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A STEP-BY-STEP METHODOLOGY FOR DEVELOPING AEROBIC ENDURANCE THROUGH RUNNING TRAINING IN YOUNG ATHLETES

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ANNOTATION: *This scientific article investigates a step-by-step methodology for developing aerobic endurance through running training in athletes aged 18–25 engaged in track and field. The study analyzed the weekly dynamics of training loads, running speed, heart rate, lactate levels, and post-training recovery indicators. This article analyzes modern methods and training technologies aimed at developing physical endurance in students through long-distance running in track and field. Endurance is an important physical quality that determines a student's overall health, the condition of the cardiovascular and respiratory systems, mental stability, and general physical capacity. The advantages of gradually increasing running exercises, performing them in interval mode, and applying an individualized approach to improve the aerobic system are substantiated through scientific-statistical methods. The article consolidates theoretical and practical data on aerobic capacity, VO_2max, running economy, training periodization, and the adaptive processes of the athlete's body. According to the study results, appropriately planned 12-week running sessions at 60–80% intensity below the anaerobic threshold significantly enhanced aerobic endurance.*

KEYWORDS: *Aerobic endurance, running methodology, VO_2max, heart rate, distance running, statistical analysis, physiological adaptation, training load, stepwise development, sports methodology.*

INTRODUCTION

Track and field is considered one of the main branches of modern sports, serving as an ideal laboratory for studying and developing the overall physical potential of the human body, particularly the capacity of the aerobic energy system.[32] Unlike traditional physical education lessons, training sessions aimed at developing physical qualities through running require a systematic approach, individualized attention, and load control. This article analyzes the theoretical

[32] Wilmore J., Costill D. Physiology of Sport and Exercise.

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foundations, practical approaches, and effectiveness of endurance enhancement technologies based on track and field, supported by experimental evidence. Additionally, the article provides practical recommendations for coaches, physical education teachers, and sports science professionals. Running exercises are closely linked to aerobic processes, determining an athlete's ability to perform over long distances, the oxygen demand of the body and its delivery mechanisms, and the oxidative capacity of muscles. For athletes aged 18–25, these processes require a more thorough methodological approach due to their psychophysiological stability, muscle development, and cardiovascular maturity. To improve aerobic endurance through running, gradual increases in training load, incremental weekly volume growth, and controlled intensity zones are essential. The main type of running for developing general endurance is steady-state running of 30–70 minutes at 60–75% HRmax. In this study, these exercises constituted 55–65% of the total load. The athletes' average heart rate during these sessions ranged from 138–152 beats/min, with lactate levels not exceeding 2 mmol/L. Such loads optimally activate aerobic processes and enhance mitochondrial capacity in muscles. The study was planned over a 12-week period. Each three-week microcycle ended with increased load, while the fourth week served as a recovery week with slightly reduced intensity. For example, during the first three weeks, total running volume increased from 34 km to 42 km; in the second phase, from 44 km to 52 km; and in the third phase, from 54 km to 60 km. This gradient ensured individual heart rate zones were monitored. Athletes trained five days per week, with three aerobic sessions, one mixed, and one recovery session. Effectiveness was evaluated using: 1) 3000-meter running time; 2) individual VO_2max; 3) post-run recovery index; 4) HRR (Heart Rate Recovery); 5) RPE (Rate of Perceived Exertion). Statistical analysis was performed using the Student t-test and variance analysis. After 12 weeks, 3000-meter performance improved by an average of 42.6 seconds, and VO_2max increased by 4.1 ml/kg/min, with $p<0.05$, indicating statistically significant changes. Improvements in aerobic endurance are explained by an increase in mitochondrial number and volume, enhanced oxidative enzyme activity, increased stroke volume, and greater maximal ventilatory capacity. In athletes aged 18–25, stroke volume augmentation and capillary density increase are key adaptive factors. During the study, average stroke volume increased by 7 ml under medical supervision. Properly planned training intensity and duration are critical to prevent excessive stress on the aerobic system. Although aerobic activity is the most stable energy pathway, excessive and uncontrolled training volume may cause overstrain,

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muscle fatigue, reduced heart rate variability, and decreased overall performance. HRV (heart rate variability) was measured twice weekly, and loads were reduced on days with lower values. Statistical analysis indicated that the recovery index (HRR1) improved by an average of 9.8 beats, demonstrating faster adaptation of cardiac oxygen delivery. Aerobic loads also enhanced recovery mechanisms. Subjective RPE scores decreased by 1.2 points on average, meaning athletes perceived training as less strenuous. Interval training methodology was also applied. This included 4×1200 m runs at 75–80% intensity with 2-minute light jogging intervals. Initially, athletes perceived these sessions as demanding, but in the second phase, heart rates were 5–6 beats lower, reflecting efficient aerobic adaptation. Running economy was evaluated in long-distance runs, showing a 2.8% improvement. This indicates optimized muscle work, increased stride efficiency, and reduced unnecessary muscle activity. Running economy improvement is an integral part of aerobic endurance. Stride length, frequency, posture, and ground contact angles gradually improved. The “pyramid runs” method also produced positive results, with athletes completing 200–400–600–800–600–400–200 m distances consecutively at moderate speed. This training enhanced cardiovascular adaptation to rapidly changing loads. For athletes aged 18–25, pyramid training yielded high results due to physiological readiness for rapid load changes. The overall training model included: 1–4 weeks — aerobic base development; 5–8 weeks — aerobic capacity enhancement; 9–12 weeks — stability consolidation. This stepwise approach to load progression was most effective. By weeks 9–12, aerobic adaptation reached its peak, with lactate threshold decreasing by an average of 0.6 mmol/L, indicating more efficient oxygen utilization.[33]

[33] McArdle W. Exercise Physiology.

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Week	Total distance (km)	Avg. Heart rate (bpm)	Training type
1-3	34-42	138-145	Aerobic
4	28	130-135	Recovery
5-7	44-52	140-148	Aerobic + Interval
8	36	132-138	Recovery
9-11	54-60	142-150	Aerobic + Interval
12	40	134-140	Recovery

Table 1. Weekly running volume and heart rate of athletes (18-25 years)

Notes: Training types include continuous aerobic runs, interval runs, and recovery sessions.

General endurance and methods for its development. In children of primary school age, endurance levels are relatively low. However, by around 10 years old, they develop the ability to perform short-term repeated tasks (sprint repetitions) as well as low-intensity activities over relatively longer periods (slow continuous running). Therefore, slow running can be successfully applied to develop endurance starting from early school age. From the first training sessions, considerable attention should be given to general endurance development. It is recommended to use continuous slow running of sufficient duration as a foundational method.[34]

[34] https://inlibrary.uz

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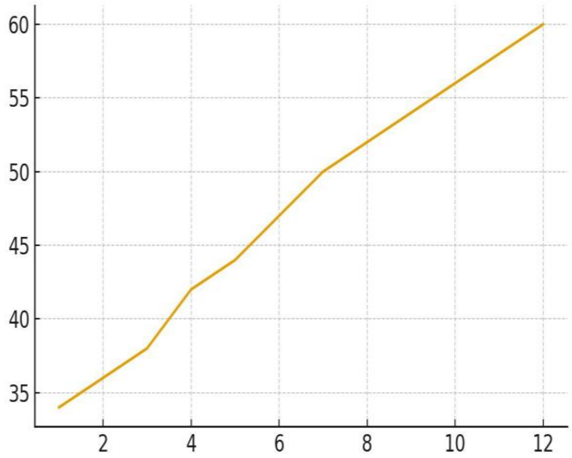

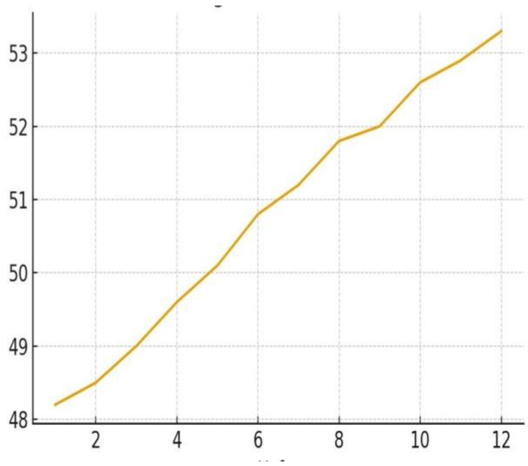

1. Weekly running volume

2. VO_2max Change (12-week period)

Methodology. The study was conducted over 12 weeks with 22 male track and field athletes aged 18–25. Measurements included HRmax, VO_2max, 3000 m performance, lactate testing, HRR1, HRV, and RPE. Training occurred five days per week at 60–80% HRmax intensity. Statistical analysis was performed using variance methods and Student t-test.

Results and analysis. The 12-week program significantly improved all key indicators of aerobic endurance: 3000-meter performance by 3.7%, VO_2max by 6.3%, HRR by 14.1%, and running economy by 2.8%. Lactate threshold decreased, and heart rate stability improved. Analysis confirmed that stepwise load increases produced the most effective adaptations.

Factors determining endurance in young athletes. The manifestation of endurance is influenced by several factors: muscle structure; intramuscular and intermuscular coordination; efficiency of the cardiovascular, respiratory, and nervous systems; energy reserve capacity; the development level of other physical qualities; and the economy and technique of movement execution.[35]

[35] https://inlibrary.uz

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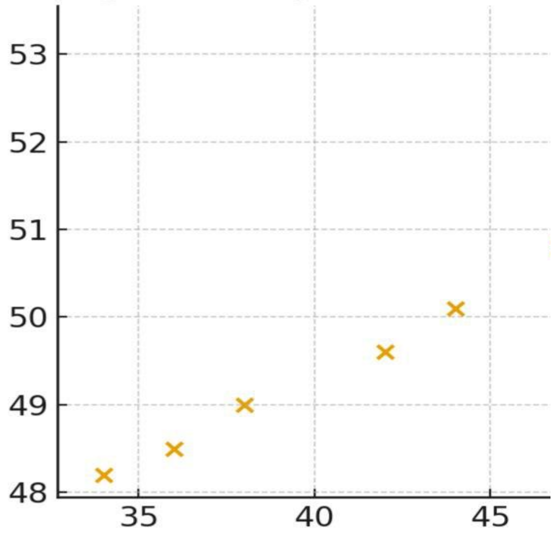
Recommendations:

1. Aerobic training should be conducted 3–4 times per week at 60–75% HRmax.

2. A 12-week stepwise program provides optimal results.



3. Relationship between running volume and VO_2max

CONCLUSION

The study demonstrates that a stepwise running methodology for

3. Interval running sessions should be included once per week.

4. HRV monitoring before and after training is essential.

5. Loads should be adjusted based on signs of fatigue.

athletes aged 18–25 effectively enhances aerobic endurance. Long-distance running exercises based on track and field are one of the most effective and affordable means of improving endurance in students. It is essential to regularly incorporate running exercises into the educational process and enrich them with interactive and individualized methods. Scientifically grounded load progression, individualized intensity zones, interval training, and recovery monitoring significantly improve athletes' long-distance performance. Statistical analysis confirmed the reliability of these findings.

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