RESEARCH ARTICLE

Integrating the prevention of musculoskeletal disorders into physical education classes in universities: Experimental intervention and effectiveness

Xin Lu[1, 2, 3], Yi Li[1, *], Wenhao Luo[4]

[1]Faculty of Education, Southwest University, Chongqing, China. [2]College of General Education, Chongqing Water Resources and Electric Engineering College, Chongqing, China. [3]Science Sports and Health Promotion Research Platform, Chongqing Water Resources and Electric Engineering College, Chongqing, China. [4]School of Physical Education, Southwest University, Chongqing, China.

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Musculoskeletal disorders, particularly head-forward tilt, are prevalent among college students and can lead to long-term health issues. This study integrated musculoskeletal disease prevention into vocational sports courses and provided practical reference for reforming vocational sports. A total of 312 students including 185 males and 127 females with the average age of 19.35 ± 1.2 years old were randomly divided into two groups. The experimental group's curriculum included musculoskeletal disease prevention content and exercises such as head-forward tilt correction through manipulative release, proprioceptive neuromuscular facilitation therapy, functional training, and respiratory training, while the control group followed the normal teaching content. Both groups participated in volleyball courses as their physical education sport. The results showed that the physical exercise attitudes and volleyball technical scores of the experimental group were better than those of the control group ($P < 0.05$). Multiple regression analysis showed that specific components of physical exercise attitudes, particularly behavioral cognition, behavioral habits, and emotional experience, significantly predicted volleyball technical performance ($F = 42.593$, $P < 0.01$), collectively explaining 91.70% of the variance. The integration of head-forward tilt correction exercises into volleyball training improved posture awareness and movement mechanics, enhancing technical performance. This study showed that incorporating musculoskeletal disease prevention into physical education could improve college students' physical activity attitudes and have a positive impact on the improvement of volleyball technical performance, indicating an interactive relationship between the two. These findings provided valuable references for physical education reforms.

Keywords: vocational; physical education; prevention; musculoskeletal diseases; body and health; teaching.

[*]**Corresponding author:** Yi Li, Faculty of Education, Southwest University, Chongqing 400700, China. Phone: +86 13637793627. Email: liyi1807@swu.edu.cn.

Introduction

The education sector in various countries has always focused on reforming physical education programs in colleges and universities [1], which is because these programs are related to the physical health and quality of training of talents after more than ten years of schooling and subsequently affect economic and social development. With China being the world's most populous country and the second largest economy in the world, the Chinese government

has introduced a series of national policies on health and school sports in recent years. Therefore, it is worthwhile to pay attention to and explore the research on reforms of the physical education curriculum in Chinese colleges and universities. Although the Chinese government highlights that it is necessary to update the concept of education, deepen the reforms in teaching and learning, and improve the overall teaching and learning quality of physical education, the poor learning outcomes in physical education have not been effectively addressed with the physical education curriculum reforms [2]. The core of these reforms in colleges and universities has focused on curriculum content reformation. However, the content of physical education courses in Chinese colleges and universities is considered among the pendulum phenomenon of biased disciplines or living [3], which leads to unknown direction. The content of primary and secondary school curriculums is simply supplemented, and among other reasons, students are not interested in the contents [4]. Based on scientific humanism, science and technology are oriented to humanistic values, fostering the coordinated development of the two to grasp the common trend of curriculum reforms worldwide, that is, "the pursuit of the unity of science and the world of life and the integration of science and humanism" [5]. The theory provides an important guideline to address the pendulum phenomenon in the Chinese physical education curriculum content, which broaden the field of knowledge, facilitate the selection of content that students care about, and ensure more effective knowledge connections with the possibility of achieving good results [6].

In higher education, professional practice environment, and occupational positions, people are prone to musculoskeletal disorders coupled with the prominent daily long-term pain in the lower head, neck, and shoulder [7]. The prevalence of head-forward tilt among Chinese high school students is 95.9%, and the severity of neck and shoulder problems have increased among college students in the next school age group. Taking effective intervention measures to address these disorders is necessary. The integration of sports and health is to comprehensively apply the knowledge, technology, and methods in the fields of sports and health to all stages of the implementation of the new health governance strategy, and to apply it to the promotion of national health, disease prevention, treatment, and rehabilitation, reflecting the functional value of sports and the essence of sports return [8]. Regarding body-health integration, interventions for musculoskeletal diseases have been studied domestically and internationally with the focus on the work environment [9]. Research on college students has mainly focused on two aspects. One focuses on healthcare major students whose work is more mechanical such as those in dentistry and nursing by comparing the results before and after an intervention to assess its effectiveness [10]. However, because the intervention was too specific to healthcare majors, the results lacked universal value. The other aspect focuses on college students with the studies aiming to prevent the adverse effects of professional activities on body posture in physical education [11]. Although universal suggestions have been provided, no experimental intervention regarding body-health integration has been performed. If experimental effect could be determined, the relationship between variables and the design and implement targeted teaching can possibly be clarified and thereby promote better learning [12].

Based on scientific humanism and the beginning curriculum content reformation, which is the core of physical education curriculum reforms in colleges and universities, it is especially necessary to integrate the prevention of musculoskeletal disorders into physical education courses in public colleges and universities. This study explored the effects of integration of musculoskeletal disorders prevention content into college physical education classes on physical education teaching quality by comparing the physical fitness scores, athletic skill scores, and attitudes toward physical

activity with traditional physical education. The study provided practical references for the reformation of the college physical education curriculum.

Materials and methods

Recruitment of participants

A total of 312 college freshmen with 185 males and 127 females and the average age of 19.35 ± 1.2 years old were involved in this research through the questionnaire survey and tests. The participants were randomly assigned to the experimental group with 151 students (93 males and 58 females) and control group with 161 students (92 males and 69 females). All procedures of this study were approved by the Institutional Review Board of Chongqing Water Resources and Electric Engineering College, Chongqing, China. All participants received informed consent prior to participating in the study.

Selection of evaluation indicators

Three elements including physical fitness score, sports technical performance, and physical activity attitude were selected as the evaluation indexes of the teaching quality of physical education before and after the experiment. Physical fitness scores were determined strictly following the standard requirements of the National Student Physical Health Standards (2014 Revision) (Ministry of Education, Beijing, China), which included 50 m of running, standing, long jump, forward bending in the sitting position, 1,000 m for male and 800 m for female, and pull-up for male and sit ups for female, as well as measurements of height, weight, and lung capacity. Sports technical performance was evaluated using volleyball training with the volleyball technical performance as the evaluation index. The participants were screened before the experiment using self-developed questionnaires, which included questions on volleyball knowledge and technical practice combined with individual tests. A 5-point Likert scale scoring was used. The higher the score was, the better the knowledge of sports technical performance was. Students with a score of five were excluded to avoid the greater impact of confounding factors on the experimental results. In the semester before the experiment, experts were invited to judge the structure and content validity of the questionnaire, and 45 (22 males and 23 females) students were randomly selected for the pilot test to guarantee the smooth progress of the study. The questionnaire was filled out and answered twice before and after the 15-day experiment. The reliability and validity of the questionnaire were determined as 0.85 and 0.86, respectively, which was consistent with the requirements of sociological surveys. The participants were observed for 2 weeks before the experiment officially started to further verify the "foundation of volleyball" technique. During the experiment, four components of volleyball skills including one-person pads, two-person pairs of pads, services, and matches were tested in stages. Physical activity attitude scale is a standardized scale used in research on exercise attitudes in China [13]. Students were tested before and after the experiment using the eight indicators of the scale, which included behavioral attitude, goal attitude, behavioral cognition, behavioral habits, behavioral intention, emotional experience, behavioral control, and subjective standards with internal consistency (α) coefficients of 0.83, 0.87, 0.73, 0.89, 0.84, 0.86, 0.80, and 0.64, respectively. $\alpha \geq 0.7$ was generally considered acceptable [14].

Teaching experiment design and implementation

Exercise prescription development and implementation is a concrete manifestation of physical and health integration [15], which were developed based on the integration of musculoskeletal disorder prevention content into the college physical education curriculum and implemented through teaching to improve the three evaluation indicators and promote teaching quality in this research. The experiments were completed in a single 90-minute class session once a week for 1 semester with a total of 16 weeks physical education. A

representative head-forward tilt correction was selected as a specific component of musculoskeletal disorder prevention in this study. The curriculum for the experimental group was developed to include the contents of hazards (to draw attention), etiology (to stop the damage in time), manipulative release (to release abnormal myofascial tension), proprioceptive neuromuscular facilitation therapy (to promote nutrient supply and recovery of muscle tone) [16], functional training (to establish the correct movement pattern and to restore and enhance musculoskeletal function) [17], and respiratory training (to establish the correct respiratory pattern and prevent abnormal myofascial tension) [18], while each session of the control group was consistent with that of the experimental group, except for not including above teaching contents. For the implementation of teaching experiments, classes typically followed the sequence of introduction to the lesson, preparatory activities, head forward tilt function correction training, forearm passing, physical fitness, relaxation, and the summary. Functional training exercise prescriptions included the mode, time, frequency, intensity, total amount, and progression of the exercise. For students with special circumstances and questions, teachers would guide them to make substitutions to the prescription during and after the class and fine-tune the prescription according to individual circumstances to develop a personalized exercise prescription. Volleyball technique was combined with functional correction of forward head tilt using moderate neck retraction followed by head tilt and frontal hand-to-wall pass to promote recovery of muscle imbalances while avoiding frequent tilting of the head in a forward head posture, which could lead to uncomfortable symptoms. For physical fitness training, moderate exercise intensity was used as it was the most appropriate exercise intensity to enhance students' physical fitness and health [19]. The maximum heart rate (HR_{max}) was calculated as $HR_{max} = 210 - 0.66 \times age$ [20], which has been confirmed with the acceptable accuracy for the college-age population [21], and the moderate exercise intensity for young people was ≥ 50 – 60% heart rate reserve (HRR) [22]. The student resting heart rate (HR) was measured before class, and the result was inputted into the formula to calculate each student's target HR. Eight students were randomly selected to wear heart rate monitors in each class, and the teacher monitored and dynamically adjusted the HR in real time.

Internal validity of the teaching experiments

Several measurements were taken to ensure internal validity. Both groups were taught by the same physical education teachers with equal seriousness. In addition to the objective content, the consistency of subjective factors such as verbal expression and emotion were recorded to eliminate the subjective-test effect. Since assessing experimental fidelity in an intervention study is important for improving the internal validity of the study [23], the instructor's performance in the experimental process was scored by one trained physical education teacher based on the fidelity of the instructional program checklist with an average fidelity of 65% (53 – 76%), which met the requirement of greater than 50% [24]. Regarding time and course factors, the two groups of students were scheduled to attend classes at the same time on different days. Other courses that required a lot of physical exertion were not scheduled before the physical education class to control the physiological response at different times of the day [19].

Statistical analysis

SPSS 22.0 (IBM, Armonk, NY, USA) was used to statistically analyze the research data. The data was presented as means (X) ± standard deviation (SD) (X ± SD). According to the Chi-square test of variances, the independent samples t-test with equal or unequal variances were performed to analyze the differences of physical fitness performance, sports skill performance, and physical activity attitudes between two groups. Multiple regression was used to analyze the relationship between attitude toward physical activity and sports skill performance, and control variables such as teachers' main test effect, time,

and course interference.

Results and discussion

Differences between groups in physical activity attitudes

Before the experiment, the distribution of the data on physical exercise attitude and physical health were tested. The overall data was normally distributed, and the independent samples t-test results showed no statistically significant difference between the two groups ($P > 0.05$). The results after the experiment showed that, except for the three aspects of goal attitude, behavioral habits, and sense of behavioral control, the differences between the two groups in the other five final test results were statistically significant ($P < 0.05$), indicating that experimental research was more effective in improving students' attitudes towards physical activities. These results suggested that the integration of musculoskeletal disorder prevention content into the physical education class enhanced students' interest in physical education. Students experiencing issues with poor posture and dysfunction caused by forward head tilt found the integrated content relevant to their needs. The class explained the causes of head-forward tilt and corrective training by correlating it with occupational and life scenarios corresponding to the students' majors, creating a strong sense of immersion. Based on Sutton's viewpoint of scientific humanism, this study unified and integrated sports and life in physical education classes. Furthermore, after integrating the content of head-forward tilt in the curriculum to stimulate students' interest, the students were guided to perform the actual exercise prescription and experience the real effect of head-forward tilt correction, which resulted in a sense of achievement and pleasure, further enhancing students' interest in the class and laying a good foundation for subsequent knowledge learning and the improvement of attitudes toward exercise. This result verified the results of the previous study that teaching based on the implementation of exercise prescription was significantly better than the conventional course for the improvement of college students' exercise attitudes [4]. According to the feedback on daily work, students in the experimental group were more willing to communicate their health and physical education topics with their teachers and were more active in classroom practice, which validated the reliability of the data to some extent.

Differences between the groups in physical fitness scores

The results of the final test showed no statistically significant difference between the two groups in terms of physical fitness performance ($P > 0.05$). Levene's test for equality of variances was conducted prior to the t-test with the results of F = 5.447 and significance = 0.022. The experimental group demonstrated a mean physical fitness score of 70.658 ± 7.255, while control group showed it as 70.754 ± 7.050. The results suggested that the experimental intervention had no effect on physical fitness performance, although moderate exercise intensity was executed. This lack of significant differences could be explained by a variety of factors. There was no significant difference in the improvement of behavioral habits and behavioral control among the groups, indicating that students had low automation, autonomy, and control over exercise (Table 1). One physical education class per week led to a very long physical activity cycle, and the development of health awareness, living habits, and extracurricular sports activities habits could not be completed in one semester, nor could it produce a load accumulation effect. Therefore, it is still unrealistic to improve the physical fitness level of college students by teaching public physical education classes within a limited class time. Some people also suggest that exercise in physical education classes is only one of the many exercise times outside of course teaching that can stimulate students' interest. Students also need to be encouraged to use the knowledge and methods learned in class to better guide their daily exercise and increase the frequency of exercise.

Table 1. Differences between groups in the final indicators of physical activity attitudes.

Dimension	Experimental group (n = 151)	Control group (n = 161)	*P* value
Behavioral attitude	29.52 ± 4.20	26.87 ± 3.53	< 0.01**
Goal attitude	49.74 ± 3.94	48.26 ± 3.44	> 0.05
Behavioral cognition	30.13 ± 2.16	28.61 ± 2.67	< 0.05*
Behavioral habits	33.06 ± 4.70	33.03 ± 4.69	> 0.05
Behavioral intention	28.77 ± 4.01	24.97 ± 3.54	< 0.01**
Emotional experience	41.58 ± 2.93	34.77 ± 6.54	< 0.01**
Behavioral control	25.10 ± 4.08	26.42 ± 3.63	> 0.05
Subjective standards	21.48 ± 3.77	19.03 ± 3.73	< 0.05*

Notes: *$P < 0.05$, **$P < 0.01$.

Differences in volleyball technical performance

Before the experimental intervention, the questionnaire survey of the two groups of students showed that the scores of each item of volleyball knowledge and technical foundation were between 1 and 2 points, that is, there was basically no foundation, which met the requirement of homogeneity. After the experiment, the overall satisfaction was assessed using independent samples t-test. The results showed that the experimental group demonstrated significantly higher volleyball technical performance scores of 84.50 ± 6.87 than that of the control group ($P < 0.01$), indicating that the experimental intervention improved technical performance in the experimental group. Such significant improvement in volleyball technical performance could be attributed to the integration of head-forward tilt correction exercises into volleyball training. By correcting posture and improving body mechanics, students in the experimental group developed better spatial awareness and motor control, which directly translated to improved volleyball techniques.

Multiple regression analysis of physical activity attitudes and volleyball technical performance

In addition to independent and dependent variable relationships, the study analyzed the relationship between the dependent variables to better understand the role and effect of the intervention. However, due to the difference between groups in physical fitness scores not significant, only the relationship between physical activity attitudes and volleyball skill achievement was focused on in this study. The results of multiple regression analysis showed that behavioral cognition (β = 0.165, $P < 0.05$), behavioral habits (β = 0.172, $P < 0.05$), and especially emotional experience (β = 0.528, $P < 0.01$) had a significant predictive effect on volleyball technical performance (F = 42.593, $P < 0.01$), while remaining five factors including behavioral attitude (β = -0.024, P = 0.790), goal attitude (β = -0.064, P = 0.491), behavioral intention (β = 0.173, P = 0.292), behavioral control (β = 0.036, P = 0.694), and subjective standards (β = 0.109, P = 0.301)) failed to predict volleyball technical performance. Overall, these variables explained 91.70% of the variance in volleyball technical performance. These results were obtained after controlling variables such as teacher-administered test effects, time, and course interference. Tian *et al*. concluded that exercise attitude could increase the frequency, duration, and intensity of participants' exercise to a certain extent, and their skills were more likely to improve [25]. However, 5 of the 8 indicators in the multiple regression analysis of this study were not significant. Li and Lv pointed out that physical activity attitude was one of the important factors influencing adolescents' sports participation, but it was only a necessary, and not sufficient, condition for encouraging exercise behaviors [26]. Qiao also highlighted that sports technology was an important factor and moderated variables that affected the

population's willingness to maintain consistency in physical activity and behavior [27]. Moreover, the better the group's mastery of the sports technology, the more positive the attitude and willingness to be physically active, which showed that sports technology could have an impact on physical activity attitudes, and the two could work simultaneously to influence exercise behavior. The interaction between physical activity attitudes and exercise techniques was well exemplified in this study, where the integration of head-forward tilt training into volleyball skill practice encouraged students who disliked volleyball to train for corrective purposes, stimulating their interest. With the accumulation of training effects, volleyball skills were improved, which increased the sense of achievement and pleasure and improved the attitude towards volleyball exercise. This result verified the correlation between sports and lifestyle rather than the biased discipline in sports, which might lead to opposite results.

Conclusion

This study integrated the content of musculoskeletal disease prevention into the physical education curriculum of colleges and universities, which was of great significance for the prevention of musculoskeletal diseases. By successfully integrating preventive training into regular physical education courses, an effective method of combining health promotion with physical education was proposed. The results of this study showed that integrating the content of musculoskeletal disease prevention into physical education courses could improve and maintain college students' physical exercise attitudes. Students not only understood the harm of poor posture but also experienced the benefits of correction through practice. Improved physical exercise attitudes helped improve volleyball technical skills, indicating that there was interaction between the two. The results of this study supplemented the deficiencies of experimental data and curriculum reform effect analysis in previous similar studies, which was helpful to improve teaching quality and provide a useful reference for physical education curriculum reform in colleges and universities in China and even around the world. This integrated approach has potential long-term benefits for reducing the prevalence of musculoskeletal diseases among college students and can serve as a model for similar integrated approaches in other educational settings. By addressing musculoskeletal disease issues through physical education, institutions can simultaneously promote physical health, technical skill development, and positive attitudes toward physical activities.

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References

1. Liang H. 2023. The reform path of physical education and training in colleges and universities based on the internet background. Curriculum and Teaching Methodology. 6(13):58-62.
2. Hu H, Hu X, Tang Y, Huang X, Zhang J. 2020. research progress on the effect of physical education learning from the perspective of self-determination motivation theory. China Sport Sci. 40(4):67-77.
3. Fan Y, Ma W. 2017. Scanning the pendulum phenomenon in the development of Chinese basic physical education curriculum—based on the discipline and life dimensions. China Sport Sci. 37(2):3-15.
4. Chai R. 2011. Analysis of the necessity to build a system of effectively connected contents of college, middle school and elementary school physical education textbooks. J Phys Educ. 18(6):91-93.
5. Yu X. 2008. China's physical education curriculum in visual field of scientific humanism. J Shanghai Phys Educ Inst. 146(1):66-69.

6. Liu J. 2019. A re-study on the theoretical and practical problems of healthy physical education curriculum model of China. J Beijing Sport Univ. 42(6):12-22.
7. Ma J, Ma A, Yan J, Fu J, He Y, Gong J. 2019. Analysis on association of physical health test, subjective exercise experience and exercise behavior among college boys. Chin J Health Educ. 35(1):50-53.
8. Jiang G, Li L, Wu X. 2023. The development thread, realistic dilemma and solution strategy for the integration of physical education and health in China. J Phys Educ. 30(1):47-53.
9. Umer W, Antwi-Afari MF, Li H, Szeto GP, Wong AY. 2018. The prevalence of musculoskeletal symptoms in the construction industry: A systematic review and meta-analysis. Int Arch Occup Environ Health. 91(2):125-144.
10. Moodley M, Ismail F, Kriel A. 2020. Work-related musculoskeletal disorders amongst undergraduate nursing students at the University of Johannesburg. Health SA Gesondheid. 25:1460.
11. Han W, Su Y, Gao R. 2019. The influence of fusion of physical education and medicine health promotion teaching model on college students' health behavior and health condition. Chin J Health Educ. 35(10):881-884.
12. Zhang S, Bu C, Li S, Yang H, Wang L, Zhang T. 2022. Research on the internal mechanism, model and effectiveness of online deep learning. J Distance Educ. 40(6):65-73.
13. Hua J, Cai J. 2020. Multidimensional analysis of college students attitude to physical exercise: Document statistics based on attitude scale for physical exercise. Zhejiang Sport Sci. 42(2):94-100.
14. Hair JF. 2009. Multivariate data analysis (7th Edition). Kennesaw State University, Kennesaw, Georgia, US.
15. Wang L, Zhang G, Chen P, Duan Z. 2022. Physical activity vital sign and referral schemes: Experience from abroad and China. J Shanghai Univ Sport. 46(7):76-88.
16. Salmen-Navarro A, Friedman-Jimenez G. 2022. Preventing work-related musculoskeletal disorders (WMSDs) in New York City informal migrant workers. Saf Health Work. 13:S53.
17. Mansfield PJ, Neumann DA. 2023. Essentials of kinesiology for the physical therapist assistant. Elsevier Health Sciences: Amsterdam, NL.
18. McKeown P. 2019. Learning to breathe: Reclaiming natural instincts. China Friendship Publishing Company: Beijing, China.
19. Dong C, Lv H. 2020. The theoretical and practical basis for the establishment of the key points of healthy physical education curriculum model of China. China Sport Sci. 40(6):24-31.
20. Karvonen MJ. 1957. The effects of training on heart rate: A longitudinal study. Ann Med Exp Biol Fenn. 35:307-315.
21. Wang B, Zhang J. 2017. A study on the validity of age-based prediction of maximum heart rate in Chinese university students. Chin J Sports Med. 36(8):693-699.
22. Thompson PD, Arena R, Riebe D, Pescatello LS. 2013. ACSM's new preparticipation health screening recommendations from ACSM's guidelines for exercise testing and prescription (9th edition). Curr Sports Med Rep. 12(4):215-217.
23. Li R, Liu Z, Li X, Qu P. 2021. Study on teaching intervention of children's basic motor skills development from the perspective of the constraints model: A case study of preschool children in a rural kindergarten in Weifang City, Shandong Province. China Sport Sci. 41(2):51-58.
24. Brian A, Goodway JD, Logan J, Sutherland S. 2017. SKIPing with teachers: An early years motor skill intervention. Phys Educ Sport Pedagogy. 22(3):270-282.
25. Tian H, Li X, Lu X, Ge J, Li A. 2018. The relationship between attitude towards physical exercise and exercise behavior in college students: The moderating effect of exercise partner. J Jilin Sport Univ. 34(1):80-85.
26. Li B, Lv R. 2020. A study on the attitude and behavior of youth physical exercises in Xinjiang. J Physic Educ. 39(5):78-86.
27. Qiao Y. 2019. From exercise intentions to exercise behavior: The moderating effect of motor skills. In: Proceedings of the 11th National Sports Science Congress. Nanjing, Jiangsu, China. November 2, 2019.