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The Effect of Swimming on Blood Lactate and Sleep, after Intense Efforts in Handball Players

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Abstract: Handball is a dynamic game and requires from the subjects an intense physical effort and a great psychic commitment. The handball training process has to solve a whole series of performance skills that are found in the handball game, in this respect in order to achieve both the offensive actions with accuracy and speed and to block the actions of the opposing team. The sooner handball players recover after training or matches, the more work can be done, and the increased levels of training translate into more efficient games. Swimming in general is associated with performance sports but also as a means of recreation and improvement of the quality of life, the horizontal position favouring this. In this regard we have investigated the efficiency of swimming in eliminating lactate from the blood, and increasing the quality of sleep after intense efforts, in the sense of optimizing sports efficiency. The study carried out on twenty amateur athletes handball players, aged between 19 and 25 years, being divided into two equal groups. The experiment group (Group 1), after intense effort, performed an active recovery with specific elements of swimming for 20 minutes at an intensity of 55-60% relative to the maximum heart rate, and the control group (Group 2) during this time achieved a passive recovery. The results of the study have shown that specific elements of swimming, after intense efforts, cause significant changes in the elimination of lactate from the blood and provide a quieter sleep for amateur athlete's handball players members of the experiment group.

Keywords: *blood lactate; sleep; swimming; active recovery; handball.*

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1. Introduction

As a performance sport, handball requires athletes to do an intense work in order to cope with extremely difficult training tasks, the resolution of which requires the maximum strain of all physical, moral, will and intellectual capacities. The requirements of obtaining the great performance and the desire of the athlete to achieve them determine him to accept with conviction a life regime free of abuses, full of restrictions, rules, the observance of which contributes to the registration of his moral profile. Many handball players, under the guidance of coaches, sports teams, have managed to assert themselves both in sport and in society, because handball teaches the individual to be disciplined, orderly, industrious, aware of the responsibility for the success of the team, ambitious and eager for self-overcoming. Unfortunately, in Romania, a lot of coaches use outdated equipment (Cosma et al., 2021), and it is difficult to compete on the same level with those who monitor performance with modern technology. Thus, the entire instructive-educational process is conducted at an increasing level, considering the biological substrate of the organism, the possibilities of adaptation, the biomechanics of movement and a faster recovery after the effort (Buse et al., 2021). Training conducted in a coherent manner, with higher indices of the level of physical development and a good knowledge of the game, will lead to the performances required at the international level, requiring quick reactions from the players to the actions of their opponents (Barbu & Stoica, 2020).

Due to the increasingly scientific character of the training of the athletes, the entire instructive-educational process began to take place at a higher and higher level, considering, more, the biological substrate of the organism and its possibilities of adaptation (Pitigoi & Petrescu, 2018).

The very high physical and mental effort to which the performance athlete is subjected during a long period of time leads to diversifying the methods and means of recovery. These refer to the rebalancing of functions that have lost their efficiency or ability to adapt to the requirements of the game (Barbu, 2009).

Supporting and restoring the body after physical effort involves a series of natural or artificial means that can be applied rationally in order to restore the state of balance for the internal organs and functional parameters that tend towards a state of homeostasis prior to effort (training or competition) and even exceeding them, by reaching a higher level, within the phenomenon of "overcompensation", which represents the moment of optimization of the recovery, when it indirectly becomes a phase of biological preparation for the competition (Ionescu & Anton, 2004). Quan,

specialist in sleep medicine, who teaches this discipline in the university environment, says that "indeed, he has met relatively many people who complain that they can no longer fall asleep after having intense physical exercises until late at night, they have a high level of adrenaline, the brain remains active, the heart rate still remains high, that's why it e it is difficult to enter the state of relaxation necessary to fall asleep easily and a peaceful sleep" (Quan, 2004). In the interval of at least two hours after movement, the body temperature drops back to 37 degrees Celsius (the temperature required to fall asleep), the heart rate returns to normal, and the adrenaline level stabilizes (Quan et al., 2018).

Swimming is different from other sports branches, because the movement of the body takes place in the aquatic environment, hence the multitude of effects on the body. Lactic acid is produced in the muscle and before it reaches the bloodstream a large part of it can be metabolized in the muscles or organs. (Lago, 2009). In a study by Achenbach et at., (2022), they found that" blood lactate concentration values observed indicate that the rate of muscle lactate production, and hence the contribution of anaerobic energy sources, may be high during elite team handball match-play, hence indirectly supporting the notion that temporary fatigue might occur in male elite team handball".

With the increase of the load during the match to 70–80% of VO2-max, the requirements for the aerobic system are moderate to high, with a direct link to the anaerobic energy systems, which is reflected in the high values of lactic acid in the blood after the match (Laver et al., 2018).It is recognized that the removal of lactate brings improvements during active recovery (Wilmore & Costill, 1999), this being more effective during the recovery phase than the massage for the removal of lactate (Hemmings et al., 2000). Also, Dodd et al., (1984) & Bonen et al., (1979) found that the concentration of lactate in the blood decreases faster after an active recovery performed at 30-70% of the maximum volume of oxygen. In this sense, many researchers, use the removal of lactic acid as the main indicator of recovery (Sahlin, 1986). Crisafulli et al., (2006), lactate may induce accumulation of peripheral blood that leads to reduced cardiac filling and cerebral circulatory volume. Thus, by knowing the most effective rhythm used to reduce lactate, it can be useful both for choosing the game strategy, during the handball match, and in the design of the training plans (Arazi et al., 2012).

2. Problem Statement

Ethe release of lactate is related to the high intensity of effort (Ursta, 2006). To remove the maximum and submaximal efforts in handball, causes the increase of lactate in the blood So it can be said that the accumulation of lactate and the decrease in pH are causes of the appearance of muscle fatigue, but they are not the only ones (Bangsbo et al., 1995). Measuring lactose is a safe way to appreciate performance levels. Once formed in the muscles, lactic acid, quickly diffuses into the blood. Following exhausting efforts, the concentration of lactate at intramuscular level exceeds 25 mmol/kg., while in the blood the concentration of lactate is 20 mmol/l (normal rest values 1-1.8 mmol/l);Absorption of lactate in inactive muscle groups increased proportionally with the speed of blood flow and that lactate enters the respective muscle cells with the same amplitude as that of H+, demonstrating the monocarboxylic transport activity (Bangsbo et al., 1995). According to Felix, (1997) if lactate is not reduced both in the blood and intramuscularly, in order to reach a level close to that of rest, further performance in training or competition may be affected. Our approach has been geared towards restoring effort capacity more quickly, answer the question: how can we increase load-bearing performance? In our study we investigated the concentration of lactate in the blood and sleep as a resting activity.

3. Research Questions~~/Aims of the research~~

The current research has addressed how to act on active recovery, through swimming, of over-lactate from the blood for handball players after intense efforts. Knowing the dimensions of the positive effect on recovery after intense efforts, we could intervene, facilitating centralized training for limited periods and with intense efforts. We have hypothesized that handball players who participate in an active recovery through swimming after intense efforts would achieve remarkable sports performances and a peaceful and restful sleep, compared to players who participate in a passive recovery.

4. Research Methods

4.1. Participants

The research was conducted on a number of 20 students, members of the handball, male and female, of "Carol Davila" University of University of Bucharest, aged between 19-25 years, where goalkeepers are excluded.

The players were divided into two groups of 10 (5 boys and 5 girls). In table number 1 there are parameters for the subjects of the research. At the beginning of the research, a presentation was held for the subjects of the research in which all possible risks and benefits were presented, and in the end, each offered a written consent with the participation agreement. Thus, all subjects became aware of the processing of data and personal values and agreed, which was written in the consent form. We mention that the presented research fully complies with the institutional and international ethical recommendations regarding the absolute confidentiality of the resulting data and the anonymity of the subjects.

Table 1. Average values of the subjects' parameters

Variables	Group 1 (experimental)	Group 2 (control)
Age (years)	21.7±2.05	21.9±2.02
Height (m)	177.8±6.73	178.4±6.13
Body mass (kg)	67.8±9.49	71.6±12.52
Lactates (mmol/l	1,097±0.034	1,095±0,029
VO_{2max} (ml/min/kg)	46.96±5.19	42.59±4.16

Source: Authors' own conception

4.2. Materials

The following devices were used in the research: Lactate Pro 2 (with which the lactate in the blood was analyzed by electrochemical method using an enzymatic response) and the Garmin Fenix 5 smartwatch watch (for monitoring the heart rate during active recovery and sleep). The Dairy Pro 2 is a portable device that measures blood lactate on site within 15 seconds of a very small amount of blood (0.3 μl), which can be extracted from the finger or earlobe, and can store up to 330 results. The Garmin Fenix 5 watch has a Garmin Chroma Display™ permanently on, high-resolution, which ensures excellent readability at any time and includes Elevate technology to measure the pulse from the wrist, from where the intensity of the training can be controlled at any time.

4.3. Procedure

The research was conducted on two groups of 10 participants, tested simultaneously, under the same conditions, with a difference of about 1-2 minutes. All subjects participated in this research voluntarily, without obligation, being informed that they can withdraw at any time. The lactate test was initially performed before physical exertion for both groups. The

first group (experimental) after sustaining an intense effort (training or competition), he performed an active recovery in the pool with elements specific to crawl and back styles, at an intensity of 55-60% of the maximum Heart Rate, for 20 minutes. The second group (control) you achieve a passive recovery for 20 minutes. After the 20 minutes both groups conducted the final test. The last two tests were conducted on three different days and the average was made. The determination of blood lactate was determined using a test strip. Blood samples were taken from the tip of the finger, which was previously wiped with isopropyl alcohol using the device Lactate Pro 2.

5. Results and discussions

5.1. Results

Regarding the results obtained by student, according to the two groups, active recovery or passive recovery, the statistics highlight some significant differences.

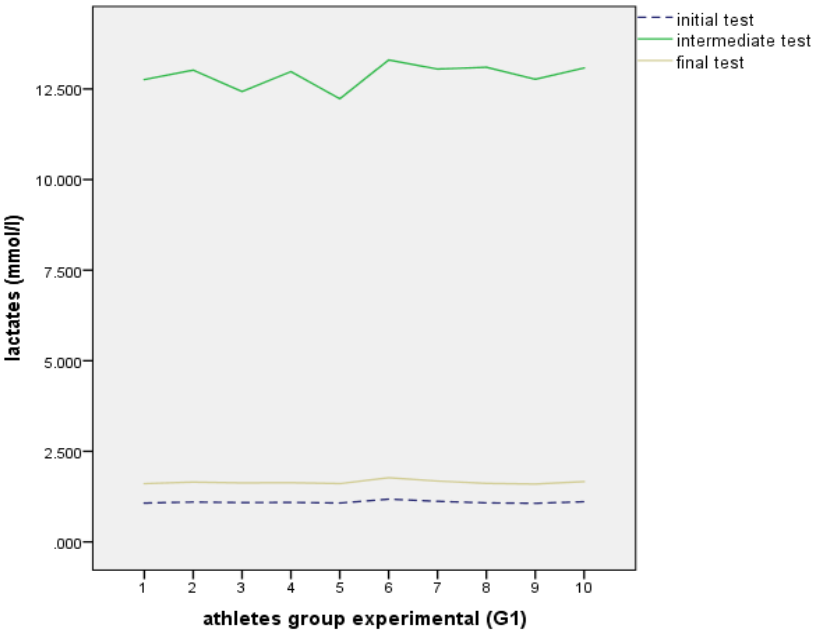


Figure 1. Change in blood dairy concentration in the three tests
Source: Authors' own conception

It can be seen from Figure 1, the active recovery by means specific to swimming, has a major effect on the blood lactate after intense efforts. The analysis of the data shows that this decrease in blood lactate is significant, on average from 12.87±0.32 mmol/l, after intense effort, to 1.64± mmol/l after active recovery in aquatic environment.

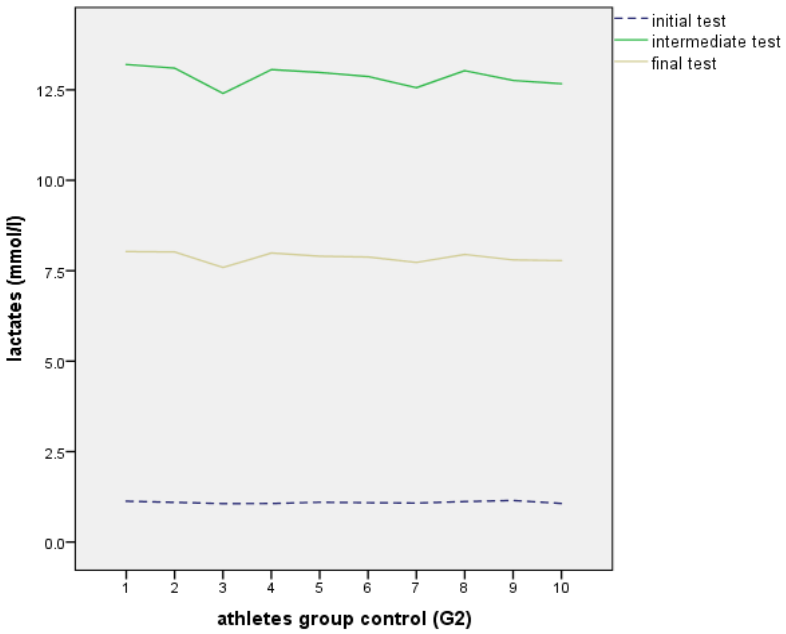


Figure 2. Change in blood dairy concentration in the three tests for

Source: Authors' own conception

It can be seen from Figure 2, through passive recovery, the blood lactate decreases by only 38.8% after intense efforts.

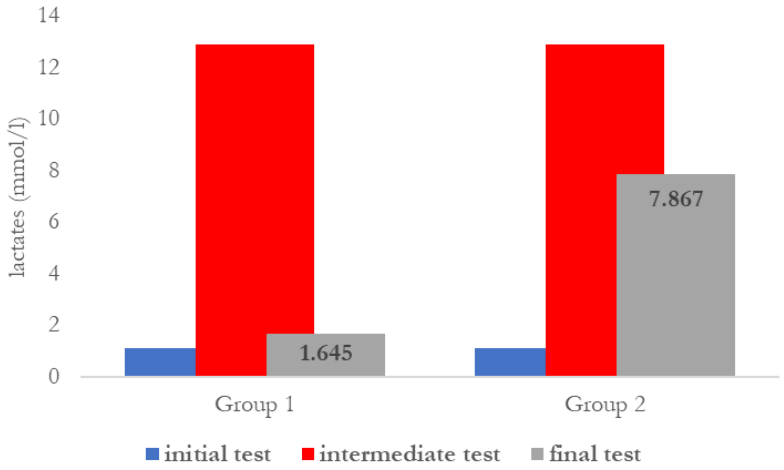


Figure 3. Comparative evolution of blood lactate concentration for the two groups
Source: Authors' own conception

Table 2. Statistical results according to groups

	N	Mean	Std. Deviation	Std. Error Mean
Final T. Group 1	10	1.645	0.051	0.16
Final T. Group 2	10	7.867	0.141	0.44

Source: Authors' own conception

The mean concentration of the dependent variable (lactate in the blood) after recovery for the experiment group is 1.64 mmol/l (SD=0.051) and for the control group 7.86 mmol/l (SD=0.14) (Tables 2).

Table 3. T-test for independent samples. *Final test after recovery*

	Levine's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Mean The Differenc	Sig. (2-tailed)	Std. Error The Difference	95% Confidence Interval of the Difference	
								Upper	Lower
Equal variances assumed	8.6000	0.009	-130,545	18	-6.221	0.000	0.0476	-6.121	-6.321
Equal variances not assumed			-130.545	11.311	-6.221	0.000	0.476	-6.117	-6.326

Source: Authors' own conception

Because the value of the meaning of Levine's Test for Equality of Variances (p=0.009), from a statistical point of view, is a significant difference, the materiality threshold p <0.05. This meaning confirms that there are significantly different variances, and the second line is used to read the values (Tables I). The 95% confidence interval for this difference ranges from -6.32 to -6.11. Since it does not contain the value 0.00, the difference is statistically significant at a two-tailed significance level of 5%. Since the range does not contain 0.00, the difference is statistically significant at the two-way level of 5%.

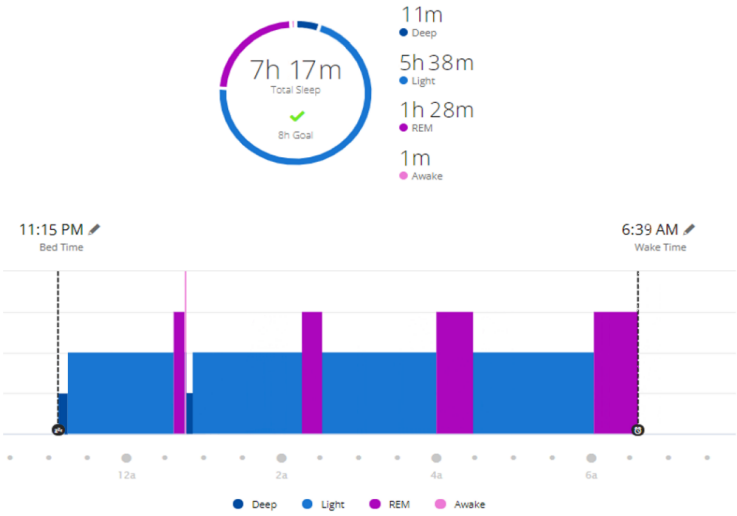


Figure 4. Evolution of sleep after active recovery
Source: Authors' own conception

During the night, for the athletes who have benefited from an active recovery, through specific elements of swimming, a normal passage through the sleep cycles is found following all their phases, on average with a single awakening that does not exceed 1 min. We can consider a quality sleep with a total duration of 7 hours and 17 minutes and a correct recovery through the help of REM (Figure 4).

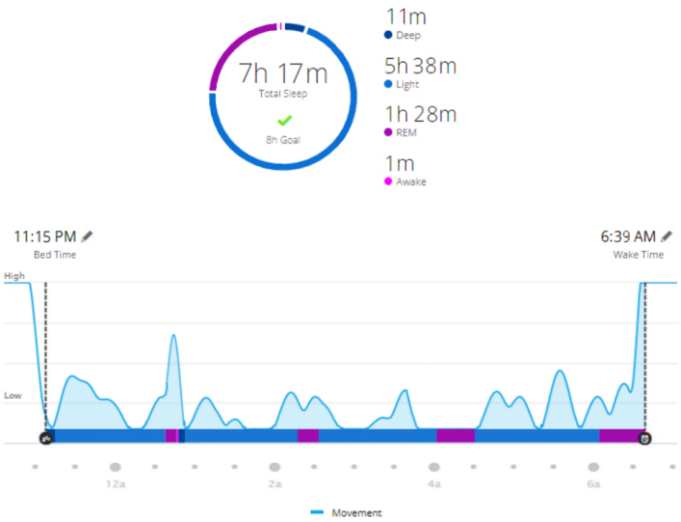


Figure 5. Evolution of body movements during sleep after active recovery
Source: Authors' own conception

The movement of the body during sleep, after active recovery, is low, the only and of higher intensity is associated with a short awakening (Figure 5).

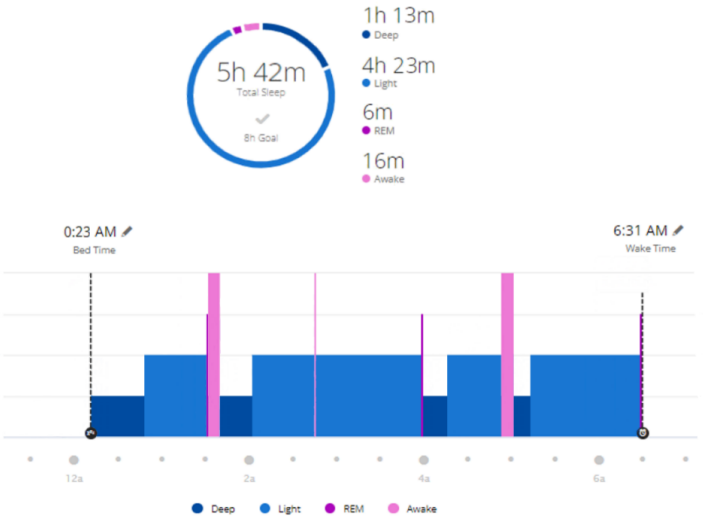


Figure 6. Evolution of sleep after passive recovery
Source: Authors' own conception

For athletes who have achieved a passive recovery, a shortening of sleep cycles is found, certain phases are eliminated, or they become smaller than normal, on average with three awakenings per night with a total duration of 16 min. We can consider a restless sleep with a total duration of 5 hours and 42 minutes having a correct recovery through the help of REM of only 6 min (Figure 6).

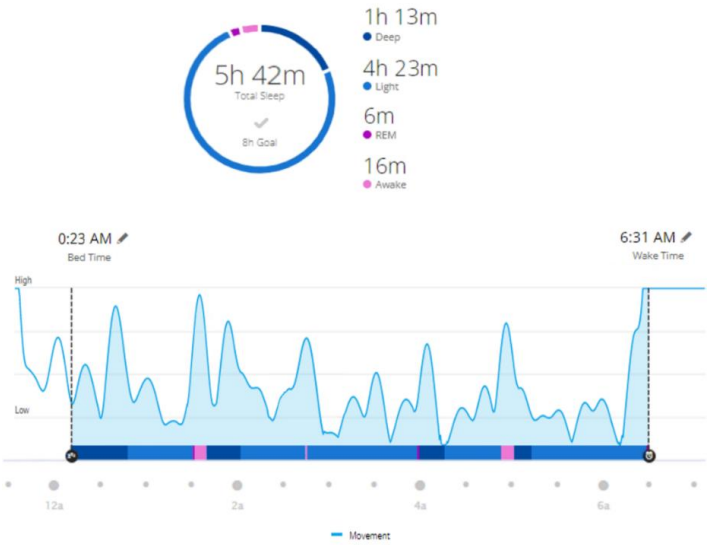


Figure 7. Evolution of body movements during sleep after passive recovery
Source: Authors' own conception

For the control group, after passive recovery, the movement of the body during sleep is quite active, not only in the stages of awakening (Figure 7).

5.2. Discussions

Following the processing of the research results, carried out by us, they provide useful information on recovery after intense efforts. Lactic acid is one of the main biochemical parameters, which estimates the possibilities of adaptation to effort, the resistance capacity of the body, as well as the level of performance of athletes (Deleu, 2020). The decrease in blood lactate offers the possibility of a faster recovery in order to get involved in new efforts be they training or competitive This fall is achieved faster by active equating than by passive recovery (Ahmaidi et al.,1996; Dodd et al., 1984;

Monedero & Donne, 2000), with no significant differences between jogging and running but significant from passive recovery (Arazi et al., 2012).

This is what Neric et al. (2009) mentions, passive recovery had the weakest efficiency in eliminating lactate, 20 minutes after exertion, the most effective being submaximal swimming followed by electrical stimulation of the muscles. In the exercise physiology lab at the University of Virginia, Greenwood et.al., (2008), they found that 15 minutes of active recovery conducted at 50% of VO2max, or a combined 7.5-minute massage program and 7.5 minutes of active recovery conducted at 50% of VO2max, decreased blood lactate compared to passive recovery.

Therefore, Arazi et al., (2012), I believe that in handball the intensity of the actions carried out must be related to the individual heart rate of each player.

In the case of athletes who have benefited from active recovery, through specific elements of swimming, statistics have shown that there are significant differences in the elimination of lactate and sleep, compared to the control group. Troxel et al., (2019) claims that a 30-minute physical activity, or even a walk, helps in better sleep health, while an intense effort conducted in the evening can cause the sleep process. According to the Beers (2006) Merk manual a light and quality sleep is 7-8 hours out of 24. A restless, uneasy sleep (parasomnia) corresponds to an action during sleep: twisting movements from side to side, tighten the sheet, wrinkle the pillow, twist your head at the feet of the bed, in the morning you wake up tired and you would like to sleep more (Colten & Altevogt, 2006). Throughout the night, non-REM and REM sleep alternates cyclically, thus, the NREM man made up 75-80% of total sleep, and the remaining 20-25% is represented by REM sleep (Velayos et al., 2007). On average, the first NREM-REM cycle lasts 70-100 minutes, and then the duration increases to 90-120 minutes (WebMD Editorial Contributors, 2020).

Without a doubt, however, that this research has certain limits, as the students subjected to this research are in a relatively small number, taking into account that the handball game team consists of 6 field players and a goalkeeper, who for our study was excluded, and the team with reserves has 14 components. Access, high costs and lack of pools can be a further hindrance to what they want to achieve. Finally, in view of the development of research, we believe that other methods and techniques of research can be used in approaching the note as a complementary sport in the training of athletes.

Finally, we mention that this research is part of the doctoral studies and complies with all the norms of ethics in accordance with the principles

enshrined in the Helsinki Declaration, which was approved within IOSUD – University of Pitesti.

6. Conclusions

This study explored the hypothesis that handball players participating in an active recovery through swimming after intense efforts would achieve outstanding sports performance and a peaceful and restful sleep, compared to players who participate in a passive recovery. Thus, as a result of the research we can argue that swimming carried out at an intensity of 55-60% of the maximum heart rate, for 20 minutes, after a specific handball effort, is effective in decreasing the lactate in the blood, from 12.87±0.32 mmol / l, after an intense effort in handball, to 1.64±0.05 mmol / l.

Following the analysis of the evolution of sleep for the two groups subjected to research, it was observed that the control group had an average sleep per night of 5 hours and 42 minutes, with a non-REM sleep of 94% of total sleep and only 6% REM sleep, the one that makes you feel rested the next day. For the experimental group, an average of 7 hours and 17 minutes was recorded, with a non-REM sleep of 80% of the total sleep and 20% REM sleep, which can give a correct recovery.

Our research is the result of an ambitious approach, aimed at demonstrating the place and role of swimming in training of amateur students who participate in sports competitions in general and handball, compared to the intense effort to which they are subjected.

Following the analysis of the data and in accordance with the presented studies, we recommend that, to support the repeated intense efforts, for untrained adults, to use specific elements of swimming according to the ones presented above.

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