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The Effect of High-Intensity Interval Training (HIIT) on Developing Explosive Power Based on Heart Rate Index Among Young Badminton Players

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Abstract

The Importance of the Study: Designing HIIT (High-Intensity Interval Training) Programs to Develop Explosive Power According to Heart Rate Index, Which Requires Physical Performance Adaptation to Achieve High Efficiency in Badminton Players. The study aims to design HIIT programs to develop explosive power based on the heart rate index among badminton players. The research problem arises from the diversity of training methods and their varying impacts, which necessitate physical preparation tailored to the players' capabilities and physical potential. Through the researcher's field experience, it was observed that there is a decline in performance levels during gameplay. This prompted the researcher to address this decline and identify the evident weaknesses in muscular strength and the adaptation of the heart rate index, which has not been given its rightful role or significance in training programs designed by coaches using various methods. This inadequacy has resulted in weaknesses and negative effects on performance levels. Therefore, the researcher decided to investigate this issue to achieve positive results. The researcher employed the experimental method using a pretest-posttest design with both experimental and control groups, as it is suitable for the nature of the study. The domain of the study included the human domain, represented by the players of Al-Mahawil Club for the 2024 sports season. The temporal domain extended from Saturday, January 6, 2024, to Saturday, March 9, 2024, while the spatial domain was the sports hall of the aforementioned club. The research population was determined to consist of young badminton players for the 2024 sports season, with a total of 12 players. From this population, the research sample was deliberately selected, consisting of 10 players, representing a percentage of 83.33%. The sample was divided into two groups: an experimental group and a control group, with 5 players in each group. Homogeneity and equivalence procedures for the sample were conducted, as shown in Tables 1 and 2. The results of the statistical data analysis for the experimental and control groups in the posttests revealed statistically significant differences in the research variables in favor of the experimental group. and this achieves one of the sustainable development goals of the United Nations in Iraq which is (Good Health)

Keywords | HIIT Training, Explosive Power, Heart Rate Index.

Introduction:

The advancements occurring worldwide in various fields, including sports, necessitate a reconsideration of how scientific methods and strategies are devised to design training programs aimed at achieving outstanding athletic performance. HIIT (High-Intensity Interval

Training) incorporates short periods of intense physical activity followed by brief intervals of rest. It also alternates between short bursts of high-intensity exercises and periods of low-intensity activity or rest. Badminton, as an individual sport, demands significant physical effort from players due to its emphasis on rapid

movements, strength, and endurance. Therefore, several physical requirements must be met, foremost among them the explosive power of the arms and legs, to enable continuous performance in the game. This depends on the correct selection of exercise lengths and recovery durations during training repetitions, guided by the heart rate returning to 120 beats per minute. This type of training is characterized by its incorporation of diverse skills, rapid movement, precision in execution, appropriate responses at the right time, quick mobility on the court, coordination across all parts of the body, and a high level of focus to avoid losing points. It also ensures that physical effort is maintained at peak levels for the longest possible duration. Hence, the importance of this study lies in designing HIIT training programs to develop explosive power based on the heart rate index, which requires physical performance adaptation to achieve high efficiency among badminton players. The research problem centres on the fact that the diversity of training methods and their varying effects necessitate physical preparation that aligns with the abilities and physical potential of badminton players. Through the researcher's field experience, a decline in performance levels during gameplay was observed. This prompted the researcher to address this decline and identify the clear weaknesses in muscular strength and the adaptation of the heart rate index, which has not been given its proper role or significance in the training programs designed by coaches with their various methods. This deficiency has led to a weakness and a negative impact on performance levels. Accordingly, the researcher aimed to study this problem to achieve positive results. The study seeks to design HIIT training programs to develop explosive power based on the heart rate index among badminton players and to examine the effect of HIIT training on developing explosive power according to the heart rate index among badminton players. The research hypothesizes that HIIT training has a positive effect on developing explosive power based on the heart

rate index among badminton players. The study's domains are defined as follows: the human domain includes the players of Al-Mahawil Club for the 2024 sports season, the temporal domain spans from Saturday, January 6, 2024, to Saturday, March 9, 2024, and the spatial domain is the sports hall of Al-Mahawil Sports Club. Regarding the research methodology and field procedures, the researcher employed the experimental method with a pre-post-test design for both the experimental and control groups, as it aligns with the nature of the study. The research population and sample were determined to include young badminton players for the 2024 sports season, totalling 12 players. From this population, the research sample was deliberately selected, consisting of 10 players, representing a percentage of 83.33%. The sample was divided into two groups: an experimental group and a control group, with 5 players in each group. The homogeneity and equivalence procedures for the sample were conducted as shown in Tables 1 and 2.

The research problem stems from the diversity of training methods and their varying effects, which require badminton players to undergo physical preparation tailored to their capabilities and physical potential. Through the researcher's field experience, a decline in performance levels during gameplay was observed. This prompted the researcher to address this decline and focus on the evident weaknesses in muscular strength and the adaptation of the heart rate index, which has not been given its rightful role or significance in training programs designed by coaches using various methods. This deficiency has led to a weakness and a negative impact on performance levels.

Thus, the researcher decided to study this problem to achieve positive results. The study aims to design HIIT training programs to develop explosive power based on the heart rate index among badminton players and to examine the

impact of HIIT training on developing explosive power according to the heart rate index among badminton players.

The research hypothesis states that HIIT training has a positive effect on developing explosive power based on the heart rate index among badminton players.

The domains of the study are as follows:

- **Human domain:** The players of Al-Mahawil Club for the 2024 sports season.
- **Temporal domain:** From Saturday, January 6, 2024, to Saturday, March 9, 2024.
- **Spatial domain:** The sports hall of Al-Mahawil Sports Club.

Research Methodology and Field Procedures:

Research Method: The researcher employed the experimental method using a pretest-posttest design for both the experimental and control groups, as it is suitable for the nature of the study.

Research Population and Sample: The research population was identified as young badminton players for the 2024 sports season, totalling 12 players. From this population, the research sample was deliberately selected, consisting of 10 players, representing a percentage of 83.33%. The sample was divided into two groups: an experimental group and a control group, with 5 players in each group. Homogeneity and equivalence procedures for the sample were conducted, as shown in Tables 1 and 2.

Table (1)
Homogeneity of the Research Sample Members

Variables	Unit of Measurement	Arithmetic Mean	Median	Standard Deviation	Skewness Coefficient
Height	cm	165.213	165.000	1.682	0.213
Weight	kg	68.210	68.000	1.319	0.149
Age	year	18.114	18.000	1.461	0.362

The value of the skewness coefficient falls within the range of ± 1 , indicating a moderately distributed population.

Table (2)
Demonstrates the Equivalence Between the Research Groups in the Variables

Variable	Experimental Group		Control Group		Calculated (t) Value	Error Level	Significance
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation			
Explosive Power of the Arms	2.431	0.432	2.223	0.051	1.028	0.328	Not Significant
Explosive Power of the Legs	10.212	0.156	9.564	0.146	0.972	0.354	Not Significant
Heart Rate Post-Effort	182.12	0.216	187.10	0.583	1.39	0.611	Not Significant

Significant at a significance level of ≤ 0.05 and under 10 degrees of freedom

Tools, Equipment, and Devices Used in the Research

Tools: Observation, personal interviews, tests, and measurements.

Equipment and Devices:

- One video camera with a speed of 120 frames per second.

- Various measuring tools (2 stopwatches, measuring tape, whistle).
- HP laptop (Korean-made).
- Handheld electronic calculator (CASIO).
- Medicine balls weighing 1, 2, and 3 kg (12 in total).
- 40 plastic cones of various sizes.
- Benches, 5 meters in length and 40 cm in height (10 in total).
- Boxes, 40 cm in height (10 in total).
- Beurer effort measurement systems for pulse monitoring (6 in total).

Tests Used in the Research

Tests Used:

First - Explosive Power of the Legs: Standing Broad Jump

(Mohammed Sobhi Hassanein: 2006) (1)

- **Purpose of the Test:** To measure the explosive power of the leg muscles.
- **Unit of Measurement:** Meters and centimetres.
- **Equipment:** Flat ground, measuring tape.
- **Performance Specifications:** The subject stands behind the starting line and pushes off the ground forcefully with both feet, attempting to jump as far forward as possible.

Scoring: The measurement is taken from the starting line to the furthest point reached by the feet during the jump.

Second - Explosive Power of the Arms: Throwing a Medicine Ball (3 kg) Overhead Using Both Hands

(Abdul Kareem Mahmoud, 2007) (2)

- **Purpose of the Test:** To measure the explosive power of the arm muscles.
- **Unit of Measurement:** Meters and centimetres.
- **Equipment:** A 3 kg medicine ball, measuring tape.
- **Performance Specifications:** A line is designated for the subject (player) to stand behind. The subject throws the ball overhead without crossing the throwing line, ensuring that both feet remain firmly on the ground.

Scoring: Three attempts are allowed, and the best successful attempt among the three is recorded.

Third - Heart Rate Test

(Mohammed Naser El-Din Radwan, 1998) (3)

- **Purpose of the Test:** To measure the heart rate after exertion and following a 60-second recovery period.
- **Equipment Used:** 12 stopwatches, pulse recording forms.
- **Performance Specifications:** After completing the exertion phase, the heart rate of the research sample individuals is measured immediately, followed by another measurement after 60 seconds. The pulse is taken by palpating the carotid artery in the neck.

Scoring: Heart rate readings are recorded for each player 60 seconds after the exertion phase.

Pilot Study

The researcher conducted a pilot study on Tuesday, January 2, 2024, involving 4 participants from the research sample to apply the tests and train the assisting team on their implementation. Additionally, the pilot study aimed to achieve the following:

1. Identifying difficulties and obstacles that may arise during the execution and progress of the tests.
2. Determining the appropriate time to conduct the tests and the duration required for their completion.
3. Assessing the participants' ability to perform the tests and evaluating their suitability for the sample.
4. Identifying the necessary equipment and tools required for the execution of the experiment and the tests.

Pre-Tests:

These tests were conducted on Saturday, January 6, 2024, at the sports hall of Al-Mahawil Sports Club.

Main Experiment:

The participants carried out the training sessions from Saturday, January 13, 2024, to Saturday, March 9, 2024.

- **Duration of the Training Program:** 8 weeks.
- **Total Number of Training Units:** 24 units.
- **Weekly Training Units:** 3 units.
- **Weekly Training Days:** Saturday, Monday, and Wednesday.
- **Training Methods Used:** Repetition Training Method (90–100%) and High-Intensity Interval Training Method (80–90%).

Post-Tests:

The post-tests were conducted on Tuesday, March 12, 2024, at the sports hall of Al-Mahawil Sports Club.

Statistical Tools:

The researcher utilized the Statistical Package for the Social Sciences (SPSS) to process the data, employing the following statistical methods:

- Arithmetic Mean
- Median
- Standard Deviation
- Skewness Coefficient
- T-Test for Dependent and Independent Samples

Results:

Table (3)

Displays the arithmetic means, standard deviations, differences, and the calculated T-value for the experimental group between the pre-tests and post-tests.

Variables	Pre-Test		Post-Test		Standard Deviation of Differences (SDD)	Calculated (t) Value	Error Level	Significance
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation				
Explosive Power of the Arms	2.430	0.065	2.612	0.079	0.025	6.533	0.001	Significant
Explosive Power of the Legs	10.211	0.156	11.466	0.154	0.149	6.769	0.001	Significant
Heart Rate Index	182.12	0.211	172.10	0.227	0.047	7.733	0.001	Significant

Significant at a significance level of ≤ 0.05 and with a degree of freedom of 5.

Table (4)

Displays the arithmetic means, standard deviations, differences, and the calculated T-value for the control group between the pre-tests and post-tests.

Variables	Pre-Test		Post-Test		Standard Deviation of Differences (SDD)	Calculated (t) Value	Error Level	Significance
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation				
Explosive Power of the Arms	2.223	0.051	2.431	0.026	0.051	9.241	0.000	Significant
Explosive Power of the Legs	9.564	0.144	10.971	0.107	0.133	16.624	0.000	Significant
Heart Rate Post-Effort	187.10	0.581	180.13	0.072	0.206	5.422	0.001	Significant

Significant at a significance level of ≤ 0.05 and a degree of freedom of 5.

Table (5)
Shows the Differences Between the Two Research Groups in the Variables in the Post-Tests.

Variables	Experimental Group		Control Group		Calculated (t) Value	Error Level	Significance
	Arithmetic Mean	Standard Deviation	Arithmetic Mean	Standard Deviation			
Explosive Power of the Arms	2.832	0.074	2.611	0.028	4.815	0.001	Significant
Explosive Power of the Legs	13.876	0.157	12.651	0.123	5.595	0.000	Significant
Heart Rate Post-Effort	167.10	0.229	175.11	0.073	4.526	0.001	Significant

Significant at a significance level of ≤ 0.05 and a degree of freedom of 10.

Discussion:

The statistical data analysis results between the experimental and control groups in the post-tests revealed statistically significant differences in the research variables in favour of the experimental group. The researcher attributes the improvement in the physical test results for the arms, legs, and heart rate adaptation in the experimental group during the post-test to the effectiveness of the program designed using HIIT (High-Intensity Interval Training). This method successfully developed the explosive power of the upper and lower limb muscles.

Additionally, the selection of exercises and their suitability for the group’s abilities played a significant role. Appropriate intensities, suitable volumes, and adequate rest periods were carefully applied, which greatly benefited the badminton players (Jenson, C.R. and Fisher, A.G., 1999) (4). The development of the explosive power of the arms is attributed to the use of medicine ball exercises, with weights appropriate to the participants' ages and physical capabilities (Sareeh Abdul Kareem, 2001) (5).

Similarly, the improvement in the explosive power of the legs is linked to enhanced neuromuscular coordination through jumping exercises on boxes and platforms, which had a significant impact on the development of this physical ability (Abu Al-Ala Ahmed Abdul Fattah, 1997) (6).

Regarding heart rate after physical exertion, achieving the desired outcomes of sports training requires a focus on developing the physiological capacities necessary for specialized performance. Measuring heart rate after exertion is considered a key functional indicator in the field of training, reflecting the impact of the training and serving as a crucial tool for regulating training loads (Bastawis Ahmed, 1999) (7).

Effectiveness was achieved after several training units with submaximal loads and repetitions adjusted to intensity levels, combined with shorter recovery periods between repetitions based on heart rate indicators. These adaptations were evident in the research sample (Mohammed Hassan Allawi and Abu Al-Alaa Ahmed Abdul Fattah, 2000) (8).

Conclusions:

- The results demonstrated a significant improvement between the pre-test and post-test measurements of HIIT in developing explosive power for the experimental group, favouring the post-test.
- The results also showed a notable improvement between the pre-test and post-test measurements of HIIT in the heart rate index for the experimental group, favouring the post-test.

Recommendations:

- Emphasize the use of HIIT in developing specific physical abilities for badminton players.
- Conduct similar studies and research on different age groups.

Author’s declaration:

Conflicts of interest: None

We confirm that all tables and figures in this article are ours and written by the researchers themselves.

Ethical-Clearance: this manuscript approved by local ethical committee of physical education and sport sciences college for women on (November /2024)

Author’s contributions:

All contributions of this study were done by the researcher (A.M.) who get the main idea and work on writing and concluding also with number of experts, Alaa Shibeeb Kadhim in Statistics, Ibrahim Dabayebbeh in revision, Enaam Ghalib in translating, Ali Al-Yaarribi in proofreading

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References:

1. Mohammed Sobhi Hassanein. Measurement and Evaluation in Physical Education and Sports, Cairo: Dar Al-Fikr Al-Arabi, 2006, p. 26.
2. Abdul Kareem Mahmoud. Designing a Physical Fitness Test Battery for Advanced Students at the Police Academy, Master's Thesis, Faculty of Physical Education, University of Diyala, 2007, p. 55.
3. Mohammed Naser El-Din Radwan. Methods of Measuring Physical Effort in Sports, 1st ed., Cairo: Center of Book Publishing, 1998, p. 19.
4. Jenson, C.R., and Fisher, A.G. Scientific Basis of Athletic Conditioning, Philadelphia, U.S.A.: Lea & Febiger, 1999, p. 43.
5. Sareeh Abdul Kareem. The Impact of Developing Specific Strength on the Performance of Middle-Distance Runners, Faculty of Physical Education, *Journal of Physical Education*, Vol. 10, Issue 1, 2001, p. 64.
6. Abu Al-Alaa Ahmed Abdul Fattah. Sports Training – Physiological Foundations, 1st ed., Cairo: Dar Al-Fikr Al-Arabi, 1997, p. 134.
7. Bastawis Ahmed. Principles and Theories of Sports Training, Cairo: Dar Al-Fikr Al-Arabi, 1999, p. 85.
8. Mohammed Hassan Allawi and Abu Al-Alaa Ahmed Abdul Fattah. Physiology of Sports Training, Cairo: Dar Al-Fikr Al-Arabi, 2000, p. 168.

Training Unit Model

Week	Training Unit	Exercises	Intensity (%)	Repetitions (Volume)	Rest	
					Repetitions	Sets
Week 1	Saturday	<ul style="list-style-type: none"> • Throwing a 1 kg medicine ball. • Lateral jumping over a platform, 10 jumps covering a 10-meter distance at a height of 30 cm. 	85 %	3 × 10 sec. 3 × 10 sec.	1 min. 1 min.	2 min. 2 min.

Monday	<ul style="list-style-type: none">• Throwing a 2 kg medicine ball.• Standing with a barbell (30 kg) on the shoulders, bending the knees and continuously jumping upward.	85 %	3 × 10 sec. 3 × 10 sec.	1 min. 1 min.	2 min. 2 min.
Wednesday	<ul style="list-style-type: none">• Throwing a 3 kg medicine ball.• Double-leg jumping onto boxes with a height of 40 cm, 10 repetitions.	85 %	3 × 10 sec. 3 × 10 sec.	1 min. 1 min.	2 min. 2 min.

تأثير تدريبات الهيبت في تطوير القوة الانفجارية وفقاً لمؤشر معدل النبض لدى لاعبي الريشة الطائرة فئة الشباب

علي محي مكطوف

جامعة بغداد / كلية التربية البدنية وعلوم الرياضة – العراق

أهمية البحث اعداد تدريبات الهيبت في تطوير القوة الانفجارية وفقاً لمؤشر معدل النبض التي تتطلب تكيف الأداء البدني للوصول إلى كفاءة عالية لدى لاعبي الريشة الطائرة. يهدف البحث اعداد تدريبات الهيبت في تطوير القوة الانفجارية وفقاً لمؤشر معدل النبض لدى لاعبي الريشة الطائرة وكانت مشكلة البحث إن تنوع لأساليب التدريبية واختلاف تأثيراتها يجعلان لاعبي الريشة الطائرة بحاجة إلى إعداد بدني يتناسب مع إمكانياتهم وقدراتهم البدنية ، ومن خلال خبرة الباحث الميدانية لاحظ وجود هبوط في مستوى الاداء اثناء اللعب حيث ارتى الباحث الوقوف عن هذا الهبوط والوقوف على نقاط الضعف الواضحة من القوة العضلية مع تكيف مؤشر معدل النبض التي لم يأخذ دوره وحجمه الحقيقيين في عملية التدريب ضمن البرنامج المعدة من قبل المدربين وبأساليبها المختلفة مما ولد ضعفاً وتأثيراً في مستوى الأداء لذا ارتأى الباحث دراسة هذه المشكلة للوصول الى نتائج إيجابية حيث استخدم الباحث المنهج التجريبي بتصميم المجموعتين التجريبية والضابطة ذات الاختبار القبلي والبعدى لملائمته طبيعة البحث. مجالات البحث هي المجال البشري لاعبي نادي المحاول للموسم الرياضي 2024. والمجال الزماني المدة من السبت الموافق بتاريخ 2024/ 1/6 الى يوم السبت الموافق بتاريخ 2024/ 3 /9. والمجال المكاني: القاعة الرياضية في النادي المذكور وتم تحديد مجتمع البحث من لاعبي الريشة الطائرة لفئة الشباب للموسم الرياضي 2024 وبعدد 12 لاعب، واختيرت منهم عينة البحث بالطريقة العمدية (ن=10) والتي مثلت نسبة مئوية قدرها (83.33%) وقسمت العينة الى مجموعتين تجريبية وضابطة (ن = 5 لكل مجموعة)، وكانت اجراءات التجانس والتكافؤ للعينة كما تبين في الجدولين 1، 2 اظهرت نتائج تحليل البيانات الإحصائية بين المجموعتين التجريبية والضابطة في الاختبارات البعدية وجود فروق دالة احصائياً في متغيرات البحث لصالح المجموعة التجريبية ، ويرى الباحث إن سبب التطور في نتائج الاختبارين البدنيين للذراعين والرجلين وتكيف معدل النبض في المجموعة التجريبية في الاختبار البعدى إلى فاعلية البرنامج المعد باستخدام تدريبات الهيبت الذي عمل على تطوير القوة الانفجارية لعضلات الطرفين العلوي والسفلي واظهرت النتائج الى تفوق ملحوظ بين القياس القبلي والبعدى لتدريبات الهيبت في تطوير بعض القدرات البدنية لدى لاعبي المجموعة التجريبية ولصالح القياس البعدى أوصى الباحث الاهتمام بتدريبات الهيبت في تطوير بعض القدرات البدنية لدى لاعبي الريشة الطائرة. يخدم البحث الهدف 3 من اهداف التنمية المستدامة (ضمان حياة صحية وتعزيز الرفاهية للجميع في جميع الأعمار). وهذا ما يحقق احد اهداف التنمية المستدامة للامم المتحدة في العراق (الصحة الجيدة).

مستخلص البحث

تدريبات HIIT، القوة الانفجارية، معدل النبض

الكلمات المفتاحية