Education Reform and Development, 2025, Volume 7, Issue 5
https://ojs.bbwpublisher.com/index.php/ERD
Online ISSN: 2652-5372
Print ISSN: 2652-5364

Study on Exercise Intensity Level and Heart Rate Standard for Promoting Physical Health of Middle School Students

Wei Wang[1], Chao Liu[2]*

[1]College of Physical Education, Yangzhou University, Yangzhou 225127, Jiangsu, China
[2]Yangzhou University, Yangzhou 225009, Jiangsu, China

**Author to whom correspondence should be addressed.*

Abstract: Since the introduction of the "Physical Education and Health Curriculum Standards for Compulsory Education (2022 edition)," which emphasized the importance of physical education intensity, there has been scholarly debate and discussion among experts and physical education instructors. This study seeks to scientifically define an appropriate range of exercise intensity tailored to students of a specific age group during regular physical education classes. By focusing on junior high school students as the experimental subjects, this research employs experimental interventions, physical assessment techniques, and mathematical statistical analysis to validate the scientific basis of the exercise intensity guidelines outlined in the 2022 Curriculum Standards while addressing related concerns. The findings indicate that optimal heart rate range for exercise load intensity for junior high school students falls between 140 and 160 beats per minute.

Keywords: Exercise intensity; PE class; Junior high school students; Physical health; Heart rate standard

Online publication: May 29, 2025

1. Introduction

"Curriculum Standard of Physical Education and Health for Compulsory Education (2022 edition)" suggests that the average heart rate of all students in a class should ideally be between 140–160 beats per minute [1], a recommendation that has sparked significant debate. Xiong Wen argues that the specified exercise intensity does not align well with physical education practices [2], whereas Zhang et al. maintain that the heart rate range outlined in the new standard is justified [3]. Additionally, some researchers contend that there are theoretical inconsistencies regarding average heart rate intensity, suggesting that low or high-intensity exercises might contradict the health benefits associated with medium to high-intensity activities, and that the prescribed exercise intensity may not be suitable for physical education contexts. They argue that specifying a particular exercise intensity is a misinterpretation of high-intensity theory and is not essential for enhancing physical

fitness, skills, or sportsmanship. Furthermore, it should not serve as a standardized regulation for physical education curricula [4–7]. In practical studies, some researchers observed that the heart rates and exercise densities in physical education classes at certain schools fell within a reasonable range, leading to significant improvements in students' physical exercise outcomes. Additionally, there was a notable correlation between physical fitness development and exercise load intensity [8–10]. However, in some schools, the intensity of physical education is insufficient, failing to meet the requirements set by the new curriculum standards [11–13].

In this study, students from six Grade 3 classes were randomly assigned to three groups: control group A, medium-intensity exercise load group B, and high-intensity exercise load group C. These groups underwent regular teaching, medium-intensity exercise load teaching, and high-intensity exercise load teaching, respectively. The differences in physical fitness among students under varying exercise intensities were then compared to identify the optimal exercise intensity conducive to the healthy development of junior middle school students' physical fitness.

2. Object and method

2.1. Object

This research selected 191 students (97 males and 94 females) from six third-grade classes at Middle School A in Yangzhou City as the study participants. They were randomly assigned to either a control group of two classes (Group A with 61 students: 32 males and 29 females) or an experimental group comprising four classes. The experimental group was divided into Group B (65 students: 32 males and 33 females) and high-intensity load Group C (65 students: 33 males and 32 females). From each group, 20 students (10 males and 10 females) were randomly chosen as fixed subjects, resulting in a total of 60 students across all groups.

2.2. Methods

2.2.1. Experimental instruments

A remote sensing heart rate tester and the Polar Team2 heart rate monitor were utilized to establish the heart rate intensity range and track heart rate changes for a multidimensional analysis of heart rate information. Monitoring heart rate in this manner can supply data support and serve as a reference [14] for promoting the healthy growth of students. Body shape was assessed using a height measurement device and a body composition analyzer. Cardiorespiratory endurance was evaluated with a spirometer, while physical fitness was measured using a stopwatch, tape measure, handgrip strength dynamometer, and seated flexibility meter.

2.2.2. Experimental design

Incorporating the classification of "physique" structure from "Exercise Physiology" based on the "National Physical Health Standards for Students" and the research by Wang et al. [15], a set of measurement indicators was chosen. These included height, weight, body mass index (BMI), percentage of body fat (PBF), obesity rate, vital capacity, maximal oxygen uptake, 50-meter dash, grip strength, standing long jump, and seated forward bend. For this study, a single-factor between-subjects design was employed.

2.2.2.1. Independent variable and dependent variable

The independent variable represents exercise intensity, while the inter-subject variable primarily consists of two levels: high intensity and moderate intensity. The dependent variables include body composition,

cardiorespiratory endurance, and overall physical fitness.

2.2.2.2. Independent variable control

The management of irrelevant variables was primarily achieved through random allocation and the constant method. First, when choosing the experimental group, the principle of random assignment was applied. Second, classes with a comparable male-to-female ratio and similar physical health conditions were selected for the experiment. Lastly, all three groups were instructed by the same teacher, ensuring that the teaching materials, class duration, instructional pace, teaching location, and learning environment remained largely consistent.

2.2.2.3. Experimental grouping

The experiment grouping is shown in **Table 1**.

Table 1. Range division of bullseye rate for different exercise intensities

Groups	Frequency	Time	Bullseye rate range	Intensity
A	3 times/week	20–25 min	No intervention	No intervention
B	3 times/week	20–25 min	140–160 times/min	Medium
C	3 times/week	20–25 min	160–180 times/min	Big

2.2.3. Experiment process

In week 1–2, a pre-test was carried out and the range of bullseye rate corresponding to medium and large exercise intensity was determined. Between week 3 and week 10, Polar Team 2 heart rate monitors and remote sensing heart rate monitors were utilized to track the heart rate of the fundamental segment of physical education classes. During this monitoring period, real-time adjustments were made to regulate the exercise intensity for the experimental group, ensuring that the heart rates of the participating students remained within the predetermined range. In the 11th to 12th week, a post-test was conducted and data were collected.

2.2.4. Data processing

The collected data before and after the experiment were analyzed using SPSS and Excel to examine the variance. In the later stages of the experiment, paired sample *t*-tests were conducted for within-group comparisons, while one-way ANOVA and post-hoc multiple comparisons were applied to assess differences among Group A, Group B, and Group C.

3. Results

3.1. The homogeneity test of students' physical fitness level before the experiment

In the initial phase of the experiment, homogeneity tests were conducted on all indicators for the three groups of students. The analysis of variance results revealed no significant differences in physical fitness metrics among the three groups ($P > 0.05$). This suggests that there were no discrepancies in the tested indicators among the three groups prior to the experiment, thereby eliminating the potential interference of group variations on the experimental outcomes.

3.2. Heart rate monitoring results

The Polar Team 2 heart rate monitor was utilized to track the average heart rate during 16 regular physical education sessions across three groups. The findings indicated that Group B maintained a relatively steady average heart rate of 140–160 beats per minute. While Group C exhibited a lower heart rate in certain classes, its overall average still hovered around 170–180 beats per minute. In contrast, Group A demonstrated significant fluctuations in heart rate, primarily staying within the range of 120–140 beats per minute.

3.3. Statistical comparison of the experimental group before and after the experiment

3.3.1. Statistical comparison results of body shape

Table 2. Statistical table of body morphology of each group before and after the experiment

Variables	Groups	Before (mean ± SD)	After (mean ± SD)	*t*	*P*
Height	A	167.572 ± 7.512	167.608 ± 7.520***	-4.274	0.000
	B	167.512 ± 7.189	167.935 ± 7.168***	-6.797	0.000
	C	168.694 ± 9.218	169.063 ± 9.330***	-6.117	0.000
Weight	A	60.111 ± 10.724	59.820 ± 11.000	1.101	0.275
	B	58.639 ± 11.092	59.045 ± 11.468	-1.636	0.107
	C	59.845 ± 11.493	59.102 ± 1.104***	3.625	0.001
BMI	A	21.305 ± 2.734	21.173 ± 2.778	1.459	0.150
	B	21.063 ± 3.203	20.621 ± 2.921***	4.517	0.000
	C	20.921 ± 2.936	20.588 ± 2.913***	4.622	0.000
PBF	A	20.551 ± 5.572	20.359 ± 5.776	0.885	0.380
	B	20.720 ± 6.532	19.054 ± 7.138***	4.971	0.000
	C	19.748 ± 6.003	19.215 ± 6.036**	2.536	0.014
Obesity rate	A	3.121 ± 13.509	2.289 ± 13.471	1.020	0.312
	B	0.804 ± 14.651	1.639 ± 14.331***	7.552	0.000
	C	0.312 ± 14.993	0.532 ± 14.319**	2.191	0.032

The experiment revealed significant differences in height among the three groups both prior to and following its conclusion ($P < 0.01$) (**Table 2**). Additionally, the post-experiment height measurements were found to be greater than those recorded before the experiment.

Regarding body weight, no significant difference was observed between Group A and Group B either before or after the experiment. However, a significant difference was noted in Group C when comparing pre- and post-experiment measurements ($P < 0.01$). The average value of Group B increased after the measurement compared to before, whereas the average value of Group C decreased after the measurement relative to before.

Regarding BMI, significant differences were observed between groups B and C both before and after the experiment ($P < 0.01$). The average value of the post-test was lower compared to the pre-test. In contrast, no significant difference was found between group A and the values prior to the experiment.

Regarding PBF, Group B exhibited the most substantial difference between pre-test and post-test results ($P < 0.01$). In Group C, there was a notable difference before and after the experiment ($P < 0.05$), with the post-test mean being lower than the pre-test mean. Conversely, Group A did not show any significant difference between the pre-test and post-test outcomes.

Regarding the obesity rate, no significant difference was observed in Group A before and after the experiment. However, Group B showed the most substantial difference pre- and post-experiment ($P < 0.01$), while Group C demonstrated a notable difference between the pre- and post-experiment results ($P < 0.05$). Additionally, the average value of the post-test was lower compared to the pre-test.

3.3.2. Statistical comparison results of lung capacity

Table 3. Statistical table of vital capacity of each experimental group before and after the experiment

Variables	Groups	Before experiment (mean ± SD)	After the experiment (mean ± SD)	*t*	*P*
Lung capacity	A	3550.541 ± 953.331	3604.607 ± 965.208	-4.461	0.420
	B	3396.784 ± 800.559	3608.077 ± 858.432***	-3.504	0.000
	C	3523.477 ± 841.398	3718.508 ± 874.963***	-4.925	0.000

From the *t*-test results (**Table 3**), it is evident that group B and group C show significant differences between the pre-test and post-test, whereas group A exhibits no notable differences between the two time points.

3.3.3. Statistical comparison results of maximal oxygen uptake

Table 4. Statistical table of maximal oxygen uptake of each experimental group before and after the experiment

Variables	Groups	Before experiment (mean ± SD)	After experiment (mean ± SD)	*t*	*P*
Vo2 Max	A	41.208 ± 5.740	41.107 ± 5.233	0.267	0.790
	B	40.961 ± 4.151	43.006 ± 4.801***	-6.475	0.000
	C	40.933 ± 4.904	42.274 ± 4.822***	-5.298	0.000

As shown in **Table 4**, significant differences were observed in Group B and Group C both before and after the experiment, with the post-test mean being greater than the pre-test mean. In contrast, Group A demonstrated no notable difference between the pre-test and post-test results.

3.3.4. Statistical comparison results of physical fitness

Table 5. Statistical table of physical fitness of each experimental group before and after the experiment

Variables	Groups	Before experiment (mean ± SD)	After experiment (mean ± SD)	*T*	*P*
Fifty meters	A	8.205 ± 0.787	8.337 ± 0.915***	-3.433	0.001
	B	8.296 ± 0.994	8.114 ± 0.938***	5.059	0.000
	C	8.164 ± 0.983	7.992 ± 0.917***	2.947	0.004
Standing long jump	A	1.948 ± 0.324	1.854 ± 0.345***	4.868	0.000
	B	1.876 ± 0.328	1.952 ± 0.292***	-4.613	0.000
	C	1.854 ± 0.332	1.914 ± 0.318***	-3.112	0.003
Grip	A	37.915 ± 10.968	36.715 ± 10.732***	3.813	0.000
	B	35.638 ± 10.841	39.568 ± 10.701***	-7.236	0.000
	C	38.192 ± 12.498	38.955 ± 12.471***	-3.196	0.002
Sit forward bend	A	10.393 ± 7.575	10.523 ± 8.005	-0.408	0.685
	B	9.814 ± 6.882	10.645 ± 6.864***	-3.114	0.003
	C	12.103 ± 6.325	12.348 ± 6.741	-1.096	0.289

As shown in **Table 5**, substantial differences existed among the three groups both prior to and following the experiment ($P < 0.01$). Specifically, the average scores of the post-tests for groups B and C decreased compared to their pre-test results, whereas the post-test average for group A increased relative to its pre-test score.

Regarding the standing long jump and grip strength, significant differences were observed among the three groups both before and after the experiment ($P < 0.01$). Post-test scores for groups B and C showed improvement

compared to their pre-test results, whereas group A's post-test scores were lower than their pre-test scores.

Regarding seated forward bending, no significant difference was observed between Group A and Group C either before or after the experiment. However, a substantial difference was noted in Group B when comparing results before and after the experiment ($P < 0.01$). Additionally, the outcomes for all three groups showed improvement compared to the pre-test results.

4. Conclusion

(1) The influence of different exercise loads is different. The promoting effect of moderate intensity and high intensity exercise on students' physical fitness is better than that of the control group, and the effect of moderate intensity exercise is the most significant.

(2) Suitable for junior high school students exercise load intensity heart rate range is 140–160 times/min.

Funding

Youth Research Project of Humanities and Social Sciences, Ministry of Education (Proejct No.: 22YJC890013); Youth Project of Social Science Foundation of Jiangsu Province (Project No.: 22TYC003); General Project of Philosophy and Social Science Research in Universities of Jiangsu Province (Project No.: 2022SJYB2110)

Disclosure statement

The authors declare no conflict of interest.

References

[1] Ji L, 2022, Teaching Design and Implementation of Physical Education Practice Class Based on Core Literacy – Expert Interpretation of Curriculum Standards for Physical Education and Health in Compulsory Education (2022 Edition). Physical Education and Teaching, 42(8): 4–7.

[2] Xiong W, 2021, Questioning and Justifying: The Intensity Correlation of School Physical Education Health Pursuit – A Reflection on the Specific Exercise Intensity of Physical Education Curriculum Teaching. Journal of Shanghai University of Physical Education, 45(1): 86–98.

[3] Zhang C, Xu B, Ji L, 2022, Influence of Exercise Intensity on Physical and Mental Health of Children and Adolescents in Chinese Health Physical Education Curriculum Model. Journal of Wuhan University of Physical Education, 56(12): 85–92.

[4] Qin G, Cheng W, 2019, Review, Consideration and Prospect of the Policy Change of Youth Sports Health Promotion in China from the Perspective of Multi-Source Theory. Journal of Harbin Institute of Physical Education, 42(1): 88–96.

[5] Yan J, Sun H, Zhang J, et al., 2021, Research on the Ecological Environment of Sports in China: Context Evolution, Frontier Hot Spots and Development Trend. Journal of Wuhan University of Physical Education, 55(2): 13–20.

[6] Guan D, Sang P, Zhou K, et al., 2023, Development Achievements and Prospects of School Physical Education in New China – Based on Quzong Lake's Oral Analysis. Journal of Nanjing University of Physical Education, 22(9): 64–70.

[7] Xu S, Li Y, 2023, Difficulties and Solutions in the Cultivation of Physical Education Core Accomplishment of Primary and Middle School Students under the Background of New Curriculum Standards. Journal of Harbin Institute of Physical Education, 41(4): 70–76.

[8] Fu Y, 2022, An Empirical Study on the Teaching Effect of Physical Education in Shanghai Primary Schools Based on Classroom Observation, thesis, Shanghai Institute of Physical Education.

[9] Wu Z, Chang G, Ji Y, et al., 2023, Analysis of Exercise Density and Exercise Load in Different Physical Fitness Classes for Grade 2 Students in a Middle School in Beijing. Chinese School Health, 44(12): 1828–1832.

[10] Chen H, 2022, The Influence of Physical Health Level on Physical Exercise Load Intensity of Junior Middle School Students, thesis, Soochow University.

[11] He Y, Liu J, Xi Y, et al., 2022, An Experimental Study of Heart Rate Interval and Training Impulse on the Evaluation of Physical Exercise Load of Primary School Students. Chinese School Health, 43(3): 378–381.

[12] He Y, 2022, Study on the Characteristics of Physical Activity Load and Its Correlation with Physical Fitness of Primary School Students, thesis, Xi'an Physical Education University.

[13] Xu X, 2024, Research on Energy Consumption and Physical Activity Level of Junior Middle School Students in PE Class under the Background of New Curriculum Standards, thesis, Minnan Normal University.

[14] Huang L, 2023, Application of Heart Rate Monitoring in Middle School Physical Education Classroom Teaching. Proceedings of 2023 Academic Symposium of Guangdong Education Society (2), Shijie Middle School, Dongguan City: 7.

[15] Wang R, Sun B, 2022, Exercise Physiology. People's Sports Publishing House, Beijing: 1–20.