

# The Comparison of Type of Music Tempo on Cardiopulmonary Function During Exercise

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**Purpose:** The study aimed to examine the effects of beats per minute (BPM) on the cardiopulmonary functions of adult men during exercise and to provide reference materials for future physical therapy studies of the respiratory system. **Methods:** This study recruited 18 healthy male adults who agreed to participate in this study and had no cardiopulmonary problems. The participants conducted a total of five experiments with no music, 30 BPM, 130 BPM, 180 BPM, and 230 BPM, and music education was conducted regarding the music experience before the experiment. The experiment was conducted twice a week for a total of 3 weeks, and one-way analysis of variance was used to compare the mean differences in  $VO_2$ max, time, respiratory rate (RR), metabolic equivalents (METs), and peak time between each BPM. **Results:** For each BPM, the  $VO_2$ max, time, RR, METs, and peak time showed significant differences. With 180 BPM, the  $VO_2$ max, time, RR, METs, and peak time were high. For each BPM, the  $VO_2$ max, time, RR, METs, and peak time showed significant differences. With 180 BPM, the  $VO_2$ max, time, RR, METs, and peak time were high. **Conclusion:** The results of this study show that the most effective BPM for cardiopulmonary functions is 180 BPM, and 180 BPM will enable to perform exercises more efficiently.

**Key words:** Music, Tempo, Cardiopulmonary Function, Exercise

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## I. Introduction

Over the years, many people have sought different ways to improve performance. A new concept in athletics and sport is the idea of musical memory utilization for increased performance. Today's re- search shows that music has positive effects on training and relaxation. It is considered that music has a positive effect on exercise performance. Some have chosen to use music as an aid to physiological performance(Atan, 2017).

Also, We live in a time when technology has brought us closer to music than ever before, enshrining its role in our emotional and social lives. According to the available evidence, music captures attention, triggers a range of emotions, alters or regulates mood, increases work output, heightens arousal, induces states of higher functioning, reduces inhibitions and encourages rhythmic movement. Ergogenic effect of music is evident as it improves exercise

performance by either delaying fatigue or increasing work capacity(Thakare et al, 2017). Like this Listening to music is tightly linked to neural processes within the motor cortex and can modulate motor cortical activity in healthy young adult(Stegemoller et al, 2018). So Motivation by music can lead to increase in exercise duration, which is a stress alleviator in young medical students(Thakare et al, 2017). According to a advance study, if you choose music properly during exercise, the results and atmosphere will improve(Schneider et al, 2010).

Staffs including Abinasdh had found that the maximum frequency of exercise using the music was higher than the frequency of exercise without the music from both men and women(Thakare et al, 2017). Especially, a frequency of approximately 3Hz seems to be dominant in different physiological systems and seems to be rated as pleasurable when choosing the appropriate music for exercising (Schneider et al., 2010). Based on this result, it is found

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out that when the rehabilitation exercise program is going on, if the music is included, then the recovery rate was higher(Fotakopoulos and Kotlia, 2018). However, if the patient is exposed to the music during the experiment, then the stamina was consisted long, but it wasn't if the patient was exposed to music before the task(Crust, 2004).

In addition, speeding up the music program increased distance covered/unit time, power and pedal cadence by 2.1%, 3.5% and 0.7%, respectively. Average heart rate changes were 10.1% (faster program) and 2.2% (slower program). That is, healthy individuals performing submaximal exercise not only worked harder with faster music but also chose to do so and enjoyed the music more when it was played at a faster tempo(Waterhouse et al, 2009).

Based on this result, it is found that the testing machine for exercise loading is very effective for finding the relationship between the music and the cardiopulmonary function. There are 2 types of protocols in the testing machine: The Bruce protocol and the Ramped Bruce protocol. The data collected from either standard Bruce protocol or Ramped protocol is proved that the result was more consistent than the result from all BMI groups. And it was achieved 80~85% of the maximum cardiac rate for each age(Bires et al, 2013). Also, the Bruce protocol is the most commonly used treadmill protocol to assess maximal oxygen consumption(Miller et al, 2007).

Staffs including Edworthy had found that the fast and loud music would increase the effect of the optimal exercise, and they also found that the loud music and the tempo were interacted each other(Edworthy and Waring, 2006). But precedent researches stated only just about the effect of music applying to the exercise(Thakare et al, 2017; Schneider and Askew, 2010; Edworthy and Waring, 2006). The effect of music applying to the cardiopulmonary function such as stamina and breath related to the exact BPM is not stated in any studies yet.

Thus, the objective of this study is the induce of the data of the effect of effective music tempo(BPM) during the exercise to the cardiopulmonary function of male adult, and the further resource of the physical treatment for respiratory system.

## II. Methods

### 1. Subjects

This study was conducted on 18 adults who are S university students in A city, usually have no problems with cardiopulmonary functions, and no experience visiting hospitals and receiving medical treatment due to chest pain. Participants listened the sufficient explanation of this study's objective and the process, wrote the consent form by their own hands and wills, and attended to the study. People who do not have any common diseases, any weights which would negatively apply to the walking, any discomfort or pain due to the breathing, any previous surgical operations in the heart, and any diseases including cardiovascular and respiratory diseases and chronic obstructive lung diseases such as angina, myocardial infarction, and arrhythmia. The physical characteristics were same as table 1.

### 2. Experimental

#### 1) Experimental procedure

In this study, through the testing machine for exercise loading, the effect of the effective music tempo(BPM) during the exercise to the cardiopulmonary function of male adult is divided into without the music, 30 BPM, 130 BPM, 180 BPM, and 230 BPM. These effects are examined comparing with the ECG, heart rate, blood pressure,  $VO_2\max$ , TIME, METs, Peak Time, RR, and PRE.

#### 2) Measurement equipment

Before the experiment, the testing machine for exercise loading was pre-heated for about 30 minute to 1 hour for more exact results, and the temperature, moisture, and the air pressure nearby was set. Using the 3L syringe pump, the air inside the machine was removed for the proper level

Table 1. General characteristic

	Men (n=18)
Age	20.71 $\pm$ 1.27
Height	174.86 $\pm$ 4.47
Weight	70.64 $\pm$ 7.57

Mean  $\pm$  Standard deviation

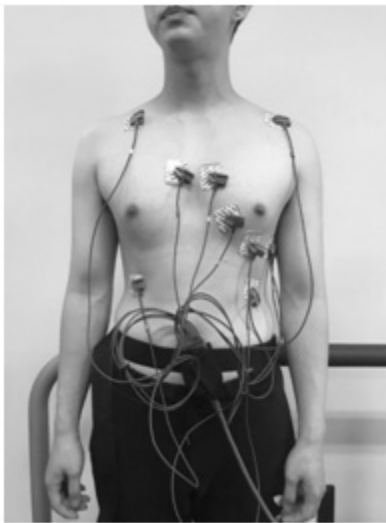


Figure 1 Elecorcardiogram



Figure 2 Cardiopulmonary exercise testing

to check only the amount of breath of the subject. 10 Electrocardiogram(ECG) were equipped to the subject's the middle of collarbone, the body part of sternum, 4-6th rib on the left chest, and both of floating ribs in Figure 1. Then, when the green & yellow signal is showed on the screen, the experiment was started, and when the red & white signal is showed, then the ECG was re-equipped. Equip the device for checking the blood pressure on the part of inner arm where the blood vessel is flowing, sit down on the chair and check the blood pressure, and check again when the subject was taking a rest in figure 2.

### 3) Experimental methods

The experiment was begun after setting the Bruce protocol. As the level is growing up between the exercise process, the PRE was showed to the subject, and checked the current state of subject regularly. When the objective level of heart rate which was set before the experiment had arrived, then the recovery state had conducted. The exercise was ended after the light walking When the recovery state was ended, then the chair was arranged to check the heartbeat until the level of stabilized state had arrived, and the experiment was ended. The stretch for safety was conducted before and after the experiment. And, the drink was also prepared for the hydration and the reduction of the fatigue.

### 3. Measurement

For the pre-caution of the accident during the experiment and the mediation, the assessor took the training and safety training beforehand, and measured. The assessor also took the gown on due to the use of ECG(ECG Attach) measurer. Also, wearing of the hat is prohibited due to wearing of Two-way mask before the experiment to measure the amount of breath. Since the day before the experiment, the smoking, drinking, and coffee which are prohibited to be taken before using the testing machine for exercise loading, were limited. For the safe and accurate measurement on the treadmill, the sneakers and comfortable clothes were given. When the improper breath is seen after the check of the subject's current state (such as heart rate or blood pressure) during the experiment, then the assessor paused the experiment immediately. After measuring the personal stabilized heart rate of the subject, the objective heart rate had been set. If the objective heartrate had been arrived, then the experiment was ended. Before the experiment, sufficient music training was done to subjects due to the need of the experience related to the music. To measure the music BPM, 'Mixmeister BPM Analyzer' program was used for the music selection. 30 BPM played Justin Bieber-silent night X 0.4, 130 BPM played Tiara-Lollipop, 180 BPM played IU-beep X 1.25 and 230 BPM played Sistar-Nahonja X 2. For the minimum relaxation, the next experiment was done 24 hours after the first experiment in minimum. The experiment for subject was done twice

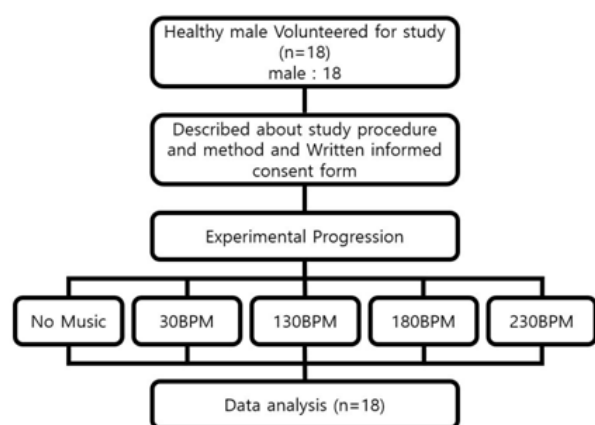


Figure 3 Flow chart

for a week, and this measurement was repeated for 5 times during 3 weeks. The mediation for the experiment without the music, the experiment with 30 BPM, the experiment with 130 BPM, the experiment with 180 BPM, and the experiment with 230 BPM were done to the same subjects. The experiment was done for 5 times, and the process was same with figure 3.

#### 4. Analysis

One-way repeated ANOVA (One-way repeated ANOVA) statistics were used to compare the average differences. All statistical analyses used SPSS statistical software (version 22.0; IBM Corp, Armonk, NY). All of statistical significance level(p) was set within 0.05. The post

analysis was done with Bonferroni.

### III. Results

To look how the music would affect to the cardiopulmonary function,  $VO_2\max$ , TIME, RR, METs, and Peak Time were measured, and the Cardiopulmonary exercise testing(CPX) was conducted with the variable of without the music, 30 BPM, 130 BPM, 180 BPM, and 230 BPM. The results were as follows table 2.

#### 1. $VO_2\max$

‘ $VO_2\max$ ’ showed the significant difference related to its value between without the music and 30 BPM, without the music and 180 BPM, 130 BPM and 180BPM, 180BPM and 230 BPM( $p<0.05$ ). Thus, as a result of post analysis, the value of 30 BPM, 180 BPM was larger than the value of without the music. And, the value of 180 BPM was larger than the value of 130 BPM, and 230 BPM.

#### 2. TIME

‘TIME’ showed the significant difference related to its value between without the music and 30 BPM, without the music and 180 BPM, without the music and 230 BPM, 30 BPM and 180 BPM, 130 BPM and 180 BPM, 180 BPM

Table 2. Comparison of different type tempo on cardiopulmonary function

(n=18)

	No Music	BPM 30	BPM 130	BPM 180	BPM 230	F	Post-hoc
$VO_2\max$ (ml/kg/min)	41.74±12.85	49.17±13.71	48.18±17.41	58.16±17.42	49.37±17.72	17.46*	a<b, a<d c<d, e<d
Time (min)	9.23±1.28	10.37±1.56	9.90±1.73	11.41±1.69	10.15±1.39	32.62*	a<b, a<c a<e, b<d c<d, e<d a<b, a<c
RR	19.02±3.88	21.93±4.31	22.14±3.23	24.86±3.62	23.14±3.56	22.01*	a<d, a<e b<d, c<d e<d
METs	6.25±1.55	7.98±2.33	8.12±2.86	9.88±2.97	8.19±3.02	14.92*	a<b, a<d c<d, e<d
Peak Time (min)	9.04±1.11	10.11±1.45	9.70±1.71	11.07±1.61	9.71±1.50	19.05*	a<b, a<d b<d, c<d e<d

and 230 BPM( $p<0.05$ ). Thus, as a result of post analysis, the value of 30 BPM, 180 BPM, and 230 BPM was larger than the value of without the music. And, the value of 180 BPM was larger than the value of 30 BPM, 130 BPM, and 230 BPM.

### 3. RR

‘RR’ showed the significant difference related to its value between without the music and 30 BPM, without the music and 130 BPM, without the music and 180BPM, without the music and 230 BPM, 30 BPM and 130 BPM, 130 BPM and 180 BPM, and 180 BPM and 230 BPM( $p<0.05$ ). Thus, as a result of post analysis, the value of 30 BPM, 130 BPM, 180 BPM, and 230 BPM was larger than the value of without the music. And, the value of 180 BPM was larger than the value of 30 BPM, 130 BPM, and 230 BPM.

### 4. METs

‘METs’ showed the significant difference related to its value between without the music and 30 BPM, without the music and 180 BPM, 130 BPM and 180 BPM, 180 BPM and 230 BPM( $p<0.05$ ). Thus, as a result of post analysis, the value of 30 BPM, 180 BPM was larger than the value of without the music. And, the value of 180 BPM was larger than the value of 130 BPM, and 230 BPM.

### 5. Peak Time

‘Peak Time’ showed the significant difference related to its value between without the music and 30 BPM, without the music and 180 BPM, 30 BPM and 180 BPM, 130 BPM and 180 BPM, 180 BPM and 230 BPM( $p<0.05$ ). Thus, as a result of post analysis, the value of 30 BPM, 180 BPM was larger than the value of without the music. And, the value of 180 BPM was larger than the value of 30 BPM, 130 BPM, and 230 BPM.

## IV. Discussion

In this experiment, the objective was looking at how the type of music tempo would affect to the cardio pulmonary function during the exercise, and it used men in their 20s as the subject. the CPX was conducted with the variable

of with out music, 30 BPM, 130 BPM, 180 BPM, and 230 BPM. As a result, there were significant differences in the  $VO_2$ max, TIME, METs, RR and Peak time. As a result, the 180 BPM was considered as the most effective BPM to the cardio pulmonary function. According to precedent studies, it was found that the exercise with proper music to healthy adult was more effective related to the heart rate and the stamina, and this suggestion was matched with the result of this experiment(Thakare et al, 2017).

Edworthy and others examined that the treadmill exercise with the music was more positive than the exercise without the music(Edworthy and Waring, 2006). Thakare and others found that the elapsed time for exercise of the group with ‘the music with slow tempo’ or ‘the music with fast tempo’ was longer than the time of the group for exercise without any music(Thakur and Yardi, 2013). Also, Lee and others conducted the exercise to patients with COPD dividing into 2 groups: a group applied with music and a group not applied with music. Lee and other examined the endurance, heart rate, oxygen saturation, and the fatigue of legs. As a result, it is found that the group applied with the music showed more effect with the stamina and the dyspnea(Lee et al, 2018). This result was matched with this study. And, Bauldoff and others conducted the arm training to 30 patients with COPD, and divided them into 2 groups: a group with slow music and a group without the music. As a result, the functional performance of the group with the music was improved. Also, it is found that the music can be a device amplifying the effect of training of the lung(Bauldoff et al., 2005). Liu and others divided 48 COPD patients into 2 groups: a group listening the cellphone music, and a group not listening the cellphone music, and conducted the initial incremental shuttle walking test(ISWT). As a result, 8 weeks later, the distance of the initial incremental shuttle walking test(ISWT) and the elapsed time of a group listening the cellphone music was greatly improved(Liu et al., 2008). Like this, these results of the effect of using music during the exercise were used as the data for the ground. Therefore, furthermore, applying the music for the treatment mediation to the COPD patient is considered to be effective.

Golino and others did the treatment to normal patients and divided them into 2 mediation groups: a group with the music and the group without the music. As a result,

the amount of breath, self-reported pain, and the anxiety level were greatly decreased. Its result was matched with this study, in the view of decrease of the amount of breath(Golino et al, 2019). Furthermore, Joke Bradt and others examined the patient with cancer by dividing them into 2 mediation groups: a group with the music and a group without the music. Most of its results were matched with the result of Golino's. However, the oxygen saturation did not show any significant difference, and it was not matched with this study(Bradt et al., 2016). Fallek and others applied the music therapy to 150 patients for 6 months, and examined the effect of music therapy related to the anxiety, pain, pulse, and the amount of breath. As a result, it is found that the music therapy can be used as a mediation for a control and the approach to the patient who shows the high level of interest, satisfaction, and receptive capacity, and it is also found that the adaption of music bed therapy is available and its effect(Fallek et al, 2020).

Edworthy and others made 6 groups: loud music/slow and quiet music/fast and loud music/fast music/slow music/no music and conducted 10 minutes of the treadmill exercise. As a result, it is found that the fast and loud music is the most effective to improve the efficiency of the exercise(Edworthy and Waring, 2006). Also, Thakur and others found that the elapsed time for exercise with 'fast music' was longer than the exercise with 'slow music'(Thakur and Yardi, 2013). But, this result was not matched with the fact that the 230 BPM which was the fastest was not more effective than 180 BPM.

Almeida and others chose without the music, 90 BPM, and 140 BPM to prove the effect of the music to the exercise. As a result, the 140 BPM was more effective than 90 BPM. Through this result, it is considered that the is less effective, so this method is not included to this study.

Schneider and others divided 18 general healthy runners into 3 groups: a group with 1Hz(60 BPM) of music velocity, a group with 2Hz(120 BPM), and a group with 3Hz(180 BPM), and examined the heart rate, brain cortex activity, and the brain delta wave activity. As a result, the 180 BPM showed the positive effect to the physiological system, such as heart rate and brain cortex activity. This result was matched with this study(Schneider et al., 2010).

Karageorghis and others mentioned that the pre-trained music during the repetitive and enduring activity would

increase the effect, decrease the grade of effort, and improve the efficiency of energy to increase the work performance(Karageorghis and Priest, 2012). Through this, in this study, it is designed to proceed the experiment after training the music training beforehand. The limitation of this study is same as following: First. The subject is limited into 18 healthy male adults in 20s, so it is hard to be generalized because of a few number, and it is also hard to be compared with other people with different ages. Second. While conducting 5 times of CPX to each person, it is presumed that because of the improvement of the stamina, it will be positively applied to the final value. Third, because of the short period, 5 weeks, so there was not enough time Fourth, the natural exercise of the subject who attended to the study could not be limited. Because the exercise and lifestyle pattern of the subject could not be limited, so if the assessor would limit the exercise outside of the study, then the result value would might be different. Finally, according to the today's condition of the subject, the result might be different. So, these limitations should be needed to be supplemented in further studies.

## V. Conclusion

The objective of this study is looking for the effect of music tempo type during the exercise to the cardiopulmonary function of the subject, who were men in their 20s.

As a result, there were significant differences in the part of  $VO_2\max$ , TIME, RR, METs, and Peak time. It is found out that the most effective BPM to the cardiopulmonary function was 180BPM.

As a result, it is expected that 180BPM of music would be suggested to perform more efficient exercise. Also, it is also expected that if the 180BPM of music will be kept pace with the treatment applied to the patient based on this study, then it will be applied positively to the cardiovascular system.

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