The Effects of Music on Muscular Fatigue and Strength in Adults with Previous Knee Injuries

Bryan J. Pizarro[1], Amber M. Shipherd CMPC[1], and Robert J. Kowalsky[1,2]
[1]Department of Health & Kinesiology, Texas A&M University–Kingsville, Kingsville, TX
[2]Department of Public Health & Exercise Science, Appalachian State University, Boone, NC

-Undergraduate Category-

INTRODUCTION

- Music can provide ergogenic, psychological, and psychophysical benefits during sport participation and exercise (Ballmann, 2021).
- Listening to one's preferred music has demonstrated evidence to optimize arousal and increase motivation during exercise which leads to performance improvements, such as increased repetitions, power, and velocity on strength tasks (Ballmann, 2021).
- Music is thought to produce these benefits via psychological, physiological, and psychophysiological mechanisms, including reducing perceived exertion, increasing muscle activation, and increasing blood flow (Ballmann, 2021; Ballmann et al., 2021; Waterhouse et al., 2010).
- Given rehabilitation patients often struggle with adherence rates due to lack of enjoyment, lack of progress, or increased pain and fatigue (Arvinen-Barrow & Walker, 2013), music may be an effective strategy in promoting rehabilitation adherence by reducing fatigue and improving strength performance.
- Thus, identifying how to more efficiently integrate music into the rehabilitation setting may improve rehabilitation effectiveness and adherence

PURPOSE

- To examine the effects of preferred music, non-preferred music, and no music on quadriceps fatigue and strength in individuals with a prior knee injury.

METHODS

Participants

- 24 participants (male = 14, female = 10; see Table 1) with the following knee injuries regardless of surgical intervention: ACL (*n* = 5*)*, ACL/meniscus (*n* = 3), MCL (*n* = 5), MCL/meniscus (*n* = 1), meniscus (*n* = 9), and PCL (*n* = 1).

Study Design

- A randomized crossover design was used with each participant completing one control (no music; NM) and two experimental conditions (preferred music; PFM and non-preferred music; NON-PFM).
- These 3 visits were separated by a minimum of 48 hours to allow the body to recover and the physiological effects to washout.

Procedures

- Individuals ranked six music genres from 1 (most preferred) to 6 (least preferred).
- Participants then participated in a 5-minute warm up on a cycle ergometer at 50 watts followed by a knee extension/flexion assessment (Thorstensson fatigue test) using the Biodex dynamometer.
- Peak torque was recorded to assess quadriceps strength by calculating the mean of the first three repetitions and a fatigue index was calculated to determine quadriceps fatigue by the equation: [(peak torque-least torque)/peak torque x100).
- Music above 120 bpm was played via a speaker throughout the warm-up and Thorstensson test during both music conditions.

METHODS, cont.

Table 1: Participant Characteristics

Variable	Mean ± SD	Range
Age (years)	23.21 ± 6.77	19 – 54
Height (cm)	168.02 ± 12.09	137.16 – 185.42
Weight (kg)	91.82 ± 35.36	51.25 – 173.24
Years since injury	4.54 ± 1.92	1 – 8

Statistical Analysis

- One-way ANOVAs were conducted to assess for differences in condition order on quadriceps fatigue and strength.
- One-way repeated measure ANOVAs were conducted to assess for differences in quadriceps fatigue and strength across all conditions (PM, NON-PM, or NM).
- An alpha level of 0.05 was used for indication of statistical significance.

RESULTS

- The one-way ANOVAs revealed there were no order effects present.
- No significant differences were found across conditions in quadriceps fatigue ($F(2,46) = 0.682$, $p = 0.510$, $\eta_p^2 = 0.029$) or quadriceps strength ($F(2,46) = 1.447$, $p = 0.246$, $\eta_p^2 = 0.059$). See Table 2 for means and standard deviations.

Table 2: Quadriceps Fatigue and Strength Means and Standard Deviations

	Fatigue (%)		Strength (Nm)	
Condition	Mean	SD	Mean	SD
No music	58.63	10.67	131.03	39.85
Non-Preferred	57.20	10.87	129.65	37.55
Preferred	59.44	10.20	135.31	47.23

Figure 1: Biodex Dynamometer (not actual participant pictured)

This work was supported by the McNair Scholars Program at Texas A&M University – Kingsville

DISCUSSION

- No differences in quadriceps fatigue or strength were observed between the conditions. This finding supports some research that failed to demonstrate differences in physiological variables between preferred and non-preferred music genres (Ballmann et al., 2019). However, other studies have found preferred music increased repetitions to failure during a strength exercise (Ballmann et al., 2021).
- The nonsignificant findings in the current study may be attributed to the large number of physically active individuals included in the study, or the high intensity of the Thorstensson test. Previous research demonstrated that music produces greater benefits in inactive individuals as compared to active individuals (Brownley et al., 1995). Research has also found that dissociative strategies, such as listening to music, are less effective at high levels of exercise intensity or when physical effort is high (Tenenbaum & Hutchinson, 2007).

Limitations

- A manipulation check was included, but we did not assess whether participants attended to the music specifically during the Thorstensson test.

Conclusions

- Music did not impact quadriceps fatigue or strength in the present study.
- Rehabilitation practitioners should consider that that music may not be the most effective strategy to increase strength or reduce fatigue in a rehabilitation setting and should explore other techniques to address these variables and improve rehabilitation adherence.

REFERENCES

- American College of Sports Medicine (2018). *ACSM's guidelines for exercise testing and prescription* (10th ed.). Wolters Kluwer
- Arvinen-Barrow, M., & Walker, N. (2013). *The psychology of sport injury and rehabilitation*. Routledge.
- Ballmann, C. G. (2021). The influence of music preference on exercise responses and performance: A Review. *Journal of Functional Morphology and Kinesiology*, *6*(2), 1–16. https://doi.org/10.3390/jfmk6020033
- Ballmann, C. G., Cook, G. D., Hester, Z. T., Kopec, T. J., Williams, T. D., & Rogers, R. R. (2020). Effects of preferred and non-preferred warm-up music on resistance exercise performance. *Journal of Functional Morphology and Kinesiology*, *6*(1), 1–8. https://doi.org/10.3390/jfmk6010003
- Ballmann, C. G., Favre, M. L., Phillips, M. T., Rogers, R. R., Pederson, J. A., & Williams, T. D. (2021). Effect of pre-exercise music on bench press power, velocity, and repetition volume. *Perceptual and Motor Skills*, *128*(3), 1183–1196. https://doi.org/10.1177/00315125211002406
- Ballmann, C. G., Maynard, D. J., Lafoon, Z. N., Marshall, M. R., Williams, T. D., & Rogers, R. R. (2019). Effects of listening to preferred versus non-preferred music on repeated Wingate anaerobic test performance. *Sports*, *7*(8), 185.
- Brownley, K. A., McMurray, R. G., & Hackney, A. C. (1995). Effects of music on physiological and affective responses to graded treadmill exercise in trained and untrained runners. *International Journal of Psychophysiology*, *19*(3), 193–201. https://doi.org/10.1016/0167-8760(95)00007-f
- Kose, B. (2018). Does motivational music influence maximal bench press strength and strength Endurance? *Asian Journal of Education and Training*, *4*(3), 197–200. https://doi.org/10.20448/journal.522.2018.43.197.200
- Tenenbaum, G., & Hutchinson, J. (2007). A social-cognitive perspective of preferred and sustained effort. In G. Tenenbaum & R. C. Eklund (eds.) *Handbook of Sport Psychology* (3rd ed., pp. 566–567). John Wiley & Sons.
- Waterhouse, J., Hudson, P., & Edwards, B. (2010). Effects of music tempo upon submaximal cycling performance. *Scandinavian Journal of Medicine & Science in Sports*, *20*(4), 662–669. https://doi.org/10.1111/j.1600-0838.2009.00948.x