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The Effect of Training With A Respiratory Resistance Mask on The Ability to Repeat High-Intensity Efforts And on Specific Endurance in Handball Players

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ABSTRACT
Backgroud: The aim of this study was to investigate the effect of training with a respiratory resistance mask on the ability to repeat high-intensity efforts and on specific endurance among players of the Al-Farahidi University handball team.
Methods: The researcher employed an experimental approach using a two-group design an experimental group and a control group with pre- and post-tests, as this was appropriate to the nature of the problem. The sample consisted of 20 university students, who were randomly divided into two equal groups of 10 players each, after verifying the homogeneity of the sample and the equivalence of the two groups. The experimental group performed the physical exercises specified in the training programme whilst wearing a respiratory resistance mask for eight weeks, at a rate of three sessions per week, with a gradual increase in the level of resistance. The control group performed the same exercises without a mask. The ability to repeat high-intensity efforts was assessed using a repeated sprint test, whilst endurance was measured using a field test specific to handball performance. The data were analysed using the mean, standard deviation and t-tests for paired and independent samples.
Results: The results showed a decrease in the mean time for the repeated sprint test in the experimental group from (5.08) to (4.91) seconds, representing an improvement of (3.3 per cent), and an increase in the distance covered in the specific endurance test from (214) to (236) metres, representing an increase of (10.3 per cent), with statistical significance in favour of the post-test. The experimental group also outperformed the control group in the post-test for both variables.
Conclusions: Eight weeks of training with respiratory resistance masks proved effective in improving the ability to repeat high-intensity efforts as well as increasing endurance in the players of the Al-Farahidi University handball team, where the mask-wearing group showed significantly superior performance compared to the control group.

Keywords: Respiratory resistance mask; High-intensity interval training; Specific endurance; Handball; University players.

INTRODUCTION

Team sports are characterised by short sprints, lasting less than ten seconds, interspersed with brief recovery periods of less than sixty seconds; consequently, the ability to recover and perform again in subsequent sprints is an important physical requirement for players (Bishop et al., 2011; Dawson, 2012; Mckee et al., 2023) . The ability to repeat sprints (Girard et al., 2011, p. 67), and this pattern applies to handball, as players alternate between attack and defence, retreating and charging forward, repeating this throughout the match with only short rest periods.

The literature indicates that fatigue during repeated sprints manifests as a decrease in maximum or average sprint speed across repetitions. At the muscular level, limitations in energy supply become apparent, arising from the breakdown of phosphocreatine, the anaerobic breakdown of glucose and oxidative metabolism, and the accumulation of metabolic by-products such as hydrogen ions (Girard et al., 2011, p. 673). This capacity is linked to the concept of specific endurance in handball, which, according to Iraqi studies, encompasses performance endurance, strength endurance and speed endurance (Ibrahim, 2024, abstract); it is not enough for a player to possess high speed in the initial sprint, but rather they must maintain this level throughout the match (Hussein & Hrebid, 2023; Malamud & Smukas, 2025) .

In the context of the search for ways to develop these abilities, the training mask emerged, which is marketed as simulating high-altitude training, However, a study by Porcari and colleagues, which applied high-intensity interval training for six weeks to 24 participants, found no changes in haemodynamic parameters and concluded that the mask does not appear to simulate altitude, but is rather closer to a device for training the respiratory muscles (Porcari et al., 2016, p. 379). This explains why the researcher chose the term 'respiratory resistance' in the study title rather than 'hypoxia', which is commonly used in some Arabic studies (Rowley et al., 2007) .

In the Arab world, several studies have examined the use of masks with handball players. Kanaan and his colleagues investigated the effect of training with hypoxic masks on certain physiological parameters, physical abilities and offensive skills among advanced handball players, The programme ran for eight weeks with 16 players, comprising 24 training sessions (Kanaan et al., 2025, p. 16). Abdulmardi investigated the effect of hypoxic training on certain training adaptations and the level of skill performance in handball players, involving 22 players over a period of eight weeks (Abdulmardi, 2024, p. 26), These two studies demonstrate the feasibility of applying this method to handball players over an eight-week period.

However, the studies reviewed by the researcher focused on general physiological, physical and skill-related variables, and did not explicitly target indicators of sprint repetition capacity, such as repeated sprint time and fatigue indices, in conjunction with a specific endurance test, Furthermore, the masks were described in those studies as 'oxygen-deprivation' masks, whilst the findings of Bourkari and colleagues suggest that their potential effect is linked to respiratory resistance. This is a gap that the present study seeks to address.

The significance of this research lies in its focus on the Al-Farahidi University handball team, a group in need of a low-cost training method that enhances the ability to repeat efforts; it may assist coaches in assessing the efficacy of respiratory resistance masks for university athletes when gradually incorporated into specific physical training sessions, It also contributes to the sports literature by measuring the ability to repeat high-intensity efforts and specific endurance together; the researcher found no comprehensive study on these two aspects in the sources consulted.

Research problem

Handball requires players to repeat short, high-intensity sprints with short recovery periods, a phenomenon known as sprint endurance (Girard et al., 2011, p. 673). Whilst observing the training sessions of Al-Farabi University's national team, the researcher noted a decline in performance levels during the final minutes of training sessions, as well as a difficulty in maintaining speed when repeatedly attacking and retreating. Masks have been used in Arab studies on handball players (Kanaan et al., 2025, p. 162); however, these were described as oxygen-deprivation masks, whilst Porcari and colleagues suggest that they are more akin to a device for training the respiratory muscles (Porcari et al., 2016, p. 379), which raises the following question: Does a respiratory resistance mask have an effect on the ability to repeat high-intensity efforts and on specific endurance?

Research Objectives

1. To develop specific physical exercises, some of which are performed whilst wearing a respiratory resistance mask, for players of the Al-Farahidi University handball team.

2. To investigate the effect of training with the mask on the ability to repeat high-intensity efforts in both the experimental and control groups.
3. To investigate its effect on specific endurance in both groups.
4. To determine the significance of the differences between the experimental and control groups in the post-test for both variables.

Research Hypotheses

1. There are statistically significant differences between the pre- and post-tests of the experimental group in the ability to repeat high-intensity efforts, in favour of the post-test.
2. There are statistically significant differences between the pre- and post-tests of the experimental group in specific endurance, in favour of the post-test.
3. There are statistically significant differences between the pre- and post-tests for the control group on both variables, in favour of the post-test.
4. There are statistically significant differences between the experimental and control groups in the post-test regarding the ability to repeat high-intensity efforts and specific endurance, in favour of the experimental group.

Research Areas

Human Field: The players of the Al-Farahidi University handball team for the academic season 2025-2026, numbering (20) players.

Time Domain: From 1/11/2025 to 31/1/2026, including exploratory experience, pre-tests, implementation of training for eight weeks, and post-tests.

Spatial Field: Handball Hall/Field at Al-Farabi University.

METHODS

Research Methodology

The researcher used the experimental method by designing the two equal groups (experimental and control) with pre- and post-tests, to suit the nature of the problem.

Research population and sample

The research community identified the players of the Al-Farahidi University handball team for the academic season 2025-2026, numbering (24) players, and excluded (4) players: two players for their injuries, and two players to conduct the reconnaissance experiment on them. Thus, the sample reached (20) players, with a percentage of (83.3%) of the population, and was randomly divided by lottery into two groups: experimental (10) and control (10), and a rapid medical examination was conducted to ensure that the players were free of respiratory and heart diseases, and each player signed an informed consent to participate.

Sample homogeneity

Table 1. Homogeneity of the sample in variables (age, height, mass, training age) (n = 20)

Torsion coefficient	Standard deviation	Broker	Arithmetic mean	Unit of Measurement	Variable
-0.14	1.05	20.50	20.45	Year	Age
-0.13	4.60	177.00	176.80	Poison	Length
0.10	5.90	73.00	73.20	kg	Mass
-0.55	1.10	5.00	4.80	Year	Training Age

The values of the torsion coefficient ranged between (±1), which indicates the moderation of the distribution and the homogeneity of the sample.

Equivalence of the two groups

Table 2. Equivalence of the experimental and control groups in the variables under study (n = 10 for each group)

Significance	Significance Level	(v) Calculated	Officer (Q±	Experimental (Q±P)	Unit of Measurement	Variable

Insignificant	0.84	0.21	20.40 ± 1.00	20.50 ± 1.10	Year	Age
Insignificant	0.92	0.10	176.70 ± 4.50	176.90 ± 4.80	Poison	Length
Insignificant	0.88	0.15	73.00 ± 5.80	73.40 ± 6.10	kg	Mass
Insignificant	0.69	0.40	4.70 ± 1.00	4.90 ± 1.20	Year	Training Age
Insignificant	0.84	0.21	5.10 ± 0.22	5.08 ± 0.21	Second	Ability to repeat the enemy (average time)
Insignificant	0.72	0.36	212 ± 13	214 ± 12	meter	Special Endurance (Distance)

The tabular value of (v) at the degree of freedom (18) and the significance level of (0.05) is equal to (2.101), and all the calculated values are smaller than them, which indicates the equivalence of the two groups.

Research Variables

Table 3. Research Variables

Unit of Measurement	Variable	Variant Type
—	Training with a respiratory resistance mask	Independent
Second	Ability to repeat high-intensity efforts (average repetitive sprint time)	Follow (1)
meter	Special endurance (distance traveled in a special endurance test)	Follow (2)

Means of information collection, tools and devices.

Means: Arab and foreign sources, observation, testing and measurement. Devices and instruments: Respiratory resistance masks with adjustable resistance levels (e.g. Elevation Training Mask or similar) with a number covering the experimental kit, light timer gates or digital stopwatch, cones and tape measure, medical scale and restameter, pulse clock, hand balls.

Tests used

High intensity effort repeatability test (repeated sprint)

Objective: To measure the ability to recur short, high-intensity infections with short recovery periods, which is the formula for the ability to recur the enemy (Girard et al. , 2011, p. 673). Performance: The player performs (6) runs with a distance of (30) meters, between each enemy and another a passive rest of (20) seconds, and each enemy starts from the same line. Recording: The time of each enemy is calculated in seconds to the nearest hundredth, and the average of the six times is based on an indicator of the enemy's ability to repeat, the lower the average, the better the performance.

Special Endurance Test.

Objective: To measure the performance tolerance of handball. Performance: The player performs a shuttle run between cones distributed in the form of a path that includes a forward runner, side defensive movements, and a backward run, at maximum speed and for 60 continuous seconds. Registration: The total distance traveled in meters is calculated during the specified time, the more distance the better the performance. Note: The test is designed by the researcher and modified for shuttle running tests, and was presented to handball specialists to verify its suitability.

Scientific Basis of the Two Tests

To verify the stability of the two tests, they were applied to (4) players outside the base sample, and they were reapplied after a week.

Table 4. Stability and Validity Coefficient of Tests

Self-Honesty Factor	Stability Coefficient (Retest)	Testing
0.95	0.90	Repetitive sprint (average time)
0.94	0.88	Special Endurance (Distance)

Exploratory experiment

The exploratory experiment was conducted on 1/11/2025 on (4) players from the research community, outside the basic sample, and the goal was to verify the validity of the masks and devices, to find out the extent of the players' tolerance to the mask, to adjust the resistance levels, to determine the rest times, and to verify the clarity of the instructions of the two tests

Pre-tests

It was conducted on 8/11/2025 in the university's sports hall, after a unified warm-up of (15) minutes. The conditions (time, place, sequence of tests, and the support team) were proven to ensure that they applied the same in the post-tests.

Respiratory Resistance Mask Training

The researcher adopted an eight-week program of three units per week (24 units), compared to the duration of application in the study of Kanaan et al. (Kanaan et al., 2025, 62), and in light of what Porcari and colleagues pointed out that the mask is closer to a device for training respiratory muscles (Porcari et al., 2016, p. 379), the resistance was gradually increased according to the levels of the mask, and the program was implemented according to the following:

The duration of the program is eight weeks, from 9/11/2025 to 1/1/2026, with three units per week (Sunday, Tuesday, and Thursday). The training module time is (60) minutes, including a warm-up (15) minutes, a main part (35–40) minutes, and a cooling down (5–10) minutes. The experimental group wears the mask during the main part, takes it off when warming up and cooling down, and the control group performs the same exercises without a mask. The player immediately stops and takes off the mask when they feel dizzy or have severe shortness of breath.

Table 5. Distribution of mask training over the eight weeks

Comfort	Special Endurance Exercises	Enemy Repeatability Exercises	Mask resistance level	Weeks
s between 30 enemies, 3 d between groups	Shuttle Run 40 s × 4 repetitions	3 Groups × 6 Enemies × 20m Intensity 80–85%	The first (less resistance)	1–2
s between 25 enemies, 3 d between groups	Shuttle Run 45 s × 5 iterations	4 Sets × 6 Enemies × 20–30 m Intensity 85%	The second	3–4
s between 20 enemies, 2.5 s between groups	Shuttle run 50 s × 6 iterations	4 sets × 6 enemies × 30m with a change of direction intensity 85–90%	The second	5–6
20 s between enemies, 2 d between groups	Shuttle Run 60 s × 6 iterations	5 Sets × 6 Enemies × 30m 90% Intensity	Third (Highest Resistance)	7–8

Post-tests

It was conducted on 3/1/2026, two days after the end of the eighth week, and under the same conditions and sequence as in the pre-tests.

Statistical methods

The data were analyzed statistically using the statistical program (SPSS), and by the following means: arithmetic mean, standard deviation, mean, torsion coefficient, simple correlation coefficient (Pearson), (T) test for correlated samples, and (T) test for independent samples, and the significance level was set at (0.05).

RESULTS AND DISCUSSION

Experimental group

Table 6. Arithmetic medians, standard deviations, and the value of (v) between the pre- and post-tests of the experimental group (n = 10)

Percentage of improvement	Significance	Significance Level	(v) Calculated	Deviation of Differences	Average spreads	Al-Badadi (Q± A)	Al-Qibli (Q± A)	Unit of Measurement	Variable
3.3%	Moral	< 0.001	7.68	0.07	0.17	4.91 ± 0.16	5.08 ± 0.21	Second	Ability to repeat the enemy (average time)
10.3%	Moral	< 0.001	9.94	7	22	236 ± 13	214 ± 12	meter	Special Endurance (Distance)

The tabular value of (v) at the degree of freedom (9) and the significance level of (0.05) is equal to (2.262). It is clear from Table (6) that the average time of repeated sprint decreased from (5.08) to (4.91) seconds, and that the distance traveled in the special endurance test increased from (214) to (236) meters, and since the two calculated values are greater than the tabular, the first and second assumptions are realized.

Control Group

Table 7. Arithmetic medians, standard deviations, and the value of (v) between the pre- and post-tests of the control group (n = 10)

Percentage of improvement	Significance	Significance Level	(v) Calculated	Deviation of Differences	Average spreads	Al-Badadi (Q± A)	Al-Qibli (Q± A)	Unit of Measurement	Variable
0.6%	Moral	0.042	2.37	0.04	0.03	5.07 ± 0.16	5.10 ± 0.22	Second	Ability to repeat the enemy (average time)
2.4%	Moral	0.027	2.64	6	5	217 ± 13	212 ± 13	meter	Special Endurance (Distance)

Table (7) shows small significant differences in favor of the post-test in the control group, and this achieves the third hypothesis.

Comparison of the two groups in the post-test

Table (8): Arithmetic medians, standard deviations and the value of (v) between the experimental and control groups in the post-test (n = 10 for each group)

Significance	Significance Level	(v) Calculated	Middle Teams	Officer (Q±)	Experimental (Q±P)	Unit of Measurement	Variable
Moral	0.039	2.23	0.16	5.07 ± 0.16	4.91 ± 0.16	Second	Ability to repeat the enemy (average time)
Moral	0.004	3.27	19	217 ± 13	236 ± 13	meter	Special Endurance (Distance)

The tabular value of (v) at the degree of freedom (18) and the significance level of (0.05) is equal to (2.101). Since the two calculated values are greater than them, the fourth assumption is fulfilled in favor of the experimental group.

DISCUSSION

Discussion of the results of the pilot group

The results showed a significant improvement in the ability to repeat the sprint and the specific endurance of the experimental group (Table 6), and the researcher explains that the performance of the mask-specific exercises, with the gradual increase of resistance over eight weeks, imposed additional respiratory effort on the players during repetitive runs, which may have contributed to delaying the onset of fatigue, and the researcher bases this on the fact that fatigue during repeated sprints appears in the form of a decrease in the speed of the runner through repetitions, and is controlled by factors including energy supply and the accumulation of metabolites (Girard et al. , 2011, p. 673), and any approach that improves intermittent effort tolerance may be reflected in reducing this regression.

The researcher's interpretation is consistent with what Porcari and colleagues said that the mask does not appear to mimic height, but rather is closer to a device that trains respiratory muscles (Porcari et al. , 2016, p. 379). Therefore, the researcher suggests that the improvement is more related to the load of respiratory muscles than to the lack of oxygen, but the research did not measure lung function or the strength of the respiratory muscles, so this mechanism cannot be confirmed by the data of the current research, and it is only a proposed explanation.

The result of the research is consistent in terms of direction with the Arab studies that applied training masks with handball players for a period of eight weeks (Kanaan et al., 2025, p. 59, Abdulmardi, 2024, p. 26), while the increase in endurance by (10.3%) is explained by the researcher by designing the units that combined short sprints and shuttle running with gradually shortened rest periods, which approaches the requirements of performance endurance and speed endurance, which are components of special endurance (Ibrahim, 2024, abstract).

Discussion of the control group's findings

The researcher attributes the slight improvement in the control group (Table 7) to the performance of the same exercises without a mask, as the gradual training load itself develops the two variables, even to a lesser extent, and in addition to this is the effect of learning resulting from repeating the two tests

Discussion of differences between the two groups

The results of the post-test (Table 8) showed that the experimental group was superior to the control group in the two variables, as the difference in the average time of the sprinter was (0.16) seconds, and the distance difference in the specific endurance was (19) meters. The researcher attributes this to the use of the mask, because the two groups are equal in the past (Table 2) and performed the same exercises with the same load, however, the difference between the repeated sprint was closer to the limits of significance than it was in the special endurance, and the researcher recommends that the results be circulated with caution due to the small sample (20 players) and its limitation to one university team.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

1. Training using a respiratory resistance mask contributed to a significant improvement in the ability to repeat high-intensity efforts in the experimental group, as the average time for repeated sprints decreased from (5.08) to (4.91) seconds.
2. The same training led to a statistically significant improvement in the experimental group's endurance, with the distance covered increasing from (214) to (236) metres.
3. The control group, which performed the same exercises without a mask, achieved a slight statistically significant improvement in both variables, but this was less than the improvement seen in the experimental group.
4. The experimental group outperformed the control group in the post-test in terms of the ability to repeat high-intensity efforts and specific endurance
5. The improvement in specific endurance (10.3 per cent) was greater than that in the ability to repeat sprints (3.3 per cent), suggesting that the effect of the mask on endurance is more pronounced than on sprint time.

Recommendations

1. Respiratory resistance masks should be introduced gradually into the specific physical training programmes for university handball teams, starting at the lowest resistance level.
2. Conduct a preliminary medical examination of players, monitor for symptoms of dizziness and shortness of breath, and stop the training session if these occur.
3. Use repeated sprint tests and specific endurance tests to assess players periodically, alongside traditional physical tests.
4. Conduct similar studies measuring lung function and respiratory muscle strength to verify the mechanism by which the mask exerts its effect.
5. Conduct studies on larger samples, including female players and other age groups, and compare the mask with other methods to develop the ability to repeat efforts.

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