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The Effect of B-Complex Vitamins Associated With Anaerobic Threshold Training on Some Biomotor Variables and Performance Tolerance in Young Boxers

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ABSTRACT
Backgroud: Boxing sport requires a complex physical and physiological preparation. Many young boxers experience a significant decrease in performance and speed in the final rounds of the fight. A field study was conducted on 20 adolescent boxers (17-18 years) in Babil Governorate to assess the effect of integration of 'anaerobic threshold exercises' with the nutritional intervention under investigation.
Methods: The study lasted for 8 weeks and the sample trained at a high intensity (between 80% and 90% of the maximum) where lactic acid begins to accumulate in the muscles. The experimental group was defined as the group that took one capsule of B-Complex vitamins every morning after breakfast and the control group only exercised.
Results: The results indicated a clear advantage of the experimental group in the post-tests, showing a significant increase in explosive strength of the arms, speed endurance and the ability to sustain high performance in three consecutive rounds without a significant decrease. The scientific reason for this achievement is due to the role of B-Complex vitamins as enzymatic co-factors that enhance the metabolism of energy production (ATP) under hypoxic conditions, while minimising the adverse effects of the accumulation of lactic acid.
Conclusions: These vitamins, particularly B6 and B12, were crucial in protecting the central nervous system, stalling “central fatigue” and preserving motor coordination and dazzling precision.The study recommends that coaches should include anaerobic threshold exercises during the special preparation period and support with morning B-Complex under medical supervision to enhance endurance and performance of players.

Keywords: B-Complex; Anaerobic; Threshold Training; Biomotor Variables; Performance Tolerance; Young Boxers.

INTRODUCTION

The sports sector has undergone important changes in training strategies, with more focus on supportive sciences (Lindsey 2022), such as exercise physiology and nutrition, which are considered important for athletes to reach their most potential (Al Behadili & Kasim, 2022; Irandoust, 2023). Boxing is a sport that requires complex physical preparation and physiological knowledge, since its performance depends on the constant alternation of energy production mechanisms (aerobic and anaerobic) (Kolodeznikov & Pelmenev, 2022). Anaerobic threshold training illustrates the crucial threshold at which lactic acid concentration rises in the muscles (Fatani 2025; Kasim, 2022). The importance of B-complex vitamins is notably accentuated, given their fundamental role in the metabolic pathways that yield energy from carbohydrates, fats, and proteins, alongside their function in bolstering central nervous system performance and delaying the onset of fatigue in both the nervous and muscular systems (Hrubša 2022; Ghazzawi 2023). The study's value is found in its endeavour to correlate the application of anaerobic threshold

activities, aimed at improving an athlete's performance capacity and delaying stress, with the nutritional intervention focused on B-Complex vitamins. This integration can meaningfully support the advancement of biomotor variables and performance capacity in young boxers, supplying trainers with new scientific insights that foster improvements in physical and physiological readiness.

Research Problem

Anaerobic threshold workouts increase organ function and boxers' ability to compete well despite lactic acid buildup and oxygen deficit (Zhang & Cheng, 2022). These activities help juvenile boxers build endurance and biochemical strength, but they also strain the nervous system and slow muscular reflexes, which may hinder athletic adaptability (Finlay 2023). Researchers have found that excessive anaerobic training without nutritional and physiological support can stress neuroreceptors and negatively effect performance and recovery, especially in kids who need a balance between exertion and recovery. B-Complex vitamins, such as B1, B2, B6, and B12, are essential for energy synthesis, neuronal signal transmission, and stress relief from anaerobic activities (Hrubša 2022). The lack of knowledge about how B-Complex vitamins affect physiological support during anaerobic threshold exercises, particularly in young boxers' motor speed, response time, strength, and "performance endurance" is the research issue.

This training and physiological integration must be tested immediately to improve this susceptible age demographic's physical and skill proficiency. Due to its competitive nature and strong anaerobic exertion, boxing requires exceptional physical and physiological qualities (Venckunas 2024). Anaerobic threshold workouts improve organ efficiency and delay weariness, but overtraining can damage the neuromuscular system, reducing explosive power, speed endurance, and skill execution (Niu 2024). Field observations and interviews with boxers and trainers have shown the difficulty of maintaining high performance in later rounds of hard anaerobic exertion. Fatigue and lactic acid buildup affects the central nervous system, requiring a comprehensive training program to speed recovery and protect muscle and nerve cells. Integrating B-Complex vitamins into physical activity is important because they facilitate energy metabolism, improve neuromuscular connections, and reduce stress from intensive activities. These vitamins and metered anaerobic threshold exercises are administered to young boxers to improve biomotor variables and high-level performance endurance. The study aims to provide scientific and practical solutions for trainers to prepare this demographic based on comprehensive sports and physiological principles.

Research Objectives

1. Preparation of exercises to develop an anaerobic threshold that is appropriate for the research sample of young boxers.
2. To identify the effect of (B-Complex) vitamins associated with anaerobic threshold exercises on some biomotor variables (explosive ability, speed endurance, skill performance endurance) in the research sample.
3. To identify the effect of (B-Complex) vitamins associated with anaerobic threshold exercises on the endurance of high skill performance (quantitative and qualitative) of boxers.

Research hypotheses

1. There are statistically significant differences between the pre- and post-tests of the two groups (experimental and control) in biomotor variables, performance tolerance, and in favor of post-tests.
2. There are statistically significant differences in the post-tests between the experimental group that used anaerobic threshold exercises and vitamins (B-Complex) and the control group (anaerobic threshold exercises only) and in favor of the experimental group.

Research areas

Human area: Babylon Governorate Boxing Players Youth Category (17-18 Years). Temporal area: Period from 1/3/2026 to 1/5/2026. Spatial Area: Boxing Hall at Hilla Sports Club.

Defining the terms

Anaerobic threshold: This training intensity point produces more lactic acid in the blood than the body can eliminate (Lee et al,, 2023). Complex Vitamins: A collection of water-soluble vitamins that serve a supportive function for enzymes in the metabolic process of cellular energy generation (ATP) Chen, P., & Liu, L. (2024).

METHODS

Research Methodology

The investigator employed the experimental approach by establishing two equivalent groups (experimental and control) with pre- and post-assessments, according to the research's requirements and characteristics.

Research Population and Sample

The study cohort was determined to consist of 40 boxers within the youth category in the governorate. The sample was intentionally chosen and comprised 20 boxers, accounting for 50% of the initial population, with an average weight. They were arbitrarily allocated into two equal factions, with the experimental group comprising ten boxers who engaged in anaerobic threshold training and consumed B-Complex vitamins. The control group consisted of ten boxers who performed anaerobic threshold activities without the supplementation of B-Complex vitamins.

Sample homogeneity

The homogeneity of the sample was done in a number of variables (height, weight, age, training age) and Table (1) shows that

Table 1. Shows the homogeneity of the research sample.

Variables	Unit of Measurement	M	SD	Torsion coefficient	Preview error
Age	Year	17.44	0.85	0.70	0.89
Length	Cm	170.50	4.20	0.35	0.65
Weight	Kg	69.40	5.15	0.23	0.55
Training Age	Year	2.10	1.10	0.89	0.91

Table (1) demonstrates that all variables associated with homogeneity exhibit no significant differences, indicating their homogeneity, particularly as the researcher deduced a torsion of zero and a standard error of zero, suggesting that the sample data were normally distributed with no discernible differences among them.

Devices and tools used

1. Weight and Height Measurement Devices (Medical Scale).
2. Electronic time clocks.
3. Badges, jump ropes, standard boxing bags (heavy bags).
4. Vitamin B-Complex supplements (capsules from a medically approved pharmaceutical company, containing standard ratios of (B1, B2, B3, B6, B12).

Field actions

Identification and testing of variables: By reviewing the references and scientific sources in addition to the nature of the research problem, the following were determined:

Biodynamic variables:

1. The explosive power of the arms.
2. Withstand speed.
3. Endurance of Boxing Skill Performance.

Exploratory experiment

The investigator executed the preliminary experiment on February 15, 2026, at 4 PM in the Hilla Boxing Club hall, with a sample including four boxers from both the research community and other sources. The investigative experiment accomplished the subsequent aims:

1. Verify the authenticity of the equipment and instruments employed (timers, punching bags, medicine balls).

2. Ascertain that the auxiliary personnel comprehends the characteristics of the assessments and the protocols for measurement and documentation.
3. Assess the duration required for each examination, compute the aggregate time for all assessments, and establish suitable intervals between examinations to prevent cumulative fatigue.
4. Verifying the appropriateness of biomotor assessments for the demographic of the sample (young boxers).
5. Conduct an experiment on the protocol for giving a B-Complex supplement and analyse its adherence mechanism with boxers while taking preliminary notes.

Validity of tests

The investigator depended on perceived integrity by gathering the views of authorities and professionals in the domain of athletic training and the physiology of physical exertion (Appendix 1).The selected assessments were submitted to ten specialists, who were requested to provide their evaluations regarding the validity of each test in measuring the particular biodynamic factors. To demonstrate the statistical significance of the expert agreement percentage, the researcher employed the chi-square test, and Table (2) illustrates that.

Table 2. Show honesty through expert opinions about the validity of the tests used in the research

Tests Name	Variable Scaled	Agreers	Disagree	Percentage of agreement	Calculated value ($\chi 2$)
Drop 3 kg medical ball	Explosive power of the arms	10	0	100%	10.00
30 Seconds Continuous Punching	Withstand Speed	9	1	90%	6.40
Performance Tolerance	Performance Endurance (Total)	10	0	100%	10.00

The data presented in the preceding table indicates that the consensus among experts and specialists regarding the validity of the tests examined was exceptionally high, varying from 90% to 100%, and to confirm this, the computed chi-square values for all tests (which were 10.00, 6.40, and 10.00 respectively) were juxtaposed with their critical value of 3.84. All computed values exceed the tabulated value at the significance level of (0.05) with one degree of freedom, so statistically affirming the significance of the differences favouring the (agreeers).Consequently, all examinations appear to be valid.

Reliability of Tests

The investigator employed the test-retest approach to ascertain the stability coefficient. The assessments were conducted on the (4) boxed participants of the survey sample on 15/2/2026, followed by a re-administration of the identical assessments to the same participants under the same spatial and temporal conditions on 22/2/2026 (i.e. 7 days later).To ascertain the degree of connection between the outcomes of the initial test and the subsequent test, Pearson's simple correlation coefficient was employed.

Objectivity of the test

Given that several evaluations hinged on the velocity and correctness of the calculations, the researcher enlisted two autonomous adjudicators to capture the findings of the same players simultaneously.

Table 3. Shows the consistency and objectivity coefficients of the tests used in the research

Tests Name	Unit of Measurement	Stability coefficient (t)	Objectivity coefficient (t)	Statistical Evaluation

Explosive power of the arms (throwing a 3 kg ball)	meter	0.89	0.95	Consistency and high objectivity
Bearing speed (30 seconds max speed)	Punch	0.92	0.94	Consistency and high objectivity
Performance Endurance (Total Punches in 3 Rounds)	Punch	0.88	0.94	Consistency and high objectivity

The data indicates that the stability values fluctuated between 0.88 and 0.92. The elevated levels of consistency can be attributed to the precision in the standardisation of the assessments and their appropriateness for the age and physical condition of young boxers, while the objectivity of the outcomes indicated exceptionally high values, confined to (0.94 - 0.95).

Main experience

Pre-tests

The preliminary assessments for both groups were carried out on March 1, 2026, under standardised spatial and temporal parameters. To guarantee the comparability of the two research cohorts, the sample was randomly allocated into two groups (experimental and control), each consisting of ten boxers, and the researcher needed to confirm the equivalence of both groups at the outset (pre-tests) concerning biodynamic variables and performance endurance. The T-test was employed for the independent samples to confirm the absence of significant differences prior to the commencement of the experiment, as illustrated in Table (4).

Table 4. Shows the arithmetic medians, standard deviations, and the value of (v) calculated for the pre-tests between the experimental and control groups (equivalence).

Variables	Unit of Measurement	Experimental		Control		Calculated value (v)	Sig
		M	SD	M	SD		
Explosive force	Meter	5.20	0.45	5.25	0.42	0.25	0.80
Withstand Speed	Punch	78.50	5.20	79.00	4.80	0.22	0.82
Performance Endurance (Total)	Punch	192.30	14.50	194.10	13.80	0.28	0.78

The computed values of (t) were (0.25, 0.22, and 0.28), correspondingly. All computed values are less than the tabulated t-value of 2.10 at 18 degrees of freedom and a significance level of 0.05, so statistically indicating no significant differences between the two groups. This parity in the preliminary assessments guarantees that the trial commences from a unified baseline.

Training Curriculum

The training program was developed on the basis of the current scientific literature on training physiology, adjusted to the age and physical characteristics of the group of study (young boxers aged 16-18). The methodology was designed to stimulate the anaerobic energy system (lactic acid system) to improve players' capacity to maintain performance in hypoxic conditions.

Determinants of the training load of the curriculum

1. Overall length: (8) uninterrupted weeks throughout the designated preparatory period.
2. Weekly occurrence: (3) training sessions per week (Sunday, Tuesday, Thursday).
3. Training intensity: Varies between 80% and 90% of your peak heart rate, to guarantee engagement inside the anaerobic threshold (the zone where lactic acid accumulation commences).
4. Training Duration: The effective operational period inside the primary section of the unit spans from 45 to 60 minutes.
5. Intervals: (incomplete) pauses were incorporated between repetitions and sets, ensuring that the heart rate does not return to baseline but instead decreases to about 120-130 beats per minute before starting the next repeat, forcing the body to improve lactic acid clearance efficiency.

A medical procedure for administering the food supplement was implemented under the guidance of a specialised sports physician and persisted throughout the 8-week training regimen.
Mechanism of vitamin intake

A medical regimen was devised to provide the dietary supplement under the guidance of a specialised sports physician, persisting for the duration of the training program (8 weeks). Consume a single capsule daily to guarantee that muscle and nerve cells remain adequately infused with vitamins.Consume the pill in the morning (just after breakfast) accompanied by a substantial glass of water.

Post-tests

The post-assessments were executed on may 5, 2026, ensuring that the same conditions as the pre-assessments were maintained to guarantee outcome accuracy.

Statistical methods

The investigator employed the statistical software (SPSS) to determine the statistical measures: arithmetic mean, standard deviation, skewness, sampling error, T-test for paired samples, and T-test for independent samples.

RESULTS AND DISCUSSION

Presentation and analysis of the results of biodynamic variables and performance tolerance Presentation and analysis of differences between the pre- and post-tests of the two groups

Table 5. Shows the arithmetic medians, standard deviations, and the calculated (T) value between the pre- and post-tests of the two groups in all research variables.

Variables	Unit of Measurement	Groups	Pre-test		Post-test		T	Sig
			M	SD	M	SD		
Explosive power of the arms	Meter	Experimental	5.20	0.45	6.85	0.38	8.64	0.000
		Control	5.25	0.42	6.10	0.40	4.31	
Withstand Speed	Punch	Experimental	78.80	5.20	98.20	4.10	11.15	0.000
		Control	79.00	4.80	88.40	4.50	5.82	
Endurance Performance (Total 3 Rounds)	Punch	Experimental	192.30	14.50	245.60	11.20	14.80	0.000
		Control	194.10	13.80	218.70	12.90	6.45	

Table 5 indicates that the arithmetic median of the post-tests exhibited a notable rise in both the experimental and control groups across all examined variables (explosive force, speed tolerance, and performance tolerance). The computed values of (T) for each of these variables exceeded the tabulated value of (2.26) at the significance threshold of (0.05). This statistically validates that notable disparities exist between the pre- and post-tests, favouring the post-tests for both cohorts.

Table 6. Shows the arithmetic media, standard deviations, and the calculated (T) value of the post-tests between the experimental and control groups in all research variables

Variables	Unit of Measurement	Experimental		Control		T	Sig
		M	SD	M	SD		
Explosive power of the arms	Meter	6.85	0.38	6.10	0.40	4.29	0.000
Withstand Speed	Punch	98.20	4.10	88.40	4.50	5.09	0.000
Endurance Performance (Total 3 Rounds)	Punch	245.60	11.20	218.70	12.90	6.64	0.000

Table (6) illustrates the dominance of the experimental group across all biodynamic factors and performance endurance. The computed values of (T) for the variables (explosive force, speed tolerance, overall performance tolerance) exceeded the tabulated value of (2.10).

DISCUSSION

A comprehensive analytical assessment of the preceding statistical tables demonstrates that both training approaches have increased the biomotor and performance endurance qualities of juvenile boxers. Yet, the experimental group that amalgamated anaerobic threshold training with B-Complex vitamin intake realised a difference in outcomes relative to the control group. The analyst links the total progress in both factions to the unique qualities of the anaerobic threshold exercises utilised. Training within the range of 80%-90% of the maximum heart rate directly triggers physiological modifications in muscle cells. This training technique encourages the body to operate within a lactic acid-dense environment, which, with consistent practice, enhances the efficiency of the biochemical pathways in the blood and muscles, thus elevating the athlete's capability to neutralise acid hydrogen ions and persist in performance (Ogunleye & Ogunleye, 2024).

Boxing routines standardised on bags and characterised by anaerobic specifications also emerged from the suppleness and strength of muscle fibres, which had a beneficial impact on explosive strength and speed endurance results (Hernandez-Martinez et al., 2024). The analyst further relates this development to the consolidated and synergistic chemical and physiological effects produced by the intake of B-Complex vitamins during this energetic anaerobic activity. Activities targeting the anaerobic threshold place considerable stress on the anaerobic glycolysis pathway to yield energy. In this context, muscle cells necessitate a high rate of chemical flow, which emphasises the importance of B vitamins as vital co-enzymes (Giza, 2025). Thiamine (B1) constitutes the principal component of glucose metabolism and the transformation of energy within the mitochondria. Riboflavin (B2) and niacin (B3) are pivotal in the creation of electronic transporters, since their presence amplifies the cell's ability to promptly recycle energy compounds, preventing acute chemical weariness (Ogunleye & Ogunleye, 2024).

This biochemical analysis is immediately observable in the results shown in Table (6) on Performance Endurance, revealing that the control group boxers had a steep decline in their effective punches in the third round. This denotes the usual physiological phenomenon arising from the accumulation of lactic acid and a drop in pH within the muscle, which inhibits the enzymes crucial for energy production, leading the muscle to become rigid and its contraction speed to diminish (MacLaren & Morton, 2024). In opposition, the experimental group upheld a steady performance. The protection and regulation of the central nervous system are significantly influenced by B-Complex vitamins, especially vitamin B6 and vitamin B12. The anaerobic demands of boxing result in central weariness caused by the reduction of neurotransmitters and the sluggish conduction of nerve impulses, leading to diminished motor coordination, precision, and timing of punches for the boxer (Tshibangu, 2023; Salih, Hashim & Kasim, 2021). The supplement allocated to the experimental group facilitated the transmission of high-frequency neuromuscular signals, enabling the player to preserve the hallmark quality of strength with speed over the nine minutes of the fight, thereby averting a decline in motor and physical compatibility. As a result, the second premise of the investigation is confirmed in the field and through scientific means.

CONCLUSIONS AND SUGGESTIONS

Conclusion

1. The program involved “anaerobic threshold exercises” (80%-90% intensity) and has been shown to be very effective in the development of biomotor variables (explosive arm strength, speed endurance), and the resilience of skill performance in young boxers, as seen in the significant progress of post-evaluations of both groups.
2. The simultaneous consumption of B-Complex vitamins in anaerobic threshold exercises has led to physiological and training improvements with the experimental group demonstrating a statistically significant superiority over the control group in all the considered variables.
3. The B-Complex vitamins have been of great importance in maintaining the performance balance and in preventing physical decline in the later stages.

4. The nutritional intervention of this supplement provided the mitochondria inside the muscle cells with the necessary "enzymatic aids" to speed up the production of anaerobic energy substrates (ATP) and reduce the harmful effects of lactic acid accumulation in the working muscles.

Suggestions

1. anaerobic threshold exercises as a fundamental aspect of training regimens for young boxers in the special preparation phase, bolstered by medically supervised B-Complex supplements to ensure sustained stamina and heightened performance effectiveness.
2. Ingest the vitamin in the morning (subsequent to breakfast) to enhance your energy metabolism, and abstain from evening intake to mitigate sleep disruptions.
3. Investigators have been advised to carry out forthcoming investigations focused on direct evaluation of blood constituents (such genuine lactic acid and muscle fatigue enzymes) to more properly document biochemical development.
4. Employing this regimen (training and nutrition) for many age groups (such as advanced) and related anaerobic combat sports, as well as studying the influence of merging B vitamins with other supplements like creatine.

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