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The Effect of Different Musical Rhythms on Anaerobic Abilities in Taekwondo Athletes

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Abstract

The aim of this study was to determine the effects of different musical rhythms on taekwondo athletes. The variance in athletes' anaerobic abilities performed under slow and fast musical rhythms was tested in the study presented. Previous studies have demonstrated how music may cause physiological responses before, during, or after different types of exercises. The aim of this study was to identify the effect of music played in two different rhythms (slow 80 b/m, and fast 200 b/m) during anaerobic exercises by measuring four specific physiological variables: heart rate (HR), blood pressure (BP), blood lactate (BL), and rate of perceived exertion (RPE). Additionally, the peak power of each athlete was assessed. Ten black-belt taekwondo male athletes (average age 20.38±1.51) performed for 30 seconds at their maximum anaerobic power on a Monarch Ergonomic that was connected to the Wingate test.

The RPE indicated significant differences with a probability value of 0.014 when measured two minutes after the testing. Measurements of heart rate, blood lactate, and diastolic blood pressure after exposure to slow and fast rhythms did not show significant differences. While it has been shown in previous research that the human body tends to synchronize with rhythmic elements of music, this only holds true for exposure to specific rhythms after a longer period of time. The study conducted was based on exposure to different rhythms for only 30 seconds, which may be why these variables did not differ significantly. Yet, results for systolic blood pressure proved significantly different for fast and slow musical rhythms with a probability value of 0.0004.

Keywords: wingate, anaerobic abilities, RPE, blood lactate, blood pressure, rhythm

1. Introduction

Physical activity is an integral part of community life and plays a crucial role in the development and improvement of our social environment (Ahn & Fedewa, 2011). Exercising provides fundamental value in the life of any individual as it offers physical, psychological, social and educational benefits. Physically, it strengthens and stimulates the muscles (Shin, Lee, & Belyea, 2018). Mentally, it supports the development of mental and emotional abilities and limits the risk of psychological disorders. Lastly, it is a chance to socially interact with others that then facilitates a variety of relationships (Amsters et al., 2016).

All sport depends on different kinds of physical activities and movements, categorized according to the nature of the exercise, speed and intensity. The amount of energy required within a certain time frame is used to classify different types of sports. Exercises that need maximum energy in the least amount of time are known as anaerobic exercises, because they function as energy production systems in the absence of oxygen. However, exercises that require the constant production of energy in small quantities over a long period of time are called aerobic exercises (Hasan & Sharaf, 2017; Kenney, Jack, & David, 2012).

Sprinting (100 meters) is an example of a sport that uses the anaerobic system in the production of energy, while in marathon running, the aerobic system is active throughout the entire length of the race. However, there are few sports that depend on both the anaerobic and the aerobic system in order to achieve the best results. Taekwondo, for instance, uses both systems as it requires fast and strong movements and for a long period of time (Sbitan, 2015). Given the nature of Taekwondo, it is important for athletes to achieve well-integrated physical skills, planning, and psychological abilities. Athletes must get accustomed to physical training as they aim to increase their physiological efficiency and adapt to the specific activity of their sport. The physiological condition of athletes is a good indicator of athletes' ability to compete and advance in their field (Salama, 2016).

Psychologists study how the organs, systems, or bodily functions affect human behavior and mental processes. These scientists are seeking answers to the following questions: What are the biological basis' of voluntary and involuntary behaviors of an individual? How do brain signals move from the brain to the rest of the body? Can psychological disorders occur due to biological causes? Are physiological and biological developments likely to be caused by psychological reactions? (Salama, 2016).

It is widely known that the body functions as an interconnected unit, and that each part has its own unique function that it must fulfill, whether this function is observable or an internal process. The importance of the ear, for example, is to absorb sounds and convert them into nerve signals recognized by the brain that then analyzes them and responds with an action. This is the physiological basis for how music can influence the physiological variables of an athlete (Atan, 2013; Stork, 2014).

Music is known as both an art and a science that is composed of melodies or tones that enhance the beauty of sound made by the world's musical masterpieces and instruments. Music is an important means of intellectual education. It is not only a form of art for professional musicians, but it is also available to everyone. An individual frequently exposed to different types of music trains the ear to distinguish between different sounds and rhythms. Humans can develop their hearing skills through various musical activities such as playing instruments, singing, rhythmic movement and more (Desuqe & Ibrahim, 2009; Younis, 2015). Music has an impact in regulating heartbeat and respiration. The timing and coordination of notes that compose single melodies affect physiological functions like the removal of nervous tension and ultimately leads to relaxation (Thompson, Schellenberg, & Letnic, 2011; Eliakim, 2014).

Researchers in the field of sports found that the effect of listening to music during strength related exercises has led to a positive response in grip strength. In contrast, endurance exercises that need longer times are not affected by music. For instance, the rhythm of music might stimulate the string of information that interacts with the athlete's mind and lead to a quicker response to the type and characteristics of that particular stimulus. Taking that into consideration, it is obviously crucial to find out more about the effect of different types of musical rhythms on anaerobic capabilities and physiological variables (Smirmaul, 2017; Khalifa, 2013).

Many studies analyze the impact of music on the human psyche, from raising the level of concentration and relaxation to the reduction of stress caused by the pressures of daily life stressors. It has also been shown that music increases the efficiency of individuals while performing daily tasks. Other studies observed the role of specific pieces of music in improving physical ability and increasing athletic achievement.

The aim of this study is to review the described effect of music on Jordan's Taekwondo athletes, and to analyze the relationship between differences in the pace of musical rhythms chanted by players and the audience to cheer on the athletes and the anaerobic capabilities of players. Certain physiological variables will be observed to carry out the evaluation of the anaerobic capabilities of Jordanian Taekwondo players. This study specifically aims to identify the effect of two different musical rhythms (fast 200 b/m, slow 80 b/m) on the anaerobic ability levels and on the physiological variables of heart rate (HR), blood pressure (BP), blood lactate (BL), and rate of perceived exertion (RPE) of Taekwondo players in Jordan. The focus lies on measuring and comparing the named variables in an anaerobic exercise setting, because Taekwondo mainly requires performance under anaerobic conditions.

While it is not common to play songs in Taekwondo competitions, the effect of a song on an athlete's anaerobic capability will be observed during this study. This is because the validity and reliability of the results are much higher when the effects of musical rhythms on an athlete's anaerobic performance are measured under the exact same circumstances without variety in the audience's choice of support, intensity of cheering, or the athlete's familiarity with the verbal slogans etc.

2. Materials and Methods

2.1 Participants

Ten male taekwondo athletes (age: 20,38±1.51; weight: 73.22±10.32; height: 178.88±6.40) from the Jordan Taekwondo Federation participated in the study. Participants were black belt taekwondo players who possessed similar backgrounds, athletic abilities, and experience in the sport. The researchers used the semi-empirical approach to suit the nature and objectives of the study.

2.2 Data Collection

To measure anaerobic capabilities, this research protocol has been approved by an ethics review board, the following instruments were used to calculate the four physiological variables mentioned in the introduction: *Lactate Scout* $^{+}$ for the BL, sphygmomanometers and stethoscope for the BP, Borg Scale for RPE, and polar 5.3 kHz Wireless heart rate chest sensor and watch sensor for the HR.

2.3 Data Analysis

The 'Monarch Ergometer and Health testing equipment' was used for the measurement of maximum anaerobic power (30 seconds) that was needed for the test. Slow and fast rhythmic music was played through Sony WH-1000XM3 headphones (with noise cancelling processor) with external sounds and a portable music player. The ten Taekwondo players were tested individually. In order to make the results comparable, the researchers used two different versions of the same song. The athletes were exposed to the original version of "*Hello*" by singer *Adele* (80 bpm) and an alternated salsa version by *Mandinga* (200 bpm). The song was chosen because it is not familiar to the participants, so that (un)familiarity with the music does not affect the results.

Two independent Wingate tests were conducted for each participant with a period of 24 hours between the two tests. Four physiological variables (HR, BP, Blood lactate, and RPE) were measured at four different points of time: before the test, immediately after the test (post-test), two minutes and four minutes after the post-test. Additionally, the peak power of the athletes during both tests was determined.

2.3 Statistical Analysis

The data analysis was analyzed through a Two-Way Repeated Measures ANOVA. For variables that showed significance in this analysis, paired sample *t*-Tests were subsequently conducted. Independent of this, a paired sample *t*-Test assessed the significance of peak power by comparing the two musical rhythms.

3. Results

Table 1. Relative peak power between slow and fast rhythms

Music rhythm	Mean	N	Std. Deviation	t	sig
Slow	10.20	10	2.10	0.92	0.377
fast	10.81	10	0.85		

Table 1 details the mean differences between the two rhythms for the relative peak power assessment. The probability value (0.377) suggests that no significant differences between the two musical rhythms were reported.

Table 2. Physiological variables measured during the two music rhythms (n = 10)

Variables	source	ss	df	ms	f	prob
HR (beat/min)	Music rhythm * Time	109.237	3	36.412	.653	.588
	Error	1505.888	27	55.774		
Systolic Blood Pressure(mm)	Music rhythm * Time	682.845	3	227.615	5.531	.004*
	Error	1111.033	27	41.149		
Diastolic Blood Pressure (mm)	Music rhythm * Time	347.850	3	115.950	2.011	.136
	Error	1556.400	27	57.644		
RPE	Music rhythm * Time	20.200	3	6.733	4.223	.014*
	Error	43.050	27	1.594		
Blood Lactate (mmol/l)	Music rhythm * Time	2.203	3	.734	.257	.856
	Error	77.205	27	2.859		

* Prob < 0.05.

During the measurement of the physiological variables between the two musical rhythms, the ANOVA test was used. The result indicated that systolic BP and RPE displayed significant differences in the interaction between time variable and the musical rhythm, with probability values of 0.004 and 0.014 respectively. A paired samples *t*-Test was carried out to specify how the musical rhythms differ over time. The results are presented in the following Tables 3 and 4.

Table 3. Systolic blood pressure compared between slow and fast rhythms

Slow rhythm	**Fast rhythm**			
	pre	**immediate**	**2 min later**	**4 min later**
Pre	0.024*	-	-	-
immediate	-	0.003*	-	-
2 min later	-	-	0.223	-
4 min later	-	-	-	0.998

* mean differences are significant (< 0.05).

Table 3 shows the main differences between the two musical rhythms at each time for systolic blood pressure. The probability values indicate that the athletes' systolic blood pressure differ significantly when exposed to slow versus fast musical rhythms. This holds true for pre-measurement and immediate (post) measurement, while no significant differences were reported at the other two points in time (2 min and 4 min after the test).

Analysis of the systolic blood pressure chart, as presented in Table 3, indicates that performance under exposure to slow rhythm music is closer to the normal range value of the systolic blood pressure (120) than under exposure to fast rhythm music in both the pre and immediate post measurement.

Table 4. Paired samples t-Test for the RPE

Slow rhythm	**Fast rhythm**			
	pre	**immediate**	**2 min later**	**4 min later**
Pre	0.468	-	-	-
immediate	-	0.148	-	-
2 min late	-	-	0.049*	-
4min later	-	-	-	0.666

* mean differences are significant (< 0.05).

Table 4 presents the main differences between the two music rhythms at each time for the RPE. The probability values provided suggest that performance under exposure to the fast rhythm differs significantly from the performance under exposure to the slow rhythm two minutes after the assessment. However, no significant differences were reported for the other points in time. Two minutes after the test, athletes reported to be significantly less exhausted when exposed to the slow rhythm song compared to performing under the fast rhythm (see Chart No. 6).

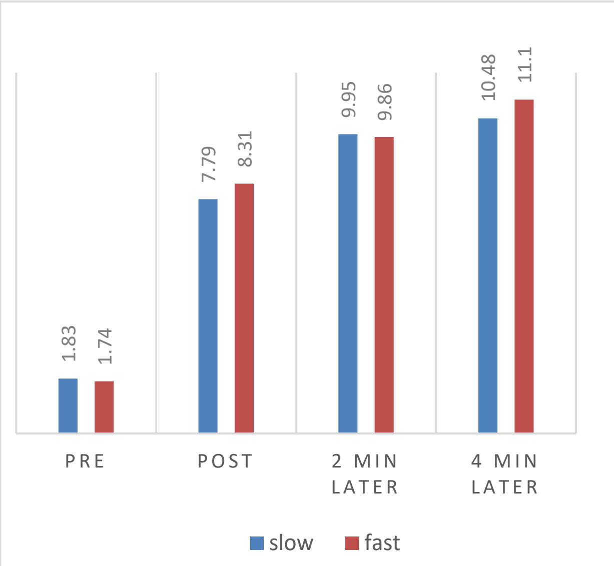


Chart 1. The Mean Values for Blood Lactate in Both Music Rhythms (Slow and Fast) mmol/l

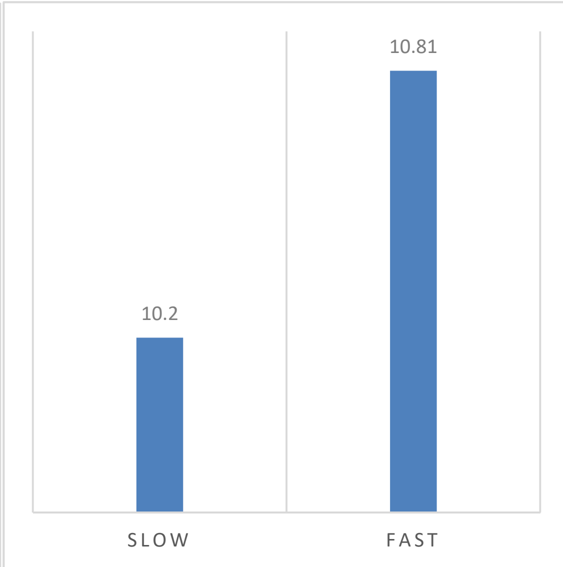


Chart 2. The mean values for peak power

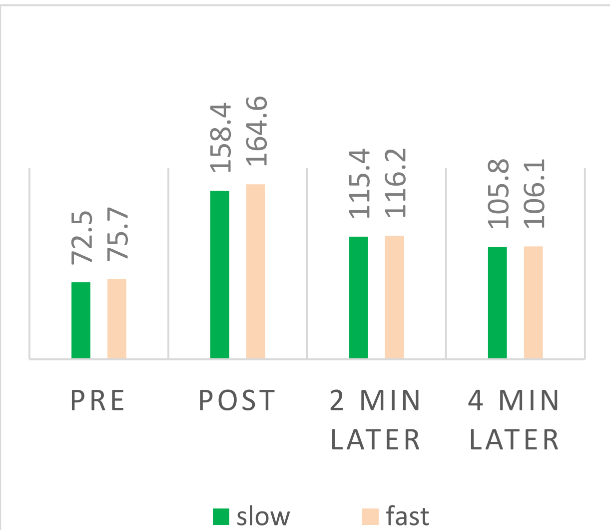


Chart 3. The Heart Rate means for both music rhythms (slow and fast) (beat/min)

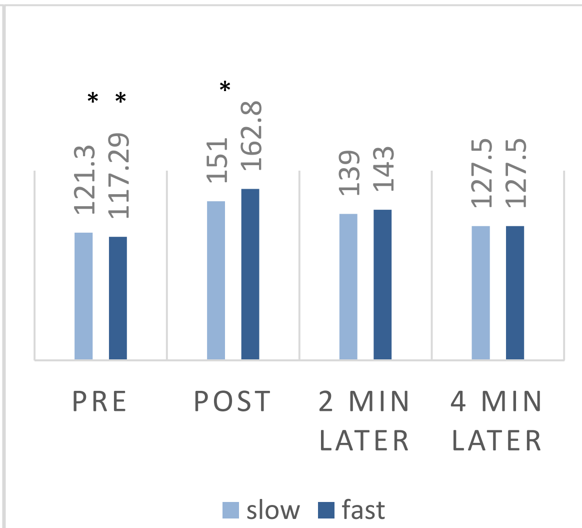
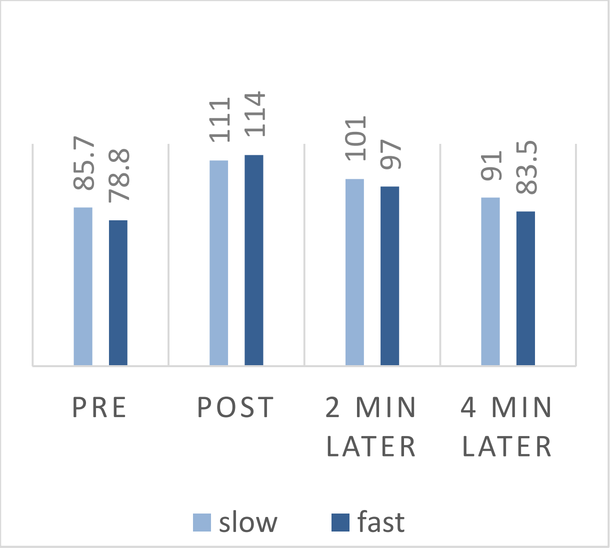


Chart 4. the systolic blood pressure in both music rhythms (slow and fast)



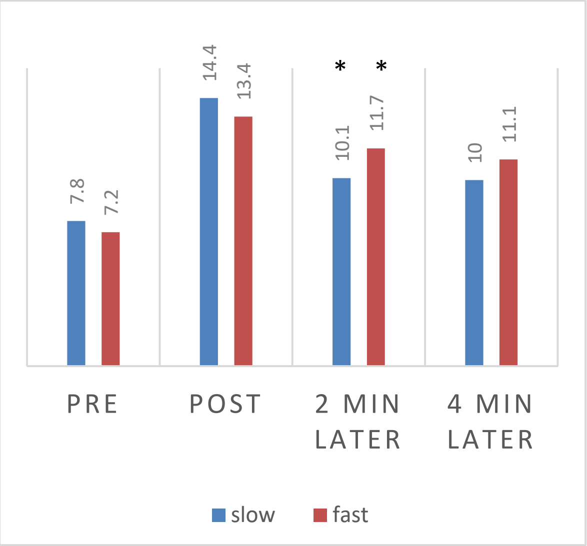


Chart 5. The diastolic blood pressure in both music rhythms (slow and fast)

Chart 6. The RPE in Both Music Rhythms (Slow and Fast)

4. Discussion

Music is frequently used by athletes to increase motivation and improve aerobic and anaerobic performances (Szabo et al., 1999). Although athletes report favorable subjective effects of music during training or competition (e.g., general feeling, mood), research studies have not always supported this notion (Yamashita et al., 2006). Research on the effects of music on athletic performance has yielded conflicting results, and it has been suggested that the timing and type of music, the type of exercise, and the fitness level of the athlete may all affect the performance response to music (Eliakim et al., 2013). The present study determined that there is no significant effect of music on peak power ability, as physiological abilities are not subject to changes in this relatively short test time. This is supported by studies (Hamburg & Clair, 2003) that observed physiological changes in a long-term VO2-peak test environment.

It is not surprising that no significant differences were found for blood lactate in this study, due to the chosen points in time for measurement (two and four minutes after the test), as lactate takes a relatively long time to assemble in the blood. At the same time, other studies have found significant differences in blood lactate value under exposure to slow and fast musical rhythms (Eliakim et al., 2012).

Physical exercise increases sympathetic activity and decreases parasympathetic activity, which results in an increase in heart rate (HR). The increased HR promptly declines after the completion of the exercise. This rapid HR recovery plays an important role in avoiding excessive cardiac work after exercise. Post-exercise decrease in HR is mediated by parasympathetic reactivation (Imai et al, 1994). The heart is under involuntary control and HR is not affected by the sympathetic nerve system. Consequently, exposure to music during exercise does not have an effect on the diastolic blood pressure – the phase when the blood is flowing back into the heart (Larry et al., 2012) – and subsequently the HR, as this phase is not controlled by the sympathetic nerve system.

The systolic blood pressure showed a significant effect between pre and post exercise. Systolic blood pressure refers to the phase of muscular contraction of the heart. Systolic blood pressure is best defined by the "Frank and Starling Theory": the muscular contraction is activated by a signal linked to the heart and this signal is connected to the central nerve system. Therefore, in this case significance is shown due to the fact that the heart is under involuntary control and HR is affected by the parasympathetic nerve system (Akiyama & Sutoo, 2011). This explains why slow music affects Taekwondo players during their performance.

Results for RPE also showed significance in the two minutes post-test. Exposure to slow music during high-intensity exercises seems to have an effect on the athlete's fatigue: athletes reported significantly less exhaustion two minutes after the exercise under exposure to slow rhythm music. At the same time, measured values for lactate, heart rate and diastolic blood pressure did not differ in the two test designs. Consequently, the pace of music affects the mental status significantly in that fast rhythm music causes higher perceived exhaustion, whilst slow music facilitates faster relaxation after the exercise (Tenenbaum, et al., 2004). This finding is in accordance with the general notion that immediately after the exercise, when the heart rate and systolic blood pressure are high, RPE is high as well. Two minutes later though, athletes' rating of their exhaustion is less influenced by physiological factors and therefore based on other factors, for example the type of music they are exposed to.

5. Conclusions

In this study, after measuring four physiological variables in two different music rhythms, only two of these variables, the systolic BP and the RPE, displayed significance. In the case of the RPE after two minutes while for the BP before the test and immediately post the test; we suggest further research that will measure RPE and BP every minute. Additionally, we recommend the researchers to conduct studies on aerobic tests like (Vo2max) on Taekwondo athletes.

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