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RESEARCH ARTICLE

Some Anaerobic Performance Variation From Morning to Evening: Warm up With Different Music Rythm Impacts Performance and Its Diurnal Amplitude in Intellectual Disabled People

Ahmet KURTOĞLU [1*]

[1]Bandirma Onyedi Eylul University, Faculty of Sport Science, Department of Coaching Education, Balikesir / Türkiye
*Corresponding author: akurtoglu@bandirma.edu.tr

Abstract
The aim of this study is to investigate the effect of functional warm-up (FWU) in different musical rhythms on anaerobic performance of mentally retarded individuals from morning to evening. Fourteen (7 male, 7 female) moderately and mildly ID individuals aged 11-14 years participated in this study. In the study, participants received no music (NM), a low music phase (LMP) phase (80-90 bpm), a modarate musical rhythm phase (MMP) (130-140 bpm), and a high music phase (HMP) (170-180 bpm) with FWU applied. To determine anaerobic performance after FWU protocol. FWU and then Sargent protocol vertical jump test was performed while playing music. The same procedure was repeated in the morning (between 08:00 a.m.-10:00 a.m.) and in the evening (between 16:00 p.m.-18:00 p.m.). In the study, participants' anaerobic power level increased significantly from morning to evening as the music rhythm increased (p= .000, F=8.643). According to the post-hoch test, there was a significant difference between the NM phase in the morning (M) and the MMP-M (p= .003), the HMP-M (p= .003), the MMP in the evening (E) (p=.003), and the HMP-E (p= .001). There was no significant difference between the LMP, MMP and HMP values in the morning and the music given in the evening. According to the results of our study, the anaerobic power values of the ID individuals were higher in the evening. However, it was found that they could reach their performance level in the evening if they listened to low, moderate and high rhythm music in the morning.

Keywords
Intellectual Disabled People, Diurnal Variation, Music Rhythm, Anaerobic Performance

INTRODUCTION

Sport is an important phenomenon in the reintegration of people with disabilities into society (Iyer et al., 2019). One of the main purposes of physical activities for people with disabilities is rehabilitation (Hoekstra et al., 2019; Yılmaz et al., 2021) and socialization (Bessa et al., 2019). However, in recent years, people with disabilities at the national and international levels have been using sports not only as a means of rehabilitation and socialization, but also to enhance performance (Cherif et al., 2022). Although the type of sports activities is important in increasing the level of performance (Hammami et al., 2019), the timing of the activity is also an important factor that affects the level of performance (Eken et al., 2022; Nişli et al., 2021).

Like all living things, the human organism is subject to variability according to environmental differences that occur as time changes (Rosa et al., 2016). Biological rhythm is a cyclic variation that repeats sequentially in a certain period of time and at certain intervals. The branch of science that

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[1]**ORCID:** 0000-0002-9292-5419

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studies the effects of biological rhythms and the factors that determine biological rhythms is chronobiology. In chronobiology, the dark-light cycle and the associated variability associated with a solar day are referred to as circadian rhythms (Geng et al., 2022). Circadian rhythms are controlled by an internal circadian "clock" that is responsible for regulating the daily function of all major organs (Hofman & Swaab, 2006; Martin et al., 2016). These rhythms are critical for maintaining various positive health outcomes in humans (Schroder et al., 2015). The body clock, also known as the circadian rhythm or diurnal variability, is controlled by the suprachiasmatic nuclei at the base of the hypothalamus (Waterhouse et al., 2005). Blanchet et al. argued that slowing of the MYT1L variant, which is an important gene for hypothalamic activities, is associated with ID syndrome and obesity (Blanchet et al., 2017). Therefore, individuals with ID are expected to have different biological characteristics than healthy individuals.

Many people like to listen to music during physical activity. It is known that personal well-being increases during physical activities with music (Bayrakdaroğlu et al., 2022). However, studies on the effects of music on athletic performance have yielded mixed results. While some studies have focused on the effects of the type of music chosen, others have suggested that the timing of music can influence anaerobic performance (Castañeda-Babarro et al., 2020). It has also been suggested that changes in mood, motivation, warm-up speed, and adaptation of music can lead to increased performance (Ballmann et al., 2018; Nakamura et al., 2010).

In the literature, individuals with ID are thought to elicit different neural responses than healthy individuals and consequently have different biological rhythms. The number of studies investigating the effects of music on biological rhythms and performance levels in ID individuals is also limited. Therefore, the aim of this study was to investigate the anaerobic performance of ID individuals from morning to evening at different music rhythms.

MATERIALS AND METHODS

Participants

A criterion sampling method was used to determine the sample group. Individuals with moderate and mild intellectual disabilities participated in the study. Participants were classified by experts from the Guidance Research Center according to their IQ levels, in accordance with the limits established by the American Association on Intellectual and Developmental Disabilities (AAIDD). Accordingly, mild intellectual disability = 55-70 IQ, moderate intellectual disability = 40-55 IQ. The consent of all volunteers was obtained, and their participation was ensured regularly. This study is approved by the Bandırma University (BU) and Human Research Ethics Committee of the BU (Approvel Nummer: 2022/221). All participants gave their written informed consent, and our study was carried out following the Helsinki Declaration. Even men and seven women volunteers who are mentally disabled (n=14), participated in the study. None of the participants had regular exercise habits and there was no injury to the upper or lower extremities in the last 6 months. Mentally disabled volunteers reported having no problems with insomnia or anxiety.

The minimum sample size for the present study was calculated using G-power software 3.1.9.7. (University of Dusseldorf, Dusseldorf, Germany). According to this analysis; a priori and F tests were used to calculate power following our study's design; within-factors; α err prob = 0.05; minimum effect size= 0.35, and power (1-β err prob)= 0.80. The power analysis indicated a minimum of twelve participants in study. Before the study, mentally disabled volunteers were asked to night sleep at least 8 hours before each test session, and to come on a full stomach, provided that they had food at least two hours before the morning and early evening session. The study was conducted 3 weeks (December-2022). The participants were given necessary information about not doing high-intensity exercise, and not using substances such as alcohol and caffeine (Reilly et al., 2007). Mentally disabled volunteers were selected using the inclusion criteria; volunteers did not have any health problems in performing tests and practicing exercises, following the researchers' instructions during the study, and the absence of any known sleep disturbances. A history of sleep disturbances, disobedience to investigators' instructions during the study, and the occurrence of any health problems during performance tests were reported as exclusion criteria for study participants.

Table1. Classification of participants

Participants (P)	Disability classification
P1	Mild intellectual disability
P2	Mild intellectual disability
P3	Moderate intellectual disability
P4	Mild intellectual disability
P5	Mild intellectual disability
P6	Moderate intellectual disability
P7	Moderate intellectual disability
P8	Mild intellectual disability
P9	Moderate intellectual disability
P10	Moderate intellectual disability
P11	Mild intellectual disability
P12	Moderate intellectual disability
P13	Mild intellectual disability
P14	Moderate intellectual disability

Study Design and Data Collection

The FWU and vertical jump tests were performed with participants in the presence of an expert instructor. Before all tests, a 2-day familiarization period was conducted to familiarize participants with the FWU and the vertical jump test. The FWU was performed by a specialized researcher using the show-and-make technique. The resting heart rate of the participants were measured by themselves using the Polar RS400 as soon as they got out of bed in the morning, without speaking or moving. The Sargent vertical jump performance of the participants were measured after FWU [No music (NM), Low rhythm music phase (LMP), Moderate rhythm music phase (MMP), High rhythm music phase (HMP)] in two different time periods of the day (between 08:00 am and 10:00 a.m. and 16:00 pm and 18:00 p.m) with at least 2 days between each other. The music used throughout the work was the same, only the rhythms were changed. In this way, the effect of different songs was prevented. The mentally disabled volunteers used to train regularly regardless of the time they participated in the study between 08:00–10:00 a.m. and 16:00–18:00 p.m. Volunteer mentally disabled volunteers are participants of World Health Organization (WHO) adults who perform at least 150 minutes of moderate or 75 minutes of vigorous physical activity (FA) or exercise per week (American College of Sports Medicine, 2018). The same times of day were utilized in the study design. Consequently, it was intended to determine the amount to which the standardized design, which had been produced before to the study, affected the performance testing. During the familiarization phase and the continuation of the experimental design, no further training program was administered to the mentally challenged volunteers beyond the research protocol. As a result, the following protocols were established (Fig. 1).

a) No music (NM);

First, the warm-up was implemented by running for 5 minutes at a heart rate corresponding to 50% of the determined heart rate reserve (HRR). The intensity of the warm- up was determined by calculating 50% of the HRR using the formula of Karvonen. The calculation of the Karvonen formula was as follows: HRR=exercise intensity×(maximum heart rate−resting heart rate)+resting heart rate (Karvonen MJ, Kentala E, 1957; Nes et al., 2013). The heart rates of the subjects were monitored during the 5-minutes warm-up using a Polar RS400 watch. After 5 minutes warm up, linear + lateral warm up (FWU) was made. FWU exercise consisted of stationary spider-man (30 s work – 30 s rest), inchworm (30 s work – 30 s rest), backward and forward lunge walks [2× (30 s work – 30 s rest)], backpedal (30 s work – 30 s rest), straight-leg skip (30 s work – 30 s rest), heel-ups [2× (30 s work – 30 s rest)] and high knee run [2× (30 s work – 30 s rest)] (Eken, et al., 2022).. This protocol consisted of 15 minutes.

b) *Low rhythm music phase (LMP);*

The same procedure above was used with LMP. In music condition, participants applied to 15 minutes of warm up by listening to music (80 to 100 bpm) rather than just warm up (Edworthy & Waring, 2006; Karageorghis et al., 2008). Fifteen minutes warm up consisted of running for 5 minutes at a heart rate corresponding to 50% of the determined HRR and 10 minutes FWU exercises (stationary spider-man (30 s work – 30 s rest), inchworm (30 s work – 30 s rest), backward and forward lunge walks [2× (30 s work – 30 s rest)], backpedal (30 s work – 30 s rest), straight-leg skip (30 s work – 30 s rest), heel-ups [2× (30 s work – 30 s rest)] and high knee run [2× (30 s work – 30 s rest)]) (Eken et al, 2022).

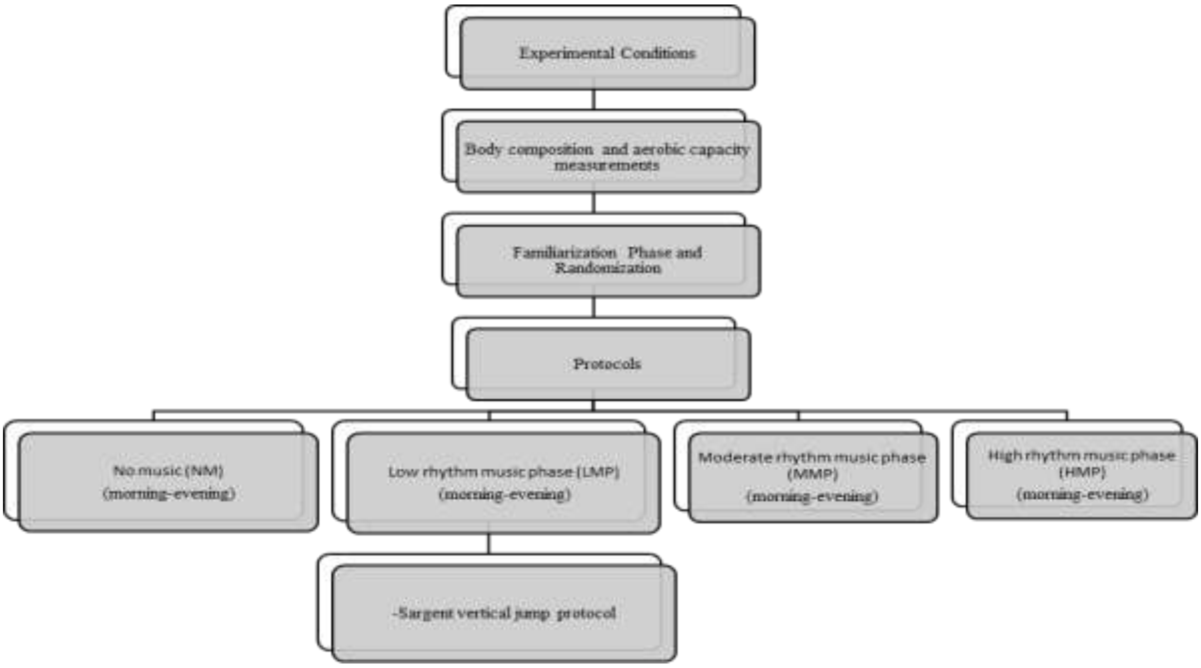

Figure 1. Experimental conditions

c) Moderate rhythm music phase (LMP);

The same procedure above was used with MMP. In music condition, participants applied to 15 minutes of warm up by listening to music (120 to 140 bpm) rather than just warm upModerate rhythm music phase (MMP); the same procedure above was used with MMP. In music condition, subjects applied to 15 minutes of warm up by listening to music (120 to 140 bpm) rather than just warm up by pedaling (Edworthy & Waring, 2006; Karageorghis et al., 2008). Fifteen minutes warm up consisted of running for 5 minutes at a heart rate corresponding to 50% of the determined HRR and 10 minutes FWU exercises (stationary spider-man (30 s work – 30 s rest), inchworm (30 s work – 30 s rest), backward and forward lunge walks [2× (30 s work – 30 s rest)], backpedal (30 s work – 30 s rest), straight-leg skip (30 s work – 30 s rest), heel-ups [2× (30 s work – 30 s rest)] and high knee run [2× (30 s work – 30 s rest)]) (Eken et al., 2022).

d) High rhythm music phase (HMP);

The same procedure above was used with MMP. In music condition, participants applied to 15 minutes of warm up by listening to music (160 to 180 bpm) rather than just warm up (Edworthy & Waring, 2006; Karageorghis et al., 2008). Fifteen minutes warm up consisted of running for 5 minutes at a heart rate corresponding to 50% of the determined HRR and 10 minutes FWU exercises (stationary spider-man (30 s work – 30 s rest), inchworm (30 s work – 30 s rest), backward and forward lunge walks [2× (30 s work – 30 s rest)], backpedal (30 s work – 30 s rest), straight-leg skip (30 s work – 30 s rest), heel-ups [2× (30 s work – 30 s rest)] and high knee run [2× (30 s work – 30 s rest)]) (Eken et al., 2022).

Anthropometric measurements

When measuring individual subjects, their body weights were calculated with 0.1 kg of precision using an electronic scale (Tanita SC-330S, Amsterdam, Netherlands) (kg). Using a stadiometer (Seca Ltd., Bonn, Germany) with an accuracy of 0.01 m, the height of each participant was obtained during the measuring process. An electronic scale (Tanita SC-330S, Amsterdam, Netherlands) was used to measure and record the BMI and lean-to-fat ratio of each participant (American College of Sports Medicine, 2018).

Vertical jump test

Sargent test protocol was applied to determine the vertical jump performance of the participants (Ayán-Pé Rez et al., 2017). Accordingly, the participant waited with both feet facing a smooth wall. A mark is drawn on the highest point it reaches. Then the participant was asked to jump as high as possible and the distance he reached was re-drawn with chalk in his hand The distance between the two drawings was recorded in cm. The participant had two trials and the best value was recorded (Bui et al., 2014).

Statistical Analysis

In this study, the analysis of normality was performed with the Shapiro-Wilk test, which is used for quantitative data. Because the data were normally distributed, they were expressed as mean and standard deviation. The measurements of the different protocols (NM, LMP, MMP, HMP) were tested with the Anova test for repeated measurements from morning to evening. To test the homogeneity of variances, the Mauchly test was performed and the Greenhouse-Geisser correction was applied. Partial Eta squared (ηp2) was used to determine the effect size between groups. Bonferoni, one of the post-hoch tests, was used to determine the difference between groups in the study. The significance level in the study was set as p< .05. Statistical operations were performed using IBM SPSS version 25 software (New York, USA). Graphs were generated using GraphPad Prism 9 software.

RESULTS

Table 2 shows the anaerobic power results of different musical rhythms of the participants from morning to evening. Accordingly, the participants' performance level was lowest at NM -M (20.17±6.89 cm). A significant difference was found between the musical rhythm protocols from morning to evening (F=8.643, p= .000, η_p^2=0.39).

Table 2. Anaerobic performance results of the participants from morning to evening in different musical rhythm

Protocols	Mean ± SD	Between Measurement F-value p-value η_p^2
NM-M (cm)	20.17±6.89	F= 8.643 p<0.001 η_p^2=0.39
LMP-M (cm)	22.67±6.88	
MMP-M (cm)	23.89±6.85	
HMP-M (cm)	25.14±7.30	
NM-E (cm)	22.57±6.67	
LMP-E (cm)	23.35±7.51	
MMP-E (cm)	23.14±6.71	
HMP-E (cm)	24.64±7.02	

Figure 2 shows the results of the post-high analysis of the participants' vertical jump test results. After post-high analysis, NM -M (20.17±6.89 cm) and MMP-M (23.89±6.85 cm) (p= .003), HMP-M (25.14±7.30 cm) (p= .003), LMP-E was found to have a statistically significant difference between (22.67±6.88 cm) (p= .003), HMP-E (24.64±7.02 cm) (p= .001).

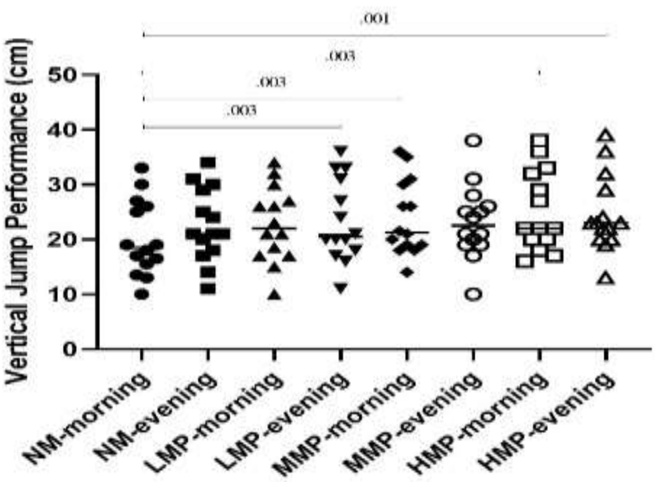

Figure 2. Vertical jump results of participants from morning to evening

DISCUSSION

In our study, the lowest anaerobic power levels of ID subjects in the morning were in the NM phase. As the music rhythm increased, the anaerobic power levels increased more. Most notably, anaerobic power levels were highest in HMP and evening ID subjects. To our knowledge, this is the first study to examine anaerobic performance in ID subjects in terms of diurnal variability and the influence of music rhythm on this performance level. Our hypothesis that the anaerobic performance of ID subjects differs at different music rhythms from morning to evening was thus confirmed.

There are many studies reporting that music has positive effects on athletic performance (Blumenstein et al., 1995; Pates et al., 2003; Tate et al., 2012). In addition to music, diurnal variability is also critical to performance levels (Kusumoto et al., 2021). Simpson et al. examined the effects of sprint performance with and without music in healthy individuals and found that sprint performance was higher with music (Simpson & Karageorghis, 2006). In a meta-analysis by Castañeda-Babarro et al. the studies on the effects of listening to music on anaerobic performance are controversial, but it may physiologically increase anaerobic performance (Castañeda-Babarro et al., 2020). In some studies, results have been obtained showing that music has no effect on performance levels (Atan, 2013). These results show that the type, rhythm, or duration of music affects the results of the studies. In a study conducted by Hammad et al. it was found that the systolic heart rate of Taekwondo athletes increased significantly when the music rhythm was fast (Hammad et al., 2019). When investigated in this context, results were obtained that support our research.

In a study conducted by Chtorou et al. in which the muscle power generated was examined as a function of diurnal variation in music, it was reported that the power level was reached in the evening when music with lower power was listened to in the morning (Chtourou et al., 2012). This study shows similar results to our study. Other studies have shown that performances in diurnal variation also vary according to the type of music. In the study conducted by Belkhir et al. the vertical jump performances were determined according to diurnal variation with synchronized music, with motivational music and after the warm-up protocol without music. In this study, it was found that performance levels were higher in the evening than in the morning, warm-up exercises with music performed better than warm-up exercises without music, and it was found that warm-up with motivational music was more effective (Belkhir et al., 2020).

When we examined the literature, similar results were obtained as in our investigation. One of the main limitations of our study is that our sample group consists of individuals with moderate and mild ID. Therefore, the results of our study cannot be generalized to all IDs. The results of our research will provide important results for the activities that should be performed in the evening to provide more benefits in anaerobic activities that can be applied to individuals with moderate and mild ID. It will also have the effect of playing music in the range of 170-180 bpm to achieve a similar level of performance in the morning. Considered in this context, the results of this study will help to design physical education and sports activities that can be applied to ID individuals. In this study, only the anaerobic performance levels of ID individuals were investigated. The effects of various performance indicators can also be investigated.

Conflict of interest

No conflict of interest is declared by the authors. In addition, no financial support was received.

Ethics Committee

This study is approved by the Bandırma University (BU) and Human Research Ethics Committee of the BU (Approvel Nummer: 2022/221).

Author Contributions

Planned by the author: Study Design, Data Collection, Statistical Analysis, Data Interpretation, Manuscript Preparation, Literature Search. Author have read and agreed to the published version of the manuscript.

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