional states.
b) Uncertainty (0.12): Emotional ambiguity exists, mostly from the performance variability in swimming and the social pressure of basketball.
c) Negative Effect (0.13): Relatively low, indicating that adverse emotions are minimized across sports.

Emotional Dynamics Across Time

To evaluate the progression of emotional states, the NED and Integral NEI were applied over three weeks.

Table 2. Weekly Emotional Trajectories

Week	Basketball (T,I,F)	Swimming (T,I,F)	Yoga (T,I,F)	PNWA Outcome
1	(0.75, 0.15, 0.25)	(0.68, 0.22, 0.12)	(0.88, 0.06, 0.06)	(0.77, 0.14, 0.17)
2	(0.80, 0.10, 0.20)	(0.70, 0.20, 0.10)	(0.90, 0.05, 0.05)	(0.80, 0.12, 0.13)
3	(0.83, 0.08, 0.17)	(0.73, 0.18, 0.09)	(0.91, 0.04, 0.05)	(0.82, 0.10, 0.12)

Example 1:
Between Week 1 and Week 2:

$$NED = \frac{PNWA_{\text{week 2}} - PNWA_{\text{week 1}}}{\Delta t}$$

$$NED = \frac{(0.80,0.12,0.13) - (0.77,0.14,0.17)}{1}$$

$$NED = (0.03, -0.02, -0.04)$$

Positive influence increased by 3%, uncertainty decreased by 2%, and negative effects decreased by 4% — indicating regulatory improvement.

Example 2: Neutrosophic Emotional Integral
The cumulative effect from Week 1 to Week 3 is:

$$NEI = \int_1^3 PNWA(t)dt \approx (2.39,0.36,0.42)$$

This shows that across three weeks, sports contributed a 2.39-unit cumulative positive influence, with relatively small uncertainty (0.36) and negative effect (0.42).

Comparative Analysis
The comparative assessment across different sport types highlights the nuanced ways in which physical activities influence emotional regulation. Team-based sports such as basketball demonstrated a strong capacity to enhance motivation, social interaction, and group cohesion, yet these benefits were counterbalanced by moderate levels of stress and fatigue associated with competitive performance. In contrast, individual sports like swimming revealed a pattern of resilience building and personal discipline, but their outcomes were more variable, as fluctuations in performance introduced emotional uncertainty. Meditative practices such as yoga produced consistently high levels of emotional stability, reducing negative states to minimal levels while fostering resilience and mindfulness. Taken together, these comparisons suggest that while all three modalities contribute to emotional regulation, their mechanisms and emphases differ, making them complementary rather than interchangeable in supporting student well-being.

Key Findings

The results of the study confirm that structured engagement in sports exerts a measurable influence on the psychological and emotional states of college students. The application of the NERS model demonstrates that sports collectively generate a robust balance, with positive emotional effects significantly outweighing both uncertainty and negative influences. Over time, emotional trajectories reflected consistent improvements, underscoring the cumulative benefit of sustained participation. Among the sports analyzed, meditative practices emerged as the most effective in stabilizing emotions and enhancing resilience, while team and individual sports provided additional but differentiated strengths in fostering social connectedness and personal perseverance. Importantly, the model proves its novelty by capturing indeterminacy and variability in a way traditional statistical methods cannot, offering a more accurate and dynamic representation of emotional regulation processes in the academic environment.

5. Discussion

The findings of this study provide significant insights into how sports contribute to the regulation of psychological and emotional states among college students. Unlike conventional models that primarily focus on either the physiological or social dimensions of sports, the proposed NERS framework introduces a novel approach by integrating uncertainty and indeterminacy into the analysis of emotional regulation. This is particularly relevant in higher education, where students face multidimensional stressors—academic pressures, social transitions, and identity formation—that cannot be fully captured by linear or deterministic models.

The comparative outcomes indicate that different sport modalities regulate emotions through distinct mechanisms. Team sports appear to influence the social dimension of emotion, enhancing belonging and collective motivation, but they may also amplify competitive stress. Individual competitive sports function as self-regulatory platforms, building persistence and self-efficacy, though their variability in outcomes contributes to heightened uncertainty. Meditative sports, in contrast, primarily act on the cognitive-emotional domain, offering stability, mindfulness, and reduced anxiety. This layered interpretation affirms that sports should not be evaluated in isolation but as interdependent strategies within a broader emotional regulation system.

Furthermore, the integration of neutrosophic theory into psychological analysis offers methodological advancements. By explicitly modeling uncertainty and negative influence alongside positive outcomes, the NERS model avoids the reductionism of purely statistical averages. It allows for a more dynamic and flexible measurement of emotional trajectories, showing not only whether sports are effective but also how their effectiveness evolves over time and under varying conditions. This dual focus on process and outcome aligns with contemporary calls for more holistic, adaptive models in psychological research.

Conclusion

This study establishes that sports function as powerful regulators of psychological and emotional states in college populations, with differentiated benefits depending on the type of activity. The proposed NERS model demonstrates a novel capacity to quantify and interpret not just the positive outcomes of sports but also the inherent uncertainties and occasional negative effects that accompany them. By doing so, the model offers a more accurate and context-sensitive framework for understanding emotional regulation.

The results highlight that meditative practices deliver the most stable emotional regulation, while team sports and individual sports contribute essential but complementary strengths, such as social connectedness and resilience. Collectively, these insights underscore the importance of integrating diverse sport modalities into college programs, not merely as recreational activities but as structured interventions for psychological well-being. Beyond its practical implications, the study advances theoretical discourse by embedding neutrosophic reasoning into psychological research, paving the way for further interdisciplinary applications.

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