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Effect of Training Using GPS Watches on Recovery Development in Athletes

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Tarek Boumedine [1], Abderrezzak Kacir [2], Abdelhamid Arroussi [3], Kamel Berroudj [4], Khellaf Mohammed [5]

[1]University Algiers 3, Department of Science and Techniques of physical and sports activities.

Laboratory:of Motor Performance Sciences and Pedagogical Interventions (LSPMIP) Algiers 3, Algeria

[2]University Sétif2, Department of Science and Techniques of Physical and Sports Activities.

Laboratory:of Motor Performance Sciences and Pedagogical Interventions (LSPMIP) Algiers 3, Algeria

[3]University Sétif2, Department of Science and Techniques of Physical and Sports Activities.

Laboratory: Sciences of Physical Activities and Public Health, (SAPSSP), Setif2, Algeria

[4]University Sétif2, Department of Science and Techniques of Physical and Sports Activities.

Laboratory:of Motor Performance Sciences and Pedagogical Interventions (LSPMIP) Algiers 3, Algeria

[5]Laboratory for Expertise and Analysis of Sports Performance «LEAPS» ISTAPS, Abdelhamid Mehri Constantine 2 University, Algeria

The Author's E-mail: tarekboumediene6@gmail.com[1], a.kacir@univ-setif2.dz[2], a.arroussi@univ-setif2.dz[3] , k.berroudj@univ-setif2.dz[4], khellaf.mohammed@univ-constantine2.dz[5]

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Abstract

This study aimed to highlight the effective role played by GPS watches as an auxiliary tool in regulating training loads to improve recovery development in athletes, specifically used as a training tool to enhance recovery among Kung Fu and Wushu athletes.It was conducted on 8 regularly training athletes with pre- and post-test measurements of the same sample. Tests included the Ruffier-Dickson test, which measures recovery capacity, and the cardiac efficiency test through heart rate monitoring to confirm the device's effectiveness in promoting recovery.

Keywords: GPS Watches, Recovery, heart rate, VES, lactate, VO_2max.

Introduction:

Al-Din (2006) states that to ensure the enhancement of the athlete's physical and functional capacities, it is essential to carefully manage the recovery process during repeated training loads. The subsequent load should occur during the phase of increased recovery, where muscle phosphate and glycogen stores are renewed, myoglobin is saturated with oxygen, and lactic acid is eliminated from muscles and blood. Therefore, every coach must regulate rest periods between repetitions within training sessions and between training sessions **(Ismail, 2006).**

The recovery process and the choice of recovery techniques depend on variables related to the athlete and the physical activity. Factors such as age, training level, gender, type of sport, its intensity, duration, and density, as well as the environment in which training or competition takes place, determine appropriate recovery strategies. Women require longer recovery periods than men, younger individuals recover faster than older ones, and resistance training differs from endurance training in terms of recovery needs. Internal and external factors of load determine recovery strategies. After strength training, the body is in a state of negative balance where protein breakdown exceeds synthesis. Additionally, the testosterone-to-cortisol ratio is lower, especially in amateurs and beginners, placing the body in a catabolic state. Consuming a protein-rich meal or supplements designed for athletes rich in protein restores this balance **(Burke, 2007).**

Recently, devices such as player tracking systems using satellites have been used for about ten years in team sports to assess external training load and monitor heart rate as an indicator of internal load **(Hourcade, 2019).**

Over the last decade, multisport GPS watches have been increasingly used in both health and social sciences, with numerous applications. In health sciences, they are interesting tools to measure the performance of athletes and non-athletes and to monitor their physical activity **(Dooly, Golaszewski, & Bartholomew, 2017).**

2.General Question:

Is there an effect of training using GPS watches on the development of recovery?

3.Partial Hypotheses:

- There is an effect of training using GPS watches on the Ruffier index.
- There is an effect of training using GPS watches on the oxygen transport ratio index.

4.Research Methodology:

An exploratory study was conducted on a sample of three runners to determine the validity and reliability of the test as well as its applicability in all fields.

The study adopted an experimental method suitable for a sample of eight athletes from the Kung Fu and Wushu team in Algeria, using a single-sample pretest design selected by purposive sampling.

5.Statistical Method:

The Statistical Package for the Social Sciences (SPSS) version 26 was used, one of the most important and popular software packages for data analysis, applying the following statistical tests:

- Pearson test for reliability
- Levene's test for homogeneity of variance
- Shapiro-Wilk test for normal distribution
- T-test
- Cohen's d for effect size

Exploratory Study:

An exploratory study was conducted on a sample of four athletes from the same team selected purposively and then excluded from the main study. The experimental protocol involved measuring resting heart rate with a smart heart rate watch (smart pro M4), measuring blood oxygen saturation with a Beurer device, followed by the Ruffier and Vameval tests, with a one-hour interval between the tests. They were repeated after 24 hours, during which the three athletes were forced into complete rest. The validity, reliability, and measured characteristics of both tests were then evaluated

Table (01): Pearson Test for Calculating Validity and Reliability

	HBGM(mg/dl)	Sp O2(%)	Lactate Mg/Dl	Rf	FC (B/min)	T (mmHg)	
						Sys	Diasys
Reliability	0,736	1	0,74	0,99	0.97	1	0.985
Validity	0,857	1	0,86	0,994	0.98	1	0.992

3. Study Tools and Scientific Measurement Procedures:

A. Functional tests and devices used:

- **Vameval Test**
- **Ruffier Test**: measurement device (smart pro M4)
- **Measurement of blood oxygen transfer concentration**: Beurer device
- **Heart rate test**: measurement device (smart pro M4)

Regarding pre- and post-measurements, Al-Hazzaa stated: “Approaching the final outcomes to sea level makes three weeks sufficient for the body to adapt to new changes at altitude**.” (Al-Hazzaa, 2010)**

1. **Vameval Test**

Figure (01): Test vameval

A. Objective of the test: To calculate the maximal aerobic speed (VMA).
B. Results: The maximal aerobic speed (VMA) is recorded for the last distance achieved between two cones. Maximal oxygen consumption (VO2max) is estimated by the following formula:

$$VO2max\ (ml/min/kg) = 3.5 \times VMA\ (km/h)$$

2. Ruffier Test for Measuring Recovery Capacity

A. Objective of the test: To assess cardiac efficiency and recovery ability. This test depends on changes in heart rate after a series of movements and classifies athletes according to the amount of recovery.

B. Performance characteristics:

Before starting the test, measure the athlete's heart rate at rest while seated (P0).The athlete stands, feet placed naturally, and upon the signal, performs the activity for 30 seconds.The activity time is 45 seconds, where the back of the pelvis touches the heels, the trunk remains straight, and the athlete's heart rate (P1) is measured immediately after finishing the exercise, and then after the second minute following exercise (P2).The results of this test are expressed by the Ruffier Index as:

Ruffier Index $= \frac{(P0+P1+P2)-200}{10}$ Ruffier defined five categories.

Table (02): Classification According to the Ruffier Test for Measuring Recovery Capacity

Category	**Index**	**Grade**
First	Less than 0	Excellent
Second	0 to 5	Very Good
Third	5 to 10	Good
Fourth	10 to 15	Average
Fifth	15 to 20	Poor

4. Scientific Procedures for Measurement:

Before applying the Ruffier and Vameval tests, resting blood pressure and heart rate for each subject were measured. The Ruffier test was performed and results related to blood pressure and resting heart rate collected. After a complete rest for 15 minutes, the Vameval test was administered for 12 minutes. At a maximal aerobic speed of 13.5, the maximum oxygen uptake was 47.25. Immediately after performance, blood lactate, blood glucose, and hemoglobin oxygen transfer rate were measured, and the same measurements were taken again after four minutes of rest to determine the speed of physiological recovery.

Display and Analysis of Results Related to GPS Watches (GPS)

A. Ruffier Test

Table (03): Shapiro-Wilk Test Results to Examine the Normality Distribution Between Pre- and Post-Measurements of the Ruffier Test Related to GPS Watches

Chapiro-Wilk test

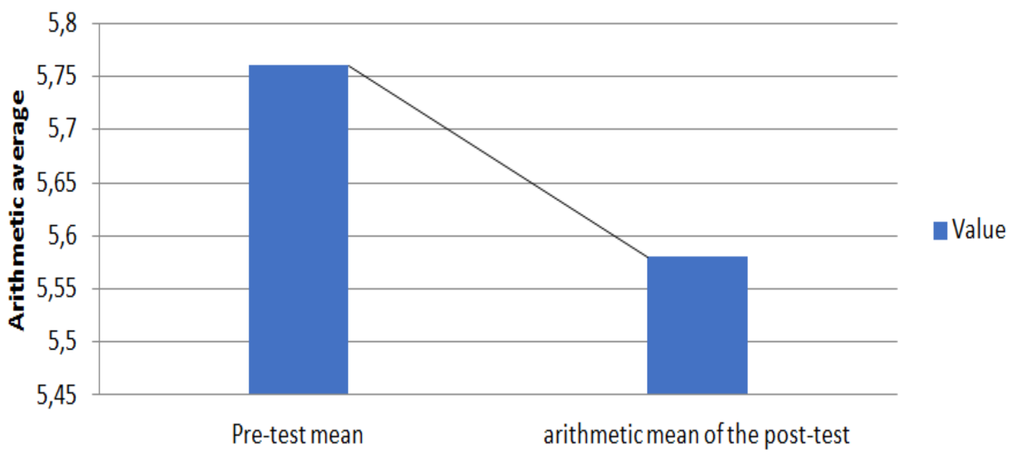
Property	Significance level	df	Pre-test sig sw	Pre-test calculated	Post test sig sw	Post test calculated	Decision
Ruffer index	**0.05**	**8**	**0,375**	**0,913**	**0,138**	**0,866**	**Follows Normal distribution**

The Chapiro-Wilk test is most suitable for sample sizes less than 50. Our sample size is 8, so this test was used to assess the normal distribution of data and the effect of GPS watch use on recovery capacity development. At the significance level of 0.05 and degrees of freedom (df=8), the p-value for pre-test measurements is 0.375 and for post-test measurements is 0.138, both greater than the significance threshold (sig SW > 0.05). The tabulated values are less than the calculated values, allowing acceptance of the null hypothesis (H0), indicating the data follows a normal distribution centered around the sample mean. The alternative hypothesis (H1), that the data do not follow a normal distribution, is rejected. Accordingly, the appropriate test for comparing pre- and post-measurements differences is the paired samples t-test, which will also identify to which sample any significant differences are attributed.

Table (04): Differences Between Pre- and Post-Measurements for the Ruffier Test Related to GPS Watches

	Student's t-test for two related samples (pre post tests measurement)								
	Significance level	**df**	**Calculated-t**	**Tabulated-t**	**Sig**	**Group 1**	**Group 2**	**Gr1 Gr2**	**Decision**
Ruffer index	**0.05**	**7**	**3,56**	**1,895**	**0.009**	**5,76**	**5,58**	**0,17**	**Significant**

Figure (02): Ruffer teste averages related to GPS hours



From the table related to the study of differences in pre- and post-test measurements using the Roufi test, derived from the effect of using GPS watches on the development of recovery efficiency in athletes, it is found at the significance level (0.05) and degrees of freedom (7) that the calculated t-value is (3.56), which is clearly greater than the tabulated t-value (1.895). Moreover, the calculated p-value (0.09) is smaller than the assumed significance level (0.05). This leads us to reject the null hypothesis (H0), which states there are no differences between the arithmetic means of the pre- and post-test measurements, and accept the alternative hypothesis (H1), which affirms significant differences between the arithmetic means of the pre- and post-test measurements. Observing the figure indicates that the pre-test measurement has a higher arithmetic mean (5.76) compared to the post-test mean (5.58). The difference, calculated by subtracting the post-test mean from the pre-test mean, is positive (0.17), which is attributed to the characteristics of the Roufi test: the lower the post-test result, the better the recall efficiency. Hence, the differences favor the post-test measurement.

Table (05): Shapiro-Wilk Test Results to Determine Normal Distribution Between Pre- and Post-Measurements of Blood Oxygen Transport Associated with GPS Watches

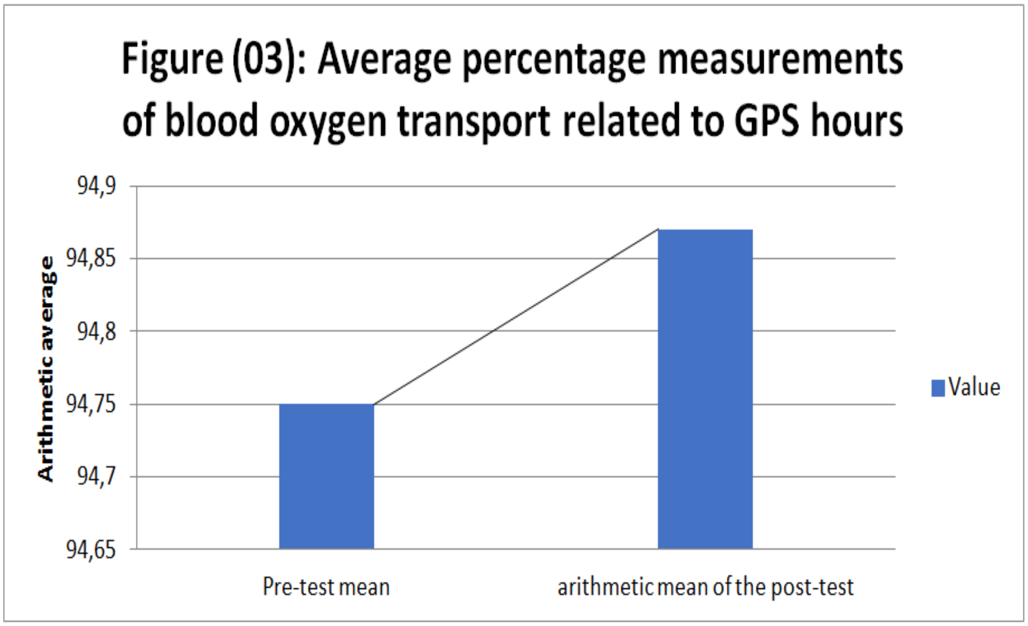
Chapiro-Wilk test

Property	Significance level	df	Pre test sig sw	Pre test calculated	Post test sig sw	Post test calculated	Decision
Oxygen %	**0,05**	**8**	**0,408**	**0,917**	**0,067**	**0,835**	**Normal distribution**

With respect to blood oxygen transport percentage, the Chapiro-Wilk test shows whether values follow the normal distribution between pre- and post-measurements related to the use of GPS devices for enhancing recovery. At degrees of freedom (8) and significance level (0.05), the pre-test significance level is 0.408 and the post-test is 0.067 , both greater than the assumed significance threshold (sig SW > 0.05). Therefore, the decision is that the data follow a normal distribution by accepting the null hypothesis (H0) and rejecting the alternative hypothesis (H1). The optimal test for differences between the paired sample means is the paired samples t-test.

Table (06): Pre- and Post-Measurement Differences for Blood Oxygen Transport Percentage Associated with GPS Watches

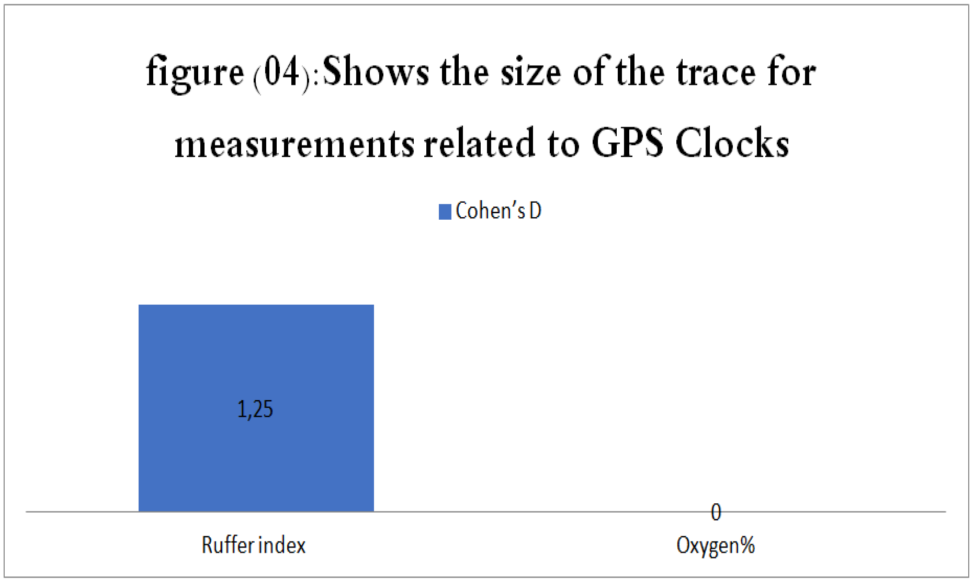
	Student's t-test for two related samples (pre post tests measurement)								
	Significance level	**df**	**Calculated t-values**	**Tabulated t-values**	**Sig**	**Group 1**	**Group 2**	**Gr1 Gr 2**	**Decision**
Ruffer index	**0,05**	**7**	**0,375**	**1,89**	**0,73**	**94,7**	**94,8**	**0,125**	**Not significant**



Results regarding the differences in pre- and post-measurements for blood oxygen transport percentage indicate that, with a significance level of (0.05) and degrees of freedom (7), the caccurate t-value is (-0.357), less than the tabulated t-value (1.895) in the negative direction (the test is two-tailed). Comparing the calculated significance value (0.732) to the threshold (0.05), we find it is much higher, leading to the decision that the difference is not significant and accepting the null hypothesis (H0) that there is no significant difference between pre- and post-test means, even though the post-test mean (94.87) is higher than the pre-test mean (94.75). Parametric tests confirm no statistically significant differences between the two measurements.

Table (07): Effect Size for Pre- and Post-Measurements Associated with GPS

Cohen'sD Test				
	n	**t**	**d**	**Effect**
Ruffer index	**8**	**3,56**	**1,25**	**Strong**
Oxygen %		/	/	/



From the table measuring effect size between pre- and post-tests related to the impact of GPS watch usage on recovery development in athletes, the effect size for the Ruffier index was strong at 1.25, whereas the oxygen transport percentage was not significant. Observing the effect size figure shows that the very large effect is attributed to the influence of GPS watch usage on the Ruffier index.

Conclusion:

From the tables related to training load regulation using GPS watches for recovery enhancement, it is evident from the Ruffier index t-value of 3.56, af Mohamed Kadri stated that physical exertion increases the physiological variables measured, such as heart rate and lactic acid level, to cope with the training load effects **(Bakri, Al-Abbasi, & Said, 2020)**. Contrary to findings by "Jamal Murabti," which explained that blood sugar levels vary during recovery periods due to the athlete's age **(Jemali, 2020).**

Our results on the impact of regulated training using GPS watches on recovery development show inconsistencies with other studies. Some indicators such as resting heart rate, systolic blood pressure, and oxygen transport percentage showed no significant changes, likewise the Ruffier index did. Consequently, researchers should further investigate this topic over longer periods to confirm the effectiveness of GPS watches as a tool for regulating training load to enhance athlete recovery.

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