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The Effect of Suggested Exercises on the Recovery of Some Physiological Indicators After Anaerobic Exercise for Indoor Gymnastics Players

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Abstract: *Given the importance of recovery for athletes during rest periods, as it is one of the components of the training load in achieving appropriate development in physiological or physical components, interest has emerged in these vital components of the training load, as the adaptation of the cardiovascular system during static exercise varies depending on the body's position, leading to a simultaneous shutdown of the pressure receptors. Hence, the researcher sees the importance of her research in the importance of the exercises the body undertakes through the suggested exercises after aerobic and anaerobic exercise during the recovery period, and in returning the athlete's body to its natural state in a better way. The problem of the research lies in the numerous problems indoor gymnastics coaches face during training for their games. During training, the athlete is exposed to two types of training effects (intensity and volume), which cause significant destruction of living cells in the body as a result of the high training load. Accordingly, The researcher believes it is necessary to conduct a field study to determine the best way for a player's body to recover after performing anaerobic exercise, allowing them to return to normal, reduce their heart rate, and return to normal. The researcher used an experimental approach, as it suited the nature and problem of the research. She conducted a pilot experiment, followed by pre-tests and exercises in the main experiment. She then conducted post-tests under the same conditions as the pre-tests. The SPSS statistical package was used to extract the results, which were then presented and discussed, supported by scientific sources. Through her research, she concluded that the proposed exercises had a positive impact on the recovery of some physiological indicators after anaerobic exercise for indoor gymnasts.*

Keywords: *Proposed Exercises, Recovery, Physiological Indicators, Anaerobic Exercise, Indoor Gymnastics.*

Introduction

In most developed countries, scientific reports and studies based on evidence and a scientific basis are considered a measure of scientific progress. Scientific progress is one of the most important features of modern life in various fields, including physical education and sports research. This is evidenced by the achievements of developed countries in various fields, including sports, in achieving success and record-breaking results by focusing on physiological and training aspects and their fundamental components. Considering the importance of athletes' recovery during periods of rest as one of the elements of training load for achieving appropriate physiological and physical development, interest in these crucial elements of training load has arisen, as cardiovascular adaptation during static exercise changes depending on body position, leading to

simultaneous cessation of pressure receptor function. Therefore, the researcher sees the importance of her research in the importance of exercises performed after aerobic and anaerobic exercise during the recovery period to better restore the athlete's body to its normal state. The research problem is that indoor sports coaches encounter many challenges during training for their competitions, as female athletes are exposed to two types of training stresses: intensity and volume, during skill training in any sport, which significantly damages living cells in the body due to high training loads. Therefore, the researcher believes it is necessary to conduct field research to determine the best way to condition female athletes after anaerobic exercise to enable recovery and a reduction in heart rate levels in certain physiological indicators, and to return to a normal state. The aim of the research is to determine the heart rate and certain physiological indicators at rest between walking, standing, and lying down, as well as the heart rate and certain physiological indicators during the first five minutes of recovery after anaerobic exercise. Furthermore, the researchers believe that the difference in heart rate and certain physiological indicators during the first five minutes of recovery after anaerobic exercise between walking, standing, and lying down is necessary. The researchers assume that there are statistically significant differences in heart rate and some physiological indicators at rest between walking, standing, and lying down, and also that there are statistically significant differences in heart rate and some physiological indicators during the first five minutes of recovery from anaerobic exercise between walking, standing, and lying down.

Methodology

The researcher employed an experimental approach. The research sample was purposefully randomly selected from among second-year students of the Faculty of Physical Education and Sports Sciences at Diyala University. The sample consisted of (20) out of (85) female students, representing the entire research community. The table below presents the physiological indicators used in the study.

Table (1) presents the arithmetic means and standard deviations for heart rate, respiration, and blood pressure at rest and in the following positions: lying down, standing, and walking.

Exercises / rest period	lying down		standing		walking	
	-Q	-A+	-Q	A+ -	-Q	A+ -
Pulse	76.82	9.86	78.36	12.37	75.49	10.39
breathing	16.61	1.29	16.46	1.04	16.58	1.02
low blood pressure	6.77	0.65	6.45	0.73	7.32	0.60
high blood pressure	12.25	0.85	11.81	0.98	11.56	0.62

Table (2) Analysis of variance for pulse, respiration, and blood pressure at rest and in the (lying, standing, and walking) positions.

rest period	source Contrast	sum of squares	degree freedom	mean squares	Calculated value of (F)
Pulse	Between groups	65.29	2	3.13	0.233
	Within groups	633.47	45	141.40	
breathing	Between groups	0.125	2	0.062	0.48
	Within groups	59.12	45	1.31	
low pressure	Between groups	3.79	2	1.89	3.18
	Within groups	27.18	45	0.60	
high pressure	Between groups	3.87	2	1.93	2.77
	Within groups	31.37	45	0.69	

* The tabular value of (F) at a significance level of (0.05) and degrees of freedom of (2-45) = 3.21

Exploratory Experiment:

The researcher conducted an exploratory experiment to determine the scientific coefficients for the tests used in the study on a sample of (8) female students from the same research community, but outside the main study sample.

Pretests:

The researcher conducted pretests on Tuesday, January 8, 2025. These included:

a. Measurement of heart rate at rest and after exercise.
b. Measurement of high and low blood pressure.
c. Measurement of respiratory rate.

Main Experiment:

The researcher implemented the exercises she proposed, which helped identify obstacles to the study. The main experiment was conducted from January 11, 2025, to March 15, 2025. The parameters were measured at rest and in three positions (lying down, standing, and walking). Fitness tests were conducted over two days, and physiological parameters were measured in the supine position after exercise and for the first, third, and fifth minutes. A 30-45-minute break was maintained between each test. The following day, fitness tests were conducted, and physiological parameters were measured in the standing position after exercise for the first, third, and fifth minutes. The same break was maintained between the tests as during the first test. The study group then underwent fitness tests, and physiological parameters were measured in the walking position after exercise. The number of students tested was (20).

Post-tests:

The researcher conducted the post-tests on Monday, March 24, 2025, under the same conditions as the pre-tests.

Statistical methods:

The researcher used the SPSS statistical package to analyze the results of her study.

Result and Discussion

Table (3) shows the arithmetic mean and standard deviation (for pulse) for the first five minutes of the recovery period, from the (lying, standing, or walking) positions, after anaerobic exercise (50 m).

Exercises / Recovery Period	Lying down		Standing		Walking	
	S	A+	S	A+	S	A+
Minute (1)	102,644	3.45	110,626	3.02	120.204	**5.43**
Minute (3)	88,243	3.57	91,411	3.07	97,404	**5.75**
Minute (5)	**75,660**	**2.50**	**77,244**	**2.35**	**81.06**	**4.09**

To reach the extent of the effect of the pulse variable through the difference in the position that is used and for the first five minutes, then use the law of variance analysis to reach the differences in these exercises and by looking at Table (4).

Table (4) Analysis of variance for pulse for the first five minutes of the recovery period and from the (lying - standing - walking) positions after anaerobic effort (50m)

recovery period	Source of variance	sum of squares	degree of freedom	mean squares	Calculated value of F*
Minute (1)	Between groups	**1443.06**	**2**	**766.54**	**40.43**
	Within groups	**409.40**	**27**	**17.60**	
Minute (3)	Between groups	**421.25**	**2**	**228.12**	**10.71**
	Within groups	**407.40**	**27**	**19.64**	
Minute (5)	Between groups	**133.82**	**2**	**74.92**	**6.55**
	Within groups	**257.01**	**27**	**9.94**	

* The tabular value of (F) at a significance level of (0.05) and degrees of freedom (2-27) = 3.35

Table (5) Comparison of arithmetic means with the least significant difference (LSD) value for the pulse for the first five minutes of the recovery period and from the positions (lying, standing, walking) after anaerobic effort (50m)

Exercises recovery period	Lying down S	Standing S	Walking S	LSD value	Difference between 1-2	Difference between 1-3	Difference between 2-3
Minute (1)	103.60	111.60	121.20	3.95	*8.00	*17.60	*9.60
Minute (3)	89.20	92.40	98.40	3.95	3.20	9.20	*6.00
Minute (5)	76.60	78.20	82.00	2.88	1.60	*5.40	*3.80

Regarding the recovery time at the third minute, we note from the table that the difference between the positions (lying down - standing) was less than the value of (L.S.D.), indicating a lack of significance between these two positions and no effect of the heart rate variable on the difference between these two positions. Regarding the difference between the positions (lying down - walking), it was greater than the value of (L.S.D.), indicating a significance between these two positions. Regarding the difference between the positions (standing down - walking down), it was greater than the value of (L.S.D.). Finally, the difference between the positions (lying down - standing) at the fifth minute of the recovery period was less than the value of (L.S.D.), indicating a lack of significance between these two positions. Furthermore, the difference between the positions (lying down - walking down) was greater than the value of (L.S.D.), indicating a significance between these two positions. Finally, the difference between the postures (standing – walking) was greater than the difference (L.S.D.), indicating a significant difference between the other two positions. The researcher believes that body position influences heart rate during the recovery period. This result is consistent with Ryan's (2003) findings, who found statistically significant differences in heart rate between the supine and standing positions (Ryan: 2003, 76).

Furthermore, Kabovich (citing Nasreddin Radwan: 1998, 69) indicates that heart rate is influenced by factors such as chronological age, body position (sleeping, sitting, standing, etc.), food intake, time of day (morning, afternoon, etc.), emotional state, and physical activity.

The researcher believes that changes in body position during the recovery period influence heart rate, especially during the first five minutes of recovery. This heart rate is also affected during the first five minutes after anaerobic exercise.

Table (6) shows the arithmetic mean and standard deviation (for respiration) for the first five minutes of the recovery period, from the positions (lying, standing, or walking) after anaerobic exercise (50 m).

	Lying down	Standing	Walking

Exercises recovery period	S	A+	S	A+	S	A+
Minute (1)	33.00	2.16	34.00	1.63	35.00	1.94
Minute (3)	26.600	0.966	26.400	2.066	28.400	1.833
Minute (5)	21.600	1.57	21.600	2.066	24.600	2.67

Table (6) shows the extent to which recovery breathing is affected by the number of exercises performed during the first five minutes. Analysis of the law of variance was used to calculate the differences in breaths per minute between these exercises, analyzing the data in Table (7).

Table (7) Analysis of variance of breathing during the first five minutes of the recovery period and in the postures (lying, standing, walking) after anaerobic exercise (50 m)

Recovery period	Source of variance	Sum of squares	Degrees of freedom	Mean squares	Calculated F value
Minute (1)	Between groups	20.00	2	10.000	2.70
	Within groups	100.00	27	3.70	
Minute (3)	Between groups	24.26	2	12.13	4.24
	Within groups	77.20	27	2.85	
Minute (5)	Between groups	60.00	2	30.00	6.47
	Within groups	125.20	27	4.63	

*Tabular value of (F) at a significance level of (0.05) and degree of freedom (2 - 27) = 3.35

From Table (7), we note that the value of (F) for the two minutes (the third and fifth) is greater than its tabular value of 3.35, which indicates the significance of the differences in the number of respirations between the two minutes (the third and fifth). In order to determine which exercises are better than the other, the researcher used the least significant difference (LSD) test. (8)

Table (8) Comparison of arithmetic means with the value of the least significant difference (LSD) for the pulse for the first five minutes in the recovery period and from the positions (lying - standing - walking) after anaerobic effort (50m)

Exercises / recovery period	Lying down S	Standing S	Walking S	LSD value	Difference between 1-2	Difference between 1-3	Difference between 2-3
Minute (1)	-	-	-	-	-	-	-
Minute (3)	26.60	26.40	28.40	1.55	0.20	1.*80	2.*00
Minute (5)	21.60	21.60	24.60	1.97	-	3.*00	3.*00

It was found that at the third minute, the difference between the lying and walking positions favored the lying position, while the difference between standing and walking favored the standing position. At the fifth minute, the difference was also in favor of the lying position, while the difference between standing and walking favored the standing position. (Muhannad Al-Bashtawi and Ahmed Mahmoud, 2006) concluded that the standing position is the best position for performing natural breathing movements. Natural breathing is enhanced by good body posture, abdominal muscle strength, and the absence of anything that impedes the breathing process, such as tight clothing or bandages (Al-Bashtawi and Ismail, 2006, 128). To determine the effect of the low-pressure variable on the change in body position after anaerobic running (50 meters) during the recovery period and the first five minutes after exercise, the researchers used the law of analysis of variance to determine differences in body position, looking at Table (9).

Table (9) Analysis of variance (for low pressure) and for the first five minutes of the recovery period and from the position (lying – standing – walking) after anaerobic exercise (50 m)

Recovery period	Source of variance	Sum of squares	Degrees of freedom	Mean squares	Calculated F value
Minute (1)	Between groups	1.66	2	0.833	0.033
	Within groups	671.70	27	24 87.	

Minute (3)	Between groups	**0.20**	**2**	**0.100**	**0.15**
	Within groups	**177.00**	**27**	**6.55**	
Minute (5)	Between groups	**1.86**	**2**	**0.93**	**0.934**
	Within groups	**369 9.60**	**27**	**13 67.**	

*Tabulated F-value at a significance level of 0.05 and degrees of freedom (2–27) = 3.35.

We note that the calculated F-values for the five-minute recovery period were lower than the tabulated values, indicating a lack of significance between body postures during the recovery period after anaerobic exercise and the five-minute values. To determine the extent of the influence of the high systolic blood pressure variable on the adoption of various body postures during the recovery period after anaerobic exercise and during the first five minutes, the researcher used analysis of variance to determine differences between body postures depending on changes over time in Table (10).

Table (10) Analysis of variance for high blood pressure during the first five minutes of recovery and for postures (supine, standing, walking) after anaerobic exercise (50 m)

Recovery period	**Source of variance**	**Sum of squares**	**Degrees of freedom**	**Mean squares**	**Calculated F value**
Minute (1)	Between groups	**41.60**	**2**	**20.80**	**0.529**
	Within groups	**1062.40**	**27**	**39.43**	
Minute (3)	Between groups	**2.60**	**2**	**1.30**	**0.147**
	Within groups	**283.10**	**27**	**8.81**	
Minute (5)	Between groups	**0.267**	**2**	**0.133**	**0.011**
	Within groups	**325.20**	**27**	**12.04**	

*Tabulated F-index values at a significance level of 0.05 and degrees of freedom (2–27) = 3.35.

Table (10) presents the data between and within groups. We note that the calculated F-index value for the five minutes post-exercise recovery period is greater than the calculated value, indicating a lack of statistical significance between the three body positions

for the high systolic blood pressure variable after anaerobic exercise during the recovery period.

Table (11) presents the arithmetic mean and standard deviation (for heart rate) for the first five minutes of the recovery period and for the positions (supine, standing, and walking) after anaerobic exercise (100 m).

Exercises / Recovery Period	Lying down		Standing		Walking	
	S	A+	S	A+	S	A+
Minute (1)	**152.80**	**4.73**	**155.60**	**3.37**	**153.40**	**3.27**
Minute (3)	**135.60**	**4.59**	**136.60**	**3.13**	**132.00**	**3.12**
Minute (5)	**114.80**	**8.54**	**123.20**	**4.34**	**120.00**	**2.49**

From Table (11), which presents the arithmetic means and standard deviations for the heart rate variable after running (100 m) as an anaerobic effort, for the first five minutes of the recovery period, and for various body positions. To determine the extent to which the heart rate variable is affected by various exercises performed by the body during the recovery period after the anaerobic effort after running (100 m) and within the first five minutes, the researcher used the law of analysis of variance to determine differences between body positions and for each minute of the five minutes, analyzing Table (12).

Table (12) Analysis of variance (for heart rate) for the first five minutes of the recovery period and for positions (supine, standing, and walking) after anaerobic effort (100 m)

Recovery period	Source of variance	Sum of squares	Degrees of freedom	Mean squares	Calculated F value
Minute (1)	Between groups	**43.46**	**2**	**21.73**	**1.46**
	Within groups	**400.40**	**27**	**14.83**	
Minute (3)	Between groups	**117.06**	**2**	**58.53**	**4.30**
	Within groups	**366.80**	**27**	**13.58**	
Minute (5)	Between groups	**359.46**	**2**	**179.73**	**5.49**
	Within groups	**883.20**	**27**	**32.71**	

*Tabulated F-value at a significance level of 0.05 and degrees of freedom (2–27) = 3.35.

This shows the data between and within groups, as well as the calculated F-value for the five minutes following anaerobic exercise during the recovery period. We note that the calculated F-value for the third and fifth minutes appeared to be greater than the tabulated value. Therefore, the researcher considered the significance of the differences between the three body positions. To determine which exercise promoted these differences, the researcher used the least significant difference (LSD) test, as seen in Table (13).

Table (13) Comparison of the arithmetic means with the least significant difference (LSD) for heart rate during the first five minutes of the recovery period and in the positions (supine, standing, and walking) after anaerobic exercise (100 m)

Exercises recovery period	Lying down S	Standing S	Walking S	LSD 2 alue	Difference between 1-2	Difference between 1-3	Difference between 2-3
Minute (1)	-	-	-	-	-	-	-
Minute (3)	13 5.60	13 6.60	13 2.00	3 .37	1. 00	3. *60	4. *60
Minute (5)	11 4.80	12 3.20	12 0.00	5 .24	8. *40	5. 20	3. 20

We note that the differences appeared at the third and fifth minutes, and the difference appeared between the positions (first/lying and third/walking) because this difference was greater than the (L.S.D.) value. Similarly, the difference appeared at the fifth minute because the difference between the positions (first/lying and second/standing) was greater than the (L.S.D.) value, which indicates the significance of the above exercises, because the researcher believes that the heart rate variable is changed after anaerobic running exercise (100 meters) during the recovery period by the body undertaking different exercises and in the third and fifth minutes of the recovery time. After running (100 meters), the athlete's heart rate increases to help eliminate lactic acid waste. We note that an increase in heart rate in the standing position helps the athlete eliminate muscle waste compared to the lying or walking position. (Muhammad Nasr al-Din Radwan - 1998) indicates that the heart rate is influenced by body position, as it increases in the standing position compared to the sitting or lying position. On the other hand, the heart rate increases due to increased physical load or oxygen (O2) consumption in both trained and untrained individuals. (Muhammad: 69).

Table (14) Analysis of variance (for breathing) for the first five minutes of the recovery period and from the (lying - standing - walking) positions after anaerobic effort (100 m)

Recovery period	Source of variance	Sum of squares	Degrees of freedom	Mean squares	Calculated F value
Minute (1)	Between groups	**16.26**	**2**	**8.13**	**6.63**
	Within groups	**33.10**	**27**	**1.22**	
Minute (3)	Between groups	**22.06**	**2**	**11.03**	**5.38**
	Within groups	**55.30**	**27**	**2.04**	
Minute (5)	Between groups	**18.06**	**2**	**9.03**	**6.98**
	Within groups	**34.90**	**27**	**1.29**	

*Tabulated F-value at a significance level of 0.05 and degrees of freedom (2–27) = 3.35.

Along with the within- and between-group data, the calculated F-value is also displayed. We note that the calculated F-value is greater than the tabulated F-value, indicating a significant difference between the exercises performed during the five-minute recovery period after the 100-meter run. To determine these differences and determine which exercises were more beneficial, the researcher used the least significant difference (LSD) test, as shown in Table (15).

Table (15) Comparison of the arithmetic means with the least significant difference (LSD) for respiration during the first five minutes of the recovery period and from the position (supine, standing, and walking) after anaerobic exercise (100 m)

Exercises / recovery period	Lying down	Standing	Walking	LSD 2 alue	Difference between 1-2	Difference between 1-3	Difference between 2-3
	S	S	S				
Minute (1)	**37.50**	**36.50**	**35.70**	**1.01**	**1.00**	**1.8*0**	**0.80**
Minute (3)	**33.80**	**32.80**	**31.70**	**1.31**	**1.00**	**2.1*0**	**1.10**
Minute (5)	**29.60**	**28.60**	**27.70**	**1.04**	**1.00**	**1.9*0**	**0.90**

It is obvious to us that the difference between the two positions (lying down and walking) was greater than the value (L.S.D) for the first minute of the recovery period, while

in the third minute the difference between the two positions (lying down and walking) seemed greater than the value (L.S.D), and finally in the fifth minute the difference between the two positions (lying down and walking) seemed greater than the value (L.S.D), which indicates that the respiratory variable is dependent on the difference in these exercises during the recovery period after the anaerobic exercise of running (100 m), because the researcher believes that when a runner (400 m) runs this distance, he has (oxygen debt) because he runs the distance at a high speed during which he consumes most of the stored oxygen and then runs in the absence of (O2), so lactic acid accumulates in the muscles due to the lack of oxygen and the increase in the concentration of lactic acid reduces the muscle efficiency and then increases the breathing process to compensate for the lack of oxygen and carbon dioxide excretion. As Muhammad Othman (1990, 230) states, carbon cannot run at full speed from start to finish because the increased running intensity prevents it from continuing the effort. Furthermore, increased lactic acid levels lead to increased blood acidity, thus impairing the blood's ability to transport carbon dioxide to the lungs for elimination, requiring increased respiration. After several minutes of continuous exercise, the runner's position changes, which helps them return to their normal state. Therefore, the researcher believes that a standing position is better than a lying position, and a walking position is better than a standing position.

To determine the effect of the variable of high blood pressure after anaerobic exercise in a 100-meter run on the recovery period by varying the exercise undertaken by the body over the five-minute period, the researcher believes that the law of analysis of variance confirms this, as can be seen in Table (16).

Table (16) Analysis of variance (for arterial hypertension) during the first five minutes of the recovery period and in the postures (supine, standing, and walking) following anaerobic exercise (100 m)

Recovery period	Source of variance	Sum of squares	Degrees of freedom	Mean squares	Calculated F value
Minute (1)	Between groups	**51.46**	**2**	**25.73**	**1.22**
	Within groups	**565.23**	**27**	**20.93**	
Minute (3)	Between groups	**6.86**	**2**	**3.43**	**0.399**
	Within groups	**232.50**	**27**	**8.61**	
Minute (5)	Between groups	**0.267**	**2**	**0.133**	**0.011**
	Within groups	**326.20**	**27**	**12.04**	

*The tabular F value at a significance level of (0.05) and a degree of freedom of (2 - 27) = 3.35. We note that the calculated F value for the first five minutes is smaller than the

tabular value, indicating that there are no differences between these different exercises in the recovery period after anaerobic effort in the high-pressure variable.

Conclusion

The study findings showed that there were statistically significant differences in heart rate and the three postures (lying, standing, walking) after anaerobic running (50 m) exercise during the recovery period, favoring the lying position during the first minute of recovery. There were also statistically significant differences in heart rate and respiration rate for the three postures (lying, standing, walking) after anaerobic running (50 m) exercise during the recovery period, favoring the lying position during the third minute of recovery.

There were also statistically significant differences in heart rate between the three exercises (lying, standing, walking) after anaerobic running (50 m) exercise during the recovery period, favoring the lying position during the fifth minute. There were no statistically significant differences in the high and low blood pressure variables between the three exercises (lying, standing, walking) during the five-minute recovery period.

There were also statistically significant differences in heart rate between the three exercises (lying, standing, walking) during the recovery period. The recovery period was in favor of the walking position and for the third minute in the 100 m test, and there were also statistically significant differences in heart rate between the three exercises (lying, standing, walking) in the recovery period in favor of the lying position and for the fifth minute, and there were also statistically significant differences in respiratory rate between the positions (lying and walking) in favor of the walking position and for the minutes (first, third, fifth) in the recovery period, and there were also no statistically significant differences in the high and low pressure variable between the three exercises (lying, standing, walking) for the five minutes in the recovery period, and the researcher recommends relying on the lying position after the anaerobic exercise of running (50) meters in the recovery period to achieve a low heart rate and for the five minutes, and relying on the walking position after the anaerobic exercise of running (100 m) in the recovery period to achieve a low heart rate and for the third minute, and relying on the lying position after the anaerobic exercise of running (100 m) in the recovery period in to achieve a low heart rate For the fifth minute, based on a walking position to achieve a lower respiratory rate after anaerobic running effort (100 m) and for the first five minutes during the recovery period, and by conducting similar studies on other physiological variables such as stroke volume, cardiac output, blood pressure rate and lactic acid ratio.

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