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ORIGINAL RESEARCH

The effects of preferred music during strength training: maximal strength, strength endurance and rating of perceived exertion

Bereket Köse[1], Ahmet Atlı[2], Ayşegül Köse[3], Ramazan Şeker[4]

[1] Department of the Recreation, Faculty of Sports Sciences, Hatay Mustafa Kemal University, Hatay, Türkiye. [2] Coach Education Department, Faculty of Sports Sciences, Igdır University, Igdır, Türkiye. [3] Institute of Health Sciences, Selcuk University, Konya, Türkiye. [4] Department of Physical Education Teaching, Faculty of Sports Sciences, Hatay Mustafa Kemal University, Hatay, Türkiye.

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Abstract

The purpose of this study was to examine the effects of listening to the music of choice of individuals performing strength training during training on maximal strength, strength endurance, and perceived exertion. 16 men with 1-2 years of strength training experience participated in the study. Participants' perceived exertion levels, maximum strength, and strength endurance with 75% of 1 maximum repetition were measured with the Borg scale on different days with their preferred music, non-preferred music, and no music. According to the results of the study, according to the perceived difficulty levels measured after the strength maintenance test, it is seen that preferred music ($F=6.323$; $p<0.05$) causes less effort than non-preferred music and no music. There was no difference in the rating of perceived exertion in the non-preferred music and no-music conditions. In the 1 maximal repetition bench press test, there was no statistical significance in the preferred music compared to the non-preferred music and no-music conditions ($F=0.427$; $p>0.656$). According to the results of the strength endurance test, it is seen that preferred music ($F=5.737$; $p<0.008$) provides more strength endurance than non-preferred music and no music. No difference was found between non-preferred music and no music ($p>0.05$). As a result, listening to the music that participants prefer during warm-up and exercise increases their strength endurance and decreases the perceived effort after strength endurance. It is observed that preferred or non-preferred music does not make any progress in maximal strength. Personal music preferences and listening to music with headphones during exercise sessions are recommended to improve strength and reduce perceived effort. Because music can redirect the individual's attention to thoughts unrelated to exercise at that moment. This can lead to less fatigue. At the same time, music is easily accessible, does not impose any extra cost on the person, and is seen to be effective as a psychological ergogenic aid.

Introduction

Music existed before verbal communication and has been a fundamental aspect of human culture and evolution (Mithen, 2006; Patel, 2008). Music is also considered a universal tool in terms of communication (Mehr et al., 2019). In various forms, it has influenced every society in the world, from the most primitive to the most developed. Music emphasises our daily life and accompanies a wide range of activities. It is an integral part of rituals, ceremonies and all kinds of activities. It motivates soldiers preparing to go into battle, and serves to coordinate their progress, and influences many aspects of exercise and sport (Clark et al., 2016; Levitin, 2006). Today, music has become an essential part of modern life and has also become one of the fashion trends. Therefore, listening to music during exercise has become a new sports trend (Lei & Huang, 2020). Moreover, individuals who use music during exercise believe that their mood is getting better, time passes faster during exercise, and there is an improvement in their performance. The widespread use of music in exercise environments has attracted the attention of scientists and opened the way for studies in this field. Many studies have reported that listening to music during exercise is an ergogenic aid that can increase some performance data

✉ B. Köse, E-mail: bereket.kose@mku.edu.tr
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(Aburto & Vargas, 2017; Eliakim et al., 2007; Hutchinson et al., 2011). However, different dimensions, such as the type of music selected, the rhythm and intensity of the music, and music preference may cause sports participants to have different physical or psychological performances (Köse, 2017). New developments in portable technology (e.g. smartphones, mp3 players) have facilitated access to music and listening to music and enabled individual selection of music during exercise (Hallet & Lamont, 2017). This has enabled athletes to exercise while listening to music of their choice. Current studies at this point have focused more on investigating how athletes improve their performance when they exercise with music of their own choice (Ballmann et al., 2021a; Greco et al., 2022; Köse, 2018). In previous years, the effect of music on sports performance, especially cardiovascular endurance and recovery, has been studied by many researchers. However, the effect of music on resistance exercises has attracted attention in recent years. Resistance exercises are generally applied by people who aim to increase muscular endurance and strength and strength performance (Folland & Williams, 2007). Optimising training regimes to maximise these aspects can lead to increased performance. Therefore, the use of ergogenic aids, substances or phenomena believed to enhance performance has become popular to improve training techniques and can range from substances such as caffeine and creatine to external influences such as music (Atan, 2013; Woolf et al., 2008). Likewise, individuals and coaches use a variety of training methods (beyond traditional resistance training) and supplements, as well as ergogenic aids such as verbal motivation or music (Filip-Stachnik et al., 2021; Pettit & Karageorghis, 2020) to improve sports performance and stamina. Music is a tool to calm fatigue-related symptoms during exercise, elicit more positive emotional responses, regulate emotional arousal and improve neural control of working muscles (Bigliassi et al., 2017; Hutchinson et al., 2018). Music has also been recognised as a sensory distraction and a means of increasing adaptation to physical activity (Clark et al., 2016). More recently, the brain mechanisms underlying the effects of music on exercise have been investigated (Bigliassi et al., 2016; Tabei et al., 2017). An increase in exercise intensity draws the focus of the exerciser's attention towards physical sensations and thus leads to a greater awareness of fatigue-related symptoms. Conversely, exposure to environmental sensory cues, such as music or video images, may direct the focus of attention during exercise to irrelevant cues outside of exercise (Karageorghis & Jones, 2014). As suggested by Conrad et al. (2007), stimulating music tracks may also regulate cardiac, respiratory and muscular activities through neurohumoral pathways. According to these researchers, music can regulate physiological arousal, leading to an effect on the activity of the autonomic system. The mechanisms highlighted by these researchers show that music may actually have a positive effect on the performance of the person by creating a psychological effect, such as other nutritional or pharmacological ergogenic aids that create physiological effects. In fact, in some of the studies, it is stated that listening to music increases recovery (Karageorghis et al., 2018; Köse, 2017; Köse & Atlı, 2019; Lim et al., 2014), increases the capacity to trigger a series of physiological changes including respiration, heart rate, motor patterns, neuroendocrine response and immunological function (Ooishi et al., 2017), running time (Köse & Atlı, 2019) and consequently improves acute exercise performance (Ballmann, 2021). As a result, listening to music helps increase athletic performance as a psychological ergogenic aid. In this context, this study aimed to investigate the effect of listening to preferred music during the training on maximal strength, strength endurance and rating of perceived exertion (RPE) of strength training individuals.

Methods

Study Design

A randomised design was used for the three conditions included in the protocol, each performed by all participants. Participants performed tests of maximal force and strength endurance under preferred music, non-preferred music, and without music conditions, and were asked to rate their self-reported RPE. Each music condition was tested on different days. Participants were allowed 3-day rest periods between each of the test days. Tests and measurements were made in the fitness center between 17:00 and 19:00 in the afternoon. To create a natural environment, measurements were made in a public fitness center that everyone uses.

Sample Size and Sampling Technique

In order to determine the number of participants in the study, power analysis was performed. According to the results of the power analysis, it was determined that 16 male participants were sufficient for the study. The mean age of the participants was 21.4 ± 2.4 years,

the mean height was 175 ± 4.7 cm, and the body weight was 72.1 ± 2.4 kg. All participants were individuals who performed strength training in the gym and had 1-2 years of strength training experience. Moreover, all of the participants had been performing uninterrupted strength training at a rate of at least two training sessions per week for at least three months. Participants were advised to maintain their nutritional routines while participating in the study, but their diets were not controlled. Participants were also asked to avoid activities that would cause fatigue during the tests and measurements.The criteria for excluding participants from the study were the diagnosis of orthopaedic injury in the previous 5 months, decreased auditory perception, or any health problem that would make it impossible to perform the tests and affect the results. The ethics committee permission for the study was obtained with meeting number 2024/16 dated 23.05.2024 of the Iğdır University Scientific Research and Publication Ethics Committee.

The Intervention Programme

The data collection process for each participant was divided into four parts, three days apart. On the first day, participants signed informed consent and answered a questionnaire regarding their music genre preferences (preferred and non-preferred) while performing various daily activities during their routine (e.g., driving, leisure, and whether they listen to music while working out at the gym). The choice of music for the conditions of this research protocol was based on each participant's preferred and non-preferred music genre during training. In the music conditions, music intensity was set at 75 decibels. According to various researchers, the music volume was recommended to range between 70-82 decibels (Köse, 2020; Karageorghis et al., 1996). The music tempo was set to 137 BPM per minute (the number of beats per minute of the song) for all participants. According to previous research, music with a tempo of >120 and above BPM was stimulating (Köse, 2020; Terry & Karageorghis, 2011). The BPM of all music genres declared by the participants was standardised in the 'Virtual DJ-8' programme. Therefore, regardless of the music genre, all songs played had the same BPM rate. On each of the three days, including the warm-up period, participants performed maximal strength and strength endurance testing with their preferred type of music, with their non-preferred type of music and without music. We randomised the order of the music conditions for the three days preceding the test sessions. In the preferred and non-preferred music sessions, participants performed a routine warm-up (10 min running, 5 min stretching and a low-load movement tested) to the music of their choice. In the music-free session, no music was played either during the warm-up nor during the measurements. On the first test day, the participants performed a 1RM test in the lat-pulldown (McGuigan, 2015), followed by the bench press (Miller, 2012) in the no-music condition after warm-up. According to this determined 1RM, tests were performed in the main measurements.

Maximal Strength Measurements: Maximal strength tests were performed with Bench Press movement. According to NSCA rules, one repetition maximum (1RM) was found on the first day of the measurements. In the following days, two trials were performed in 1RM bench press measurements, and 5 minutes of rest was given between sets. During the 1RM bench press measurement, the participants lay on their backs with their heads, shoulders and hips on the bench and their legs touching the floor. The arms gripped the bar slightly wider than shoulder-width apart, and for safety purposes, a person accompanied the ascent and descent bar. For the starting position, the participants lowered the bar to the point where it touched their chest and continued to raise it until the elbows were in the full extension position. During the movement, the participant's head, shoulder and hip continued to touch the bench (Miller, 2012).

Strength endurance measurements: Strength endurance was assessed in the lat-pulldown exercise, which was chosen as it was frequently performed in resistance training and a good indicator of upper limb strength (Signorile et al., 2002). The strength continuity test was performed with a load equivalent to 75% of 1 RM determined on the first day of testing (Sheppard & Triplett, 2015). The movement rhythm was set to two seconds for the concentric movement, followed by two seconds for the eccentric movement. All participants were encouraged to perform two sets of the maximum number of repetitions until they reached muscle failure, which corresponds to the inability to sustain contractions without a change in posture or movement tempo (Steele et al., 2017). The number of lifts at the end of the two sets was recorded, and the mean value of these two sets was taken as the final strength maintenance value. Between each set, participants were allowed five minutes to rest to allow the muscles to completely recover (McGuigan, 2015).

Ratings of Perceived Exertion

We assessed participants' RPE with the Borg questionnaire (on a 10-point scale) immediately after each lat-pulldown trial. This protocol was selected as it provides a reliable, non-invasive assessment of individual effort as well as exercise intensity (Borg, 1998). We considered the mean value of the two trials as the final RPE value.

Data Analyses

For statistical analysis, the mean of the three values obtained from each test for each music condition was used. Since all variables showed homogeneity of variance and co-variance, we performed three different one-way analyses of variance (ANOVAs) using the music condition (preferred music x non-preferred music x without music) as a factor, considered repeated measures. The dependent variables were strength endurance, maximum strength and rating of perceived exertion. Post-hoc tests were performed with Bonferroni. All statistical analyses were performed using SPSS software (SPSS-22), and a significance level was taken as $p<0.05$.

Results

According to the RPE measured after the strength endurance test, preferred music ($F_{(2.28)}=6.323$; $p<0.005$; $\eta^2=0.311$) caused less exertion than non-preferred music and without music. No difference was found in the RPE in the case of non-preferred music and without music. In the one maximal repetition bench press test, it was observed that there was no statistical significance between preferred music, non-preferred music and without music ($F_{(2.28)}=0.427$; $p>0.656$; $\eta^2=0.030$). According to the results of the strength endurance test, it was seen that the preferred music ($F_{(2.28)}=5.737$; $p<0.008$; $\eta^2=0.291$) provided more strength endurance than the non-preferred music and without music. No difference was found in the case of non-preferred music and without music ($p>0.05$). According to the RPE measured after the strength endurance test, preferred music ($F_{(2.28)}=6.323$; $p<0.005$; $\eta^2=0.311$) caused less exertion than non-preferred music and without music. No difference was found in the RPE in the case of non-preferred music and without music. In the one maximal repetition bench press test, it was observed that there was no statistical significance between preferred music, non-preferred music and without music ($F_{(2.28)}=0.427$; $p>0.656$; $\eta^2=0.030$). According to the results of the strength endurance test, it was seen that the preferred music ($F_{(2.28)}=5.737$; $p<0.008$; $\eta^2=0.291$) provided more strength endurance than the non-preferred music and without music. No difference was found in the case of non-preferred music and without music ($p>0.05$).

Table 1
The RPE, strength and strength endurance values in different music conditions (Mean ± SD).

	RPE	Maximal Strength	Strength Endurance
Preferred Music	6.20 ± 0.56*	88.13 ± 9.09	11.40 ± .73*
Non-preferred Music	6.73 ± 0.59	88.26 ± 9.11	10.93 ± .70
No Music	6.86 ± 0.64	88.26 ± 9.13	10.60 ± .83

** p < 0.05*

Discussion

In the literature, many studies have investigated the effect of different music genres and tempos on endurance performance and anaerobic performance, while fewer studies have investigated the effect of music on maximal strength and strength endurance. The current study analysed the effect of listening to preferred music genres, listening to non-preferred music genres and without music on upper limb maximal strength and upper limb strength endurance test performances, as well as perceived exertion ratings during a resistance training test. The results revealed that listening to preferred music increased participants' strength endurance more than listening to non-preferred music and the without-music condition, and participants reported lower perceived exertion after the strength endurance test. On the other hand, there was no difference in performance between the conditions of listening to a non-preferred music genre or not listening to music during the tests. In the maximal strength test, it was found that the preferred music did not increase maximal strength performance compared to the other conditions. We observed that participants perceived a lower degree of exertion when listening to a preferred music genre after strength endurance exercises, confirming previous results from other studies (Biagini et al., 2012; Nakamura et al., 2010). Silva et al. (2021) found an approximately 6% reduction in RPE when participants performed a strength test while listening to their preferred music, compared to without music and non-preferred music listening conditions. In our

study, RPE was significantly reduced when participants performed a strength endurance test while listening to their preferred music genre, compared to the without music and non-preferred music listening conditions. Music appears to reduce perceived exertion and improve positive mood during exercise (Ballmann et al., 2020; Carlier & Delevoye-Turrell, 2017). Biagini et al. (2012) reported that in strength-endurance tests with and without self-selected music, they noticed a lower RPE when participants listened to music compared to without music. According to Biagini et al. (2012), even if individuals feel more tired, their subjective perception of effort tends to decrease when they hear their preferred music style. They suggest that music can reduce physiological responses in athletes while performing resistance exercises. Therefore, coaches and strength and conditioning professionals should use music to reduce RPE and physiological responses during warm-up and resistance exercises (Arazi et al., 2015). Similarly, music can be considered a legitimate ergogenic aid for well-trained athletes to reduce perceived exertion and minimise training time during the warm-up before and during resistance exercise (Arazi et al., 2015; Köse, 2019). As a result, Silva et al. (2021) stated that the decrease in RPE found while listening to the preferred music genre may be due to the ergogenic effect of music, the psychophysical effect of music on fatigue perception, or it may function as a dissociative strategy.

Strength endurance discussion: Our results show that listening to preferred music increased strength endurance more than non-preferred music and without music conditions. In literature, some studies also found that listening to the motivational music of the participants' own choice increased strength endurance by 3.9% compared to without music condition (Köse, 2018). Similarly, Bartolomei et al. (2015) reported that music increased strength endurance by 5.8%. Moreover, it was also emphasized that athletes can benefit from the option of listening to their preferred music to increase their motivation and resistance exercise performance (Ballmann et al., 2021b). It was stated that listening to self-selected music during exercise can increase lower extremity isometric strength endurance in healthy middle-aged adults. The remarkable part of this study was that the participants were older adults, unlike other studies (Greco et al., 2022). Our results were similar to previous studies (Bartolomei et al., 2015; Crust, 2004; Cutrufello et al., 2019; Moss et al., 2018; Silva et al., 2021) despite the different study designs adopted (exercise type, music direction, and sample included in the study). Especially, Crust (2004) and Bartolomei et al. (2015) revealed a greater endurance performance after listening to preferred music than in a without-music condition. Silva et al. (2021) showed that strength endurance performance increased when listening to preferred music compared to non-preferred and without music conditions. In contrast, Biagini et al. (2012) and De Lima et al. (2023) reported that preferred music did not improve bench press strength endurance performance. It was suggested that listening to preferred music during active/passive rest between sets had no effect on endurance and strength output in barbell squats and bench press performed for 3 sets at 50% of 1RM (Latocha et al., 2024). The reasons for this difference seem to be searched for in the differences between the protocols of this study and previous studies. In this study, music was only listened to during rest between sets, but not while performing the movement (Latocha et al., 2024). In most of the other studies, music was listened to during exercise or during both rest and exercise. As a matter of fact, Crust (2004) reported that listening to music during strength training provided higher muscular endurance and that listening to music throughout the entire training increased the duration of strength endurance, in contrast to listening to music before exercise. In our study, the participants started to listen to motivational music of their own choice and continued to listen to this music during exercise because listening to music before exercise helps to revitalise and motivate individuals. In studies, it has been reported that starting to listen to motivational music with warm-up before starting exercise increased strength endurance time and short-term maximal performance (Crust, 2004; Chtourou et al., 2012; Köse, 2018). Therefore, it was recommended that athletes and exercising individuals should listen to music of their own choice during the exercise session starting from warm-up to improve performance (Köse, 2019).

Maximal strength discussion: According to our results, preferred and non-preferred music had no effect on maximal strength. As a matter of fact, in a similar study, it was stated that the music listened before and during exercise did not increase maximal strength performance in bench press (Köse, 2018). Likewise, in some studies, it was emphasised that the preferred music did not affect maximal strength performance (Bartolemia et al., 2015; Greco et al., 2022). In contrast to some studies emphasising that

music did not increase maximal strength, Silva et al. (2021) stated that music increased maximal strength. The reason why music did not increase maximal strength may be the lack of an effect of music on maximal strength and the lack of a rhythmic compound in a repetition at high load. Another reason predicted to reduce the effect of music on performance was the maximum intensity of the 1RM test (Bateman & Bale, 2008; Bartolomei et al., 2015; Simpson & Karageorghis, 2006). Some researchers suggest that when the workload is excessively high, an individual's attention shifts toward the painful effects of exertion, preventing them from benefiting from music during exercise due to a lack of focus on auditory stimuli (Waterhouse et al., 2010). Under conditions of maximal or near-maximal exertion, this physiological load imposed on the body induces stress, prompting the central nervous system to allocate its attentional resources entirely toward overcoming this demand to overcome the stress. As a result, it was stated that music does did not increase performance during maximum exercise because the brain cannot pay attention to the music (Köse, 2018). As a result, listening to fast or slow tempo music did not harm performance or psychological results in high-intensity resistance exercises. Personal preference may allow coaches and athletes to continue using self-chosen up-tempo music during high-intensity resistance exercises. Nevertheless, it should not be considered as an ergogenic aid to influence performance during maximal strength exercises (Svobova & Kostrna, 2024).

Conclusion

Listening to the participants' preferred music during warm-up and exercise increased their strength endurance, but decreased the perceived exertion after strength endurance. It was observed that preferred or non-preferred music did not improve maximal strength. To improve strength and reduce perceived exertion, it is recommended to listen to music with personal music preferences and headphones during exercise sessions. The reason why music can redirect the individual's attention to thoughts that are not related to the exercise at that time. This may lead to less exertion. As a result, it is seen that listening to the preferred music is effective as a psychological ergogenic aid.

Future studies should include more muscle groups and more sets. Additionally, it would be useful to investigate a lower weight performed to failure (i.e. lower % of 1-RM), as this may increase the number of repetitions and therefore the duration of the exercise. In general, it is thought that more and more comprehensive studies are needed to explore the possible benefits of music as an ergogenic aid. The effects of music on resistance exercises in different sports branches should be examined.

Authors' Contribution

Study Design: BK, AA; Data Collection: BK, AA, AK; Statistical Analysis: AA, RŞ; Manuscript Preparation: BK, AK.

Ethical Approval

The ethics committee approval for the study was obtained from the Iğdır University Scientific Research and Publication Ethics Committee with the meeting number 2024/16 dated 23.05.2024 and it was carried out in accordance with the Code of Ethics of the World Medical Association also known as a declaration of Helsinki.

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Conflict of Interest

The authors hereby declare that there was no conflict of interest in conducting this research.

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