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The effects of music with different rhythms on various sports parameters: an investigation on traditional Turkish archery athletes

Kübra Şahan¹ and Emre Boz^{2*}

Abstract

Background This study seeks to contribute uniquely to the underexplored field of traditional Turkish archery by objectively examining the effects of music on physiological and technical parameters, including heart rate, shooting duration, shooting frequency, shooting performance, and draw biomechanics.

Methods In this context, the study investigated the effects of rhythmic diversity on parameters such as heart rate, shooting frequency, shooting duration, shooting accuracy, and draw biomechanics. The participants of the study were 14 students studying at Bayburt University and interested in traditional Turkish archery. The athletes were assigned shooting tasks initially without music and then with music at different BPM ranges (Downbeat, Medium, and Upbeat). Various biometric and athletic data were recorded before and after the music. During the practice, the effects of downbeat, medium, and upbeat tempo music on different physiological reactions and performance variables were analyzed. A Polar watch, a digital stopwatch, and a high-resolution camera were used during the shooting sessions. Kinovea software was used to measure draw biomechanics.

Results The study results revealed significant differences in heart rate between shots performed with music at different rhythms, with higher average values found with higher tempo music ($p < 0.05$; $F = 13.842$). Regarding shot duration ($p < 0.05$; $F = 9.212$) and shooting frequency ($p < 0.05$; $F = 8.763$), shots performed without music took longer, while shots performed with moderate tempo music were found to be the most efficient. Participants scored significantly higher for shots performed with both no music (42.09) and medium rhythm music (44.71) than for shots performed with downbeat and upbeat tempo music ($p < 0.05$; $F = 9.826$). However, no differences were found in the draw biomechanics that shape technical performance during shooting based on music type ($p > 0.05$; $F = 0.968$).

Conclusions The findings indicate that while higher musical tempos elevate athletes' heart rates and reduce shooting duration and frequency, shooting performance is superior at moderate tempos compared to downbeat or upbeat tempos.

Keywords Sporting performance, Traditional turkish archery, Music, Rhythm

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Introduction

Athletic performance is the totality of the physical, technical, tactical, and psychological abilities an individual demonstrates in a particular sport [1]. This performance is not limited to physical capacity; it is shaped by the interaction of many variables, including psychological endurance, cognitive flexibility, motivation level, and environmental conditions [2]. Athletes' success in competitive environments is possible through the synchronized functioning of these multiple components. In this context, athletic performance is influenced not only by an individual's physical skills but also by various parameters such as psychological balance and mental preparedness [3]. Music, which is thought to influence athletic performance in sports sciences and is still a topic of debate today, is among these parameters [4].

Throughout human history, music has been used as a tool to shape emotions, provide rhythm, and enhance motivation. Research on the effects of music on performance in sports science demonstrates that this relationship is bidirectional. Music, which has both an enhancing physical performance and supporting psychological well-being, can enable athletes to work with Music, which both enhances physical performance and supports psychological well-being greater motivation during training [3]. Studies show that fast-tempo music increases individuals' arousal levels and expands their exercise capacity, while slow-tempo music promotes relaxation and positively impacts emotional balance [5].

Music use in athletes impacts not only the training process but also pre-competition preparation. Music, particularly in psychophysiological preparation, stands out as a tool for athletes to balance their mental states. Training accompanied by music has been found to reduce perceived exertion and enable longer-lasting physical activities [6]. This suggests that music serves both an ergogenic (performance-enhancing) and a psychoregulatory (mood-regulating) function.

The development of athletic performance is not limited to modern sports; traditional sports are also influenced by this development process. In this context, traditional Turkish archery, with its deep-rooted history, stands out as a unique sport that blends both physical and mental elements into a holistic structure [7]. Turkish archery requires not only physical proficiency but also the combined implementation of mental processes such as balance, attention, breath control, focus, and patience [8, 9]. In this sport, where rituals and mental training play a significant role in its traditional structure, it is essential that athletic performance be evaluated not only from a results-oriented perspective but also from a process-oriented perspective.

In Turkish archery, the shooting process proceeds in a systematic manner. During this process, the athlete's

heart rate, breathing patterns, and mental state play a significant role in focusing on the target. Mental strategies used to minimize distractions and achieve internal rhythm, especially during competition, strengthen the spiritual aspect of this sport [10]. However, today, by integrating modern scientific methods into traditional approaches, it is possible to objectively measure and improve these processes [11].

Although traditional Turkish archery is considered a spiritual experience performed in silence, it is susceptible to various effects on individuals' mental balance, attention levels, and internal rhythms. In this respect, music can be considered a supportive tool without disrupting the inherent nature of this traditional structure [12]. In particular, scientifically demonstrating the effects of music with different rhythms on athletes' performance parameters such as shooting duration, shooting frequency, heart rate, and draw biomechanics will contribute to the literature in this field. Considering the relevant literature, the primary objective of this study is to examine the effects of music with different rhythms on the physical performance parameters of traditional Turkish archery athletes. The study evaluated the effects of music on physical indicators such as heart rate, shooting duration, draw biomechanics, and draw frequency.

Materials and methods

In this section of the study, detailed information regarding the research model, research aim, participants, data collection tools, data collection process and data analysis is included, respectively.

Research model

The study was designed using a quasi-experimental model, one of the quantitative research models. A quasi-experimental research design is a type of research that aims to examine cause-and-effect relationships, where experimental control is limited but intervention or application is made, and is closer to real-life conditions [13].

Research aim

In the field of sports sciences, identifying the variables that influence individual performance is crucial for establishing more efficient and scientifically sound training processes. In this context, the impact of music on athletic performance has been researched across many disciplines, particularly through factors such as endurance, tempo, attention, and motivation. However, the majority of these studies have focused on modern sports, and the literature contains limited information on the impact of music on sports with a strong traditional and cultural dimension. One of the most notable traditional sports is traditional Turkish archery. This sport requires not only physical competence but also mental focus, balance,

and aesthetic integrity, draw attention with its cultural dimension. Every shot in this sport requires both technical skill and an internal balance and rhythm. In this respect, scientifically examining the effect of a rhythmic external stimulus like music on an athlete's physiological and technical parameters has the potential to both fill a gap in the literature and offer an innovative perspective in training planning. The main aim of this research is to examine the effects of music with different rhythmic structures on sporting performance parameters such as shooting duration, heart rate, and number of shots in traditional Turkish archery athletes.

The sub-questions supporting the research aim were structured as follows:

1. Do music with different BPM intervals cause changes in the heart rate of traditional Turkish archery athletes?
2. Do music with different BPM intervals cause changes in the shooting duration of traditional Turkish archery athletes?
3. Do music with different BPM intervals cause changes in the shooting frequency of traditional Turkish archery athletes?
4. Do music with different BPM intervals cause changes in the shooting performance of traditional Turkish archery athletes?
5. Do music with different BPM intervals cause changes in the draw biomechanics of traditional Turkish archery athletes?

Participants

Participants consisted of a total of 14 university students ($n = 8_{\text{male}} + 6_{\text{female}}$) who had been actively involved in traditional Turkish archery for at least one year and competed in at least one national tournament in 2025. All participants had participated in archery training and possessed basic technical knowledge and experience. G*Power analysis was used to calculate the sample size during the inclusion process. Based on the results of this analysis, which was conducted by referencing the findings of studies similar to our research model in the literature and research groups, it was found that a sample size of at least 8 people would be sufficient to achieve an effect size of 0.28 at a significance level of 0.05 and a statistical power of 0.95 [14]. In this context, a total of 14 athletes were initially included in the study as a precaution against possible disruptions that may occur during the implementation of the research.

Data collection tools

In this study, multiple instruments were used to measure various physical parameters while evaluating the shooting performance of traditional Turkish archery athletes

to different musical rhythms. The measurement instruments were selected to provide both objective data and repeatable and valid results.

Polar watch

Participants' heart rate data was recorded using the Polar Flow mobile app, which was synchronized with a Polar chest strap. Polar is a widely used brand in sports science literature for heart rate measurement and has high scientific validity. Compared to the gold standard, the electrocardiogram (ECG), the Polar device has been found to be highly valid and reliable for accurately measuring heart rate, particularly during low- and moderate-intensity exercise [15]. Measurements were taken in real time using the app's synchronization feature, and data was recorded after each trial.

Stopwatch

The duration of each arrow shot was measured using a manual stopwatch, assuming the start and end points were fixed. Stopwatches are simple yet effective tools that are still widely used and recognized for their accuracy, especially for timing short-duration physical activities [16]. By having the same person perform all time measurements, human error is minimized and measurement reliability is increased.

Video camera

The athletes' arrow shots were recorded with a fixed-position, high-resolution smartphone camera (60 FPS). Camera stabilization was crucial for accurate and repeatable angle analysis. These video recordings allowed us to calculate both the participants' total shooting time and shooting frequency.

Kinovea software

Video recordings obtained during archery shooting were evaluated using Kinovea 0.9.5 software for motion analysis and angle measurement. Kinovea is an open-source program widely used in sports sciences and developed specifically for 2D motion analysis. The program allows for frame-by-frame video analysis of the athlete's arm, shoulder, and elbow angles, allowing measurements to be made with millimeter accuracy. The validity and reliability of this software have been supported by various academic studies [17, 18].

Data collection process

The data collection process for the study was completed over four separate days. Information regarding this process, which was completed using the materials specified in the data collection tools, is provided in Table 1.

Before starting the study, all participants were provided with detailed information about the study. Following

Table 1 Application order regarding the data collection process

	Day 1	Day 2	Day 3	Day 4
Application	Measurements of the athletes were completed in an environment without music.	The measurements of the athletes were completed with downbeat music (93 BPM).	The measurements of the athletes were completed with medium rhythm music (123 BPM).	The measurements of the athletes were completed with upbeat rhythm music (140 BPM).

**Fig. 1** Visual of traditional Turkish archery shooting and data collection period

this information, informed consent was obtained from all participants. During the measurement phase, participants were given a warm-up period before each shot. After completing the warm-up process, the participant took their designated position to shoot arrows at a target 28 m away (the standard competition distance). Shooting performance scores were obtained for a total of 35 shots per day, consisting of 7 series (5 shots each). Specific points on the target are scored as 3 points and 1 point, respectively. Therefore, the maximum total score a participant can achieve is 105 points.

During all shooting sessions, participants were exposed to music with varying rhythms from day to day (see Table 1). However, their performance was measured without music on the first day. On all days when shooting was performed with music, participants were exposed to music through a speaker. During these shots, heart rates were recorded with a stopwatch, and video recording was continued using the kinovea software to calculate shooting biomechanics, total shooting duration, and shooting frequency. The researchers recorded the participants' scores in writing after each shot (see Fig. 1).

Heart rates

The average value of the participants' heart rates calculated by the Polar Watch during the shooting period.

Shooting times

This time refers to the time valid for athletes to shoot arrows in 1 series.

Shooting frequency

This period refers to the frequency of the time between two shots.

Shooting performances

This performance score refers to the average score obtained from the relevant target points (3 points or 1 point) as a result of 7 x 5 arrow shots.

Draw biomechanics

This value is obtained by calculating the angle between the participants' shooting arms and their pelvis during shooting.

Statistical analyses

SPSS (version 26) software was used to analyze the data. First, mean scores were calculated for each parameter. Mean scores for each day of measurement were grouped separately. Repeated-Measure ANOVA was used to determine differences between these groups. A statistically significant difference between the groups was set at " $p < 0.05$ ".

Results

According to the research results, statistically significant differences were found between the heart rates of the groups ($p < 0.05$; $F = 13.842$). Post hoc analysis revealed that participants' heart rates at upbeat rhythms had higher average scores compared to their performances without music, with downbeat rhythm music, and with medium rhythm music (Table 2).

According to the research results, a statistically significant difference was found between the groups' shooting times ($p < 0.05$; $F = 9.212$). Post hoc analysis revealed

Table 2 Repeated measures ANOVA results for heart rates in different rhythms of the study group

Measurements	N	$\bar{X}$	sd.	F	P	Difference
Without Music (1)	14	80.56	1.615	13.842	0.000*	4 > 1
Downbeat Music (2)	14	81.08	1.996			4 > 2
Medium Rhythm Music (3)	14	81.79	1.798			4 > 3
Upbeat Music (4)	14	88.34	2.212			

* $p < 0.05$ **Table 3** Results of repeated measures ANOVA between measurements regarding the shooting times of the research group in different rhythms

Measurements	N	$\bar{X}$ (sec.)	sd.	F	P	Difference
Without Music (1)	14	82.46	0.770	9.212	0.038*	1 > 4
Downbeat Music (2)	14	81.83	0.849			
Medium Rhythm Music (3)	14	81.41	0.712			
Upbeat Music (4)	14	79.94	0.735			

* $p < 0.05$ **Table 4** Results of repeated measures ANOVA between measurements regarding the shooting frequency in different rhythms of the research group

Measurements	n	$\bar{X}$ (sec.)	sd.	F	p	Difference
Without Music (1)	14	12.77	0.610	8.763	0.041*	1 > 4
Downbeat Music (2)	14	11.96	0.572			
Medium Rhythm Music (3)	14	11.89	0.595			
Upbeat Music (4)	14	10.01	0.638			

* $p < 0.05$ **Table 5** Results of repeated measures ANOVA between measurements regarding shooting performances of the research group in different rhythms

Measurements	n	$\bar{X}$	sd.	F	p	Difference
Without Music (1)	14	42.09	3.272	9.826	0.024*	1 > 2
Downbeat Music (2)	14	37.82	2.376			1 > 4
Medium Rhythm Music (3)	14	44.71	2.849			3 > 1
Upbeat Music (4)	14	36.16	2.098			3 > 2
						3 > 4

* $p < 0.05$ **Table 6** Results of repeated measures ANOVA between measurements of draw biomechanics in different rhythms of the research group

Measurements	n	$\bar{X}$	sd.	F	P	Difference
Without Music (1)	14	165.13	1.549	0.968	0.239	-
Downbeat Music (2)	14	166.04	1.456			
Medium Rhythm Music (3)	14	166.27	1.823			
Upbeat Music (4)	14	165.16	1.367			

that the participants' shooting times without music had a higher average score than their shooting times with a upbeat rhythm (Table 3).

According to the research results, a statistically significant difference was found between the groups' shooting movement frequencies ($p < 0.05$; $F = 8.763$). Post hoc analysis revealed that participants' shooting movement frequencies without music had higher average scores than those with upbeat rhythms (Table 4).

The research results revealed statistically significant differences between the groups' shooting performances

($p < 0.05$; $F = 9.826$). Post hoc analysis revealed that participants' shooting without music had higher average scores than those shooting at downbeat and upbeat rhythms. It was also determined that participants' shooting with medium rhythm music had higher average scores than those shooting at downbeat and upbeat rhythms (Table 5).

According to the research results, it was determined that there was no statistically significant difference ($p > 0.05$; $F = 0.968$) between the draw biomechanics of the groups (Table 6).

Discussion

According to the results of the research, it was found that there were statistically significant differences between heart rates during shooting performed with music at different rhythms ($p < 0.05$; $F = 13.842$), and that heart rates at upbeat rhythms had higher average scores compared to performances without music, with downbeat rhythm music, and with medium rhythm music. When the literature regarding this result was examined, it was determined that many studies found that upbeat rhythm music causes changes in heart rate [19–21]. Kirk et al., on the other hand, measured physical and cognitive performance on four different days, with and without three different types of music, as in our study [22]. They found similar results to our findings, finding that heart rate increased during performances with music compared to performances without music. De Giorgio et al. explained that this situation is due to the transmission of signals from the body to the human brain, and thus, the movements in physical activity are regulated and the heart rate is increased by upbeat rhythm music [23]. Rhoads et al. found that this stimulus could be provided by music with a rhythm higher than 120 BPM and that the heart rate would increase [24]. In addition to the experimental studies mentioned, as a result of a systematic review, Bezuglov et al. argued that there may be an increase in heart rate as well as in sporting performance with music with a high BPM range [4].

According to shooting durations ($p < 0.05$; $F = 9.212$) and shooting movement frequencies ($p < 0.05$; $F = 8.763$), it was determined that shooting performances without music took longer, while shooting performances with medium music achieved the highest scores. The common finding from both measurements shows that the athletes' shooting frequency increases with increasing musical rhythm. Based on these data, it is necessary to remember that human behaviors are outputs obtained through neural messages and that music has a significant effect on this stimulation point [22, 23, 25]. In this way, it is also known that the behavior of individuals from various disease groups [26, 27], shopping individuals [28, 29] or animals [30, 31] can be controlled with the known effects of music and rhythms at various intervals. Similar findings were found when this behavior and movement frequency control was examined in the field of sports sciences. In this context, Song et al. found in their research on "Melodic Movements" that music in the high BPM range was decisive in the sportive movements of athletes [32]. Researchers have argued that the effects of this ergonomic tool consist of four different mechanisms and that the most important element that causes behavioral change is due to its basic stimulating effect [6]. The frequency of behaviors occurring as a result of these stimuli

depends on various research results: it has been found to reduce fatigue [33] and regulate exercise responses [34].

Participants' shots performed without music and with a moderate rhythm received significantly higher scores than shots performed with downbeat and upbeat rhythm music ($p < 0.05$; $F = 9.826$). However, no difference was found in the biomechanics of draw, which determines technical performance during shooting, based on music type ($p > 0.05$). These findings regarding the effect of music on shooting performance in archery can be explained in another way: music with a moderate rhythm can have positive effects on shooting performance and does not biomechanically affect the athlete's technique. In this context, an examination of the first finding revealed that, as stated by Koç and Curtseit, the outcomes of physical activity accompanied by downbeat and upbeat rhythm music have different potentials [35]. These effects have been argued in various research studies that downbeat rhythm music calms people down and motivates them to exert minimum power during many athletic performances, such as aerobic power and sprinting. Therefore, music above 120 BPM generally helps to create a greater power and success in athletic performance [32, 36–39]. On the other hand, many studies have found that athletes can reach optimal levels of motivation and athletic performance with their preferred music, regardless of whether the rhythm is downbeat or upbeat [40–42]. Based on all these data, it is possible to say that musical rhythm affects human behavior as well as athletic performance. Regarding the recent finding that musical rhythm has no effect on athletes' technique in shooting biomechanics, the results of a study conducted by McCrary and Gould with cyclists yielded data quite similar to our results. This study argued that cyclists can use the rhythmic structure of music as a movement regulator during pedaling, but it does not directly affect technical skills [43]. Chiat et al. argued that using this movement regulator in rhythmic gymnastics can enable more successful demonstrations of technical skills [44]. In short, the positive or negative contribution of musical rhythm to technical performance varies, and it is believed that it did not affect the biomechanical technical performance of our participants.

All findings obtained in the study regarding shooting performance and other parameters by music type are also supported when examined specifically within a sport. Focus is known to be crucial in target-oriented disciplines such as archery [45]. Lombard stated that this is related to the neurocognitive processes of archery. The researcher determined that heart rate is important for shooting performance in archery and that cognitive calmness and silence are required [46]. Arbinaga and colleagues determined that these important elements can be achieved either in a quiet environment or by shooting

at optimal rhythms [47]. Considering our findings and the results of this research, it is thought that the music chosen during performance in traditional archery, which requires cognitive calmness and focus, may have acute effects such as calming or increasing heart rate.

Limitations of the study and recommendations for future research

This study was conducted with 14 students from the Faculty of Sports Sciences at Bayburt University. The fact that the participants were recruited from the same institution limits the ability to generalize the findings. Furthermore, the effects of music on participants' performance were measured acutely and were conducted using a quasi-experimental research design. Examining the long-term effects of music and employing an experimental research design with a control group could provide a more in-depth understanding of the topic.

Conclusion

The study found that musical rhythm exerts various psychophysiological effects on athletic performance during traditional Turkish archery, leading to changes in heart rate. Furthermore, it was determined that shooting accompanied by music played a significant role in regulating participants' motor behavior, resulting in significant effects on both total shooting time and shooting frequency. Furthermore, it was concluded that athletic performance accompanied by music generally had a positive effect, but that downbeat and upbeat rhythm music could have negative effects on performance. Furthermore, considering shooting biomechanical measures, listening to music did not significantly alter participants' technical performance.

Abbreviations

ANOVA	Analysis of Variance
BPM	Beats Per Minute
n	Number of Participants
p	Significance Level
sd	Standard Deviation
SPSS	Statistical Package for the Social Sciences
$\bar{x}$	Mean
sec	Second

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Authors' contributions

Study Conception and Design: K.Ş., E.B.; Data Acquisition, Analysis, or Interpretation of Data: K.Ş., E.B.; Drafting the Manuscript: K.Ş., E.B. All authors critically reviewed the manuscript for significant intellectual content. Senior Authorship: K.Ş. All authors approved the final version of the manuscript.

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Data availability

The data supporting the findings of this study are available from the corresponding author upon reasonable request. However, the data contains images and information about individuals and is not publicly available due to confidentiality or ethical restrictions.

Declarations

Ethics approval and consent to participate

The research was conducted with the knowledge and approval of the school administration. The study was carried out in accordance with the Declaration of Helsinki and applicable local guidelines and regulations. Ethical approval was obtained from the Faculty Ethics Committee of the Bayburt University Rectorate, Bayburt University, with the decision number 29.04.2025–277430, dated 29.04.2025 documented in the 2025/179 Bayburt University Rectorate Ethics Committee Decisions. The participants in this study voluntarily participated of their own accord. Informed consent was obtained from all participants. All methods were carried out in accordance with the relevant guidelines and regulations.

Consent for publication

All participants gave written consent for the use of their personal or clinical information and descriptive images in the publication of this study.

Competing interests

The authors declare no competing interests.

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