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EFFECT OF FIT LIGHT TRAINING AT ALBANIAN ELITE BOXERS IN IMPROVING REACTION TIME AND PUNCH FREQUENCY

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Abstract.

Background and Study Aim. Boxing is a sport of self-defense art that utilizes compounds of muscle power, brain and conscience realistically and rationally. The speed required in boxer sports is very dominant in the speed of stimulating reaction of arms and legs when defending and responsive in attacking with a blow or kick. Reaction time is defined as the time elapsed between the stimulus and the response time to the stimulus, which is the determining factor in terms of performance level superiority in many sports branches and it is possible to improve it with training. The purpose of this study is to evaluate the effect of fit light training at elite Albanian boxers.

Material and Methods. The group in this study is consisted by 16 elite Albanian boxers, divided by an experimental group and a control group. At the experimental group, fit light training was used to collect data before and after training, while the basic boxing training was given to the control group. The paired samples t-test and the independent t-test were used to evaluate the data. The statistical significance at $p < 0.05$ was set.

Results. The results have revealed that variables of R_T Arm, R_T Leg and $P_{Freq.}$ in pretest data in control group were in similar levels, in the posttest data they were respectively: R_T Arm and R_T Leg higher and $P_{Freq.}$ power, for the experimental group. It can be concluded that the fit light training method is very effective and it is highly recommended to use widely for the training of all boxers, not only the elite ones.

Conclusions. The conclusions from the results of this study are: applying fit light method in elite Albanian boxers, a high intensity sport competition was very effective in: reducing reaction time of arm and legs, increasing punch frequency, for the boxing players of our national team. The results of this study are expected to be useful for coaches of boxing and other sport disciplines such as: kick boxing, wrestling, and also in all sports that require a faster reaction time to improve sports results and performance.

Keywords: Reaction time, punch frequency, fit training, Opto-jump, boxing.

Introduction

Boxer is a branch of martial sports that originated from Indonesia and almost the same as other martial sports. It is also a sport of self-defense art that utilizes compounds of muscle power, brain and conscience realistically and rationally. In the implementation of this sport, it takes several elements of the main physical conditions, namely anaerobic endurance, strength, speed, accuracy, and mental elements that include courage and tenacity. The speed required in boxer sports is very dominant in the speed of stimulating reaction of arms and legs when defending and responsive in attacking with a blow or kick [1]. Punching impact is perhaps the most important performance parameter in elite boxing [4]. Punching is a high-speed movement where muscular force is required to accelerate the arm [5]. The quality of the kick depends on the power component to get the power of the punch and kick, while the quality of the reaction ability of the athlete depends on arousing the speed of the move to hit and kick to get the value. Given the importance of arm and leg reactions, one of the exercises that can increase reaction speed and agility is Speed, Agility and Quickness (SAQ) [2]. Reaction speed is the time interval between the stimuli from outside the response with the response [3]. A study that had examined the activity profile of high-level boxing performance had revealed that explosive boxers had higher effectiveness of head punches. [6]

Boxers apply active and passive warm-up activities to improve performance parameters. As a result of these activities, they can improve existing performance parameters such as agility, anaerobic power, vertical jump, flexibility, reaction time [7, 8]. It is known that reaction time, which is of great importance in terms of athlete performance, is one of the most difficult sports performance parameters to develop. Reaction time performance in Athletes may vary according to the sport branch in terms of development. Especially in combat sports such as boxing reaction time is of such great importance that it can directly or indirectly affect the outcome of the competition. Reaction time is defined as the time elapsed between the stimulus and the response time to the stimulus [9]. The stimuli that will enable the athletes to take action can be visual, auditory and tactile. The prominent stimuli in combat sports; are visual and tactile stimuli [10]. Especially, visual reaction time is the determining factor in terms of performance level superiority in many sports branches and it is possible to improve it with training. Vision is an important sense for controlling balance. The visual system provides peoples with information about environment displayed as a result of the reflection of light from objects. [11] Vision is a critical part of human body balance which is used to gather information about the orientation of the body in space [12]. Postural orientation is the ability to maintain the relationships between different segments of the human body and its environment [12, 13], while postural stability is the ability to maintain the position of the body within the base of support [12, 14, 15]. Maintaining postural balance involves complex coordination & integration of multiple sensory motor & biomechanical components [11]. Most effective programs emphasize several common components, including plyometric and proprioceptive training in combination with biomechanical parameters and technical training. [16]. Proprioception training was very effective in reducing sway indexes at athletes, in order to

improvement and to increase the balance condition and sport performances [17]. There have been studies on reaction time performance for many years, and it has been reported that physical training can shorten reaction time in most of these studies [3, 18, 19].

However, in comparison, there has been a lack of research investigating the role of the neuromuscular system (i.e., muscular strength) on punch impact forces in boxers. Although technique is likely to play a major role in a boxer's punching ability, it is suggested that the force production capabilities of the neuromuscular system may also be a limiting factor. However, it is important to highlight that, to date, there are a lack of experimental studies in both elite amateur and professional boxing. [20]

It is known that boxing, which is one of the competitive and challenging sports branches, is a complex sport activity and requires the presence of various functional features [21]. Muscle strength, speed, coordination, balance, high anaerobic and aerobic power and reaction time are important factors that play a role in athlete performance. As a result of boxing training, it is aimed to improve the aerobic power, muscle strength and endurance, flexibility, coordination and reaction times of the athletes [12]. Most concurrent training studies have been performed on moderately trained and trained individuals, and there are still extremely few studies on highly trained athletes [22]. It is of outmost importance to examine populations with different training statuses because of existing differences in anthropometric, physiological, and biomechanical parameters [23].

Importance of research:

• Fit light training method has been used for the first time in Albania in the training of elite boxers of the national team and its impact is expected to be large and to have a wide use in the future,

• This research is among the applied research that may benefit the sport coaches, trainers and players in different disciplines, especially those of combating sports, but not only.

• This research is among the studies addressing the ways how to improve the performance and as such it is expected to be very important.

Aim of Study. The purpose of this study is to evaluate the effect of fit light training and its importance at elite Albanian boxers to improve reaction time and punch frequency.

Materials and Methods

Participants. This group involved 16 elite Albanian boxers, aged between 21.78 ± 4.08 years old, weight 84.97 ± 12.55 (kg), height 1.84 ± 0.72 (m) and Body Mass Index (BMI) 25.4 ± 3.96 (kg/m^2), respectively. The recruited sample was based as consideration, namely elite boxers, part of the Albanian National Boxing team, who were actively regularly in boxing training for at least over 10 years. Written consent was obtained from the participant's whose involvement in study was voluntary.

Research Design. This research is an experimental study using pretest and posttest control group design. The group in this study is consisted by an experimental group and a control group. At the experimental group, fit light training was used to collect data before and after training. Basic boxing training was given to the control group and the pretest and posttest data were gathered, which were used to compare with the results taken from the experimental group.

Instrument and Protocols

Fit light – can be used as a training system that help the athletes to strengthen the connections between the brain and the body as well as to improve the development of reaction speed. The methods used are: Program sequence, Run programmed sequence, Hand/eye co- ordination. Opto-jump –through an optical system with two tracks, receiver (R_X) and transmitter (T_X), as well as with the help of two cameras, it provides with live images (figure 1), which are very important for the evaluation of movement, in addition to numerical data. All the data were recorded and performed in opoto jump device, Biomechanics Laboratory of Sports University of Tirana [21].

Figure 1. Image from opto jump optical system measurements

Procedure

The procedure in this study is consisted by three stages:

Stage 1- Pretest measurements

In this phase, the pretest data of biomechanical variables for both groups experimental and control group were collected, with the hypotheses that the pretest data of the two groups data didn't have a significant difference on average values.

Stage 2- Training methods

This stage includes: (1) both groups have an warm up protocol: a 5 min self-paced run followed by 5 min of active all body limbs, stretching and specific movements. At the end of warm up period, an interval of 5 rested was applied. (2-a) The experimental group is given, the fit light

training (2-a), while the basic boxing training (2-b) was used to the control group. The duration of experiment was 12 weeks. The frequency of training is 3 times a week, 90 min each training session.

Stage 3- Posttest measurements

The data posttest for both groups was collected after two different training methods, and they were used to undergo through statistical procedures

Statistical Analysis.

The data analysis techniques include: A variance homogeneity test was applied in order to test the similarity of variance in the pretest and posttest, experimental and control group. The homogeneity test used Levine's test with t-test [24]. The paired samples t-test and the independent t-test were used to evaluate the data. Pretest and posttest data were used to identify the variations in the Biomechanical variables in a paired samples t-test in each group. Then all the data collected were compared using the independent samples t-test. All the data were analyzed using the statistical program SPSS version 20, with a significance level of 5% ($p < 0.05$).

Results

The descriptive statistics of anthropometric data for experimental and control group are given in table 1. As it can see from this table, the respective values for every parameter are approximately similar for age and height, with very small changes between other parameters, but not significant changes

Table 1. Descriptive statistics of anthropometric data for experimental and control group.

Parameter	**Mean ± SD Exp. Group**	**Min.value Exp. Group**	**Max. value Exp. Group**	**Mean ±SD Contr. Group**	**Min. value Contr. Group**	**Max. value Contr. Group**
Age (year)	21.77±4.086	18.00	28.00	21.00±4.246	18.00	27.00
Height (m)	1.84±0.72	1.75	1.94	1.83±0.07	1.75	1.93
Weight (kg)	84.97±12.55	70.50	112.10	80.08±8.85	70.50	91.20
BMI (kg/m^2)	25.42±3.96	20.52	34.20	23.84±2.71	20.50	27.50

Values are expressed as means ± standard deviations. BMI= body mass index.

The biomechanical variables of reaction time (R_T) for upper limb (arms), reaction time (R_T) for lower limbs (legs) are measured in second; and punch frequency (P_F), which presents the number of punches/sec, within each group of study: the experimental group and control group, taken from measurements during three rounds x 3 minutes in pretest and posttest data.

Table 2 shows the results of paired samples t-test within each group in terms of means of three rounds for pretest and posttest data for both groups: experimental and control group.

Table 2. Pair of variables comparison within group of pretest and posttest data for experimental and control groups.

Parameter (within groups)	**Group**	**Pretest Mean**	**Posttest Mean**	**Percentage of change**	**t-value**	**Sig. p-value**
R_T Arm (s)	Experimental	0.6205	0.4944	20.32	12.173	0.000
R_T Arm(s)	Control	0.6182	0.5779	6.51	7.314	0.000
$P_{Freq.}$(punch/s)	Experimental	1.3369	1.6462	18.79	20.121	0.000
$P_{Freq.}$(punch/s)	Control	1.3461	1.4086	4.43	7.058	0.152
R_T Leg(s)	Experimental	0.6215	0.5102	17.94	4.124	0.000
R_T Leg(s)	Control	0.6195	0.5797	6.42	5.401	0.000

Values are expressed as means and changes in percentages (%).

Table 3 shows the results of paired samples t-test between experimental group and control group in terms of means of three rounds for pretest and posttest data for both groups.

Table 3. Pair of variables comparison of pretest and posttest measurements for experimental and control groups.

Pair of variables (between groups)	**Data test**	**Mean Experimental**	**Mean Control**	**Percentage of change**	**t-value**	**Sig. p-value**
R_T Arm(s)	Pretest	0.6205	0.6182	0.37	1.070	0.297

R_T Arm(s)	Posttest	0.4944	0.5779	14.45	-3.672	0.001
$P_{Freq.}$(punch/s)	Pretest	1.3369	1.3461	0.68	2.406	0.254
$P_{Freq.}$(punch/s)	Posttest	1.6462	1.4086	14.43	-3.365	0.000
R_T Leg(s)	Pretest	0.6215	0.6195	0.32	-2.682	0.131
R_T Leg(s)	Posttest	0.5102	0.5797	11.98	-1.061	0.001

Values are expressed as means and changes in percentages (%).

Table 4 reports the independent samples t-test results for the pretest and posttest data for experimental and control group.

Table 4. Independent samples t-test for the posttest data for Experimental and control groups.

Parameter	**Levine's test sig.**	**Mean Experimental**	**Mean Control**	**Percentage of change**	**t-value**	**Sig. p-value**
R_T Arm(s)	0.275	0.4944	0.5779	14.45	0.562	0.000
$P_{Freq.}$(punch/s)	0.100	1.6462	1.4086	14.43	-3.443	0.001
R_T Leg(s)	0.305	0.5102	0.5797	11.98	-2.125	0.039

Values are expressed as means and changes in percentages (%).

Discussion

Based on the results for the biomechanical variables reaction time (R_T Arm) for upper limb, reaction time (R_T Leg) for lower limbs and punch frequency ($P_{Freq.}$) between two groups, experimental and control group, taken from each phase of measurements, and their respective rounds. From the comparisons of results of table 2 for the pair of variables within group of pretest and posttest data for experimental and control groups, it can be concluded that for:

Pair 1: The comparison of R_T Arm parameters in pretest–posttest data experimental group. The control analysis of R_T Arm variable for experimental group in pretest – posttest data, varies considerably, respectively with a mean value of 0.6205 and 0.0499 and they are accompanied with a standard error mean (0.0156 and 0.0513), statistically the same. However, the confidence interval CI, ($\gamma = 95\%$) of reaction time values differentiation is: $]0.01976; 0.02779[$ and t-test value t(7)=12.173; p<0.05 indicate a good improvement in statistical terms of the test performed for experimental group.

Pair 2: The comparison of R_T Arm parameters in pretest–posttest data control group. Table 2 shows a difference of the mean of R_T Arm parameter for control group, as a considerable SD. The control analysis of paired t-test shows that there is a difference that is indicated by the respective values: t(7)=7.314 and p<0.05, statistically significant. It should be that CI interval is not very wide: $]0.0935;0.01665[$, as a result of the standard error mean, 0.01762 and 0.01802 respectively.

Pair 3: The comparison of $P_{Freq.}$ parameters in pretest–posttest data experimental group. Statistically, punch frequency pretest data is larger than posttest data, thus the respective values 1.3369 and 1.6462 increase considerably after training phase and this is statistically significant: t(7)=20.121; p<0.05. However, the standard error mean for the selection is a little bit higher (0.04635) pretest than the value (0.04224) posttest value of the mean value after training, and it is made evident from the effect of fit light training.

Pair 4: The comparison of $P_{Freq.}$ parameters in pretest–posttest data control group. For the control group, t-test analysis of punch frequency variable shows that there is no essential difference in terms of mean value of this parameter, but it is noticed a considerable SD value. The t-test values: t(7)=7.058 and p=0.152>0.05, confirm that there is no statistical significance at this control group. It should be highlighted that the CI ($\gamma = 95\%$), proves to be wide $]0.07665;0.13964[$ and this is a result of the standard error mean.

Pair 5: The comparison of R_T Leg parameters in pretest – posttest data experimental group. Comparing the results for R_T Leg variable at experimental group, it is observed that the mean values pretest and posttest have changed from 0.6215 to 0.5102, with the respective standard error mean (0.0119; 0.01334), statistically the same. The CI confidence interval values differentiation is: $]0.00873;0.02608[$, t(7)=4.124 and p<0.05, shows a good improvement of R_T Leg for this experimental group, after fit light training method.

Pair 6: The comparison of R_T Leg parameters in pretest – posttest data control group. Analysis results for the same variable R_T Leg at control group, revealed respectively the mean values: 0.6195 and 0.5797 for pretest and posttest measurements. These values are accompanied by standard error means: (0.01019; 0.00953) statistically the same. The respective t-test values: t(7)=5.401 and p<0.05 indicate a statistical significant result. Meantime, the CI interval for the control group $]0.00711;0.01585[$ shows slight differences as a result of standard mean.

From the comparisons of results of table 3 for the pair of variables between groups of pretest and posttest data for experimental and control groups, it can be concluded that for:

Pair 1: The comparison of R_T Arm parameters in pretest data experimental –control group. In table 3, it is not observed a noticeable difference of the mean of R_T Arm pretest data of experimental and control group, 0.6205 and 0.6182, practically the same. The control t-test analysis shows that there is no essential difference between the differences of R_T Arm parameter,

as indicated by the respective values: t(7)=1.070 and p=0.297>0.05. This is proven by the CI interval to be very wide: $]-0.002212;0.7012[$, as a result of the standard error mean.

Pair 2: The comparison of R_T Arm parameters in posttest data experimental –control group. Whereas posttest data shows that mean values of R_T Arm for experimental–control group are respectively: 0.4944 and 0.5779, which are smaller than the ones pretest results, which were 0.6205 and 0.6182. Yet these values are statistically different after posttest, since the statistical findings show t(7)=-3. 672; p=0.001<0.05 and for the reason that R_T Arm of experimental group is smaller than R_T Arm of control group.

Pair 3: The comparison of $P_{Freq.}$ parameters in pretest data experimental–control group. In pretest conditions, punch frequency $P_{Freq.}$ parameter seems to be the same for both groups: 1.3369 and 1.3461, without any noticeable difference. The t-test analysis, t=2.406 and p=0.254>0.05, shows that there is not any difference of this parameter. The CI ($\gamma = 95\%$) results that this interval is very wide $]0.2194;0.2732[$, as a result of the standard error mean.

Pair 4: The comparison of $P_{Freq.}$ parameters in posttest data experimental–control group. Statistically, $P_{Freq.}$ variable posttest data indicate that they are larger than $P_{Freq.}$ pretest, so this variable increase considerably after training period, this is statistically distinct, even though the respective values are taken after training phase in posttest measurements for the both groups. The mean values are respectively: 1.6462 and 1.4086, quite different from those taken from pretest measurements: 1.3363 and 1.3461, respectively. The analysis paired t-test results: t(7)=-3.365; p<0.05, indicate a good improvement in statistical terms of the posttest after training phase. However, the standard error mean for the selection in pretest data is considerably higher than posttest data, which is proven by the very wide of CI, $]-0.36220;-0.10225[$.

Pair 5: The comparison of R_T Leg parameters in pretest data experimental –control group. The pretest data for R_T Leg parameter gives the man values: 0.6215 and 0.6195 for experimental and control groups, which show no essential difference between them. This is proven by the t-test results respectively: t(7)=-2.682 and p=0.131>0.05, statistically non-significant. These mean values are accompanied with a standard error mean (0.038 and 0.048), statistically the same. This result is shown also by the CI value interval $]0.0693;0.0639[$, without any noticeable difference.

Pair 6: The comparison of R_T Leg parameters in posttest data experimental–control group. Whereas after training phase, it is observed that the posttests mean values of R_T Leg of experimental and control group are respectively: 0.5102 and 0.5797. These values are smaller than the pretest mean values, which were (0.6215 and 0.6195), CI ($\gamma = 95\%$). T_R leg variable is seen to be changed after training phase in posttest data, with these values: t(7)=-1.061, p=0.001<0.05, since R_T Leg of experimental group is statistically lower than R_T Leg of control group. However, it should be highlighted than the CI interval ($\gamma = 95\%$) is proven to be wide, $]-0.06155;0.0813[$, as a result of the standard error mean.

From the independent samples t-test in table 4, it can be verified whether the Levene's test is significant. Since the significance value p=0.275>0.05, this means that the equal variances is not significant, this implies that equal variances assumed. The mean score of the reaction time R_T Arm for the elite boxers of experimental group is 0.49 (SD=0.78) and that of the control group was 0.58 (SD=0.05). This difference was statistically significant: t(7)=0.562; p<0.05. Regarding to the punching frequency ($P_{Freq.}$) variable, the Levene's test result p=0.100>0.050, non-significant, equal variances assumed. The $P_{Freq.}$ parameter for experimental group is reported as follow: mean value 1.65 (SD = 0.04) for experimental group and 1.41 (SD=0. 61) for the control group. In this way, the difference was statistically significant, because t(7)=-3.443, p=0.001<0.05, statistically significant. For the last variable R_T Leg, results of Levene's test p=0.305>0.050, show that it is no significant and it implies that equal variances assumed. The value reported in means for experimental group: 0.51 (SD=0.07) and for the control group: 0.58 (SD=0.43). The respective values from t-test results, t(7)=-2.125 and p=0.039<0.05, confirm that the differences between two groups are statistically significant.

Conclusions

Considering the objectives of the research and presenting the results of the research study, the following can be concluded:

1. The biomechanical analysis point out significant statistical changes in one of the more important sport disciplines of movement, such is boxing.

2. The results have revealed that variables of R_T Arm, R_T Leg and $P_{Freq.}$ in pretest data in control group were in similar levels, in the posttest data they were respectively: R_T Arm and T_R Leg higher and $P_{Freq.}$ lower.

3. The application of the fit light training method is very effective and it is highly recommended to use widely for the training of all boxers, not only the elite ones.

3. Applying fit light method in elite Albanian boxers, a high intensity sport competition was very effective in: reducing reaction time of arm and legs, increasing punch frequency, for the boxing players of our national team.

In other words, applying fit light training method, is very effective in improving R_T Arm, R_T Leg and $P_{Freq.}$.

Recommendations

1. The results of this study are expected to be useful for coaches of boxing and other sport disciplines and combating sports such as: kick boxing, wrestling, martial arts, etc.

2. Similar studies should be performed on different sport disciplines and samples.

3. The fit light method can be applied also in all sports that require a faster reaction time to improve sports results and performance.

Limitations of the study:

However, there are some limitations, which need to be validated for the future researches. These limitations include: the size of the sample used, so it is necessary to involve a wider sample size, including boxers, kick boxers, and wrestling of different ages and weights, in order to see the results over a longer period of time and to reduce comparisons between them.

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