

Exploratory Research on Educational Intervention Methods for Sports-Related Concussions among University Students Majoring in Physical Education

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Keywords: University students majoring in physical education; Sports-related concussion; Cognitive level; Risk identification; Teaching strategies

Abstract: This study aims to explore the factors influencing the behavioral intentions of university students majoring in physical education regarding sports-related concussion prevention and to examine the intervention effects of different teaching models. A questionnaire survey was conducted with 471 physical education students at Shenzhen University, and a model was constructed based on the Theory of Planned Behavior. Additionally, 90 students were selected and randomly divided into three experimental groups (short-video group, online course group, and offline course group) and a control group for a three-week educational intervention. The survey indicated that perceived behavioral control and attitude were the core factors influencing behavioral intentions for prevention. After the intervention, the short-video group showed the most significant improvement in risk identification and behavioral intention ($P < 0.01$). The offline course group demonstrated the optimal effects in the dimensions of knowledge, subjective norms, and perceived behavioral control ($P < 0.01$). The online course group exhibited a prominent effect in attitude change ($P < 0.01$). Different teaching models each possess unique advantages in enhancing various dimensions of the ability to prevent sports-related concussions. Accordingly, this study proposes constructing a three-tiered optimization strategy encompassing a knowledge system, cognitive attitudes, and social support, thereby providing a theoretical and practical basis for establishing a scientific and precise educational system for sports-related concussion prevention.

1. Research Background

Sports-related concussion (SRC), as a mild traumatic brain injury occurring in sports^[1], is characterized by its subtle nature and cumulative effects. It may potentially trigger long-term neurodegenerative diseases and has been identified as a severe public health challenge in the field of sports medicine in the 21st century^[2]. Domestic data indicate that SRC exhibits age and sport specificity^[3]; adolescents and young adults (aged 15-24) constitute a high-incidence group (accounting for 42.7% of cases)^[4], with individuals aged 5-24 facing a higher overall risk. Even subclinical repetitive head impacts can result in cumulative neurological damage^[6]. Domestic surveys

reveal that the annual incidence of concussion reaches as high as 597,000 individuals, with injuries caused by competitive sports accounting for over 20% of all traumatic brain injuries^[5].

2. Research Significance

Establishing a systematic concussion identification and management system (including symptom screening, risk assessment, and tiered management) is crucial for reducing disability rates. As university students majoring in physical education may assume responsibilities for sports safety supervision in the future, serving as "first responders," their knowledge of concussions and capacity for management are directly related to the effectiveness of prevention, early identification, and intervention for sports-related concussions. Therefore, constructing a scientific prevention and management system holds significant theoretical value and practical significance.

3. Research Status

Research indicates that concussion interventions yield significant effects: approximately 82% of intervention programs can improve athletes' immediate performance on knowledge tests (effect size $d = 0.63$, 95% CI 0.51-0.75), and 37% of programs achieve knowledge retention for more than three months^[7]. However, deficiencies exist in the capabilities of core populations. A study by Yang Hao and other scholars^[8] points out that Chinese pre-service physical education teachers exhibit structural deficiencies in concussion management capabilities, with only 29% mastering standardized assessment tools and a pass rate of less than 40% for first-aid skills. There is an urgent need to enhance the relevant capabilities of university students majoring in physical education.

4. Research Purpose

This study aims to improve the prevention and management system for sports-related concussions through targeted research and intervention. The core needs to address two main issues:

- 1) Systematic assessment of the current state of concussion knowledge among university students majoring in physical education, encompassing three core dimensions: the accuracy rate of basic pathological cognition, the sensitivity of symptom identification, and the execution degree of preventive behavioral intentions;
- 2) The development of targeted educational intervention programs aims, through structured course design, to increase the achievement rate of basic knowledge mastery in this group to $\geq 80\%$, achieve an increase of no less than 40% in clinical diagnostic accuracy, and raise the conversion rate of intentions to implement preventive behaviors to $\geq 60\%$.

5. Research Methods

5.1. Questionnaire Survey Method

This study utilized the 16-item concussion symptom identification checklist and the 11-item concussion questionnaire designed by Saunders et al.^[9], as well as the student version of the Rosenbaum Concussion Knowledge and Attitudes Survey (RoCKAS-ST) developed by Rosenbaum and Arnett and other scholars^[10]. Drawing on Kroshus's concussion reporting model based on the Theory of Planned Behavior, the research investigated symptom identification, knowledge and attitudes, subjective norms, and perceived behavioral control regarding sports-related concussions among university students majoring in physical education. Consequently, the research team revised and formed the "Questionnaire on Sports-Related Concussion Risk Identification, Knowledge,

Attitudes, Subjective Norms, Perceived Behavioral Control, and Behavioral Intentions" (based on the RoCKAS and KASCQ-24 scales). To ensure reliability and validity, the scales were aligned with established theoretical frameworks. In consideration of the study's specific dimensions, relevant domestic and international scales were referenced, translated, modified, and adapted. Scoring was divided into two categories: risk identification, knowledge, and symptom identification adopted dichotomous 2-point scoring, while dimensions related to the Theory of Planned Behavior utilized a 5-point Likert scale. The survey respondents were undergraduate students from the College of Physical Education at Shenzhen University, enrolled between 2021 and 2024.

The questionnaires for this study were distributed via the Questionnaire Star platform. A total of 213 questionnaires were collected in the preliminary survey, and 516 were collected in the formal survey. After two rounds of data cleaning, 471 valid questionnaires were ultimately obtained, yielding an effective response rate of 91.3%. This study has been reviewed and approved by the Ethics Committee of Shenzhen University (Approval Number: PN-202400181), and all participants signed an informed consent form.

5.2. Data Analysis Methods

Excel was used to compile and organize the questionnaire data. In alignment with the research hypotheses and theoretical model, various mathematical statistics methods and software were employed for analysis: SPSS 27.0 was utilized to conduct descriptive statistics, normal distribution tests, correlation analysis, and factor analysis. AMOS 24.0 was used to construct a structural equation model to verify the hypotheses and guide the experimental design. During the experimental phase, a one-way ANOVA and analysis of covariance (ANCOVA) were conducted between the experimental groups and the control group, while paired samples t-tests were used to analyze within-group differences before and after the intervention for both groups.

5.3. Experimental Method

An experimental study employing course interventions was conducted with the purpose of enhancing the prevention attitudes and perceived behavioral control concerning sports-related concussions among university students majoring in physical education. The experiment adopted a design incorporating pre-test and post-test measurements both between groups and within groups, utilizing experimental groups (a short-video group, an online course group, and an offline course group) alongside a control group. Integrating course education and feedback, a diversified intervention approach was implemented. The experimental groups underwent a three-week course intervention, whereas the control group received no intervention.

6. Experimental Design

6.1. Intervention Purpose

Based on the survey results and the test findings of the structural equation model, intervention measures were designed to verify the influence of perceived behavioral control and attitude on preventive behavioral intentions, while simultaneously evaluating the effectiveness of these interventions. The ultimate goal was to enhance preventive behavioral intentions by improving perceived behavioral control and attitudes, thereby reducing the risk of sports-related concussions.

6.2. Intervention Subjects

The intervention subjects consisted of 90 individuals from three distinct groups within the College of Physical Education at Shenzhen University. Additionally, after excluding the intervention groups from the survey respondents, 30 individuals were randomly selected to form a non-intervention control group. The sampling process resulted in three course groups: a short-video group, an offline course group, and an online course group. The procedure followed a pre-test, intervention, and post-test format over three weeks, with one 40-minute session per week.

6.3. Intervention Content

The test results of the structural equation model indicated that perceived behavioral control (an individual's perception of their own capability to perform a behavior) and attitude (an individual's positive or negative evaluation of a behavior) were the core factors influencing the behavioral intentions of university students majoring in physical education regarding sports-related concussion prevention. As proposed by Kneavel M E et al.^[11], educational interventions could indirectly enhance athletes' perceived behavioral control by improving their concussion-related cognition and attitudes, thereby making them more confident when facing risks and enabling them to adopt correct preventive and responsive measures. Daly E et al.^[12] also pointed out that educational interventions could improve athletes' attitudes towards concussions, deepen their understanding of the severity of concussions, and strengthen their preventive intentions. Accordingly, the intervention in this study aimed to enhance students' awareness of sports-related concussion prevention, bolster their confidence and sense of control regarding preventive behaviors, and consequently reinforce their positive attitudes and behavioral intentions towards prevention.

6.4. Intervention Plan

The intervention plan for this study focused primarily on knowledge education, skill training, case analysis, and value guidance. It was conducted as a course intervention over three weeks. The specific plan is shown in Table 1.

Table 1. Specific Arrangements of the Intervention Plan

Group	Intervention Subjects	Intervention Duration (per session)	Number of Participants	Intervention Content	Intervention Format
Short-video group	Students enrolled in 2022	40 minutes	30 students	Week 1: Basic knowledge and risk identification of sports-related concussion; Week 2: Response to and management of sports-related concussion; Week 3: Prevention of and support for sports-related concussion	Watching videos (from platforms such as TikTok, Xiaohongshu, Tencent Video, YouTube, and the Concussion Awareness Training Tool)
Offline course group	Students enrolled in 2023	40 minutes	30 students	Same as above	PPT presentation (in lecture format) delivered by the researchers and the team's supervising instructors
Online course group	Students from the Innovation and Entrepreneurship Short Course	30-40 minutes	30 students	Same as above	Self-directed learning using online learning software

7. Results and Analysis

7.1. The Impact of Course Intervention on Risk Identification of Sports-Related Concussions among University Students Majoring in Physical Education

A comparison of risk identification scores before and after the intervention between the experimental groups and the control group is presented in Table 2. The paired samples t-test revealed that the pre-test and post-test scores of all groups showed a significant increase ($P < 0.01$), with the experimental groups exhibiting a greater magnitude of improvement than the control group. Among these, the short-video group demonstrated the highest improvement ($d = -6.80$, $T = -17.81$, $P = 0.000 < 0.01$), and the difference before and after the intervention demonstrated an extremely high level of significance.

Table 2 Analysis of Differences in Risk Identification Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Risk Identification	Short-video group	8.83 \pm 1.84	15.63 \pm 1.03	-6.80	-17.81	0.000**
	Online course group	8.90 \pm 1.845	13.37 \pm 1.03	-4.47	-10.71	0.000**
	Offline course group	8.80 \pm 1.972	14.23 \pm 0.94	-5.43	-13.48	0.000**
	Control group	8.87 \pm 2.08	11.97 \pm 1.13	-3.1	-7.30	0.000**

7.2. The Impact of Course Intervention on the Cognition and Mastery of Sports-Related Concussions among University Students Majoring in Physical Education

The paired samples t-test on knowledge scores before and after the experiment showed that the post-test scores of all groups were significantly improved ($P < 0.05$), indicating that the intervention was effective. Among these, the offline course group achieved the most optimal results, with a mean post-test score of 16.93 ± 0.91 , and a paired difference of -5.90 and a T-value of 15.97 , both higher than those of the other groups. The short-video group and the online course group also showed significant improvement, but their effects were slightly inferior to that of the offline group. The control group had a mean post-test score of 11.97 ± 1.13 and a paired difference of -2.53 , with a magnitude of improvement significantly smaller than that of the three intervention groups. Among the three intervention groups, the offline group achieved the highest score, demonstrating the most effective intervention outcome. The specific plan is shown in Table 3.

Table 3 Analysis of Differences in Knowledge Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Knowledge of Sports-Related Concussions	Short-video group	10.10 \pm 2.22	15.63 \pm 1.03	-5.53	-13.18	0.000**
	Online course group	10.53 \pm 1.94	16.20 \pm 1.35	-5.67	-14.19	0.000**
	Offline course group	11.03 \pm 1.84	16.93 \pm 0.91	-5.90	-15.97	0.000**
	Control group	9.43 \pm 2.32	11.97 \pm 1.13	-2.53	-5.55	0.000**

7.3. The Impact of Course Intervention on Attitudes towards Sports-Related Concussions among University Students Majoring in Physical Education

The paired samples t-test revealed that the attitude scores towards sports-related concussions in all three experimental groups (short-video, online course, and offline course groups) were significantly higher after the intervention than before the intervention ($P < 0.05$). The intervention had a significant positive impact on attitudes, with the online course group exhibiting the largest d value ($d = -4$), indicating the most optimal effect. In contrast, the control group showed no significant difference in attitude scores before and after the intervention ($P > 0.05$), suggesting that attitudes did not change noticeably without intervention (see Table 4 for details).

Table 4 Analysis of Differences in Attitude Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Attitude	Short-video group	9.7 \pm 2.292	13.067 \pm 1.76	-3.367	-6.411	0.000**
	Online course group	9.067 \pm 2.815	13.067 \pm 1.721	-4	-6.717	0.000**
	Offline course group	8.767 \pm 2.569	12.067 \pm 1.893	-3.3	-5.58	0.000**
	Control group	9.433 \pm 2.609	9.767 \pm 2.388	-0.333	-0.507	0.616

7.4. The Impact of Course Intervention on Subjective Norms regarding Sports-Related Concussions among University Students Majoring in Physical Education

Regarding subjective norms, the scores of all three experimental groups (short-video group, online course group, and offline course group) were significantly higher after the intervention than before the intervention (with all P-values less than 0.05), indicating that the intervention measures had a significant positive impact on subjective norms. Among these, the offline course group showed the most significant improvement, with a paired difference (d) of -3.5. The control group showed no significant difference in subjective norm scores before and after the intervention (P-value greater than 0.05), indicating that subjective norms did not change significantly without any intervention. Details are presented in Table 5.

Table 5 Analysis of Differences in Subjective Norm Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Subjective Norms	Short-video group	14.267 \pm 2.463	16.833 \pm 2.614	-2.567	-3.847	0.001*
	Online course group	12.9 \pm 3.726	15.867 \pm 2.596	-2.967	-3.277	0.003*
	Offline course group	12.267 \pm 3.657	15.767 \pm 2.515	-3.5	-3.949	0.000**
	Control group	13.867 \pm 2.813	14.133 \pm 1.889	-0.267	-0.368	0.715

7.5. The Impact of Course Intervention on Perceived Behavioral Control regarding Sports-Related Concussions among University Students Majoring in Physical Education

Concerning perceived behavioral control, the scores of all three experimental groups (short-video group, online course group, and offline course group) were significantly higher after the intervention than before the intervention (with all P-values less than 0.05), indicating that the intervention measures had a significant positive impact on perceived behavioral control. Among these, the offline course group demonstrated the most significant improvement, with a paired difference (d) of -2.667. The control group showed no significant difference in perceived behavioral control scores before and after the intervention (P-value greater than 0.05), indicating that perceived behavioral control did not change significantly without any intervention. Details are presented in Table 6.

Table 6 Analysis of Differences in Perceived Behavioral Control Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Perceived Behavioral Control	Short-video group	15.4 \pm 4.09	17.233 \pm 2.609	-1.833	-2.009	0.044*
	Online course group	15.667 \pm 2.551	17.4 \pm 2.143	-1.733	-2.364	0.025*
	Offline course group	14.933 \pm 2.728	17.6 \pm 2.027	-2.667	-3.853	0.001*
	Control group	14.1 \pm 2.591	14.967 \pm 1.691	-0.867	-1.482	0.149

7.6. The Impact of Course Intervention on Behavioral Intentions regarding Sports-Related Concussions among University Students Majoring in Physical Education

The paired samples t-test indicated that the behavioral intention scores regarding sports-related concussions in all three experimental groups (short-video, online, and offline course groups) were significantly higher after the intervention than before the intervention ($P < 0.05$), demonstrating that the intervention had a significant positive effect. Among these, the short-video group had the largest d value (3.165), indicating the most optimal improvement. The control group showed no significant difference in scores before and after the intervention ($P > 0.05$), suggesting that behavioral intentions did not change noticeably without intervention (see Table 7 for details).

Table 7 Analysis of Differences in Behavioral Intention Scores between the Experimental Groups and the Control Group Before and After the Intervention

Intervention Dimension	Group	Pre-test Score, Mean \pm Standard Deviation	Post-test Score, Mean \pm Standard Deviation	Paired Difference (d)	T	P
Behavioral Intentions	Short-video group	15.204 \pm 9.11	18.369 \pm 1.823	-3.165	-6.221	0.000**
	Online course group	14.406 \pm 8.57	16.335 \pm 2.225	-1.929	-2.116	0.031*
	Offline course group	15.337 \pm 8.13	17.875 \pm 1.937	-2.538	-3.085	0.003*
	Control group	14.135 \pm 7.95	15.279 \pm 1.669	-1.144	-1.998	0.094

8. Conclusion

Different intervention formats each possess unique advantages in enhancing various dimensions. The short-video course group demonstrated a relatively more pronounced intervention effect in the dimensions of sports-related concussion risk identification and behavioral intentions for prevention. The online course group showed better improvement after the intervention in the dimensions of sports-related concussion knowledge and attitudes. The offline course group exhibited a more significant intervention effect in the dimensions of subjective norms and perceived behavioral control regarding sports-related concussions.

Addressing the shortcomings in the intervention effects of each experimental group, the construction of a diversified educational intervention system is recommended. The specific measures are as follows: First, optimize the intervention content design by module. For the short-video group, the focus should be on enhancing risk identification and preventive intentions, creating situational and highly interactive content. Online course resources need to systematically build concussion knowledge modules, incorporating case analyses and interactive tests to strengthen knowledge transfer and attitude change. Offline practical training should enhance participants' awareness of subjective norms and behavioral control capabilities through activities such as role-playing and first-aid drills. Second, the proposed intervention program enriches teaching formats to enhance course effectiveness. It integrates practical operations such as virtual reality simulations, complemented by multimedia resources including videos, animations, and case studies, to make the content more vivid and comprehensible. Moreover, it adds interactive elements like online discussions and real-time question-and-answer sessions to increase course engagement, practicality, and participation. Third, this program strengthens incentive mechanisms and process control. It introduces incentive mechanisms such as certificates, credits, and material rewards to stimulate learning motivation. Furthermore, it encourages participants to complete the course through regular reminders and progress tracking, while simultaneously promoting the course through multiple channels, utilizing social media and team meetings to enhance participants' awareness of the course's importance. Finally, the program improves feedback and long-term consolidation mechanisms. It establishes channels for timely feedback and follow-up, and designs subsequent review and consolidation sessions. A regular review system is built to ensure long-term knowledge retention and to compensate for the shortcomings of a single intervention model.

Furthermore, future research could expand the sample size and include different populations, designing differentiated teaching content for students with different sports specialties and foundational levels to verify the effects of optimized courses. This would not only increase the penetration rate of concussion prevention education but also provide new perspectives for theoretical research on behavioral change. Through the above recommendations, future research can further deepen the understanding of the preventive intentions regarding sports-related concussions among university students majoring in physical education and provide scientific support for formulating effective preventive intervention strategies. Simultaneously, these recommendations also offer important references for the practice of sports safety education, contributing to the reduction of the incidence rate and long-term impact of sports-related concussions.

Acknowledgement

Guangdong Province Philosophy and Social Sciences Planning 2023 Discipline Co-construction Project (Project Name: Research on the Construction of a Sports-Related Concussion Management System Based on the Integrated Behavior Model; Grant No. GD23XTY43); Shenzhen City Educational Science 2023 Planning Project (Project Name: Exploratory Research on School-Based Teaching Materials for Educational Intervention Methods for Sports-Related Concussions among

University Students Majoring in Physical Education; Grant No. xbjy23005).

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