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Acute Effects of Music-Accompanied and Non-Music Exercise on Perceived Exertion And Exercise Enjoyment in Athletes

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Abstract

Enhancing motivation and reducing perceived exertion during exercise are critical objectives in sports science, both for optimizing athletic performance and ensuring long-term adherence to physical activity. In this context, music-accompanied exercise has been proposed as a potential intervention to positively influence athletes' psychological states and overall exercise experience. However, its effects require objective evaluation, particularly in sports such as bocce, where strategy, concentration, and balance play a central role. The aim of this study was to examine the acute effects of a single session of music-accompanied and non-music exercise on perceived exertion (RPE) and exercise enjoyment (PACES) in individual bocce athletes aged 11–14 years. A quasi-experimental, crossover design was employed, involving 34 licensed athletes engaged in regular training. Each participant completed two separate standardized 20-minute exercise protocols on different days: one with music (120–130 BPM) and one without. The protocols consisted of a 5-minute warm-up, 15 minutes of moderate-intensity anaerobic exercise, and a 5-minute cool-down. Post-exercise measurements were obtained using the Borg Rating of Perceived Exertion Scale (RPE) and the Physical Activity Enjoyment Scale (PACES). Due to non-normal data distribution, Wilcoxon Signed-Rank, Mann-Whitney U, and Kruskal-Wallis H tests were applied ($p<0.05$). Findings indicated that, for both male and female athletes, music-accompanied exercise significantly reduced perceived exertion ($p<0.001$) and increased enjoyment ($p<0.001$). No statistically significant differences were found between sexes or grade levels; however, consistent trends favoring the music condition were observed across all subgroups. In conclusion, music-accompanied exercise enhances the training experience of bocce athletes by reducing perceived exertion and increasing enjoyment, thereby potentially boosting motivation. These findings suggest that the deliberate integration of music into training programs for developing athletes may contribute to improved psychological well-being and greater engagement in sport.

Keywords: *Music, Perceived exertion, Enjoyment, Youth athletes.*

INTRODUCTION

Music has been recognized throughout history as a potent form of artistic expression that influences both the cognitive and emotional states of individuals, often serving as a catalyst for action and engagement (Say, 2008; Karayol & Turhan, 2020). Within the domain of sport, music has emerged as more than a cultural or recreational element; it is now acknowledged for its ergogenic potential to enhance athletic performance, delay the onset of fatigue, improve muscular endurance, and increase power output (Thakare et al., 2017). These benefits are particularly relevant in competitive contexts, where the optimization of both physiological readiness and psychological resilience is essential for peak performance.

Athletes have long relied on psychological strategies to complement physical training, recognizing that success in sport depends not only on technical skill and physical conditioning but also on mental preparedness (Seleciler, 2019,Tazegül et al 2015). Optimal athletic execution requires the selection of appropriate techniques at the right time and under the right conditions, with factors such as personality traits, individual expectations, training readiness, and competitive motivation playing influential roles

(Samur, 2017,Duyan et al.2024). Consequently, psychological performance is considered a critical determinant of competitive success, particularly in disciplines that require sustained focus and strategic execution (Bali, 2015).

In this pursuit of performance enhancement, stakeholders in sport science have explored various innovative methods, with music emerging as a promising adjunct. Appropriately selected music—aligned with the athlete's personal preferences and the demands of the sport—has been shown to serve as a powerful motivational aid (Koç & Koç, 2023; Köse, 2017; Lee et al., 2017; Terry et al., 2012,Sekban et al 2022). Stevens and Lane (2001) describe music as a mood-regulation strategy, while other research highlights its capacity to modulate arousal levels, increase concentration, and sustain performance output under physically and mentally demanding conditions (Clark et al., 2016). Music can also influence physiological variables, such as heart rate, and enhance reflexive motor responses, further contributing to athletic performance (Çelik & Karabilgin, 2022).

Bocce is a multifaceted sport incorporating disciplines such as Volo, Raffa, Petanque, and Lawn Bowls. It can be played individually or in teams and demands high levels of concentration, balance, and precision. Its competitive nature often elevates anxiety levels, which have been shown to impair athletic performance (Abrahamsen, 2008). Strategies to mitigate anxiety and enhance motivation are therefore essential. Rhythmic synchronization between music and motor execution has been found to positively influence psychological states, fostering self-confidence, self-esteem, and a willingness to train more intensely (Pagnoni, 2010; Sood et al., 2016; Türkmen, 2011).

The sustainability of high-level performance in sport is determined not only by physical capabilities but also by mental processes and the influence of external stimuli. Evidence indicates that music can enhance motivation, reduce anxiety, improve attentional focus, and elevate overall performance (Çelik & Karabilgin, 2022). However, empirical research on the psychological and physiological effects of music in bocce—especially among youth athletes—remains scarce. This gap is noteworthy given that bocce, particularly in its Volo discipline, requires rapid, precise, and repetitive technical execution under conditions of cognitive and emotional load.

The present study addresses this gap by investigating the acute effects of music-accompanied and non-music exercise on perceived exertion (RPE) and exercise enjoyment (PACES) in individual bocce athletes aged 11–14 years. By examining psychophysiological responses under both conditions, the study aims to provide evidence-based insights into the role of music as a supportive element in training and competition. Ultimately, these findings may guide the design of youth-focused training programs that integrate music to enhance motivation, reduce perceived effort, and improve the overall sporting experience.

METHODS

Research Design

This study employed a quasi-experimental, crossover design to compare the acute effects of a single session of music-accompanied and non-music anaerobic exercise on perceived exertion (RPE) and exercise enjoyment (PACES) in individual bocce athletes. Each participant completed two identical exercise protocols on separate days: one under music-accompanied conditions and the other without music. A minimum interval of 48 hours was provided between sessions to minimize potential carry-over effects. A within-subject comparison approach was adopted.

Participants

The study sample consisted of healthy, licensed bocce athletes aged 11–14 years (mean age: 12.50 ± 1.08 years; height: 147.38 ± 9.28 cm; body mass: 39.56 ± 9.55 kg) residing in Bingöl, Türkiye. All participants engaged in regular training and reported no health problems. The minimum required sample size was determined a priori using G*Power 3.1.9.7 software based on a paired-samples t-test for two dependent measures (music and non-music conditions), with an effect size of Cohen's d = 0.5 (medium), $\alpha = 0.05$, power $(1-\beta) = 0.80$, and two-tailed testing. Calculations indicated that at least 34 participants were required to detect statistically significant differences (Faul et al., 2007).

Participants and their guardians were informed about the study's purpose, exercise protocol, measurement procedures, and potential risks. Written informed consent was obtained from all participants' legal guardians. The study was conducted in accordance with the Declaration of Helsinki ethical guidelines. In order to conduct the study, the necessary permission and approval were obtained

from the Ethics Committee of Scientific Research in Health Sciences at Malatya Turgut Özal University (date: 30/07/2025, decision no: 6)

Inclusion, Exclusion, and Withdrawal Criteria

Inclusion criteria were: (i) aged 11–14 years, (ii) possession of a valid bocce license issued by the relevant federation or provincial sports authority, (iii) regular training for at least the last six months (≥3 days/week), (iv) no chronic disease or physical disability, (v) no contraindications to performing the exercise protocol, and (vi) provision of signed parental consent.

Exclusion criteria included: (i) cardiovascular, respiratory, musculoskeletal, metabolic, or neurological disorders; (ii) serious injury, surgery, or trauma in the last three months; (iii) current use of medication, hormonal treatment, or ergogenic aids; (iv) cognitive or communication impairments preventing completion of assessments; (v) non-compliance with study instructions; and (vi) absence of parental consent.

Withdrawal criteria included: (i) occurrence of adverse symptoms during exercise (e.g., excessive fatigue, dizziness, chest pain, palpitations), (ii) heart rate exceeding 85% of the age-predicted maximum (Tanaka et al., 2001), (iii) voluntary withdrawal by participant or guardian, (iv) inability to complete the exercise protocol, and (v) incomplete or invalid data.

Study Design

Each participant completed both music and no-music exercise protocols with a rest period of at least 72 hours between sessions (Bowers et al., 2012). In each condition, the participant performed a 20-minute exercise session. The acute effects on perceived exertion and exercise enjoyment were assessed using the Borg 6–20 Rating of Perceived Exertion (RPE) scale and the Physical Activity Enjoyment Scale (PACES – 5). Gender and school grade were used as analysis variables. Given that, in the Turkish education system, students of the same age are placed in the same grade, the age variable overlapped with grade and was excluded from the analysis.

The study focused on athletes competing in the Volo category of bocce. The Volo discipline is a dynamic sub-branch of bocce, and this study targeted the "basamak" event for middle school athletes. The competition court length ranges from 8.5 m to 11.5 m. Target balls weigh between 300–340 g, while throwing balls range from 600–1100 g. Athletes perform throws at opposing target balls for three minutes (TBBDF, 2023).

Exercise Protocol

Each participant completed a standardized anaerobic exercise protocol lasting approximately 20 minutes, consisting of three phases:

Warm-up (5 minutes): Light-intensity walking and jogging, combined with dynamic stretching exercises (e.g., arm–knee rotations, hamstring mobilization, hip rotations) to prepare the musculoskeletal and cardiovascular systems for exercise.

Main Exercise Phase (15 minutes): Moderate-intensity, bodyweight-based aerobic movements, including jumping jacks, squats, high knees, mountain climbers, and burpees. Exercise intensity was calculated according to the formula proposed by Tanaka et al. (2001) for maximum heart rate (HRmax = 208 − (0.7 × age)), targeting 64–76% of HRmax as moderate intensity. For example, for a 12-year-old, HRmax ≈ 200 bpm, resulting in a target heart rate range of approximately 128–152 bpm. Heart rate was continuously monitored using chest-strap heart rate sensors (e.g., Polar H10).

- **Music Condition:** 120–130 BPM rhythmic, motivational, and non-distracting music was played throughout the session, selected to enhance performance, reduce perceived exertion, and increase enjoyment (Karageorghis & Priest, 2012; Terry et al., 2020).
- **No-Music Condition:** The identical protocol was performed in silence.

Cool-down (5 minutes): Low-intensity walking and static stretching (e.g., quadriceps, hamstrings, shoulders, lower back) to gradually lower heart rate and initiate recovery.

Measurements

Heart Rate (HR) Assessment: Prior to each test session, participants were fitted with a Polar H10 chest-strap heart rate monitor (Polar Electro, Finland). Baseline data including name, age, height, and resting HR were entered into the Polar Team iPad application. HRmax was automatically calculated according to Tanaka et al. (2001).

Anthropometric Measurements

Height: Measured barefoot, with heels together, body upright, eyes forward, and arms relaxed at the sides, using a calibrated Harpenden stadiometer (Holtain Ltd.) accurate to 0.1 cm.

Body Mass: Measured barefoot and in minimal clothing using a digital scale with ±0.1 kg accuracy.
Body Mass Index (BMI): Calculated as BMI = weight (kg) / height² (m²).

Borg Rating of Perceived Exertion (RPE) Scale: The 6–20 scale was used to assess subjective exertion immediately after exercise (Borg, 1982). Participants responded to the question: "How strenuous was the exercise for you?" Responses ranged from 6 ("no exertion at all") to 20 (maximal exertion). Standardized instructions were provided for each assessment to ensure consistency.

Exercise Enjoyment Scale (PACES – 5): This single-item, 1–7 Likert scale measures subjective enjoyment of physical activity, where 1 = "not at all enjoyable" and 7 = "extremely enjoyable." Originally developed by Raedeke (2007) and adapted into Turkish by Soylu et al. (2023), the scale is validated for use with adolescent and adult athletes. Participants completed the scale immediately post-exercise.

Statistical Analysis

Data were analyzed using IBM SPSS Statistics 25.0. Normality was assessed using the Shapiro–Wilk test, supported by graphical methods (histogram, Q–Q plot). Given that data were not normally distributed ($p < 0.05$), non-parametric tests were applied. The Mann–Whitney U test was used for comparisons between two independent groups, the Wilcoxon Signed-Rank test for two related samples, and the Kruskal–Wallis H test for comparisons among three or more independent groups. The significance level was set at $p < 0.05$ for all analyses.

FINDINGS

Table 1. Mann–Whitney U Test Results for Perceived Exertion and Enjoyment Levels in Music and Non-Music Exercise by Gender of Participants

Variable	Gender	N	Mean ± SD	Mann–Whitney U	p
RPE–M	Female Student	16	12.75±2.51	132.500	.688
	Male Student	18	12.56±2.87		
RPE–NM	Female Student	16	16.25±2.76	143.000	.972
	Male Student	18	16.33±2.52		
ENJ–M	Female Student	16	44.56±2.92	105.000	.174
	Male Student	18	43.05±3.36		
ENJ–NM	Female Student	16	22.93±2.32	137.000	.806
	Male Student	18	22.38±2.59		

RPE–M = Ratings of Perceived Exertion – Music Condition; RPE–NM = Ratings of Perceived Exertion – Non-Music Condition; ENJ–M = Enjoyment – Music Condition; ENJ–NM = Enjoyment – Non-Music Condition

Table 1 presents the comparison of Rating of Perceived Exertion in the music condition (RPE-M) and no-music condition (RPE-NM), as well as Enjoyment scores in the music condition (ENJ-M) and no-music condition (ENJ-NM), according to gender. According to the results of the Mann–Whitney U test, RPE-M did not show a statistically significant difference by gender ($U = 132.500$, $p = .688$). The mean score for female students ($\bar{X} = 12.75$, $SD = 2.51$) was very close to that of male students ($\bar{X} = 12.56$, $SD = 2.87$), and this difference was not statistically significant. Similarly, no significant gender difference was found in RPE-NM ($U = 143.000$, $p = .972$). The mean score for female students ($\bar{X} = 16.25$, $SD = 2.76$) and male students ($\bar{X} = 16.33$, $SD = 2.52$) did not differ notably. For ENJ-M, the analysis revealed no statistically significant gender difference ($U = 105.000$, $p = .174$). Although the mean enjoyment score of female students ($\bar{X} = 44.56$, $SD = 2.92$) was higher than that of male students ($\bar{X} = 43.05$, $SD = 3.36$), this difference was not statistically significant. Lastly, for ENJ-NM, no significant difference was observed between genders ($U = 137.000$, $p = .806$). The mean score of female students ($\bar{X} = 22.93$, $SD = 2.32$) was slightly higher than that of male students ($\bar{X} = 22.38$, $SD = 2.59$), but this difference was not statistically significant. Overall, the findings indicate that both male and female participants exhibited similar levels of perceived exertion and enjoyment during exercise sessions conducted with and without music.

Table 2. Wilcoxon Signed-Rank Test Results for Perceived Exertion and Enjoyment Levels in Music and No-Music Exercise Conditions by Gender

	Variable	N	Mean ± SD	Z	p
Female Student	RPE–M	16	12.75±2.51	-3.266	.001
	RPE–NM	16	16.25±2.76		
	ENJ–M	16	44.56±2.92	-3.520	.000
	ENJ–NM	16	22.93±2.32		
Male Student	BPE-M	18	12.56±2.87	-3.685	.000
	BPE-NM	18	16.33±2.52		
	ENJ-M	18	43.05±3.36	-3.738	.000
	ENJ-NM	18	22.38±2.59		

RPE–M = Ratings of Perceived Exertion – Music Condition; RPE–NM = Ratings of Perceived Exertion – Non-Music Condition; ENJ–M = Enjoyment – Music Condition; ENJ–NM = Enjoyment – Non-Music Condition

In Table 2, the perceived exertion (RPE) and enjoyment levels (ENJ) of participants in music and non-music exercise conditions were compared according to gender. According to the results of the Wilcoxon Signed-Rank test, a significant difference was found in the perceived exertion (RPE) levels of female athletes between music and non-music exercise conditions (Z = -3.266, p = .001). Examining the mean scores, the perceived exertion level of female athletes during music-accompanied exercise ($\bar{X}$ = 12.75, SD = 2.51) was lower compared to non-music exercise ($\bar{X}$ = 16.25, SD = 2.76). Similarly, a significant difference was found in the enjoyment (ENJ) levels of female athletes between music and non-music exercise conditions (Z = -3.520, p = .000). Female athletes reported a higher enjoyment level during music-accompanied exercise ($\bar{X}$ = 44.56, SD = 2.92), whereas their non-enjoyment level during non-music exercise ($\bar{X}$ = 22.93, SD = 2.32) was higher. This finding indicates that female athletes experienced greater enjoyment when exercising with music. The results for male athletes showed a similar trend. The perceived exertion level of male athletes during music-accompanied exercise ($\bar{X}$ = 12.56, SD = 2.87) was significantly lower than during non-music exercise ($\bar{X}$ = 16.33, SD = 2.52) (Z = -3.685, p = .000). Furthermore, a significant difference was observed in the enjoyment levels of male athletes between the two conditions (Z = -3.738, p = .000), with higher enjoyment reported during music-accompanied exercise ($\bar{X}$ = 43.05, SD = 3.36) and higher non-enjoyment levels during non-music exercise ($\bar{X}$ = 22.38, SD = 2.59). Overall, the findings indicate that both female and male athletes perceived less exertion and reported higher enjoyment during music-accompanied exercise. Accordingly, it can be concluded that exercising with music reduces perceived exertion and makes the exercise experience more enjoyable.

Table 3. Kruskal–Wallis H Test Results for the Comparison of Perceived Exertion and Enjoyment Levels in Music and Non-Music Exercise Conditions by Participants' Education Level.

Variable	Class Level	N	Mean ± SD	Kruskal-Wallis H	p
RPE–M	5th Year	8	12.75±3.57	.994	.803
	6th Year	8	12.50±2.67		
	7th Year	11	13.18±2.75		
	8th Year	7	11.86±1.46		
	Total	34	12.65±2.67		
RPE–NM	5th Year	8	16.25±3.05	2.346	.504
	6th Year	8	15.00±3.20		
	7th Year	11	17.00±2.00		
	8th Year	7	16.71±2.05		
	Total	34	16.29±2.60		

ENJ-M	5th Year	8	44.50±2.07	6.456	.091
	6th Year	8	45.00±2.32		
	7th Year	11	41.90±3.04		
	8th Year	7	44.42±4.50		
	Total	34	43.76±3.21		
ENJ-NM	5th Year	8	22.75±3.37	.899	.826
	6th Year	8	23.12±2.47		
	7th Year	11	22.54±2.20		
	8th Year	7	22.14±1.95		
	Total	34	22.64±2.44		

RPE–M = Ratings of Perceived Exertion – Music Condition; RPE–NM = Ratings of Perceived Exertion – Non-Music Condition; ENJ–M = Enjoyment – Music Condition; ENJ–NM = Enjoyment – Non-Music Condition

In Table 3, the participants' perceived exertion (RPE–M, RPE–NM) and enjoyment levels (ENJ–M, ENJ–NM) during music and non-music exercise conditions were compared according to grade level using the Kruskal–Wallis H test. The analysis for perceived exertion in the music condition (RPE–M) revealed no statistically significant difference among grade levels (H = 0.994, p = .803). Examination of the mean scores showed that 7th-grade students reported the highest perceived exertion ($\bar{X}$ = 13.18, SD = 2.75), whereas 8th-grade students reported the lowest ($\bar{X}$ = 11.86, SD = 1.46); however, these differences were not statistically significant. Similarly, for the non-music condition (RPE–NM), no significant difference was observed among grade levels (H = 2.346, p = .504). Based on mean scores, 7th-grade students perceived the non-music exercise as the most demanding ($\bar{X}$ = 17.00, SD = 2.00), while 6th-grade students reported lower exertion levels ($\bar{X}$ = 15.00, SD = 3.20). Regarding enjoyment levels in the music condition (ENJ–M), the analysis indicated a difference among grade levels that approached but did not reach statistical significance (H = 6.456, p = .091). According to the mean scores, the highest enjoyment was reported by 6th-grade students ($\bar{X}$ = 45.00, SD = 2.32), whereas the lowest enjoyment was reported by 7th-grade students ($\bar{X}$ = 41.90, SD = 3.04). This finding suggests that music during exercise might be perceived more positively by certain grade levels; however, the difference was not statistically significant. Finally, for non-music enjoyment (ENJ–NM), no significant differences were found among grade levels (H = 0.899, p = .826), with mean scores being quite similar across groups. Overall, these findings indicate that students' perceived exertion and enjoyment levels during music or non-music exercise did not significantly differ by grade level, although certain tendencies may be noteworthy.

DISCUSSION AND CONCLUSION

The performance exhibited by athletes during training or competition is influenced by numerous factors such as the type of sport, physical capabilities, psychological state, and environmental conditions. In particular, for athletes aged 11–14, motivational factors are considered to be of primary importance, and it has been reported that making training sessions enjoyable and engaging during this period can have a positive effect on performance. In this context, it is evaluated that in the bocce branch, incorporating music into training and competitions may help reduce the potential monotony or demotivating aspects of the sport and increase enjoyment, thereby enhancing performance through its motivational impact. A review of the literature emphasizes that exercising with music positively affects athletes' attention, motivation, and mood, thereby improving performance (Akhshabi & Rahimi, 2021; Koç & Koç, 2023). Similarly, Stork et al. (2015) reported that music may facilitate participation and motivation in high-intensity training such as sprint interval training, making such sessions more willingly undertaken.

When the study was examined in terms of gender, no statistically significant difference was found between music and non-music exercise conditions regarding perceived exertion and enjoyment levels. However, an evaluation of mean scores revealed that exercise with music provided higher motivational benefits; female students enjoyed these exercises more and reported lower levels of exertion compared to male students. The literature contains both supporting and contradicting findings in this regard. For instance, Albay et al. (2022) found no significant gender differences regarding the effect of music in a study examining sport commitment among university students. Conversely, Bektaş and Demir (2022) reported a significant gender-based difference in the "physical resilience" sub-dimension of the scale measuring the

effect of music in sports practices. Similarly, Ekiz and Atasoy (2021), in their study on physical education students, found statistically significant gender differences in the effect of music before, during, and after sports practices, favoring male students.

When participants were evaluated separately by gender, statistically significant differences were identified in favor of the music condition for both female and male students. In both groups, exercises performed with music were associated with lower perceived exertion and higher enjoyment, whereas non-music exercises were linked to higher exertion levels and reduced enjoyment. The literature also reports similar and differing results. For example, Vural et al. (2019), in a study examining the influence of music on karate athletes and their academic self-efficacy, found no significant difference by gender. Likewise, Turhan (2021), in a study investigating the relationship between the effect of music in sports practices and sport-specific achievement motivation, reported no significant gender differences in the sub-dimensions of motivation, physical strength and performance, and psychological resilience.

Regarding grade level, no statistically significant differences were found in perceived exertion and enjoyment levels between music and non-music exercise conditions. Evaluation of the overall scores indicated that, regardless of educational level, students reported higher enjoyment and lower perceived exertion for exercises performed with music compared to those without music. In the literature, results on the educational level variable in music-related sports studies generally reveal statistically significant differences. For instance, Barış (2024), in a thesis on the effect of music on the motivation levels of taekwondo athletes, reported significant differences in the sub-dimensions of motivation, physical strength and performance, psychological resilience, and in the total mean scores of the scale. Similarly, Gacar (2021), in a study on taekwondo athletes, identified significant differences between educational level and the effect of music in sports practices across the same sub-dimensions. In another study, Bulut (2023) reported significant differences according to class level in a study on coach candidates, with 4th-year students achieving the highest scores.

This study demonstrated that music-accompanied exercise reduces perceived exertion and increases enjoyment in both female and male students. While some findings align with the literature, others differ regarding gender and educational level. Overall, the results indicate that music is a supportive element in enhancing athletes' motivation and positive attitudes toward exercise. Particularly for athletes in their developmental years, incorporating music into training may benefit both physical performance and psychological well-being. These findings suggest that music should be consciously integrated into training program design as an effective tool for enhancing athlete motivation. Especially in the volo discipline of bocce, exercise with music emerges as an important factor contributing positively to performance.

It is recommended that training programs, particularly for children and young athletes, make greater use of the motivational effects of music in order to create a more engaging and enjoyable exercise environment. The type, tempo, and rhythm of the music to be used during training should be selected with consideration of the athletes' age, gender, and sport-specific characteristics. For athletes in their developmental years, future research should investigate the long-term effects of integrating music into training content on sport participation continuity and motivation. Additionally, comparative studies should be conducted to examine the impact of music use on performance and group cohesion in both team and individual sports.

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