

# The effect of relaxation and concentration on the performance of archers in Sri Lanka Army

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**Abstract** - Archery is a mental sport, requiring high levels of attention and physical/mental relaxation. Nevertheless, our initial questionnaire survey established the fact that the status of knowledge on relaxation and concentration techniques was minimal among the study population. Present study was hence conducted to find the effect of relaxation and concentration on the performance of archers in Sri Lanka Army archery pool, using a "Pretest-Posttest Control Group Design". An eight-week relaxation and concentration training was provided as the treatment for the experimental group consisting seven male and five female archers while the control group consisted two males and two females. Eight techniques were used in the training: breath-control and progressive relaxation for somatic relaxation; meditation for cognitive relaxation; over learn skill, imagery, non-judgmental thinking, self-talk and eye control for concentration. Pulse was assessed to find the effectiveness of relaxation. Pulse rates between the pretest and posttest showed a significant difference soon before shooting ( $p=0.071$ ) as well as soon after shooting ( $p=0.005$ ), indicating an increased relaxation. But when the experimental and control groups were compared at the posttest, before and after shooting the difference between pulse rates was not significant ( $p=0.833$  and  $0.651$ ), indicating the treatment has not been responsible for increased relaxation. Although, there was no significant difference, when experimental and control group performances were compared at the posttest ( $p=0.1815$ ), there was a significant difference between the performance of experimental group archers between the pretest and posttest ( $p=0.033$ ). Therefore, although the relaxation has not found to be effective during this trial (compared to a small control group), it could be argued that the concentration techniques might have affected the improved performance in the experimental group. To receive more conclusive results a similar but more intense study is recommended with an extended treatment period and with larger sample sizes for both experimental and control groups, following this preliminary but pioneering study in Sri Lanka.

**Keywords:** Somatic relaxation, Cognitive relaxation, Concentration

## I. INTRODUCTION

Archery has been known as a mental sport, which requires high levels of attention. In competitions, archers should repeat shooting for a long time, and every shot requires high attention, physical and mental relaxation and precise shooting skills (Lee, 2009). The present research project was formulated as a result of the researcher's study visit to the Sports Village, Army Cantonment in Panagoda, Sri Lanka, followed by a discussion on research needs, which stimulated an interest to understand the most needed physical and psychological traits of the game of archery.

Literature, especially at global context, well supports concentration, attention or the focus as well as the relaxed conditions both in physical and mental body as attributes that are essential in a mental game like archery (Lee, 2009; FITA, 2014; WADA, 2009). Unfortunately, it was observed (and later established from a questionnaire, during the initial stage of the present study) that, the archers of Sri Lanka Army archery pool were not practicing any relaxation or concentration improvement techniques and even majority were not aware even if such techniques were available (Pers. Obs., 2015). Hence, the need was identified to research on the relaxation and concentration aspects required for the game of archery.

The overall objective of the study was therefore to establish the effect of relaxation and concentration on the performance of archers in Sri Lanka Army archery pool. It was achieved through quantitative evaluation of (a) the effectiveness of techniques used in the treatment for relaxation through the assessment of archers' pulses and oxygen saturations, and (b) the effect of relaxation and concentration techniques on the performance of archers. Initially the status of knowledge on the relaxation and concentration among archers in the archery pool of Sri Lanka Army was assessed at the onset of the study.

## II. METHODOLOGY AND EXPERIMENTAL DESIGN

This research was based on a Pretest-Posttest Control Group Design. A pretest was conducted to identify the archers' initial performances, while their pulse rate and oxygen saturation by pulse oximeter (SpO<sub>2</sub>) were also

recorded soon before performance and soon after performance. Relaxation and concentration improvement techniques were then introduced, as the treatment, which were practiced for a period of two months. Eventually a posttest was conducted to assess the performance, pulse and SpO<sub>2</sub> similar to the pretest, in order to detect any differences in performance and in the levels of relaxation. The methodology is outlined by the flowchart in Figure 1.

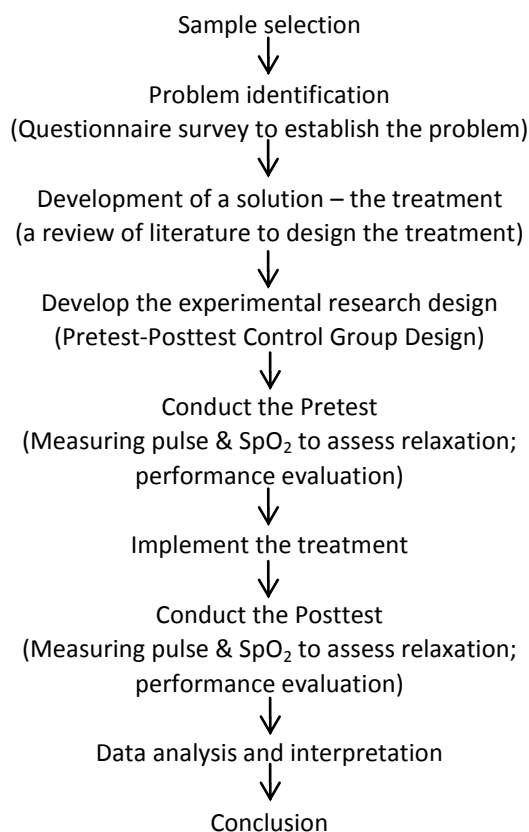


Figure 1. Flowchart explaining the chronology of the methods used in this study

#### A. The study population

Archery pool of Sri Lanka Army which consists of 16 archers (nine male and seven female) was the study population. Archers were selected for the experimental and control groups through simple random sampling. Twelve archers (five female and seven male) represented the experimental group, while four archers (two male and two female) comprised the control group.

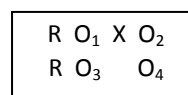
#### B. Problem Identification and development of a solution

Upon the initial problem identification through observations made and discussions conducted at the Sports Village, Army Cantonment, Panagoda, a questionnaire survey was conducted for the archery pool of Sri Lanka Army in order to establish the status of their knowledge on relaxation and concentration. From the survey it was found that the archers of Sri Lanka Army archery pool were not practicing any relaxation or concentration improvement techniques, despite their

belief that relaxation and concentration are essential for archery. They were willing to increase their awareness in relaxation and concentration techniques and thereby use those techniques to improve their performance. Therefore the research was focused on improvement of relaxation and concentration abilities of the archers in Sri Lanka Army archery pool and to identify the effect of those improved abilities on their performance.

#### C. Research Design

The research was conducted under the “Pretest- Posttest Control Group Design” which is a type of “True Experimental Research Designs”. Control group was provided with exactly the similar experiences compared to the experimental group, except the experience of the treatment (X) that was exclusive to the experimental group. Both groups were given a pretest (O<sub>1</sub> and O<sub>3</sub> respectively) and a posttest (O<sub>2</sub> and O<sub>4</sub> respectively). The pretest-posttest control group design could be summarized as:



R indicates the factors (e.g., selection) that have been controlled by using randomization (Tuckman, 1994).

#### D. Pretest-Posttest procedure

Pretest and posttest scores were collected using standard target face of 50 m distance. Performance was evaluated from the exact game itself. Therefore each archer was given 36 arrow shoots as per six ends. The total score was calculated for each archer’s performance at the pretest and posttest. Pulse and SpO<sub>2</sub> was measured in each archer soon before and soon after shooting both at the pretest and the posttest.

#### E. The treatment

The relaxation and concentration training program consisted of three relaxation techniques namely breath-control and progressive relaxation for somatic relaxation and meditation for cognitive relaxation. Five techniques were used for concentration improvement namely overlearn skill, imagery (mental rehearsal), non-judgmental thinking, self-talk and eye control (Sheard and Golby, 2006; Mamassis and Doganis, 2004; Johnson et al., 2004). These techniques were used throughout the program length of eight weeks, with sessions ranging from 30 minutes to three hours per day, conducted for three days per week.

#### F. Data analysis and interpretation

After a period of eight weeks under treatment, the performance of archers was evaluated in comparison to their initial performance, using appropriate quantitative statistical tests with acceptable level of statistical significance (based on p-values). Performance evaluation

was done using the Wilcoxon Signed Rank Test and Mann-Whitney Test, as the performance data were not normally distributed. The former was used to compare the performance of archers in the posttest with that of the pretest, while the performance of experimental group archers were compared with the control group at the posttest using the later.

Archers pulse and the SpO<sub>2</sub> were assessed to evaluate the effectiveness of techniques used in the relaxation treatment. Pretest and posttest SpO<sub>2</sub> data were compared using the same non-parametric tests as the data was not normally distributed. Nevertheless, the data for pulse rate was otherwise, and were assessed using two parametric tests, viz. Paired T-Test and Two Sample T-Test, used respectively for the comparisons between the pretest and the posttest, and experimental group archers and control group archers at the posttest.

### III. RESULTS

#### A. Questionnaire survey

A majority of archers were not aware and doubted their awareness about both the relaxation (75%) and concentration (75%) techniques. Nevertheless, the archers' opinion on most needed traits in archery revealed the first priority for cognitive relaxation, second for somatic relaxation, third for both somatic relaxation and concentration and fourth priority for concentration.

#### B. Progress evaluation during the treatment

There were four progress tests conducted in every other week for eight weeks after introducing the relaxation and concentration training techniques. Figure 2 provides the average scores assessed at the each progress test for control and experimental groups including the average scores of the pretest at the beginning and the posttest at the end.

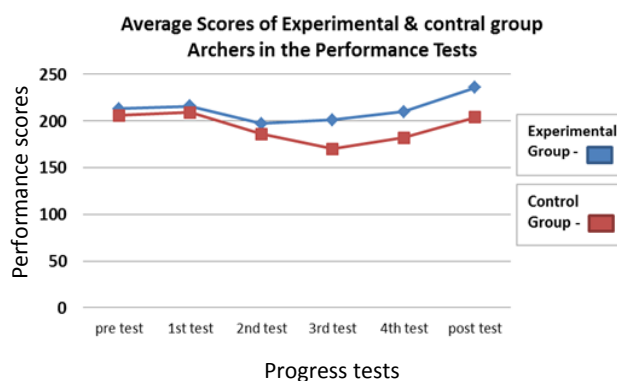


Figure 2. Average scores of experimental and control groups archers at progress tests

#### C. Relaxation and performance assessment and the effect of the treatment

1) *The saturation of oxygen in the blood as measured by pulse oximeter (SpO<sub>2</sub>):* Table 1 and 2 provides the two-way tables showing the analyzed data of SpO<sub>2</sub> soon before and soon after performance at the pretest and posttest.

Table 1. The difference of SpO<sub>2</sub>% soon before shooting at the pretest and posttest and its statistical significance

SpO <sub>2</sub>	Control group			Experimental group			Both	
	Q1	Mdn	Q3	Q1	Mdn	Q3	Mdn	CI
Pretest before performance	99.00	99.50	100.00	99.00	99.00	100.00	99.50	99.00, 99.50
Posttest before performance	99.00	99.50	100.00	99.00	99.00	100.00	99.50	99.00, 99.50
Wilcoxon Signed Rank Test							<b>p-value= 0.500</b>	

Table 2. The difference of SpO<sub>2</sub>% soon after shooting at the pretest and posttest and its statistical significance

SpO <sub>2</sub>	Control group			Experimental group			Both	
	Q1	Mdn	Q3	Q1	Mdn	Q3	Mdn	CI
Pretest after performance	99.00	99.50	100.00	99.00	99.00	99.00	99.00	99.00, 99.50
Posttest after performance	99.00	99.00	99.75	99.00	99.00	99.75	99.00	99.00, 99.50
Wilcoxon Signed Rank Test							<b>p-value= 0.395</b>	

Table 3. The difference of pulse rate (beats per minute) soon before shooting at the pretest and posttest and its statistical significance

Pulse	Control group			Experimental group			Both		
	Mean	SD	CI	Mean	SD	CI	Mean	SD	CI
Pretest before performance	78.0	9.90	62.25, 93.75	83.92	8.28	78.65, 89.18	82.44	8.77	77.76, 87.11
Posttest before performance	78.8	10.9	61.45, 96.05	80.08	8.14	74.91, 85.26	79.75	8.52	75.21, 84.29
Paired T-Test							<b>2.69</b>	6.94	-6.38, 1.01
							<b>p-value= 0.071</b>		

Table 4. The difference of pulse rate (beats per minute) soon after shooting at the pretest and posttest and its statistical significance

Pulse	Control group			Experimental group			Both		
	Mean	SD	CI	Mean	SD	CI	Mean	SD	CI
Pretest after performance	82.5	17.9	53.99, 111.01	90.4	11.5	83.09, 97.74	88.44	13.20	81.41, 95.47
Posttest after performance	79.3	22.9	42.8, 115.7	85.2	10.0	78.79, 91.55	83.69	13.63	76.42, 90.95
Paired T-Test							<b>4.75</b>	6.44	-8.18, -1.32
							<b>p-value= 0.005</b>		

Table 5. The difference of performance scores at the pretest and posttest and its statistical significance

Score	Control group			Experimental group			Both	
	Q1	Mdn	Q3	Q1	Mdn	Q3	Mdn	CI
Pretest performance	136.8	226.0	255.3	166.3	240.5	259.8	220.3	178.5, 251.5
Posttest performance	136.5	194.5	281	179.5	254.5	277.8	232.5	195.5, 268.0
Wilcoxon Signed Rank Test							<b>12.2</b>	-5.0 37.0
							<b>p-value= 0.057</b>	

2) *Pulse rates:* Table 3 and 4 provides the two-way tables showing the data analysis on pulse rates soon before and soon after performance at the pretest compared with that of the posttest.

3) *Performance Scores:* Table 5 provides the two-way table showing the analysis of data on the performance scores at the pretest and posttest.

#### IV. DISCUSSION

##### A. Progress evaluation during the treatment

When the average score of experimental and control group archers were considered separately at each progress test, there was a relative progress in increments of performance scores in the experimental group archers compared to the control group. Nevertheless, the statistical significance of the increases in performance scores as well as the impact of the treatment on any such progresses is discussed in the section B below.

The variation of performance scores shown at the progress tests could be attributed to some of the limitations of present study, such as the non-synchronized monthly leave received by the study subjects, and individual lifestyle attributes. For instance it was possible those archers who lived outside the sports village to have a much deviated lifestyle from the condition of the archers lived in the sport village. Limitations of this preliminary and pioneering study are discussed in detail in the section C below, in order for future studies with similar objectives to avoid such discussions.

##### B. Relaxation and performance assessment and the effect of the treatment

1) *SpO<sub>2</sub>:* No significant difference could be established when SpO<sub>2</sub> soon before shooting at the pretest was compared with SpO<sub>2</sub> soon before shooting at the posttest ( $p = 0.500$ ; table 1), as well as in the comparison of SpO<sub>2</sub>

soon after shooting at the pretest against that of the posttest ( $p = 0.395$ ; table 2).

A healthy individual with normal lungs, breathing air at sea level, would have an arterial oxygen saturation of 95% – 100% (WHO, 2011). Therefore the peripheral oxygen saturation of a healthy individual is almost a constant that does not vary significantly. Although the study considered SpO<sub>2</sub> as a measurement of effective relaxation it was found to be a parameter that needs to be measured at a very fine resolution in such a usage.

Breath control was a technique used for somatic relaxation of archers during this study. According to Lieurance (2015) and White (2015) it was found that the peripheral oxygen saturation of a healthy individual could not be affected by one or two breathing techniques but could be approached from a number of different directions simultaneously. Peripheral oxygen saturation was widely considered in studies conducted for patients with chronic obstructive pulmonary disease (COPD) (McGovern et al., 1996), but not in healthy individuals.

Hence the present study, being in line with the literature, revealed that SpO<sub>2</sub> was not a good indicator of effective relaxation as the parameter was not sensitive enough among healthy individuals, and no significant difference could be established in the average values of SpO<sub>2</sub> in both before and after performance between pretest and at the posttest. Hence the pulse measurement alone was used to establish the effectiveness of relaxation techniques.

2) *Pulse rates*: When the averages of pulse rate soon before shooting in control and experimental groups together were compared between the pretest and at the posttest, the difference was significant enough ( $p=0.071$ ; Table 3). Furthermore, a highly significant difference was found ( $p=0.005$ ; Table 4) in the average of pulse rates soon after shooting, between the pretest and at the posttest, when control and experimental groups considered together. Both above results indicate an increased level of relaxation in the posttest (see tables 3 and 4).

Nevertheless, when the experimental and control groups were compared at the posttest, before shooting as well as after shooting the difference between pulse rates were not significant ( $p=0.833$  and  $0.651$  respectively), indicating those techniques used for relaxation during the treatment have not been significantly effective at increasing the relaxation levels. The fact that increased levels of relaxation could not be accounted to the treatment of this study could be explained by the limitations discussed later (see section C).

3) *Performance scores*: When the average scores for performance in control and experimental groups together were compared between the pretest and the posttest, the

recorded increase of the score (12.2) was marginally significant ( $p= 0.057$ ). Furthermore, a highly significant performance increment was established when the pretest and posttest performance of the experimental group archers' were compared alone ( $p=0.033$ ), while the same comparison for control group performance alone did not show a significant performance increment ( $p=0.572$ ), leading to presume the treatment for the experimental group may have had a positive impact on performance increment.

Nevertheless, the present study could not establish a significant difference between the performance scores, when experimental and control group performances were compared at the posttest ( $p=0.1815$ ), indicating that the study did not statistically signify the treatment as directly responsible for the increased performances. The inability to attain the desired levels of significance in pretest and posttest performance comparisons could further be explained by numerous limitations encountered in the present study, which was the first of its kind conducted in Sri Lanka.

### C. Limitations of the study

During first three weeks of the treatment three relaxation techniques were taught to the archers and they were instructed to practice them for three days a week until the posttest. Except for the progressive relaxation other two techniques, breath control and meditation were self-oriented techniques. Therefore, though they were continuously guided and provided supervision it was difficult to state if they properly practiced those techniques. Even the concentration techniques used in the treatment such as imagery, non-judgmental thinking and self-talk were also self-oriented, where the researcher could only facilitate. When it comes to effective concentration techniques like imagery (mental rehearsal) it also depends on the person's ability to imagine. A person with poor imagination skills would not benefit much from such techniques. Therefore, five different concentration techniques were introduced during the present study in order to minimize such limitations.

Additionally, making the study schedule further difficult, each archer received 10 days of leave each month, which were not synchronized. This absenteeism affects the training program seriously. Continuous participation and practice of both relaxation techniques and regular shooting was considerably interrupted by the non-synchronized leave for study subjects. This might have probably affected the physiological attributes related to the study and the overall performance of the archers, despite the matter was beyond the control of the researcher. Furthermore, the posttest happened to fall after a couple of weeks of leave for some subjects. Therefore, the effectiveness of training program could

have been lowered by the time of the posttest at least in some archers.

When it comes to female archers their premenstrual and menstrual conditions have also affected their participation in the study schedule. Furthermore, respective hormonal changes during menstrual period could affect their psychological and physiological attributes and thereby the performance. According to Wilson (2015), rapid heart rate is possible during this period. There were also external factors affecting heart rate such as smoking, which also affect SpO<sub>2</sub> (WHO, 2011).

The archers' regular participation in training and study schedules were further disturbed by (a) two archers participating in a physiotherapy course during the last two weeks of research (one each from the experimental and control groups), and (b) a trial held to select archers for a foreign tour set with 70 m distance shooting, which was different to 50 m distance used in the present study (two from control and three from experimental groups).

Furthermore, even if the archers have practiced relaxation and concentration techniques, anyone's mind could have acutely troubled and/or emotionally tensed for any personal matter at the time of the posttest, possibly affecting the archer's heart rate at the time of measuring and so did his or her performance.

Lastly, the eight weeks relaxation and concentration training program might not be enough to make significant changes in physiological parameters like heart rate and to significantly affect experimental group archers' performance. It is supposed that at least six weeks period is required to make any physical adaptation (Burgomaster et al., 2008) hence a much longer period could be needed when it comes to psychological adaptations.

#### V. CONCLUSION

According to the present analysis the effect of relaxation and concentration on the performance of archers in Sri Lanka army archery pool could not be completely established with desired level of statistical significance. The difference between pulse rates was not significant when the experimental and control groups were compared at the posttest, before and after shooting, indicating the relaxation techniques have not been effective, while the performance scores of posttest between the control and experimental groups did not show a significant difference.

Nevertheless the study provides insight that there was a considerable effect where the difference between pretest and posttest performance in the experimental group was statistically significant, although there was no significant

difference, when experimental and control groups performances were compared at the posttest.

Considering all the results interpreted above it can be concluded that, although the relaxation has not found to be effective from pulse assessment, relaxation together with concentration or concentration techniques alone have improved the performance of experimental group archers, although it could not be directly attributed to the treatment with an acceptable statistical significance.

Furthermore, personal communication with archers indicated they themselves felt some positive effect of the relaxation and concentration techniques. Lastly, if the factors mentioned under limitations of the study were controlled this study would have provided more conclusive evidence. Hence the need of more intense conditions to conduct experimental studies of this nature is further emphasized. This preliminary study is recommended to be further developed and executed under more intensive conditions, with a larger sample size (for both experimental and control groups) and with an extended treatment period in a real experimental setting.

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