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The Impact of Jump Rope Exercise on the Cardiovascular Endurance of Chinese Middle School Students

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Abstract: This study employed a pre-test and post-test experimental design involving 90 randomly selected first-year students from Jinan's Seventh Middle School. The students were divided into two experimental groups (A and B) and a control group for a 12-week training intervention. Training modalities included rope jumping, endurance running, and general physical activities during school recess. Cardiovascular endurance was assessed through maximal oxygen uptake tests on a watt bike. The study found that rope jumping positively impacts cardiovascular endurance in middle school students and is more effective than running. This research provides theoretical support for promoting rope jumping in China, offers alternative training options for improving cardiovascular endurance among middle school students, and suggests enhancements for school physical activity programs.

Keywords: Rope jumping; Middle School Students; Cardiovascular endurance; Experimental research

1. Introduction

Over the past 30 years, research on the physical fitness and health of Chinese students indicates a notable increase in growth and development levels, including height, weight, and chest circumference, compared to 2005. However, critical physical fitness indicators such as lung capacity, explosive power, flexibility, strength, and endurance have consistently declined. This decline poses significant concerns for students' overall well-being.

The lack of physical activity among students contributes to various health issues like obesity and poor cardiovascular health, as well as mental health issues such as anxiety and depression. Additionally, hyperactivity among middle school students can adversely affect their academic performance and engagement. Studies have demonstrated a positive correlation between physical activity and cognitive functions, including attention, memory, and problem-solving skills (Li, 2018). Inactive students often exhibit lower academic performance and reduced engagement in classroom activities (Chambonnière et al., 2021).

Given these concerns, it is crucial to assess the effectiveness of specific physical activities that can be readily implemented in schools and offer measurable benefits. Jump rope exercise stands out as an economical and easily administered activity with significant cardiovascular advantages. This study aims to investigate the impact of jump rope exercise on the cardiovascular endurance of Chinese middle school students and to identify its advantages over other sports. Such insights can inform the integration of this simple yet effective activity into the physical education curriculum to maximize its benefits.

2. Literature review

Skipping is a simple yet effective exercise that requires minimal equipment and space, making it highly accessible for inclusion in physical education curricula worldwide (Arufe-Giráldez et al., 2022). In China specifically, studies have indicated that middle school students exhibit increased engagement and enthusiasm in physical education classes that incorporate skipping (Guo et al., 2023). This heightened engagement not only improves physical health but also enhances academic focus and discipline.

Beyond being a physical exercise, skipping is a fun activity that can capture students' attention, thus fostering sustained engagement in physical education. Research conducted by Zheng and Wu (2018) in a Chinese middle school setting revealed that skipping reduced absenteeism and increased participation in physical education classes. The rhythmic and repetitive nature of skipping stimulates cognitive functions, promoting academic engagement.

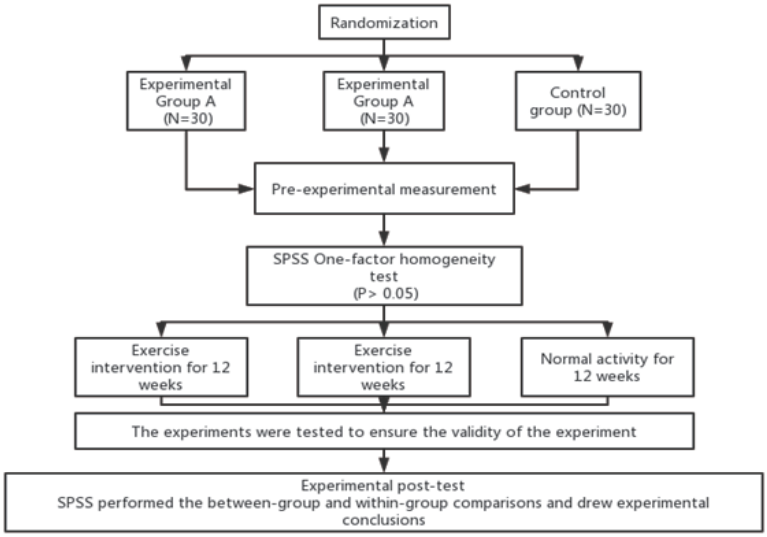
The documented relationship between physical exercise, increased oxygen intake, and cognitive function underscores the importance of skipping exercises in middle schools in China. These exercises have been shown to enhance students' attention span and memory retention, facilitating what is termed "academic activation". While many schools incorporate running programs to enhance middle school students' cardiovascular endurance, the persistent decline in physical fitness among Chinese middle school students over the past three decades necessitates the establishment of innovative physical education courses to optimize the effectiveness of student exercise.

3. Method

This study utilized a pre-test-post-test experimental design, wherein a specialized questionnaire developed through the Delphi method was administered to 10 physical education experts to establish a jump rope training plan. The plan encompassed criteria such as movement standards, exercise duration, intensity, and frequency. Given the current status of extracurricular sports activities in middle schools and the importance of implementing cardiovascular endurance training, the study opted to measure students' cardiovascular endurance using wattbike tests for maximum oxygen uptake.

Participants engaging in jump rope exercises constituted Experimental Group A, while those involved in endurance running exercises formed Experimental Group B. A Control Group was also established without any experimental intervention. The hypothesis posited that jump rope exercises would prove more effective than endurance running in enhancing high school students' cardiovascular endurance. Predictions were made regarding maximum oxygen uptake levels for students in both experimental groups and the control group.

Before commencing the experiment, an independent t-test was conducted to ensure no significant differences between the groups. Following the experiment's conclusion, post-test measurements were taken for all three groups, and intra-group and inter-group differences in pre- and post-test levels were analyzed to draw conclusions. The respondents were six classes randomly selected from the first year of high school at Jinan City's Seventh Middle School. A sample of 90 students was then categorized into Experimental Group A, Experimental Group B, and the Control Group based on their health statuses, with each group maintaining a 1:1 male-to-female ratio and participant ages ranging from 15 to 17.



4. Results and discussion

4.1 Comparative analysis of pre-and post-test of cardiopulmonary endurance

Upon conducting a comparative analysis of the data before and after the experiments within each experimental group, a significant difference in the maximum oxygen uptake of Experimental Group A was observed ($P=0.000 <0.01$), with the average maximum oxygen uptake increasing from 32.33ml/kg/min to 44.56ml/kg/min. Notably, the average maximum oxygen consumption for men rose from 35.91 ml/kg/min to 52.47 ml/kg/min, while for women, it increased from 29.94 ml/kg/min to 39.29ml/kg/min, meeting the excellent standard level outlined in the Evaluation Table of the Maximum Oxygen Uptake (Relative Value) in China.

Similarly, Experimental Group B exhibited a significant difference in maximum oxygen uptake ($P=0.016 <0.05$), with the average maximum oxygen uptake increasing from 34.35ml/kg/min to 39.38ml/kg/min. Specifically, the average maximum oxygen intake for men rose from 41.06ml/kg/min to 48.82ml/kg/min, and for women, it increased from 29.88 ml/kg/min to 33.08 ml/kg/min. The post-test scores for both men and women in Experimental Group B reached the good and medium standard levels, respectively, as stipulated.

Conversely, the Control Group showed no significant difference between post-test and pre-test results ($P=0.519 > 0.05$). Notably, while the average maximum oxygen consumption index for women decreased from 29.44ml/kg/min to 26.90ml/kg/min, the average maximum oxygen consumption index for men increased from 38.04ml/kg/min to 40.15ml/kg/min.

4.2 Comparative analysis of cardiopulmonary endurance between each group after the experiment

The comparative analysis of post-experimental data between groups revealed a significant difference in the average maximum

oxygen consumption index between Group A and Group B (P=0.035 <0.05), with Group A exhibiting an average maximum oxygen consumption index 5.18 ml/kg/min higher than Group B. This indicates that although both groups showed improvement in maximum oxygen uptake to varying degrees after the experiment, the progress observed in Group A was more pronounced.

Furthermore, the average maximum oxygen consumption index of Experimental Group A significantly differed from that of the Control Group (P=0.000 <0.05), with the post-test score of Experimental Group A significantly higher than that of the Control Group. Similarly, the average maximum oxygen consumption index of Experimental Group B significantly differed from that of the Control Group (P=0.036 <0.05).

In summary, both running and skipping training were significantly more effective in improving the maximum oxygen uptake of middle school students compared to campus extracurricular sports activities. Among these, skipping rope demonstrated the most optimal effects. Adolescents are in a critical period for developing cardiopulmonary endurance, which can be significantly enhanced through targeted training. However, without such training, there is a risk of stagnation in their physical development.

4.3 Discussion on Current Situation of Extracurricular Sports Activities

Extracurricular physical activities play a pivotal role in schools' efforts toward physical fitness training, with organized sports activities being particularly effective in enhancing adolescents' physiological health. In a 2023 survey on endurance activities conducted in regular middle schools in Shandong Province, it was found that all 17 surveyed schools utilized centralized student running as a form of cardiovascular training. However, only 17.6% of these schools set specific requirements for exercise intensity. Most schools organized collective running activities lasting approximately 14 minutes, with an average running distance of only 1000-1200m, indicating low activity intensity insufficient to enhance cardiovascular endurance. Consequently, researchers observed that in many schools, students engaged in jogging at a slow pace in unison. Given the prevalent lack of effective physical exercise among Chinese middle school students, the results of this study hold broad applicability and practical significance, suggesting a need for policymakers to incorporate more rope jumping activities into middle school physical education curricula.

Shandong Province's middle schools offer a diverse extracurricular physical education curriculum, encompassing popular sports like football, table tennis, badminton, and basketball, as well as traditional Chinese sports such as shuttlecock kicking, Tai Chi fan, and Tai Chi. This diversity underscores the richness of courses available to students. However, due to the study's limitations, researchers were unable to explore the comparative impact of rope jumping versus other types of exercises (such as ball games, swimming, etc.) on cardiovascular endurance.

5. Conclusion

According to the guidelines outlined in the "Chinese Maximum Oxygen Uptake (Absolute Value) Evaluation Chart," pre-experiment measurements revealed that the maximum oxygen uptake scores for all three student groups only met the medium and below-average evaluation standards. This highlights the generally low level of cardiovascular endurance among current middle school students and underscores the urgent need for efficient training programs to enhance their stamina. While both jump rope training and endurance running methods can effectively improve students' cardiovascular endurance, jump rope training emerges as the more effective option. Therefore, substituting jump rope training for endurance running presents a viable alternative for schools with limited space and sports facilities.

The current extracurricular sports activities on school campuses are inadequate in promoting the development of cardiovascular endurance among middle school students. Simply getting students moving is insufficient; what's crucial is ensuring they move efficiently. The absence of clear guidelines on exercise intensity and frequency in the extracurricular activities offered by schools leads to ineffective development of students' endurance levels.

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