

ORIGINAL ARTICLE



Comparative Characteristics of Psychophysiological and Shooting Performance Between Intermediate and Elite Compound Archers

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Submitted October 06, 2023; Accepted in final form December 03, 2023.

ABSTRACT

Background. Archery is a sport that requires a unique set of skills, equipment, and mental focus. **Objectives.** The aim of this study was to compare characteristics of psychophysiological and shooting performance between intermediate and elite compound archers. **Methods.** Using a cross-sectional study design, twenty archery players participated in the study (age range from 13–21 years old). The participants were divided into two groups: intermediate groups and elite groups. The revised Competitive State Anxiety-2 (CSAI-2R) was used to measure competitive anxiety and arousal. In addition, heart rate was measured using a Polar heart rate monitor, and a digital pulse oximeter (Instant Read Finger Pulse Oximeter, Model OX250, MeasuPro, USA) was used to monitor participants' blood oxygen percentage. **Results.** The results of the groups were compared using descriptive, independent T-test and Pearson correlation tests. The descriptive analysis indicated a pattern of decrement in cognitive anxiety, somatic anxiety, blood oxygen, and heart rate among the elite group compared to the intermediate group during shooting. The results also showed a significant difference between groups for oxygen percentage and shooting performance. No significant difference between groups for cognitive anxiety, somatic anxiety, self-confidence, and heart rate. Furthermore, self-confidence and shooting performance showed a higher correlation among the elite group. **Conclusion.** It can be concluded that the elite archers with better shooting scores are associated with lower psychophysiological variables, including cognitive anxiety, somatic anxiety, blood oxygen percentage, heart rate, and higher self-confidence compared to intermediate archers.

KEYWORDS: *Psychophysiological Characteristics, Shooting Performance, Compound Archers.*

INTRODUCTION

Archery is a sport that requires a unique set of skills, equipment, and mental focus. Athletes must have a higher level of physical fitness, technical proficiency, and the ability to consistently use techniques and tactics (1) to hit their target. Furthermore, archers must have a strong upper body, especially in their shoulder and forearm muscles, as they need to draw and release the bowstring with precision and strength. Archery also demands mental discipline and focus, as archers must maintain a calm and

focused mindset while shooting. To excel in archery, athletes must continually practice their motor representations and perfect their shooting technique. This includes working on their stance, tension and aiming, release, and subsequent procedures. Furthermore, archery requires a combination of physical strength, endurance, mental focus, and technical skill (2). These elements must all be honed and integrated for an archer to achieve consistent accuracy and success on the range or in competition.

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The Compound Archer is a highly skilled and disciplined individual who participates in the sport of archery using a compound bow. Their success in the sport is characterized by consistently hitting targets with exceptional precision and accuracy. To achieve this level of skill, the Compound Archer must possess a combination of physical fitness, technical proficiency, mental focus, and tactical awareness (2). Due to the static nature of archery shooting, they must have a strong upper body, particularly in the forearm and shoulder girdle (3). In addition, the Compound Archer must have excellent fine motor skills, as archery is a sport that requires precise and controlled movements. Furthermore, the Compound Archer must possess the mental fortitude to maintain concentration and focus during competitions. With the use of a compound bow, the Compound Archer can take advantage of the bow's mechanical assistance, which allows for greater accuracy and consistency in shot placement. However, it is important to note that even with the assistance of a compound bow, the Compound Archer still needs to possess a high level of skill, technique, and other important aspects to excel in the sport.

Psychophysiology is an interdisciplinary science that studies the relationship between mental activities and physical function. Psychophysiological responses, such as increased tension, anxiety, and stress, can significantly impact an archer's performance. These responses can be measured through physiological indicators, such as heart rate, blood pressure, and cortisol levels. Understanding the psychophysiological responses in archery can help athletes and coaches develop strategies to manage stress, optimize focus, and improve overall performance. Moreover, research has shown that long-term professional training in archery does not guarantee success, as psychological factors and neurological reasons can create barriers to reaching elite levels (4).

MATERIALS AND METHODS

Participants. The study involved 20 compound archers, who represented their state in national competition. The participants were assigned into 2 groups of 10 people based on the total score obtained during the 50m scoring. The range between 320–339 points represented junior archers. While range between 340–360 points represented by elite archers. To be included in the study, archers must have at least two years of experience with state teams and national

competitions. This study was approved by the University's Research Ethics Board Committee and conducted according to the Declaration of Helsinki. All participants and their parents gave their written consent to research and were informed about the purpose and test procedures and about the possibility of withdrawal of consent at any time for any reason.

Instruments. Competitive State Anxiety Inventory – 2 Revised (CSAI-2R) (5). CSAI-2R was used to measure athletes' competitive state anxiety. The measure consists of three subscales with 5 items for cognitive anxiety, 7 items for somatic anxiety, and 5 items for self-confidence. The items are attached to a 4-point Likert scale ranging from "1=not at all" to "4=very much so". Subscale scores were calculated by summing the scores of each item in each subscale. Its validity and reliability have been widely reported, and the Bahasa Malaysia version of this study was validated (6).

Heart rate was measured using a Polar heart rate monitor (S710i, Polar Electro Oy, Finland). The transmitter belt was fitted on the participants' chest wall before the beginning of the data recording. A heart symbol will start flashing and a heart rate (beats per minute) will appear in a maximum of 15 seconds. The data obtained from the heart rate monitor were transmitted through infrared to the computer via polar precision performance software and stored for data analysis.

Blood oxygen percentage - The blood oxygen used in this study was a digital pulse oximeter (Instant Read Finger Pulse Oximeter, Model OX250, MeasuPro, USA), which allows the simple measurement of blood oxygen with minimum inconvenience to the participants (7). Each participant inserted their right index finger into the digital pulse oximeter, measuring their blood oxygen level. Using the simple tool can prevent the possibility of provoking and deterring participants' psychological state by fitting them with unfamiliar scientific apparatus (7).

Archery Performance Recording Sheet - A simple score sheet was used to record archers shooting performance. Performance was measured for 50m distance shooting with a total of 36 arrows.

Procedures. Ethical clearance from the University's Research Ethics Board Committee was obtained before the study began. The measurement was obtained during training

sessions at their training center, respectively. Archers were approached and briefed regarding the nature and aims of the study. Consented archers were then signed an informed consent form. Participants underwent the test according to the sequence set by the researcher alternately. The measurement has begun with completing the CSAI-2R questionnaire. Followed by a fixed HR transmitter chest belt on the chest wall. Next, participants immediately set the archery equipment and completed warming up on the archery range. They were given two ends of sight test to confirm their sighting. Then participants were given two minutes to get ready before starting the 50 meters scoring trial. The HR monitor was started, and participants began by scoring six ends to complete the 36 arrows. Polar Heart Rate (HR) was recorded continuously throughout the scoring session. After completing the scoring, the HR monitors were removed, and the Instant Read Finger Pulse Oximeter was taken immediately after the end of the scoring.

Statistical analysis. All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS version 26). Descriptive statistics were calculated for each variable: cognitive anxiety, somatic anxiety, self-confidence, oxygen percentage, heart rate, and shooting score. Variables were described by themselves mean (M) and standard deviation (SD). The Kolmogorov–Smirnov test and Shapiro–Wilks test were used to check the normality of the data. The independent T-test was used to determine the differences between groups, the differences were significant at ($p < 0.05$). The Pearson correlation coefficient (r) was used to

examine the correlation. The correlation was considered significant at r not less than 0.5 ($p < 0.05$). Before the main analysis, the data were screened for accuracy, missing values, outliers, and basic assumptions.

RESULTS

Table 1 shows descriptive and independent T-tests of competitive state anxiety, oxygen percentage, heart rate, and shooting score between intermediate and elite compound archers. The results revealed significant differences in blood oxygen percentage and shooting score ($p < 0.05$). It was observed that elite compound archers had a lower blood oxygen level during exercise compared to intermediate compound archers. The results of the T-test also revealed a significant difference in shooting scores, in which the elite compound archers show a higher score than intermediate compound archers. However, no significant ($p > 0.05$) in cognitive anxiety, somatic anxiety, and self-confidence, as well as heart rate between the two groups was observed. Despite these non-significant differences, we observed a pattern that a better shooting score is associated with lower psychophysiological variables among elite compound archers in the current study. Meanwhile, the Spearman correlation in Table 2 shows a strong positive correlation between self-confidence with shooting performance ($r = 0.56$, sig = $0.01^* < 0.05$). However, other psychophysiological variables did not significantly correlate with shooting performance ($p > 0.05$).

Table 1. Descriptive analysis and independent T-test of psychophysiological and shooting performance between intermediate and elite compound archers (M±SD)

Variables	Intermediate	Elite	t	p-value
Psychophysiological				
Cognitive	10.90±3.03	9.80±3.33	0.77	0.45
Somatic	11.60±2.95	11.00±3.27	0.43	0.67
Self-confidence	13.60±3.50	16.40±2.91	-1.94	0.68
Blood oxygen (%)	98.50±0.71	96.90±1.45	3.14	0.01*
Heart Rate (bpm)	98.50±17.00	96.50±16.02	-0.54	5.96
Shooting Performance				
50M score	329.60±6.90	341.80±3.20	-5.09	0.00*

Note: *: $p < 0.05$; M: Mean; SD: Standard Deviation.

DISCUSSION

This study aimed to examine a comparative analysis of psychophysiological characteristics and

shooting performance between intermediate and elite compound archers. Archery is not only about strength and physical abilities but also requires a

deep understanding of body control, skill, focus, and the ability to maintain a state of relaxation and concentration (8). Archers must also possess the ability to synchronize and repeat the stages of posture, holding the bow, pulling, aiming, and shooting. Achieving success in archery is a

multifaceted endeavor. It requires a combination of physical and mental discipline, as well as consistent practice and training (9). Archers must also navigate factors such as reaction time, coordination, technical features of equipment, breathing control, and physiological and psychological state.

Table 2: Pearson correlation of psychophysiological and shooting performance between intermediate and elite compound archers

Variables	(n=20)	
	r	p-value
Psychophysiological		
Cognitive	-0.27	0.23
Somatic	-0.40	0.07
Self-confidence	0.56	0.01*
Blood oxygen (%)	-0.39	0.08
Heart Rate (bpm)	0.11	0.64
Shooting Performance		
50M score	0.68	0.00*

Note: *: $p < 0.05$

The present study showed no significant interactions between groups for cognitive anxiety, somatic anxiety, self-confidence, and heart rate except for oxygen percentage and shooting performance. During the act of aiming, drawing the bow, and releasing the arrow, archers engage their muscles and increase their oxygen demand. Blood oxygen saturation, also known as BOP, refers to the amount of oxygen present in the bloodstream. Maintaining adequate blood oxygen saturation levels is essential for optimal performance in archery (10). Studies have shown that archers with higher blood oxygen saturation levels tend to have better focus, accuracy, and overall performance. Additionally, low blood oxygen saturation levels can lead to fatigue, decreased muscle function, and impaired cognitive abilities, all of which can negatively impact archery performance.

Archery competitions can be organized outdoors or indoors and the main goal in archery is to get the highest score by hitting the center of the target/yellow area (11). The release phase must be balanced and highly reproducible to achieve commendable results during competition (12). In archery, the ability to shoot an arrow at a given target with high accuracy is defined as high-performance shooting (13). The equipment used by both elite and beginner archers is of the same general quality, however, the difference between their performances must

be reliant on their controlled actions (14). Athletes who have a higher level of achievement will usually exhibit better performance compared to athletes with a lower performance. Therefore, the results of this study show differences in sports performance among intermediate and elite archers.

In addition, the results of the present study also indicated a pattern of increment in all psychophysiological variables and a higher level of self-confidence in elite groups. Psychology plays a significant role in the sport of archery, making it more than just a physical activity. Psychological factors such as focus, concentration, mental state, and control of one's thoughts and emotions are crucial in achieving success in archery (4). These factors are even more prominent in archery compared to other sports due to their close and highly precise nature. Previous research findings have shown that the psychological training using biofeedback was lower in both somatic and cognitive anxiety although there was non-significant interaction between groups across the measurement sessions. Meanwhile, there was also an increase in the self-confidence score after the intervention for experimental groups (9). It is essential for archers to properly understand and manage their mental state to perform at their best (15). This can involve techniques such as visualization, breathing exercises, and positive self-talk to enhance focus and concentration.

Additionally, research has shown that the brain undergoes complex processes during archery preparation, including recognition of stimuli, decision-making, and execution of actions (8). Furthermore, the level of concentration and attention required for excellent performance has been emphasized in cognitive psychology. Overall, the psychological aspect of archery is crucial for archers to achieve peak performance and overcome challenges such as tension, anxiety, and stress.

In terms of heart rate, according to earlier studies, expert archers typically exhibit higher accuracy and a lower heart rate than their beginner archers (9). Experienced archers can balance the sympathetic and parasympathetic nervous systems by decreasing heart rate and improving arousal control and accuracy at the same time. Sports like archery that need accuracy or precision would perform better with increased parasympathetic activity and greater balance between parasympathetic and sympathetic processes. Experience archers may improve arousal control and accuracy while reducing heart rate and thus a balance between sympathetic and parasympathetic systems (16). Heart rate plays a crucial role in the performance of archers during the sport (17). Several studies have shown that archery imposes a specific stress on the cardiovascular system (1). During the different phases of archery, such as drawing the bow, aiming, and releasing the arrow, there are changes in heart rate values influenced by psycho-physiological factors (17). Additionally, muscular stress is imposed on the whole-body musculature and chest and shoulder girdle muscles due to posture, limited time of shooting, and repetitive shooting. A previous study of archery athletes found that high-performing athletes had a higher HF (high-frequency), low LF (low-frequency), and low LF/HF ratio, indicating a more favorable heart rate variability (18). This suggests that optimal performance in archery may be associated with a higher level of heart rate variability and a more balanced autonomic nervous system response. Furthermore, another study found that more skilled archery athletes had higher scores and lower heart rates during competitions compared to less experienced athletes, indicating a potential correlation between skill level, performance, and heart rate in archery (19). Incorporating exercise that targets

cardiovascular fitness, as well as addressing the psychological and motor performance aspects of archery, can contribute to improved heart rate control and overall performance in archery (3).

Moreover, the present study also indicated a strong positive correlation between self-confidence and shooting performance. It is well known that self-confidence may affect athletic performance. The results of the present study and previous studies have parallel findings. It has been found that the level of self-confidence an individual possesses has differed between elite and novice athletes (9). Novice athletes may have less experience and exposure in their sports, which may cause inconsistent results compared to other studies (20). The differences between them could be due to factors such as skill levels (i.e., elite and non-elite groups) and high- and low-performance groups.

CONCLUSION

In conclusion, the present study has shown that there are differences in some psychological, physiological, and performance features between intermediate and elite archery. Even though the finding for cognitive anxiety, somatic anxiety, and heart rate is not significant, the trend showed that those variables are lower in the elite group. In short, with a lower level of psychophysiological resulted in better achievement.

APPLICABLE REMARKS

- More outcomes of psychophysiological and shooting performance to provide guidance and evidence to athletes, coaches, and various involved parties to know, identify and understand the psychophysiology status and shooting performance of athletes.
- Most of the previous studies focused on the recurve category and found a lack of research on compound archers.
- By knowing the psychological demands and shooting performance of an archer, will help in designing the appropriate training program and make sure they can perform better in reaching their peak performance.

ACKNOWLEDGMENTS

This study was made possible by the Research Grants Fundamental University (GPUF) from Sultan Idris Education University (Research Code: 2022-0576-01).

AUTHORS' CONTRIBUTIONS

Study concept and design: Mon Redee Sut Txi. Acquisition of data: Fatin Nurfatehah Mat Salleh. Analysis and interpretation of data: Fatin Nurfatehah Mat Salleh. Drafting the manuscript: Mon Redee Sut Txi. Critical revision of the manuscript for important intellectual content: Wan Nurlisa Wan Ahmad. Statistical analysis:

Fatin Nurfatehah Mat Salleh. Administrative, technical, and material support: Wan Nurlisa Wan Ahmad. Study supervision: Mon Redee Sut Txi.

CONFLICT OF INTEREST

The authors declare no conflict of interest related to the materials in the manuscript.

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