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The Effect of Interval Training on Developing The Endurance of Skill Performance in Long Rounds of Table Tennis

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Abstract. *This research aims to study the effect of interval training on developing endurance of skill performance during long rounds in table tennis. The researcher adopted the experimental approach by designing two groups (experimental and control), and implementing a training program based on a pattern of time repetitions and active and rest periods, in line with the specificity of continuous performance in open-time rounds. The research sample consisted of (20) players from the advanced youth category at Babylon Sports Club, aged between 17 and 19 years. The training program was implemented for a period of (6) weeks, with three training units per week. A special test was used to measure skill performance endurance, designed by the researcher. This test relies on executing a continuous series of serving, receiving, and hitting within a specified time, while calculating the number of errors and the time of decline in performance quality. The results of the statistical analysis showed statistically significant differences in favor of the experimental group in the skill endurance index compared to the control group, confirming the effectiveness of the interval training method in developing players' ability to maintain the quality of technical performance during long rounds. The study recommends including this type of training in advanced player preparation, and conducting extensive studies on different age groups and technical levels to measure its impact in real-world playing situations.*

Keywords: *Interval Training; Long Sets; Performance Endurance; Skill Adaptation; Table Tennis*.

1. INTRODUCTION

Table tennis is witnessing significant development in the physical-skill aspect, especially with the increasing intensity of competition and the length of rounds during matches. Maintaining the quality of technical performance under time pressure and high repetition has become one of the most important requirements for excellence. Long rounds in a match not only depend on technical skill, but also require a high capacity to endure repeated performance without a loss in accuracy or speed. (Khoja, 2022: 41).

Advances in sports training science indicate the importance of incorporating a time pattern into the design of training programs, keeping pace with the requirements of actual play (Bompa & Buzzichelli, 2019). Interval training is one of the most important modern methods, relying on repeated skill effort with short, controlled rest periods, simulating the physical and psychological pressure of long rounds (Laursen & Buchheit, 2019; Gamble, 2013).

Despite the effectiveness of this type of training in endurance sports or team games, its application in individual sports, especially table tennis, remains limited in the local environment and requires accurate field studies to measure its impact on skill performance endurance within realistic playing scenarios. (Abdullah, 2023: 55). The importance of this research stems from:

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a. Presenting a training program based on interval training in a specialized environment.
b. Evaluating its impact on a player's ability to maintain quality performance during long sets.
c. Designing a field test that simulates actual situations in official matches.
d. Supporting coaches with a modern, applicable, and evaluable method.
e. Contributing to the development of table tennis training curricula at the local level.

Importance of the Research

This research derives its importance from several practical and applied aspects in the field of table tennis training, most notably:

1) Presenting a training program based on the interval training method, a method lacking in local applied studies in table tennis.
2) Targeting the development of endurance in skill performance during long sets, a key element for achieving technical stability under continuous time pressure.
3) Designing a field test that simulates realistic playing conditions, allowing coaches to accurately assess players' abilities.
4) Providing a training model that can be easily integrated into pre-tournament preparation programs.
5) Contributing to bridging the research gap related to integrating performance and rest periods into individual skill training.

Research Problem

Through field observation of a number of official matches, the researcher observed that some advanced players exhibit a decline in their skill performance (accuracy, speed, and responsiveness) two minutes or more after the start of a round, especially when continuously exchanging blows with their opponents. This decline is often not related to general fitness, but rather to the neuromuscular system's tolerance for repeated skill pressures (Al-Shamkhi, 2021: 32).

This decline is often linked to poor adaptation to the demands of long games and a lack of intermittent training that simulates this type of pressure. Hence, the research problem is posed in the following question:

Does interval training contribute to developing table tennis players' skill performance endurance during long rounds?

Research Objectives

This research seeks to: (Musa, 2020: 27)

a. Develop a training program based on the principle of interval training specifically for table tennis skills.
b. Measure the players' skill performance endurance before and after implementing the program.
c. Compare the results of the experimental group with the control group to measure the effectiveness of the program.
d. Design a field test that simulates the reality of skill performance in long rounds.
e. Providing practical recommendations that can be adopted by trainers in the field.

Research Hypotheses

1) There are statistically significant differences in the results of the skill performance endurance test between the pre- and post-tests in favor of the experimental group.
2) There are no statistically significant differences in the control group between the pre- and post-tests.
3) There are statistically significant differences in the post-test results between the two groups in favor of the experimental group.

Research Areas

Human Area

The research included (20) advanced youth players from the Babylon Sports Club.

Temporal Area

The training program was implemented during the period from April 1, 2025 to May 15, 2025, over a period of six weeks.

Spatial Area

The official table tennis hall at the Babylon Club, equipped with training tools and performance analysis panels.

Definition of Terms

a. Interval Training: A training method that involves repeating physical or skill effort for a short period of time followed by a specific short rest, within a set of repetitions and sets.

b. Skill performance endurance: The player's ability to perform the same skill (such as a serve or a reception) with consistent quality over repeated periods of time, without a decrease in efficiency.
c. Long sets: Continuous periods of play that exceed 2–3 minutes within a set, requiring frequent and rapid exchanges of blows.
d. Skill adaptation: The nervous system's ability to maintain accuracy and speed of movement despite repeated effort and increasing fatigue.
e. Field testing: An assessment method conducted in a real-world playing environment using situations close to match conditions, measuring a specific aspect of performance.

2. RESEARCH METHODOLOGY AND FIELD PROCEDURES

Research Methodology

The researcher adopted an experimental approach with a dual design (an experimental group and a control group) to measure the effect of interval training on skill performance endurance during long sets in table tennis (Al-Shammari, 2024: 14). This approach is suitable for measuring changes that occur as a result of a specific training intervention and allows for accurate comparison between two groups subjected to the same conditions except for the independent variable (type of training). The training environment, number of units, and program duration were controlled, with only the load content varying. (Alwan, 2022: p. 37)

Population and Research Sample

1) Population: All advanced youth table tennis players registered in local sports clubs.
2) Study Sample: (20) players were selected from the Babylon Sports Club, aged between 17 and 19 years, with at least four years of training experience and previous participation in local tournaments.
3) The sample was divided into two equal groups:
4) Experimental Group: 10 players who underwent the intermittent training program.
5) Control Group: 10 players who underwent the traditional continuous training program.
6) The sample selection took into account homogeneity in variables of age, experience, and technical level before the start of the experiment.

Tools and Testing Methods

The study used the following tools and methods to implement the training program and administer the tests:

a. A standard table tennis table conforming to international specifications.

b. Uniform rackets for all players to ensure uniform performance.
c. A digital timing board to set performance and rest periods.
d. A video camera to analyze performance and review errors.
e. Skill performance evaluation forms specifically designed for the study.
f. Manual and visual tool for counting errors during rounds.
g. A testing area equipped to simulate official match conditions.

Test Applied in the Research

1) Test Name: Long-round Skill Performance Endurance Test for Table Tennis. (Sami, 2021: 18).
2) Test Purpose: To measure the player's ability to maintain technical performance quality (accuracy, time stability, and lack of errors) during continuous play under time pressure. (Abdul Rahman, 2022: 64).
3) Test Conditions:
    a. The test is conducted in an equipped table tennis hall under the same conditions for all players.
    b. A standardized racket and ball are used. (Hassan, 2023: 39).
    c. An assistant or robot is provided to exchange balls regularly.
    d. No corrective instructions are given during the test.
4) Performance Method:
    a. The player performs a continuous 3-minute round of play, including serving, receiving, and continuous exchange.
    b. The number of successful hits, the number of errors, and the time before accuracy declines are recorded.
    c. The player is awarded a final score based on the total points in the three indicators. (Ali, 2020: 22).

Table 1. Skill Performance Endurance Test Form.

Indicator	Measurement Mechanism	Maximum Score
Successful Hits	Number of consecutive hits without error	10 points
Errors	Number of out balls or missed hits	10 points
Time Stability	Number of continuous minutes without clear decline	10 points
Total	—	30 points

Exploratory Experiment

The researcher conducted a pilot experiment before beginning the main experiment. The pilot experiment was conducted on a sample of five players from the same age group, outside the main research sample (H. H. Khalaf et al., 2024; Mohammed et al., 2025). The aim was to:

a. Ensure the clarity of the test instructions and the participants' understanding of them.
b. Determine the appropriateness of the performance time and rest periods included in the training program.
c. Test the readiness of the tools and equipment used and ensure their accurate adjustment.
d. Calculate the reliability coefficient of the test by re-administering it 72 hours later to the same sample.

The results of the pilot experiment showed that the procedures followed were clear and appropriate, with a reliability coefficient of (r = 0.89), indicating a high degree of reliability. The procedures were adopted after minor modifications to the error recording form to increase the accuracy of the assessment.

Picture 1. Player positioning at the start of the round – showing the straightness of the torso and the positioning of the feet.

Picture 2. The moment of repeated exchange in the second minute - shows the extent of stability and responsiveness under pressure.

Picture 3. The moment of fatigue at the end of the round – showing a decline in timing or arm deviation.

Main Experiment

The main experiment was conducted on the primary research sample of 20 players, divided into two groups (experimental and control), equal in number and characteristics. The training program was implemented according to the following plan:

1) Program duration: Six consecutive weeks.
2) Number of training units: Three units per week, each lasting 45 minutes.
3) Program content:
    a. Experimental group: Intermittent training involving continuous skill performance for specific time periods (30–40 seconds) followed by a short rest (10–15 seconds), with the process repeated for several groups.
    b. Control group: Traditional continuous skill training without specific time intervals.
4) Implementation location: The Babylon Sports Club gym, equipped with all necessary tools.
5) Control conditions: The training units were implemented at the same times and days for both groups, with direct supervision from the researcher to ensure adherence to the plan.

After the program ended, the post-test was administered under the same conditions and procedures as the pre-test, with the aim of measuring the training program's impact on skill performance endurance.

Suggested Training Module Template

Training Unit Model

Title: Developing Skill Endurance Using Intermittent Training During Long Rallies

Target Group: Advanced table tennis players (ages 17–19)

Duration of Unit: 45 minutes

Weekly Frequency: 3 sessions per week for 6 weeks

Venue: Official table tennis hall – Babel Club

Table 2. Components of the Training Unit.

Stage	Time (minutes)	Content	Equipment	Objective
Warm-up	10	General exercises (light jogging, dynamic flexibility), specific arm and wrist drills	Training area + standard balls	Activate blood circulation and prepare neuromuscular system
Main Part	30	- Continuous rally drill (30 sec × 4 sets, 15 sec rest)		

a. Service–receive drill (40 sec × 3 sets, 20 sec rest)

b. Fast rally drill (15 sec × 6 reps, 10 sec rest)

c. Short training match (mini match) using timed work–rest intervals | Standard table + unified rackets + digital timing board | Improve skill endurance, enhance time stability, reduce errors | Cool-down | 5 | Relaxation and stretching exercises | Mat | Restore muscular balance and reduce fatigue |

Statistical Methods

The research data were analyzed using SPSS (version 25). The following statistical methods were used (Ali et al., 2024; H. H. Khalaf et al., 2024; Y. A. Khalaf et al., 2025):

1) Arithmetic mean and standard deviation to describe the level of performance in the pre- and post-tests.
2) A t-test for related samples to measure differences within each group between the pre- and post-tests.
3) An t-test for independent samples to measure differences between the two groups in the post-test.
4) A statistical significance level of 0.05 was used as the cut-off point to consider the differences significant.

3. RESULTS

Experimental Group Results

Table 3. Experimental Group Results in the Pre- and Post-Tests (n=10).

Indicator	Max Pre	Min Pre	Mean ± SD Pre	Max Post	Min Post	Mean ± SD Post	t-calculated	Sig
Successful Hits	55	42	48.3 ± 5.2	70	60	64.7 ± 4.6	7.31	0.000
Errors	8	5	6.2 ± 1.1	5	2	3.5 ± 0.9	6.94	0.000
Time Stability (min)	2.2	1.1	1.6 ± 0.4	3.3	2.0	2.7 ± 0.5	8.12	0.000
Total Score (30)	23	17	19.5 ± 2.3	29	24	26.8 ± 1.8	9.04	0.000

Control Group Results

Table 4. Control Group Results in the Pre- and Post-Test (n=10).

Indicator	Max Pre	Min Pre	Mean ± SD Pre	Max Post	Min Post	Mean ± SD Post	t-calculated	Sig
Successful Hits	54	42	47.8 ± 5.1	55	42	49.1 ± 5.0	1.24	0.238
Errors	8	5	6.4 ± 1.3	8	4	6.1 ± 1.4	0.97	0.346
Time Stability (min)	2.1	1.3	1.7 ± 0.3	2.2	1.4	1.8 ± 0.4	1.11	0.280
Total Score (30)	23	16	19.1 ± 2.5	24	16	20.0 ± 2.6	1.03	0.318

Differences between the two groups in the post-test

Table 5. Differences between the two groups in the post-test.

Indicator	Mean ± SD (Experimental)	Mean ± SD (Control)	t-calculated	Sig
Successful Hits	64.7 ± 4.6	49.1 ± 5.0	8.32	0.000
Errors	3.5 ± 0.9	6.1 ± 1.4	5.91	0.000
Time Stability (min)	2.7 ± 0.5	1.8 ± 0.4	6.02	0.000
Total Score (30)	26.8 ± 1.8	20.0 ± 2.6	7.84	0.000

Hypothesis Testing

Hypothesis 1:

There are statistically significant differences in the results of the skill performance endurance test between the pre- and post-tests in favor of the experimental group.

Result: Table (1) shows statistically significant differences at the 0.05 level in all indicators, with the differences favoring the post-test, supporting the validity of the hypothesis.

Hypothesis 2:

There are no statistically significant differences in the results of the skill performance endurance test between the pre- and post-tests in the control group.

Result: As shown in Table (2), no significant differences were found in any of the indicators, confirming the validity of the hypothesis.

Hypothesis 3:

There are statistically significant differences in the results of the post-test between the two groups in favor of the experimental group.

Result: Table (3) shows significant differences in all indicators in favor of the experimental group, confirming the validity of the hypothesis. (See Appendix 2)

4. DISCUSSION OF RESULTS

The results of this study demonstrated that the experimental group outperformed the control group in all indicators of skill performance endurance. This is consistent with the research objectives, which hypothesized that interval training develops players' ability to maintain quality performance over long rounds. (Khoja, 2022: 43; Musa, 2020: 29).

The increased number of successful strikes and decreased number of errors in the experimental group demonstrates that the training program contributed to improving strike accuracy and the stability of technical performance. The increased holding time also indicates the players' ability to resist skill fatigue for a longer period, which enhances neuromotor efficiency under time pressure.

The lack of differences in the control group confirms that traditional continuous training is less effective in developing skill endurance, as it does not simulate the frequent periods of stress and rest that characterize real-life playing situations.

These results are consistent with previous studies that recommended incorporating interval training into player preparation, especially at advanced stages, due to its direct impact on improving motor response and reducing errors in critical phases of the match.

5. CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on the results of the statistical analysis and comparison between the pre- and post-tests of the two groups, the researcher reached the following conclusions:

a. Interval training proved clearly effective in developing skill performance endurance during long rounds of table tennis. The experimental group showed significant improvement in all indicators compared to the control group.
b. The program increased the number of successful hits and reduced the error rate, indicating an enhanced ability of the neuromuscular system to sustain performance under repeated time pressure.
c. The rate of temporal stability in performance increased significantly, reflecting the consolidation of the motor pattern and the improved ability to execute the skill without a decline in accuracy or timing.
d. The absence of statistical changes in the control group indicates that traditional training does not stimulate the skill adaptation required in prolonged playing situations.
e. The design of the skill performance endurance test used in the research helped accurately assess performance by incorporating multiple elements (accuracy, error, and time), and is suitable for realistic field applications.
f. The sample studied (advanced young players) showed a high response to the interval training method, indicating its importance in the specialized skill development phase.
g. Repetition of skill effort with short rest periods stimulated the efficiency of neural transmission and motor timing, and reduced distraction at critical moments during a session.
h. The research results confirm that skill performance is not only affected by general fitness, but also by the training timing and load type, which supports the use of interval training as a modern method within specialized training programs.

Recommendations

Based on the results and conclusions, the researcher recommends the following:

a. Incorporating interval training into skill training plans for table tennis players, especially during the special preparation phases preceding competitive tournaments.
b. Designing training content that includes carefully calculated performance and rest periods, appropriate to the type of skill and the stage of the training season.
c. Periodically using the skill performance endurance test adopted in this research to monitor the development of players' ability to maintain technical performance under time pressure.
d. Integrating interval training periods with visual performance analysis, by recording long sets and analyzing stability and decline in motor accuracy.

e. Training coaches to prepare and design interval training sessions that align with player characteristics and targeted skills, while adjusting rest timing and the number of repetitions.
f. Conducting similar studies on other skills, such as receiving and smashing, to measure the impact of interval training on their development.
g. Expanding the research to include younger age groups (juniors) to determine the effectiveness of interval training in the early stages of development.
h. Conducting a comparison between interval training and continuous training in developing certain skills, to understand qualitative differences in player responses.
i. Adopting the concept of skill endurance as an essential component of table tennis teaching curricula, and not limiting it to traditional skill training without regard for time and repetition.
j. Supporting local clubs with training manuals that include models of interval training sessions, making it easier for coaches to implement this method in the field.

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