

A Study on the Impact of Campus Table Tennis Courses on Students' Physical and Mental Health

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Abstract: As a crucial vehicle for promoting students' holistic development, the design of campus physical education curricula necessitates a deep integration of the specific characteristics of sports with the developmental patterns of adolescents. Table tennis, owing to its unique biomechanical features and intermittent high-intensity physiological load pattern, confers targeted benefits for enhancing cardiorespiratory function, neuromuscular coordination, and metabolic health. Concurrently, its situational demands for rapid decision-making and emotional regulation constitute a structured training ground for cognitive function and psychosocial development. This study aims to systematically construct a theoretical framework and practical pathways through which campus table tennis curricula influence students' physical and mental health. Firstly, it elucidates the theoretical foundations and underlying mechanisms through which table tennis promotes physical and mental health, drawing from the perspectives of biomechanics, developmental systems theory, and curriculum studies. Secondly, it delves into the physiological adaptations induced by skill acquisition, the psychological regulation driven by the sports context, and the dose-response relationship between participation and health benefits, thereby revealing the intrinsic pathways of influence. Finally, it proposes a curriculum system construction plan targeting the synergy of body and mind, employing a progressive, layered approach and ensuring optimization through dynamic assessment and feedback. This approach aims to maximize the comprehensive promoting effect of table tennis on adolescents' physical and mental health through structured and scientifically-based curriculum design.

Keywords: Table Tennis Curriculum; Physical and Mental Health; Influence Mechanism; Curriculum System Construction; Adolescent Development

Introduction

Physical and mental health during adolescence serves as the cornerstone for an individual's lifelong development, and the physical education curriculum in schools plays an irreplaceable role in this process. With a deeper understanding of the educational philosophy centered on holistic development, the objectives of physical education have shifted from a singular focus on skill instruction and physical fitness enhancement to a comprehensive promotion of dimensions including physiological health, cognitive function, emotional well-being, and social competence. Table tennis, as a sport combining widespread popularity with significant exercise value, possesses unique potential health-promoting value within school physical education due to its multi-dimensional complex movement patterns, intermittent metabolic characteristics, and highly cognitively demanding context. However, how to move beyond experiential teaching to systematically unearth and realize its synergistic benefits for body and mind remains an area lacking integrative research spanning from theoretical mechanisms to curriculum design. Therefore, clarifying the inherent logic of how table tennis curricula affect students' physical and mental health, and constructing a scientific and operable curriculum system based on this understanding, is not only a theoretical necessity for deepening school physical education reform and enhancing curriculum quality, but also a practical imperative for accurately and efficiently promoting students' holistic development. This study aims to fill this gap by providing a theoretical foundation and a systematic framework for the optimization and innovation of table tennis curricula in schools.

1. Theoretical Foundations for the Promotion of Physical and Mental Health through Table Tennis Curricula

1.1 Biomechanical and Physiological Load Characteristics of Table Tennis

The biomechanical characteristics of table tennis are embodied in its multi-dimensional and complex movement patterns. Athletes are required to execute strokes while moving rapidly. This process involves pushing off the ground with the lower limbs to initiate movement, the transmission of force through the rotational kinetic chain of the torso, and the whipping motion of the racket by the upper limbs, constituting a complete system for force generation and transfer. This full-body coordinated movement demands high-frequency fine motor control and rapid responses from the neuromuscular system, offering targeted benefits for enhancing an individual's coordination, agility, and dynamic balance. The diversity and non-cyclical nature of the movements prevent excessive load on single joints and muscle groups, reducing the risk of sports-related injuries while promoting the balanced development of muscles throughout the body^[1].

From the perspective of physiological load, table tennis presents an energy metabolism pattern characterized by intermittent high-intensity activity interspersed with periods of moderate-intensity continuous activity. Extended rallies and rapid transitions between offense and defense place significant demands on the phosphagen and glycolytic energy systems, while the sustained nature of the overall activity engages the aerobic metabolic system. This mixed-energy supply profile enables a table tennis curriculum to effectively stimulate adaptive improvements in students' cardiorespiratory function, enhancing maximal oxygen uptake and cardiac efficiency. The heart rate during play exhibits non-steady-state fluctuations, and this intermittent load is believed to contribute to improved regulatory capacity of the autonomic nervous system and enhanced cardiovascular functional reserve.

1.2 Multidimensional Theoretical Models of Adolescent Physical and Mental Health Development

The development of physical and mental health during adolescence is not a singular linear process of biological maturation, but rather is embedded within a complex system of continuous interaction between the individual and their environment. The Biopsychosocial Model provides an integrated analytical framework for this, emphasizing the dynamic interweaving and mutual construction of three dimensions: physiological function, cognitive-emotional states, and social adaptation. During adolescence, the physiological basis of neuroplasticity and endocrine changes is closely coupled with psychological processes such as identity formation and the development of emotional regulation abilities, and is significantly modulated by social interactions and role expectations. School-based physical activity constitutes a crucial contextual vehicle for this interactive process.

Based on Developmental Systems Theory, an individual's developmental trajectory is the product of continuous bidirectional interactions between their genetic endowment, behavioral characteristics, and multi-layered environments (such as the micro-level classroom atmosphere and the meso-level school sports culture). Physical and mental health can be viewed as an emergent property of this system. Within this system, physical activity plays the role of a "facilitative experience." By providing regular physical challenges, goal-oriented tasks, and opportunities for social comparison, it potentially influences multiple developmental pathways in adolescents, including body image, self-efficacy, stress coping strategies, and the quality of peer relationships. Its effects are both cumulative and context-dependent^[2].

1.3 The Associative Mechanism Between Curricularized Physical Activity and the Promotion of Physical and Mental Health

Curricularized physical activity differs from spontaneous physical play or exercise. Its core lies in systematically guiding students' physical participation and cognitive engagement through purposeful, organized, and sequenced instructional design and structured implementation. This formalized arrangement transforms the sports experience from a random event into a predictable and repeatable educational intervention, thereby providing an institutional guarantee for the stable output of physical and mental benefits. Elements such as goal setting, content progression, load control, and feedback assessment within the curriculum collectively construct a developmental environment imbued with educational intent, ensuring the quality and continuity of the physical activity experience.

Curricularized implementation promotes the mechanistic transformation of physical and mental

health enhancement. At the cognitive level, the step-by-step progression of skill learning (such as advancing from hitting a ball from a fixed point to executing combined techniques in motion) adheres to the principles of motor skill development and helps enhance students' procedural knowledge and metacognitive strategies. At the behavioral level, a stable curriculum schedule cultivates students' exercise habits and regular participation patterns, strengthening their intrinsic motivation and self-regulatory capacity for healthy behaviors. At the socio-emotional level, the structured social interactions embedded in the curriculum, such as cooperation, competition, and rule adherence, provide students with a social field for learning emotional management, empathy, and fair play. The curriculum thus becomes a key transformative bridge connecting a specific sport form (like table tennis) with broad physical and mental health goals.

2. The Influence Mechanism of Table Tennis Curricula on Students' Physical and Mental Health

2.1 Physiological Adaptations and Functional Improvements during the Process of Table Tennis Skill Acquisition

The systematic process of acquiring table tennis skills induces specific physiological adaptations across multiple systems of the human body. Adaptive changes in the neuromuscular system manifest as an enhanced efficiency of motor unit recruitment and an optimized pattern of neuromuscular coordination. To meet the combined demands of responding to a rapidly approaching ball and executing a precise return, the central nervous system optimizes the timing and intensity ratio of activation among agonists, antagonists, and synergists through selective activation and inhibition. This enhances the economy and effectiveness of movements. This process is accompanied by an increased acuity of proprioception and a shortened reaction time, constituting the physiological foundation for the automation of motor skills and the enhancement of performance^[3].

At the level of the cardiovascular and metabolic systems, long-term participation in the curriculum can induce significant functional improvements. The intermittent, high-intensity nature of extended rallies and footwork repeatedly stimulates the regulatory mechanisms governing cardiac stroke volume and heart rate, thereby promoting enhanced myocardial contractility and adaptive thickening of the ventricular wall. The periodic curriculum load increases mitochondrial density and oxidative enzyme activity in skeletal muscle, enhancing aerobic metabolic capacity and energy utilization efficiency. Beneficial changes in body composition, such as optimized body fat percentage and increased lean body mass, are also realized during this process as part of metabolic adaptation. These adaptive changes collectively constitute the physiological basis for the improvement of students' physical fitness and health levels.

2.2 The Pathway for Enhancing Psychological Regulation Ability through Situational Cognition in Sport

A table tennis curriculum creates a specific sport situation rich in cognitive challenges, which provides participants with a continuous and structured training ground for their psychological regulation abilities. When confronted with tasks such as judging spin, anticipating ball placement, and making tactical decisions, students must continuously employ advanced executive functions, including working memory, selective attention, and cognitive flexibility. This process of cognitive engagement is not confined to sports performance itself; its transfer effects may enhance an individual's information processing speed and resistance to interference when facing general cognitive tasks, thereby offering training opportunities for the effective management and allocation of cognitive resources.

The inherent challenges and uncertainties within the sports context provide students with a realistic setting for emotional regulation and stress management. Each point won or lost, and the handling of critical moments in a match, simulates stressful events ranging from low to moderate pressure. In this process, students need to learn to recognize their own state of emotional arousal and employ strategies such as deep breathing, positive self-talk, or attentional refocusing for regulation. Through repeated exposure and adaptive learning within the curriculum, an individual's physiological and psychological response patterns to stress may be reshaped, and their emotional resilience can be honed. This, in turn, helps them construct more robust psychological adaptability and coping strategies for adversity^[4].

2.3 The Dose-Response Relationship between Curriculum Participation and Physical and Mental Health Benefits

As an intervention dose, curriculum participation exhibits a non-linear dose-response relationship with physical and mental health benefits. Participation is a multidimensional concept, encompassing the frequency of engagement, the duration of individual sessions, the total length of the curriculum period, as well as the intensity of behavioral involvement and the degree of cognitive focus during participation. Research indicates that achieving physical and mental benefits typically requires a minimum effective dose threshold, below which it is difficult to induce significant adaptive changes. Conversely, beyond a certain threshold, the growth curve of benefits tends to plateau, and excessive load may even lead to negative effects or a decline in participation motivation.

Differential sensitivity exists among various dimensions of health benefits concerning the constituent elements of participation. Fundamental improvements in cardiorespiratory function and certain psychological benefits, such as immediate mood enhancement, may become apparent following moderate-intensity, regular participation. In contrast, more complex outcomes like skill automation, significant changes in body composition, or profound positive shifts in cognitive and personality traits—such as the cultivation of resilience—likely require a longer cumulative participation period and a higher intensity of focused engagement. Individual difference factors, including initial health status, genetic predisposition, and psychological traits, also moderate the specific manifestation of the dose-response relationship. This implies that curriculum design needs to consider individualized target ranges for participation to optimize overall health outcomes.

3. Constructing a Table Tennis Curriculum System for Enhancing Student Physical and Mental Health

3.1 Structured Design of Curriculum Content Based on the Synergistic Development of Body and Mind

The structured design of curriculum content must transcend the limitations of singular skill instruction and shift towards an integrated planning of physiological, cognitive, and affective-social developmental goals. Its theoretical premise lies in recognizing that the sport of table tennis itself constitutes a micro-ecosystem encompassing complex decision-making, fine motor control, and emotional regulation. The core of the design is to transform the intrinsic elements of this ecosystem—such as the visuospatial processing required to anticipate a ball's trajectory, the decision-making and execution at the moment of impact, and the emotional fluctuations following a point won or lost—into sequenced and teachable modules. For example, a continuous backhand drive drill is not merely aimed at establishing a stable motor pattern; through setting variations in placement and rhythm control, it can simultaneously train students' executive functions such as attention distribution, response inhibition, and action plan adjustment. The structuring of content needs to adhere to the "whole-part-whole" principle of skill acquisition and the progressive laws of psychological development, ensuring that technical learning and psychological growth are isomorphically integrated throughout the curriculum's progression. Each instructional unit should thus serve as a vehicle carrying composite developmental objectives^[5].

This synergistic design entails the development of a series of "integrative exercises" that closely combine physical activity with psychological tasks. For instance, introducing a "tactical timeout" element into multi-player drills, where students are required to voluntarily pause at specific score points to conduct a brief technical and strategic review and verbally report their emotional state, serves to externalize implicit thought processes and foster the development of metacognition and emotional awareness. A logical progression and functional complementarity should exist between content modules. The physiological adaptive foundations and psychological skills acquired in preceding modules should provide support for subsequent, more challenging comprehensive application modules. The curriculum content thus becomes a meticulously orchestrated "sequence of developmental experiences," and its degree of structuring directly influences the manifestation and efficacy of the synergistic effects promoting body and mind.

3.2 Considerations for Physical and Mental Adaptability in Progressive, Tiered Teaching Arrangements

The essence of a progressive, tiered teaching arrangement is its respect for individual student differences and the laws of physical and mental adaptation. Its purpose is to provide an optimized "developmentally appropriate challenge" for a heterogeneous student population. Tiering should be based not only on initial skill diagnosis but also incorporate a comprehensive assessment of basic physical fitness (such as aerobic capacity, core stability), neurological traits (such as reaction tendency, sensation seeking), and psychosocial factors (such as goal orientation, social anxiety). The dynamic grouping or personalized task assignments derived from this can effectively match the challenge of learning tasks with the individual's current state of physical and mental readiness. This alignment is key to maintaining a positive learning experience, stimulating intrinsic motivation, and preventing sports injuries or psychological burnout. The logic of tiered instruction needs to permeate the entire curriculum and be dynamically adjusted based on students' progress trajectories^[6].

Progressivity is manifested in a systematic, escalating pathway across three dimensions: learning objectives, environmental complexity, and physical-mental load. From a physiological adaptation perspective, the progressive increase in exercise load strictly adheres to the principle of physiological supercompensation and the principle of training specificity. It guides the cardiovascular, metabolic, and neuromuscular systems towards safe and efficient long-term adaptations, transitioning gradually from low-intensity, decomposed technical drills in closed-skill environments to high-intensity competition in open-ended situations that demands rapid decision-making amidst uncertainty. From a psychological development perspective, progressivity is reflected in the gradual increase in cognitive load and emotional regulation demands. Curriculum design can systematically introduce distracting factors (such as noise, scoring pressure), increase the required speed of decision-making, or alter modes of social interaction (for instance, moving from cooperative practice to competitive games), thereby constructing a supportive yet challenging ladder for psychological adaptation. This carefully designed progressive exposure helps students accumulate experiences of successfully coping with pressure within a controllable range, gradually building more robust self-efficacy and psychological resilience.

3.3 Multi-dimensional Assessment and Dynamic Optimization Mechanism for Curriculum Effectiveness

Constructing a scientific, multi-dimensional assessment system is a prerequisite for accurately identifying curriculum benefits and validating its promoting mechanisms. This system must transcend the limitations of traditional physical education curricula, which often emphasize summative skill assessments, and establish a comprehensive framework that integrates process-oriented and outcome-oriented indicators, while also balancing objective measurements with subjective reports. For the physiological dimension, in addition to routine physical fitness tests, indicators specific to table tennis should be incorporated, such as choice reaction time, dynamic balance ability, and eye-hand coordination tests. Assessments for the psychosocial dimension can employ scales with proven reliability and validity to measure students' sports motivation (e.g., the Intrinsic Motivation Inventory), psychological skills (e.g., the Attention Control Scale), usage of emotional regulation strategies, and perceived social support related to physical activity. The behavioral participation dimension focuses on classroom engagement, frequency and duration of extracurricular practice, among other factors. The collection of multi-source data provides a chain of empirical evidence for a comprehensive depiction of the curriculum's impact.

A dynamic optimization mechanism based on assessment feedback is the core element ensuring that the curriculum system remains scientific, targeted, and vital. This mechanism operates within a continuous improvement loop of "design-implement-assess-feedback-redesign." Aggregate and individualized analysis of periodic multi-dimensional assessment data can reveal the overall curriculum's efficiency and shortcomings in achieving specific physical and mental objectives, while also identifying differentiated response patterns among various student subgroups (e.g., those with different skill levels, genders, or motivation types). These evidence-driven insights can directly lead to precise adjustments in curriculum content, teaching methods, or organizational forms. For example, if assessment data indicate a general decline in the stability of students' technical execution in high-pressure game situations, a targeted "stress inoculation training" module could be added to subsequent classes. This would involve training technical execution in simulated matches with gradually increasing psychological pressure. This data-driven, problem-oriented process of dynamic optimization transforms the table tennis curriculum system from a static teaching plan into an

intelligent educational intervention system capable of self-monitoring, diagnosis, and renewal.

Conclusion

This study systematically elaborates on the logical framework through which campus table tennis curricula influence students' physical and mental health and proposes a corresponding system construction plan. The research indicates that the health-promoting benefits of a table tennis curriculum are rooted in the sport's unique biomechanical and physiological load characteristics and are mechanistically realized through its curricularized organizational form. The pathways of influence are specifically manifested in the multi-system physiological adaptations during the skill acquisition process, the structured training of cognitive and emotional regulation abilities provided by the sports context, and the non-linear dose-response relationship between participation and health outcomes. Based on these findings, an effective curriculum system should be dedicated to the synergistic design of physical and mental objectives, adopt progressive, tiered teaching arrangements that respect individual differences, and establish a dynamic optimization mechanism grounded in multi-dimensional assessment data. This transformation turns the curriculum from a static teaching plan into an intelligent educational intervention system with feedback and adaptive capabilities. Future research should further explore the empirical effects of different curriculum design variables (such as the ratio of content modules, teaching feedback methods) on specific physical and mental health indicators, and pay attention to the long-term impact of sustained curriculum participation on student developmental trajectories. This will continuously refine the theoretical model and enhance the precision and effectiveness of curricular interventions.

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