

# Effects of Synchronous Music Intervention Duration on Maximal Aerobic Speed in Female Students of Physical Education Classes

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## Abstract

Music act as ergogenic aid able to enhance the physiological and psychological status of participants during sport-related activities and physical exercise. Music is used synchronously to accompany repetitive endurance tasks such as cycle ergometer, walking and running. Maximal Aerobic Speed (MAS), defined as the minimum speed required to elicit maximal oxygen consumption (VO<sub>2</sub>max) during a graded exercise test, has also been validated outside of the laboratory as a field test. Previous study calculated that the most suitable duration for measuring maximal aerobic speed by a field test was 5 min. For years, mostly the effects of music on cardiovascular endurance performance was related to volume; type and tempo of the music been studied. However, to the best of our knowledge there have been no studies to date that examined the effect of music intervention duration on maximal aerobic speed during the physical education classes. As such, the primary aim of this study was to assess and compare the Maximal Aerobic Speed between intervention duration groups with music. A total of 207 female students enrolled in the Physical Education courses at Saigon University were recruited in current study. They were randomly divided into three groups: Intervention group 1, with 15 weeks of synchronous music throughout the whole semester (69 students); intervention group 2 with 7 weeks of synchronous music (69 students); and a control group (69 students). Results revealed that there was no significant main effect of Group on overall MAS performance ( $F(1,204) = .86, p = .43, \eta^2 = .008$ ). Descriptive statistics showed that the groups (15-week group: Mean=825.65, SD=64.61; 7-week group: Mean=827.10, SD=63.34) with music intervention performed better in MAS performance compared to the control group (Mean=806.38, SD=55.97). From looking at the graph we can see that all groups showed a similarly upward trend between Pre-Post Intervention. The results of this study revealed that popular music has no effect on MAS performance in the students attended the physical education classes for 15 weeks.

**Keywords:** Synchronous Music, Maximal Aerobic Speed (MAS), Physical Education Classes, Female Students.

## INTRODUCTION

Listening to music while exercising is becoming more frequent also in recreationally active individuals. The role of music is dependent on when it is introduced in relation to the task and the intensity of the exercise undertaken.

In sport, the use of music during training represents a special paradigm for trainers to stimulate people undertaking different types of exercise. As previous findings reported that music, especially when selected according to its motivational qualities, renders moods and feeling states more positive across a range of exercise modalities and tasks (Terry & Karageorghis, 2011).

A number of authors have proposed that the positive effects of music on feeling states can lead to increased adherence to exercise (i.e., attendance). This notion is also supported by interview-based evidence (DeNora, 2000).

Also, music appears to be of greater benefit to untrained or recreationally active individuals than it does to those who are highly trained (Mohammadzadeh, Tartibiyani, & Ahmadi, 2008). This may be attributable to motivational differences between the two groups or the fact that, whereas trained individuals tend to work at high intensities, the untrained do not.

Music act as ergogenic aid able to enhance the physiological and psychological status of participants during sport-related activities and physical exercise (PE) (Karageorghis & Priest, 2012a). Many health and fitness instructors regard the addition of music to exercise similarly to an ergogenic aid. The evidence in this field demonstrates that music has the capacity to exert beneficial psychological and ergogenic effects across a wide range of exercise tasks and through a number of applications, pre-task, in-task and post-task.

In term of tempo of music used, several studies have been conducted on the music tempo (e.g., 120 bpm) as a dominant characteristic to consider while exercising, with specific attention given to the use of music in the sport context or as a therapeutically approach (i.e., music therapy) (Greco et al., 2022).

Previous researchers proposed that human movement and rhythmical perception are both bound to the same optimal frequency of 120 beats per min (bpm) (Schneider, Askew, Abel, & Strüder, 2010). This argument was predicated on the fact that participants adopt a spontaneous tempo of 120 bpm when asked to finger tap (Kay, Kelso, Saltzman, & Schöner, 1987) or walk (Imai, Moore, Raphan, & Cohen, 2001). Moreover, an analysis of over 70,000 pieces of popular music until 1990 indicated that 120 bpm was the most prevalent tempo (MacDougall & Moore, 2005).

The results from study showed that music acts efficiently as an ergogenic aid, particularly at submaximal exercise intensity, suggesting that, in the case of tasks around 70% of maximum aerobic capacity, beats around 115 to 125 could be more appropriated to elicit positive emotions (Bigliassi, Estanislau, Carneiro, Kanthack, & Altimari, 2013).

The application of music before, during, and after cardiorespiratory exercise has been the aim of extensive research literature in athletes (Terry, Karageorghis, Curran, Martin, & Parsons-Smith, 2019). It is evident that pre-task music can promote heightened arousal, both of the psychological and physiological variety. It is logical to infer that music can also act as a sedative when used pre-task. Those engaging in motoric activities that require elevated levels of psychomotor arousal are likely to prefer simulative music (Hargreaves, North, & Tarrant, 2012).

When in-task music was used over a longer duration, during bouts of work completed to exhaustion, similar results ensued in that ergogenic effects were reported in 12 of the 14 studies cited. Music helps increased arousal, increased power output and heart rate, delayed fatigue, and increased exercise duration and intensity (Shoemark, 2016). Music is used synchronously to accompany repetitive endurance tasks such as cycle ergometer, walking and running (Terry & Karageorghis, 2011).

Physical education (PE) is a science, and specialists define it as "an activity that systematically exploits the whole of the physical exercises in order to increase mainly the biological potential of man in accordance with social requirements." (Potop, 2017).

Performance tests are undertaken regularly by athletes to assess changes in physical fitness in response to changes in training load, and to inform the prescription of future training loads and intensities (Bassett, 2011). Field-based performance assessments in comparison are generally time-efficient (allowing for frequent monitoring), inexpensive and have the greatest external validity, and thus may be considered more practical (Dimarucot & Macapagal, 2021).

Fitness Test and the Yo–Yo Intermittent Recovery Test have been shown to be valid measures of performance (Leibetseder, Ekmekcioglu, & Haber, 2002), but are not typically used to prescribe future training loads since their outcome measure is recorded as stage or level completed rather than speed, pace or power output (Dupont et al., 2009). In contrast, measurement of maximal aerobic speed (MAS), defined as the minimum speed required to elicit maximal oxygen consumption ( $\dot{V}O_{2max}$ ) during a graded exercise test (GXT) (Dupont et al., 2009), has also been validated outside of the laboratory as a field test (Poulain, Vinet, Bernard, & Varray, 1999), and utilized as a measure of change in physical fitness (Buchheit, 2009) that can be used to prescribe future training loads (Dupont et al., 2009).

From the theoretical approach from world record running data, previous study calculated that the most suitable duration for measuring maximal aerobic speed by a field test was 5 min. The 5-min test provided valuable information on  $\dot{V}O_{2max}$  which was close to and highly correlated with treadmill results and track performances especially over 3,000 m. This test could also be used for  $\dot{V}O_{2max}$  evaluation. Nevertheless, the simple equation that we proposed to calculate  $\dot{V}O_{2max}$  from the distance covered during 5-min running needs to be validated on a greater number of subjects of both sexes, from sedentary to experienced runners with a wide range of performances (Berthon et al., 1997).

In the former study, music was used synchronously to ergogenic effect during a 400-m sprinting task. The runners strode in time with a piece of motivational music that was delivered during the task. This music elicited faster times than a no-music control condition. Another study used a running task: a submaximal treadmill run to the point of volitional exhaustion. A sample of elite triathletes was able to endure longer in the presence of two synchronous music conditions (self-selected and an alternative that was neutral in motivational terms)(Terry et al., 2019).

Also, one research investigated the ergogenic effects of the synchronous application of music during treadmill walking. Participants began the task at 75% of their maximum heart rate and continued walking until voluntary volitional exhaustion. In addition to the no-music control, two synchronous conditions were employed: motivational and oudeterous music. Both music conditions promoted greater endurance than the control, with the motivational music proving superior to the oudeterous selection. Indeed, the motivational music elicited a marked 15% increase in treadmill endurance when compared to the control, and a clear 6% increase relative to the oudeterous condition(Terry & Karageorghis, 2011).

In a Malaysian study (Maddigan, Sullivan, Halperin, Basset, & Behm, 2019)of running time-to-exhaustion for 12 runners during the synchronous music and no music conditions, it was reported that participants ran significantly run longer before reaching exhaustion while listening to synchronous music compared to the no music condition with a main gain of 151s.

From the literature, most of the studies related to synchronous music and aerobic fitness was conducted on healthy college students, highlighted not only the effect of music on performance and fatigue, but also on the emotional state during training and performance (Stork, Kwan, Gibala, & Ginis, 2015).

#### Purpose of current study

For years, mostly the effects of music on cardiovascular endurance performance was related to volume; type and tempo of the music been studied. However, to the best of our knowledge there have been no studies to date that examined the effect of music intervention duration on maximal aerobic speed during the physical education classes. Also, the effects of music in elite and amateur athletes are better known, no data are available regarding the students in the physical education classes.

As such, the primary aim of this study was to assess and compare the Maximal Aerobic Speed between intervention duration groups with music. The hypotheses we studied were that: (1) the 15-week of synchronous music intervention group were significantly higher than the 7-week of synchronous music intervention group and the control group; (2) the 7-week of synchronous music intervention group perform higher maximal aerobic compared to the control group.

## Methods

### Participants

A total of 207 female students enrolled in the Physical Education courses at Saigon University: Badminton course with 69 students; Basketball course with 69 students and Volleyball course with 69 students were recruited for this study. They were informed of the test procedures before providing a written consent form to participate. The appropriate Review Boards (Saigon University Board and Faculty Board) approved this study for the use of human beings.

### Procedures

All the recruited students participated in the physical education classes in 15 weeks, it is equivalent to one semester in the academic calendar of Saigon University. They were randomly divided into three groups: Intervention group 1, with 15 weeks of synchronous music throughout the whole semester (69 students); intervention group 2 with 7 weeks of synchronous music (69 students); and a control group (69 students).

This study consisted of two phases (a) Familiarization and Pre-Test, (b) Intervention period and post-test. Each subject was tested twice (Pre and Post) under the same conditions. Two weeks before the physical education classes, all participants answered a brief questionnaire about their demographic information. All the participants were introduced to the fitness tests and familiarization with the fitness tests. One week prior to the official classes kick-off, all the participants were invited to take

the fitness tests. Six tests were used to identify physical fitness for female students, such as 30 seconds sit-up test (evaluated the core strength), 30m sprint test (Engdahl, Speed, Eberly, & Schwartz), 4x10m Shuttle run test (agility), standing long jump test (the explosive power of the legs), handgrip strength test (maximum isometric strength of the hand), and 5 minutes running field test (maximal aerobic speed-MAS). These tests were suitable to evaluate the fitness of amateur athletes (Ministry of Education & Training, 2008), and also suitable to evaluate general physical fitness in all students enrolled at Saigon University (Tuan & Son, 2017), with high validity and reliability.

During the semester, all participants underwent the 15-week of physical education classes with the same condition, time for studying and facility use in Saigon University. The classes were held every week in the morning (from 9.00 to 10.40 am), Wednesday catered for the 15-week group with synchronous music, Thursday is for 7-week group with synchronous music, and the control group was held on Friday. The purpose to implement music after the 7-week was due to the mid-term examination time, while the time for the 15-week was to synchronize with the final examination schedule. The software used to examine the tempo of music (beats per minute - bpm) was the “Metronome” application. The type of music chosen and utilize in this study was the popular music (also called light music, pop music). The tempo of the music was range from 90-120 bpm in the “warm-up music”, 120-150 bpm for the “physical training music”, and 70-90 bpm in the “cool-down music”. All of the popular music were selected for non-profit purposes, did not advertise or recommend these music for any reason, and were used for the purpose of this research only. All music chosen with a vibrant beat and created excitement to the listeners. The schedule of using music was applied throughout the classes (100 minutes/session), which was shown in Table 1.

Table 1: Music Application During Physical Education Classes

No.	Activities	Duration	Applied popular music
1	Class announcement, checking attendance	5 minutes	X
2	Warm-up	15 minutes	Warm-up music
3	Short break	5 minutes	X
4	Physical fitness training <sup>1</sup>	20 minutes	Training music
5	Long break	10 minutes	X
6	Physical fitness training <sup>1</sup>	25 minutes	Training music
7	Short break	5 minutes	X
8	Cool-down	10 minutes	Cool-down music
9	Evaluation after training	5 minutes	X
Total		100 minutes	70 minutes

For the intervention groups, the popular music was played via the speakers (JBL Party box 300). The music was played randomly, but with an increasing orientation in the tempo of the music. The tempo of the music played synchronize with the increasing intensity of exercises due to the differences in training activity such as warm-up, training, or cool-down sessions. As previous researchers suggested, in group exercise classes when music is used synchronously, it appears that the rhythmic abilities of participants warrant careful consideration in the sequencing of music selections (DeNora, 2000). Also, in order to have a stimulative effect, the music chosen should be up-tempo (>120 bpm) and possess prominent percussive and rhythmical features. In order to sedate, the inverse is true in terms of percussion and rhythmical features, and tempi <80 bpm are

recommended (Terry & Karageorghis, 2011). We implemented the music tempo during different session based on previous researchers' recommendations.

### Statistical Analysis

The statistical software package “SPSS Statistics 26.0” (Fichten, Libman, Creti, Bailes, & Sabourin) was used for statistical analysis. Mean value and standard deviation for the research parameters were calculated. Split-Plot ANOVA (SPANOVA) were used for comparative analyses with repeated measures. The level of significance was set at  $p < 0.05$ .

## Results

Descriptive results on the Pre and Post Tests for the Maximal Aerobic Speed (MAS) Performance showed in table 2.

Table 2: Descriptive Statistics of Pre-Post on MAS Performance

Results	Group	Mean	Std. Deviation	N
Pre-Test Performance	MAS 15-Week	725.22	53.37	69
	MAS 7-Week	728.41	59.18	69
	Control	725.36	58.45	69
	Total	726.33	56.86	207
Post-Test Performance	MAS 15-week	825.65	64.61	69
	MAS 7-week	827.10	63.34	69
	Control	806.38	55.97	69
	Total	819.71	61.86	207

The results of the Split-Plot ANOVA Test (SPANOVA) showed that there was a significant main effect of Pre-Post ( $F(1,204) = 1393.25, p = .001, \eta^2 = .87$ ) on the overall MAS Performance with Pre-test (Mean=726.33) and Post-test (Mean=819.71).

Results from current study revealed that there was a significant interaction between Pre-Post and Group on MAS Performance ( $F(1,204) = 6.15, P = .003, \eta^2 = .06$ ) with a similar standard error scores between groups.

In contrast, there was no significant main effect of Group on overall MAS performance ( $F(1,204) = .86, p = .43, \eta^2 = .008$ ). Descriptive statistics showed that the groups (15-week group: Mean=825.65, SD=64.61; 7-week group: Mean=827.10, SD=63.34) with music intervention performed better in MAS performance compared to the control group (Mean=806.38, SD=55.97). From looking at the graph we can see that all groups showed a similarly upward trend between Pre-Post Intervention (Figure 1).

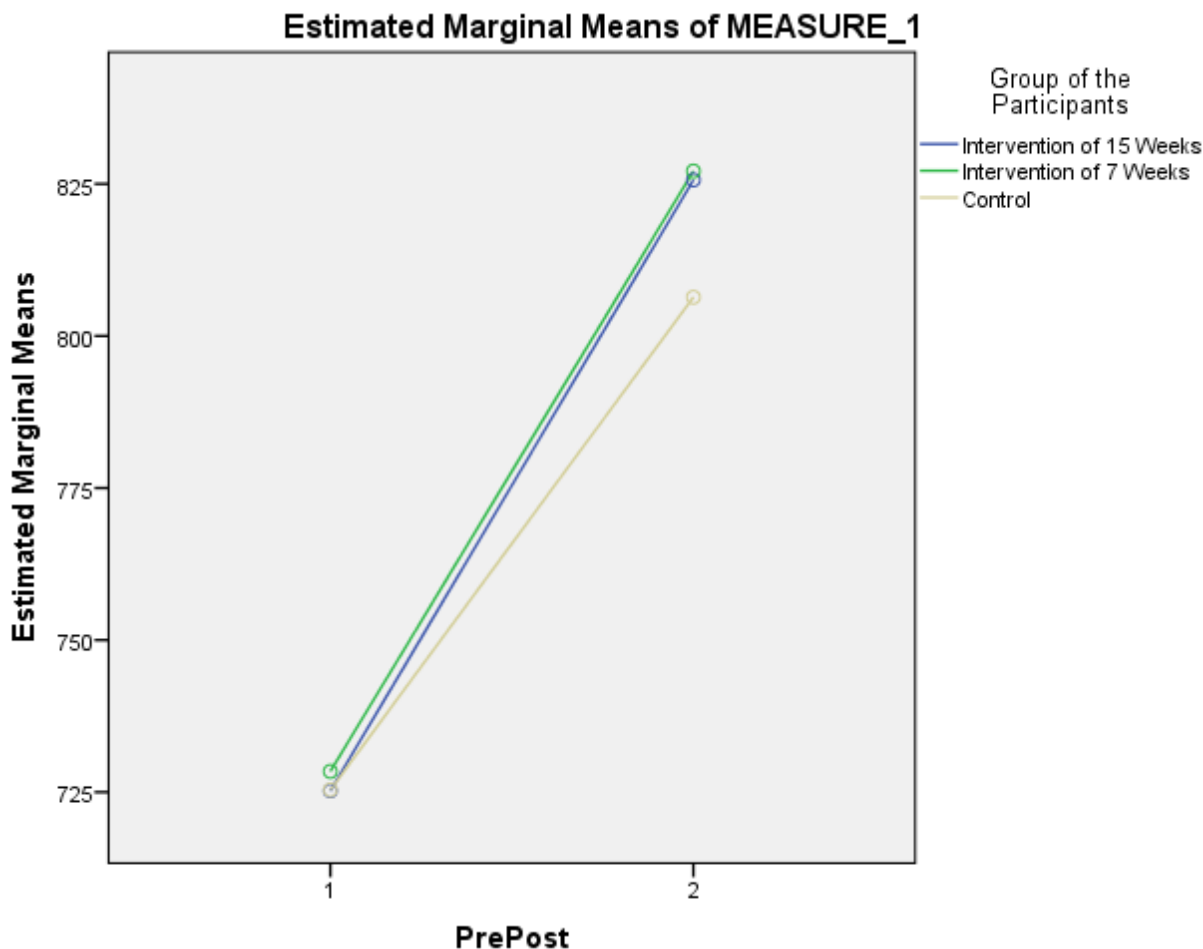


Figure 1: Profile Plots on Pre-Post with Groups

## Discussions

The purpose of this study was to determine the effects of synchronous music duration on maximal aerobic speed (MAS) performance in the students enrolled in physical education classes. Results revealed that there was no significant main effect of group on overall MAS performance ( $F(1,204) = .86, p = .43, \eta^2 = .008$ ). It means regardless of 15-week or 7-week of synchronous music intervention on these students didn't induced any significant differences when compare with the control group on MAS performance. We rejected the hypotheses of this study where by the synchronous music duration intervention to the physical education classes did not effect on MAS performance.

The descriptive statistics also showed that the groups (15-week group: Mean=825.65, SD=64.61; 7-week group: Mean=827.10, SD=63.34) with music intervention even though performed better in MAS performance compared to the control group (Mean=806.38, SD=55.97). From looking at the graph we can see that all groups showed a similarly upward trend between Pre-Post Intervention (Figure 1).

Current findings are supported by Nakamura et al. (2010) who found that total distance covered during constant-load exercise performed at critical power ( $207 \pm 53$  W) was not increased compared to the control group, irrespective of listening to preferred or non-preferred music. In contrast, there was a study done by Atkinson et al. (2004), when athletes listened to music, there was an improvement in performance during a 10km cycling time trial compared to no music. Possible explanation with the current

results most probably due to the methodological issues such as the differences in exercise protocols and other aspects of age, music tempo, musical preference and socio-cultural influences (Nakamura, Pereira, Papini, Nakamura, & Kokubun, 2010).

Further explanation on this results may be that music appears to have a greater effect when external validity is relatively high, especially when either the task or music selection is self-regulated (as is often the case during exercise). This draws on self-determination theory insofar as autonomy is one of the three primary needs that underlie intrinsic motivation (Ryan & Deci, 2000). Similar findings also reported that exercise participants have reported a strong anticipation effect whereby particular segments of musical pieces were awaited and used as a conscious trigger for increased work output (Priest & Karageorghis, 2008).

Also, the observed ergogenic effect of music when used synchronously is concurrent with the documented predisposition of the human organism to respond physically to the rhythmical qualities of music (Terry & Karageorghis, 2011). Various neuropsychological mechanisms have been advanced to explain this predisposition, including the presence of a neural pacemaker (Terry & Karageorghis, 2011), a property of the nervous system used to control repetitive movement known as time form printing (Clynes & Walker, 1982) and the dual involvement of certain brain sectors in music response and movement (Kornysheva, Cramon, Jacobsen, & Schubotz, 2009).

Additionally, it is logical to infer that, when movements are synchronized to music, additional benefits are obtained both in terms of dissociation (through having to focus on keeping time) and energy efficiency in repetitive endurance activities and those with a marked rhythmic component (e.g., callisthenic-type exercises). But, the physical education classes were concentrated on skills acquisition instead of callisthenic-type exercises. As such, the effectiveness of the synchronous music may not affect the MAS performance in current study.

Current results was contradict to the previous studies which have demonstrated that music regulates processes in the autonomic nervous system and can be used to regulate the cardiovascular system with regard to both HR and blood pressure (Karageorghis & Priest, 2012b).

Our results did not support a study conducted on college students evidenced that also music tempos could influence aerobic performance and perceived fatigue (Köse & Atli, 2019). After a Bruce treadmill test, results reported that fast tempo music (140 bpm) improved running time compared to no music and slow tempo music (100 bpm) conditions. This study highlights the potential impact of different tempo music on aerobic performance, suggesting the usage of a fast tempo music to motivate active individuals and to provide an ergogenic aid. One possible explanation may be due to the endurance exercise seems more sensitive to external stimuli (Van Cutsem et al., 2017) due to the mental fatigue and perception of effort involved in endurance exercise.

## Conclusion

The results of this study revealed that popular music has no effect on MAS performance in the students attended the physical education classes for 15 weeks. One possible reason had to be the choice of music. Preferred music could motivate and improve physical performance (Terry & Karageorghis, 2011), influenced perceived exertion (Nakamura et al., 2010). Thus it is suggested that more investigation on the effects of type of music and music preference on endurance performance would be investigated.

Current study only recruited female students from the physical education classes. In particular, do females derive greater benefit from the synchronous use of music when undertaking complex motor tasks such as callisthenic-type exercises or aerobic dance exercise (Terry et al., 2019). Researchers may also consider the role of rhythmic ability in response to the synchronous use of music (Roerdink, 2009). Accordingly, there is scope to examine how syncopated (off beat) rhythms are processed by high and low rhythmic ability groups. There is a strong likelihood that individuals with high rhythmic ability and/or musical training will process such complex rhythms more easily, thus responding with greater bodily precision than their less musical counterparts (Vuust, Ostergaard, Pallesen, Bailey, & Roepstorff, 2008).

The results of our study also not in line with the findings from Cole and Maeda tried to understand if music could have a different impact on aerobic performance depending on gender (Cole & Maeda, 2015). They evaluated the effect of preferred, non-preferred and no music on aerobic performance, through the 12-min Cooper Test in 20 women and 15 men who reported running at least once per week. Results showed that preferred music could improve running performance in women but not in

men, suggesting a higher sensitivity to music by female subjects and a possible sex difference (Cole & Maeda, 2015). But our study didn't compare between gender.

This study presents some limitations. First, the results refer to the students enrolled in physical education classes, they are physically untrained female population. Consequently, these results need to be confirmed for other populations such as male subjects, trained people, older people, or adolescents. Also, the preference of the participants concerning their musical preferences were not collected and considered in the present study.

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#### Conflict of interest

The authors declare no conflict of interest.

#### ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the local Ethics Committee. The patients/participants provided their written informed consent to participate in this study.

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