EFFECTS OF EXERCISE WITH MUSIC ON EXERCISE PERFORMANCE AND HEALTH VARIABLES AMONG PHYSICALLY INACTIVE INDIVIDUALS: A SCOPING REVIEW

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by

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CERTIFICATE

This is to certify that the dissertation entitled EFFECTS OF EXERCISE WITH MUSIC ON EXERCISE PERFORMANCE AND HEALTH VARIABLES AMONG PHYSICALLY INACTIVE INDIVIDUALS: A SCOPING REVIEW is the bona fide record of research work done by Ms NURUL SHAZWANIS BINTI RUHAIZAD during the period from March 2020 to June 2021 under my my supervision. I have read this dissertation and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation to be submitted in partial fulfillment for the degree of Bachelor of Health Science (Exercise and Sports Science).

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DECLARATION

I hereby declare that this dissertation is the result of my own review, except where otherwise stated and duly acknowledge. I also declare that it has not been previously or concurrently submitted as a whole for any other degrees at Universiti Sains Malaysia or other institutions. I grant Universiti Sains Malaysia has the right to use the dissertation for teaching, research and promotional purposes.

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Nurul Shazwanis Binti Ruhaizad

Date : 23 June 2021

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EFFECTS OF EXERCISE WITH MUSIC ON EXERCISE PERFORMANCE AND HEALTH VARIABLES AMONG PHYSICALLY INACTIVE INDIVIDUALS: A SCOPING REVIEW

ABSTRACT

Introduction: Music has been a natural part of humans' everyday lives. Music is considered as a motivational tool in sports and exercise. Literature has documented the application of music in order to examine its motivational effects on various measures related to sports and exercise. This scoping review aims to provide a synthesis from the previous studies regarding the effects of exercise with music on exercise performance and health variables among physically inactive individuals. **Methods:** The searching of academic journals in English language related to this topic and published from 2015 to 2021 was conducted. A total of 12 studies were selected from 317 studies screened from the electronic databases including the Scopus, ScienceDirect, PubMED and EBSCOhost. **Results:** Six studies investigated the effects of exercise with music on exercise performance. Four studies reported the effects of music on maximal oxygen consumption (VO_2 max), two studies reported on exercise duration while one study reported on exercise behaviour. Six studies investigated the effects of exercise with music on health variables. Three studies reported the effects of exercise with music on blood lipid profile, two studies reported on anthropometric indices, two studies reported on blood pressure and one study reported on diabetes condition. **Conclusion:** Overall, the literature supports the benefits exercise with music on exercise performance and health variables.

KESAN SENAMAN DENGAN MUZIK TERHADAP PRESTASI SENAMAN DAN KOMPONEN KESIHATAN DALAM KALANGAN INDIVIDU YANG TIDAK AKTIF SECARA FIZIKAL: SUATU ULASAN PENSKOPAN

ABSTRAK

Pengenalan: Muzik telah menjadi sebahagian yang semula jadi dalam kehidupan seharian manusia. Muzik dianggap sebagai satu alat motivasi dalam sukan dan senaman. Kajian telah mendokumentasikan penggunaan muzik untuk memeriksa kesan motivasinya terhadap pelbagai langkah yang berkaitan dengan sukan dan senaman. Tinjauan ini bertujuan untuk memberikan sintesis dari kajian sebelumnya mengenai kesan senaman dengan muzik terhadap prestasi latihan dan pemboleh ubah kesihatan di kalangan individu yang tidak aktif secara fizikal. **Kaedah:** Pencarian menyeluruh jurnal akademik dalam bahasa Inggeris yang berkaitan dengan topik ini dan diterbitkan dari tahun 2015 hingga 2021 telah dilakukan. Sebanyak 12 kajian dipilih dari 317 kajian yang disaring dari pangkalan data elektronik termasuk Scopus, ScienceDirect, PubMED dan EBSCOhost. **Hasil:** Enam kajian menyelidik kesan latihan dengan muzik terhadap prestasi senaman. Empat kajian melaporkan kesan muzik terhadap penggunaan oksigen maksimum (VO_2max), dua kajian melaporkan tempoh latihan dan satu kajian melaporkan tingkahlaku bersenam. Enam kajian menyelidik kesan senaman dengan muzik terhadap komponen kesihatan. Tiga kajian melaporkan kesan senaman dengan muzik terhadap profil lipid darah, dua kajian melaporkan indeks antropometri, dua kajian melaporkan tekanan darah dan satu kajian melaporkan keadaan diabetes. **Kesimpulan:** Secara keseluruhan, literatur menyokong manfaat latihan dengan muzik kepada prestasi latihan dan komponen kesihatan.

Table of Content

Chapter 1
Introduction

1.1 Background of the review

1.1.1 Music in Exercise

Music has been a natural part of humans' everyday lives. Application of music in human life can be classified into following domains including cognitive development, exercise, and the body, psychoanalysis, self-actualisation, and transcendence (Eliakim et al., 2012). Music also plays an important and consistent role in human lives daily whether we listen to it consciously or played in the background (Desblache, 2019).

In sports and exercise, music is considered as a motivational tool. Many researchers have attempted to measure the magnitude of its motivational effects (Karageorghis et al., 2008) on sports and exercise performance. Previous research has shown that music has measurable and relatively consistent effects on the behaviour and psychological states of exercise participants. When the music is carefully selected, it can enhance individual's performance and psychological states. Both of these components are important to increase exercise participation and adherence (Karageorghis, Terry & Lane, 2012)

Figure 1 shows four factors of motivational music that can enhance individual experience and performance during sports and exercise activities. Rhythmic response and musicality are considered as internal factors, whereas cultural impact and association are considered as external factors (Karageorghis & Priest, 2012). Rhythmic response refers to individuals' natural responses to musical rhythm, especially tempo that related to the speed of music (Karageorghis & Priest, 2012). The musical rhythm has a significant role in physical activity (PA) because it replicates natural forms of movement, such as walking and running (Karageorghis & Priest, 2012). Musicality is an

element that represents melody and harmony within a musical piece that creates different interpretations of the music and influence psychological state, such as mood and emotions (Karageorghis & Priest, 2012). The cultural impact influences individuals from social and cultural perspectives. For example, living in a sub-culture or sub-society may determine how individuals perceive the role of music and their preference for music that is important in their society (Karageorghis & Priest, 2012). Association is when music has extra-musical associations with any events or individual experiences. For example, exposure to a certain type of music during childhood can influence how individuals respond to that music emotionally during adolescent (Miranda, 2013). It is suggested that selecting music with motivational qualities possibly leads to improved mood, arousal control, flow state, improved skill, reduced RPE and enhance performance (Karageorghis & Priest, 2012).

Figure 1. Factors of motivational music and potential benefits of motivational music in sport and exercise (Terry & Karageorghis, 2006)

The application of music in exercise is well-known either when it involves individual or group exercise. People nowadays listen to music during exercise to gain benefits in terms of their performance and motivation. Music attracts attention, triggers

a variety of emotions, alters or regulates mood, increases work output, increases arousal, induces higher functioning states, reduces inhibitions and induces rhythmic movement (Thakare, Mehrotra & Singh, 2017). Music is an ergogenic tool in that aspect and listening to music may improve exercise performance, slow down fatigue, improve performance and endurance, power and strength (Thakare, Mehrotra & Singh, 2017).

Furthermore, music also has the capacity to lower perceived exertion (RPE), primarily by distracting attention away from sensations of fatigue (Terry & Karageorghis, 2011). In addition, based on the parallel-processing model and relevant to physical activity and exercise, perception is considered an active process that can influence judgments of sensory cues (Hernandez-Peon, 1961; Rejeski, 1985). Thus, according to this parallel-processing model, dissociative strategies can reduce ratings of perceived exertion (RPE) during exercise conducted at low-to-moderate intensities (Chow & Etnier, 2017).

1.1.2 Physical Activity and Health Variables

Physical activity was defined by WHO as any bodily movement produced by skeletal muscles that requires energy expenditure (WHO, 2020). Physical activity refers to all movement including during leisure time, for transport to get to and from places, or as part of a person's work. Both moderate- and vigorous-intensity physical activity improve health (WHO, 2020). Regular physical activity is proven to help prevent and manage noncommunicable diseases such as heart disease, stroke, diabetes and several cancers (WHO, 2020). It also helps prevent hypertension, maintain healthy body weight and can improve mental health, quality of life and well-being (WHO, 2020).

Physical inactivity is one of the leading risk factors for noncommunicable diseases mortality (WHO, 2020). People who are insufficiently active have a 20% to 30% increased risk of death compared to people who are sufficiently active (WHO,

2020). Moreover, sedentary lifestyles increase all causes of death, doubles the risk of cardiovascular disease, diabetes, and obesity, and increases the risks of colon cancer, high blood pressure, osteoporosis, lipid disorders, depression and anxiety (WHO, 2002).

As preventive measures, WHO recommended children and adolescents aged 5-17 years should do at least an average of 60 minutes per day of moderate-to-vigorous intensity, mostly aerobic, physical activity, across the week while adults aged 18–64 years should do at least 150–300 minutes of moderate-intensity aerobic physical activity (WHO, 2020). Moreover, from the same report adults aged 65 years and above are recommended by WHO to do the same as what adults are being recommended but older adults should do varied multi-component physical activity that emphasises functional balance and strength training at moderate or greater intensity, on three or more days a week, to enhance functional capacity and to prevent falls (WHO, 2020). While people living with chronic conditions (hypertension, type 2 diabetes, HIV and cancer survivors) are recommended to do at least 75–150 minutes of vigorous-intensity aerobic physical activity; or an equivalent combination of moderate- and vigorous-intensity activity throughout the week (WHO, 2020).

Physical activity has numerous health benefits, including improved cardiovascular and respiratory health, enhanced insulin sensitivity, heightened bone and muscle strength, improved positive affect and cognitive function, and increased resistance to type 2 diabetes, cancers, and depression (Corder, Ogilvie & van Sluijs, 2009; Kohl et al., 2012 & Powell et al., 2011). However, less physical activity and lack of exercises can cause a lot of chronic diseases or conditions (Booth, Roberts, & Laye, 2012), but there are still many people who do less exercise and 60 to 85% of people in the world from both developed and developing countries lead sedentary lifestyles (WHO, 2002).

According to Booth et al. (1997), the most prevalent barriers to exercises are lack of time, poor health or injury, lack of motivation, and lack of facilities. It has been recommended that listening to music during exercise may positively impact our psychology (i.e., mood, motivation) (Ballmann, 2021). Therefore, music may help in increasing individual's motivation to perform exercises.

Implementation of non-medication strategies, such as diet and exercise, is recommended to improve the prognosis of the disease. For example, positive effects of long- term participation in aerobic exercise in improving blood lipid profile in human has been reported in past study (Greene, Martin & Crouse, 2012). The health risks associated with hypercholesterolemia have led to intervention programmes designed to reduce cholesterol levels. Greene, Martin, and Crouse (2012) reported that aerobic training performed on the treadmill and in the water increased HDL-C and reduced LDL-C between pre and post exercise.

Although, there are few studies on effect of exercise with music on health variables and previous researchers studied the effects on sports performance, exercise with music may enhance exercise performance and improve health variables regardless if it is among athletes, physically active individuals and physically inactive individuals. Therefore, this scoping review was conducted with the aim to provide a brief synthesis on the effect of exercise with music on exercise performance and health variables especially among physically inactive individuals.

1.2 Problem Statement

There are quite a number of studies examining the effect of music on exercise performance. However, studies reporting the effect of exercise with music on health variables are limited. In general, using music in exercise showed positive outcomes

when sports performance is analysed, and its effects to the health variables is an interesting topic that is rarely explored. Hence, reviewing this topic will help in understanding the effectiveness of exercise with music on exercise performance and health variables.

1.3 Objective of The Scoping Review

i. Provide a synthesis from the previous studies regarding the effects of exercise with music on exercise performance and health variables among physically inactive individuals.

1.4 Research Questions of The Review

i. Does exercise with music improve exercise performance among physically inactive individuals?

ii. Does exercise with music improve health variables among physically inactive individuals?

1.5 Significance of The Review

This review will provide knowledge on the effect of exercise with music on exercise performance and health variables. In addition, the outcome of this review will discuss the application of music and exercise prescription that can improve exercise performance and health variables.

Chapter 2
Literature Review

2.1 Effects of music on exercise performance

Listening to music has been repeatedly shown to have ergogenic benefits during various modes of exercise, including endurance, sprint, and resistance-based activities (Ballmann, 2021). Over the last two decades, advancements in technology have enabled music to evolve into an effective intervention that can achieve various psychological and performance effects in both athletes and patients alike (Sonmez, Vatansever, Olcucu & Cinar, 2015). For exercise physiological responses, listening to music has been shown to modulate many of these responses (i.e., heart rate, catecholamines, muscle activation) often leading to improved performance. Furthermore, listening to music during exercise may positively impact psychological (i.e., mood, motivation) and psychophysiological (i.e., rate of perceived exertion, arousal) changes, which may allow for favorable responses during an exercise challenge (Ballmann, 2021).

In terms of physiological responses, music produces positive effects on exercise performance parameters, for example, muscle fitness and endurance (Priest & Karageorghis, 2008). Many studies have been conducted on the effects of music on exercise performance. For example, a study conducted by Loizou and Karaqeoughis (2014) evaluated 15 male participants to determine the effects of 4 different conditions on Wingate anaerobic test performance, including music only, video and music, video with music and motivation primes, and a no video/no music control. They reported that listening to music increased anaerobic performance. Similarly, Stork et al. (2015) reported that listening to music increased peak and mean power during Wingate

anaerobic test conducted on moderately active adults. Thus, music may be an effective strategy for improving anaerobic performance.

Thakare, Mehrotra, and Singh (2017) investigated the effect of music tempo on exercise performance and heart rate among young adults and they reported that under conditions of self-paced moderate exercise and self-selected music, music may exert an ergogenic and distractive effect during exercise. Researchers also found that motivational music can lead to an increase in exercise duration, which also acted as a stress reliever. Also from the study, when music was played fast and loud, the total duration of exercise and heart rate increased. Thakur and Yardi (2013) compared the effects of listening to slow versus fast music on treadmill and walking performance in 30 healthy female college students. Studies have suggested that exercise can be performed for a longer period of time when a subject is listening to music and that this effect is more pronounced with fast music than with slow music. Furthermore, when listening to music, individuals perceived that they were engaging in the same level of exertion as without music, although walking duration was considerably increased.

Moreover, previous research investigating the effects of exercise with music among healthy participants suggested that, in comparison with no music, the presence of music benefits performance through synchronisation effects, meaning the rhythmic characteristic of music influence individuals to increase their pacing during exercise (Simpson & Karageorghis, 2006). Lee and Kimmerly (2016) demonstrated that fast tempo music increased mean running pace and heart rate and slow tempo music enhanced recovery. In a study conducted by Yamashita et al. (2006), eight males performed two 30-minute sessions of submaximal cycle ergometer exercise, with one session performed at 40% VO_2max and one at 60% VO_2max. It was found that subjects in the 40% VO_2max trial who listened to self-selected music had a lower rating of perceived exertion (RPE) than controls (no music). However, a similar effect was

not produced during the 60% VO_2max trial. Thus, it can be concluded that, music effectiveness may vary in different exercise intensities.

In addition, there are also benefits of exercise with music in terms of its psychological effects. Music appears to positively and significantly influence psychological constructs such as emotion, affect, mood, and cognitive level among exercise participants, thereby leading to better exercise performance (Birnbaum, Boone, & Huschle, 2009). In a previous study, Stork et al. (2015) reported that listening to music increased perceived enjoyment during a 30-second-long “all-out” Wingate anaerobic test conducted on moderately active adults. In another study conducted by Hutchinson et al. (2015), the efficiency of subjects at 10% below and 10% above maximal ventilatory threshold (VT) was measured under various music and video conditions (music only, music and video, and control conditions) during running on a treadmill. Regardless of exercise intensity, the music and video condition elicited the highest levels of dissociation, lowest ratings of perceived exertion, and most positive affective responses. Researchers have concluded that attentional manipulations influence psychological and psychophysical variables at exercise intensities above and below VT and that these effects are enhanced by a combination of auditory and visual stimuli. A similar study reported that listening to music increased valence and enjoyment scores independent of exercise intensity both during and after a cycling exercise that was performed at 10% below and 10% above VT (Jones et al., 2014). Moreover, another study has revealed that before circuit training, listening to preferred music can enhance participants’ self-reported confidence and reduced their state anxiety (Priest & Karageorghis, 2008).

Therefore, from several previous studies, we can conclude that listening to music during exercise gave positive effects to psychological, physiological and exercise

performance. However, there is limited number of studies that study on physically inactive population.

2.2 Exercise with music and its effect on health variables

Research has shown that music can influence central physiological variables such as blood pressure, heart rate, respiration, EEG measurements, body temperature and galvanic skin response (Myskja & Lindbaek, 2000). Music also affects immune and endocrine function (Myskja & Lindbaek, 2000). The existing research literature shows a growing knowledge on how music can reduce pain, anxiety, nausea, fatigue and depression. However, not much research has been done on how music, and what type of music are used and administered specifically for optimum effect in specific clinical populations (Myskja, & Lindbaek, 2000).

Previous study on the effect of exercise on one of the health variables (cholesterol) reported that aerobic training performed on a treadmill and in water increased HDL-C and reduced LDL-C between pre- and post-exercise (Greene, Martin, and Crouse, 2012). Another study by Dunn et al. (1997) investigated the effects of a 6-month aerobic exercise programme, which developed from 50 to 85 % of maximum aerobic power for 20–60 min three times a week and reported a significant decrease in total cholesterol (-0.3 mmol/L, $p < 0.001$) and in the ratio of total HDL cholesterol (-0.3, $p < 0.001$). Snyder et al. (1997) concluded that moderate intensity, intermittent exercise for 30 min, 5 days per week for 32 weeks duration was not a sufficient stimulus to significantly increase aerobic capacity, alter weight, body composition or improve blood lipids, insulin or glucose for the entire age population. However, for both groups, moderate-intensity, intermittent exercise showed excellent adherence and this may be a useful model for future research studies.

The influence of acute exercise with music is rarely considered in medical related conditions. However, from previous existing study, we propose that the strategy of using music during exercise would promote individuals to exercise at an increasing intensity, from time to time, and results in improving health status.

Chapter 3
Methods

3.1 Data Sources

Studies were searched electronically using the following databases: Scopus, ScienceDirect, PubMED and EBSCOhost. Briefly, the selected studies were searched using the same selection criteria as described below. In addition, cross referencing related previously published study was performed of obtain extra information. Peer-reviewed articles in English language from 2015 until 2021 were used to get the recent information for this scoping review. No attempts have been made to contact authors for additional information. Comparable searches were made for the other database.

3.2 Study Selection

The search was conducted according to the PRISMA Extension for Scoping Reviews (PRISMA-ScR) guidelines (Figure 2). The following keywords were used during the search: #exercise and #music and #physical inactivity or #physically inactive or # sedentary. Studies were screened for employing exercise with music as intervention, and exercise performance or health variables as outcome measure. Randomised controlled trials, controlled trials and laboratory studies on human only are included in this review.

Exercise performance was described as: (1) maximal oxygen consumption (VO_2max) (2) exercise duration (3) exercise behaviour

Health variables were described as: (1) blood lipid profile (2) anthropometric indices (3) blood pressure (4) diabetes condition

3.3 Data Extraction

The titles and abstracts of retrieved articles were reviewed using the specified criteria to determine whether full text was required for further analysis. Each full-text manuscript was evaluated systematically according to the study: (1) objective/s, (2) characteristics of the study (targeted population, age, sample size and study design), (3) contents of intervention (intervention types, duration of intervention or mode of exercise tested (4) targeted outcome/s, and (5) main findings. The outcomes extracted from those studies were not combined, reanalysed or changed due to the nature of this scoping review.

3.4 PRISMA FLOW

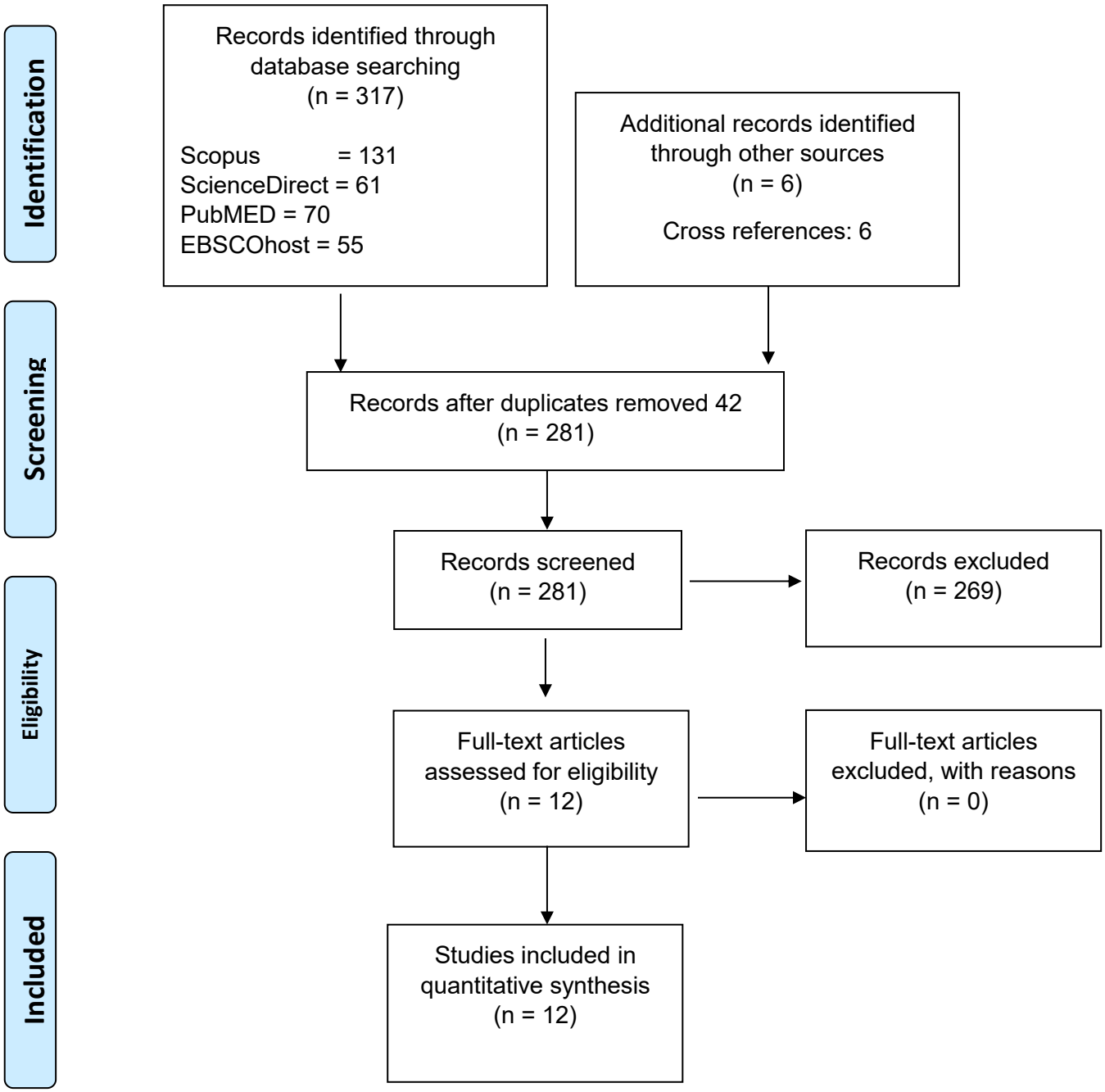

Figure 2 PRISMA flow for study selection

Chapter 4
Results

4.1 Search Results

A total of 317 potential articles were retrieved from four databases while six articles were found from cross-referencing. After removing duplicates, 281 articles were evaluated based on the titles and abstract against the selection criteria. A total of 269 articles were excluded for not investigating exercise with music and the participants involved in the study were not physically inactive individuals. After a detailed analysis of the remaining full-text articles, 12 articles were included in this scoping review. Figure 2 describes the PRISMA flow diagram for study selection.

From the 12 studies reviewed, all studies involved human participants. From the included articles, six studies were related to the effects of exercise with music on exercise performance (Agre et al., 2021; Aasa, Paulin & Madison, 2016; Cokorilo et al., 2018; Tuominen et al., 2017; Barranco-Ruiz & Villa-González, 2020; Ivanova et.al., 2015) and six studies were related to the effect of exercise with music on health variables (Jia et al., 2016; Amorim et al., 2017; Ji et al., 2015; Barranco-Ruiz, & Villa-González, 2021; Karagöz, & Koken, 2020; Ativie et.al., 2018). In addition, from the 12 articles that were selected and included at the final stage of the screening in this scoping review, seven articles obtained from the screening are experimental studies and five articles are randomised controls trials studies.

From the 12 studies, eight studies involved sedentary or physically inactive individuals (Aasa, Paulin, & Madison, 2016; Cokorilo et al., 2018; Tuominen et al., 2017; Barranco-Ruiz, & Villa-González, 2020; Ivanova et.al., 2015; Jia et al., 2016; Amorim et al., 2017; Karagöz, & Koken, 2020), three studies involved overweight or obese

sedentary individuals (Agre et al., 2021; Barranco-Ruiz, & Villa-González, 2021; Ativie et.al., 2018) while one study involved sedentary diabetic patients (Ji et al., 2015).

4.1.1 The use of musical elements in exercise

Of the twelve studies found in this review, two studies used music during Zumba dance session. The first study was conducted by Barranco-Ruiz & Villa-González (2021) that used fast tempo music (140-180) along with 16-week Zumba dance programme. The second study was conducted by Barranco-Ruiz, and Villa-González (2020). Participants in the study participated in Zumba fitness class that consists of three parts: (i) warm-up (music from 125 to 135 bpm); (ii) main part used choreography with Latin rhythms (merengue, salsa, reggaeton, music from 140 to 180 bpm); (iii) cool down used choreography based on soft Latin rhythms (bachata or salsa, music from 120–135 bpm).

Moreover, one study by Ativie et al. (2020) used music played with music player along with aerobic dance exercise and another study by Cokorilo et al. (2018) used music with aerobic exercise including step aerobics, fitness aerobics and Zumba. Agre et al. (2021) did a study that compared slow tempo music (60-80bpm) and fast tempo music (140-160bpm) that was performed with aerobic exercises (circuit training). Another study by Aasa, Paulin, & Madison (2016) used music along with different exercise types (cardio, strengthening, mobility and balance exercises) performed in this study.

Besides that, a study by Ivanova et. al. (2015) was conducted by asking participants to listen to music while exercising. The music was chosen by the participants according to their own preference from four genres, which are Pop, Hip-Hop and R&B, Electronic Dance, and Alternative Rock. Twelve songs from each of these genres were selected from the Billboard Canadian Hot 100 (2011–2013) and the beat was screened using the BeatScanner software to select songs with a tempo of

135–140 beats per minute, considering optimal beat for a high intensity exercise. In another study, Jia et al. (2016) used participants favourite music and they had to listen to it while performing exercise. Also, an intervention study used a video game (Just Dance) that incorporates music with exercise (Amorim et al., 2017). Similarly, a study by Tuominen et al. (2017) also used music video programme as its musical condition.

Ji et al. (2015) used music media therapy along with exercise. Five musical genres were initially selected, including classical, folk instrumental, cheerful, religious and soothing. The final selection of musical genre was categorised as a "soothing aesthetic", based on patient's preferences after listening to sample music from each style. Finally, a study used high tempo music (120-160 bpm) music during cardio tennis exercise activity. The cardio tennis exercise was performed while listening to music at 120-160 bpm. The music was arranged starting from warm-up, main phase and cool down phase (Karagöz, & Koken, 2020).

4.1.2 Types of exercise intervention

Majority of the studies involved intervention using aerobic exercise. One study by Agre et al. (2021) involved aerobic exercise in the form of circuit training as an exercise intervention. Participants were assigned into different groups: Group A: circuit training with fast music, Group B: circuit training with slow music, Group C: circuit training without music. Exercise intervention were performed for four weeks (3 times/week) with progressions as the number of weeks increased. Exercise intensity was set at moderate level for the first two weeks and high for week 3 to week 4. In addition, a study by Aasa, Paulin, & Madison (2016) used low impact exercises as an exercise prescription for 11-weeks of bi-weekly classes. Furthermore, a study by Cokorilo et al. (2018) used aerobic exercise which consist of step aerobics, fitness aerobics and Zumba. The exercise intervention was conducted twice a week for 60 minutes and it consists of three phases, Phase 1: low intensity preparation exercise (10

minutes), Phase 2: continue with interval exercise on 60–80% of maximal heart rate, Phase 3: low intensity and stretching exercise for cooling down (5 minutes).

A study by Ativie et.al. (2018) used aerobic dance exercise that involved experimental group and a control group. Experimental group performed dancing activities for 10 minutes every two weeks, starting from the second week until the eight weeks. Another study by Tuominen et al. (2017) applied movement to music video programme to guide the exercise, consisting of three separate exercise programmes, and each exercise lasted for 10 minutes. There are two studies which used Zumba as an exercise prescription. A study by Barranco-Ruiz, & Villa-González (2020) involved 3 groups which has a control group that received no exercise intervention, an endurance training group that performed Zumba fitness classes only and a concurrent training group that performed extra muscle-strengthening workout after the Zumba Fitness class. Another study by Barranco-Ruiz, & Villa-González (2021) involved experimental exercise group that performed structured choreographic fitness classes (CFC) with the Zumba Fitness program (3 days/week and 60 min/session) and control group that received no exercise.

The exercises prescribed by Ivanova et al. (2015) was a constant work rate (CWR) cycle test involving an experimental group (ACT-based cognitive techniques and listening to music during the CWR exercise tests) and a control group (listening to music during the CWR exercise tests). Before intervention (CWR-1) and after the intervention (CWR-2), participants completed a CWR cycle exercise test at 80% of maximal incremental work rate (Wmax) until volitional exhaustion. A study by Jia et al. (2016) used cycle ergometer with the pedal load set at 60 watts for males and 40 watts for females. In that study, there were 4 sessions separated in four days which are sedentary session, music session, cycling session, and cycling with music session. A study used exergaming called Just Dance music video game, in which participants

were asked to play the game twice a week for 60 minutes while listening to pre-determined songs, at the intensity of 55–69% of maximum HR (Amorim et al., 2017).

One study applied lower extremity exercise that includes the strengthening of quadriceps, balance and ankle/foot as well as kicking before and after the strengthening exercises (Ji et al., 2015). The study involved an experimental group (extremity exercise in addition to the music media) and a control group (only received the lower extremity exercise). The participants exercised for 15 minutes every day for at least six months. Finally, a study by Karagöz and Koken (2020) applied a cardio tennis exercise that involved control group with no exercise and exercise group that performed exercise intervention for 10 weeks, three days a week for one hour and was performed at 50-70% intensity of heart rate reserves (HRR).

4.1.3 Studies on exercise performance

Table 1 shows a summary of the effects of exercise with music on exercise performance. Four studies reported on oxygen consumption (VO_2 max). One study by Agre et al. (2021) reported that slow tempo music showed more increment in VO_2 max than fast tempo music or no music after performing aerobic exercises intervention. In another study by Cokorilo et al. (2018), it was shown that recreational group exercises (Zumba, aerobics, Step aerobics, and Pilates) improve both relative oxygen consumption (VO_2max), absolute oxygen consumption (VO_2max). Another study by Aasa, Paulin, & Madison (2016) demonstrated that after performing low impact exercises intervention, participants aged 35-65 years showed increment in their maximal oxygen consumption (VO_2max) compared to younger age group (20-34). One study by Barranco-Ruiz, & Villa-González (2020) reported that both Zumba with and without muscle strengthening workout showed improvement in estimated maximal oxygen uptake (VO_2max). Barranco-Ruiz, & Villa-González (2020) also reported on the duration of exercise and the result showed improvement in the time taken for 2-km

walking test in both exercise intervention groups (Zumba with and without muscle strengthening workout group).

In addition, one study reported on exercise duration. In Ivanova et al. (2015) study, acceptance and commitment therapy (ACT) was used in combination of music during exercise. ACT is a form of psychotherapy (Hayes et al., 1999) that is widely used in clinical settings for the treatment and management of psychological disorders. The result shown that used of ACT combined with music in CWR cycle exercise intervention helped low-active women performed high-intensity exercise for longer time. Finally, a study by Tuominen et al. (2017) showed movement-to-music video programme did not change the sedentary behavior (SB) or increase physical activity (PA) in sedentary preschool-aged children and their mothers.

4.1.4 Studies on health variables

Despite the advantage of using music during exercise that has been reported in literature, only small number of studies investigated exercise with music on health variables. Table 2 shows a summary of the effects of exercise with music on health variables. Three studies reported on blood lipid profile. A study by Amorim et al. (2017) reported that performing exergaming by using music video game successfully lowered the lipid profile of participants. In another study, Barranco-Ruiz and Villa-González (2021) reported that Zumba programme significantly improved the blood lipid markers (triglycerides, HDL, and LDL) in sedentary overweight women compared with a control group (non-exercise group). One study has also shown that there was a significant difference in HDL-cholesterol levels after exercise whereas there were no significant differences in total cholesterol, LDL-cholesterol and triglyceride values (Karagöz, & Koken, 2020).

Two studies reported on anthropometric indices. In a study by Ativie et.al. (2018), the result showed a significant reduction in waist circumference (WC), hip

circumference (HC), Waist-Hip ratio (WHR) and body mass index (BMI) after 8 weeks of aerobic dance training. Another study with a 16-week healthy lifestyle program based on a structured choreographic fitness classes with the Zumba Fitness significantly reduced the values of the waist circumference (WC) among physically inactive women (Barranco-Ruiz, & Villa-González, 2021).

Two studies reported on blood pressure. A study showed both music and exercise did not significantly affect blood pressure in post-exercise orthostatic hypotension through the modulation of autonomic nervous system activity (Jia et al., 2016). A study by Barranco-Ruiz, & Villa-González (2021) reported that blood pressure showed a significant improvement after the intervention in the Zumba Fitness program group compared with the non-exercise group.

Finally, a study also reported that participation in music media therapy with low extremity exercises improved condition of patients with diabetes (Ji et al., 2015). The result of the study showed improved in blood sugar level and foot blood circulation after low extremity exercises intervention (included the strengthening of quadriceps, balance and ankle/foot as well as kicking before and after the strengthening exercises).

4.2 Table of Results

Table 1: Effects of exercise with music on exercise performance among physically inactive individuals

No	Authors, year and study title	Participants	Used of music in exercise studies	Types of exercise prescription	Outcome measures	Result (effects on exercise performance)
1.	Agre et al. (2021) Comparing the Effect of Fast Tempo Music and Slow Tempo Music During Aerobic Exercise on Cardiovascular Endurance in Overweight Adolescents	90 overweight adolescents	Slow tempo music (60-80bpm) and fast tempo music (140-160bpm) along with exercise (group A: exercise to fast tempo music, group B: slow tempo music, group C - CG: no music)	Aerobic exercise (circuit training) Group A: circuit training with fast music, Group B: circuit training with slow music, Group C: circuit training without music. Exercise intervention perform for 4 weeks (3 times/week) with progression as the weeks progressed.	Maximal VO_2max pre and post aerobic exercise	Slow tempo music showed more increment in maximal VO_2max than fast tempo music or no music.
2.	Aasa, Paulin, & Madison (2016) Correspondence Between Physical Self-Concept and Participation in, and	92 sedentary women	All exercises were performed synchronously with the music	11 weeks of biweekly of low impact exercises.	pre and post-test maximal VO_2max	Participants aged 35-65 years showed improvement in their maximal VO_2max compared to younger age group (20-34). .

	Fitness Change After, Bi-Weekly Body Conditioning Classes in Sedentary Women					
3.	Cokorilo et al. (2018) Effects of Group Exercise on Functional Abilities: Differences Between Physically Active and Physically Inactive Women	64 healthy women, experimental group (N = 36) which consisted physically active women, Control group (N= 28), which consisted of physically inactive women.	Music along with aerobic exercises	Aerobic exercise consists of step aerobics, fitness aerobics and Zumba (twice a week for 60 minutes) Period 1: low intensity preparation exercise (10 minutes) Period 2: continues and interval exercise on 60–80% of maximal heart rate Period 3: low intensity and stretching exercising for cooling down (5 minutes)).	Relative VO_2max, absolute VO_2max	Physically active women group showed more increased in both relative VO_2max, absolute VO_2max compared to physically inactive women group.
4.	Tuominen et al. (2017) The Effect of a Movement-to-Music Video Program on The Objectively Measured Sedentary Time and Physical Activity of Preschool-Aged	228 mother-child pairs (child age 5-7 years), sedentary	Music video program	Movement to music video program (consisting of three separate exercise programs, each lasting 10 minutes)	Changes in SB and PA improvement.	Movement-to-music video program did not change the SB or increase PA

	Children and Their Mothers: A Randomized Controlled Trial					
5.	Barranco-Ruiz, & Villa-González (2020) Health-Related Physical Fitness Benefits in Sedentary Women Employees after an Exercise Intervention with Zumba Fitness	98 physically inactive adult women	Zumba fitness class with music	Zumba Fitness class CG: no exercise intervention Endurance training group: Zumba fitness classes only Concurrent training group: extra muscle-strengthening workout after the Zumba Fitness class	Time taken of 2-km walking test and estimated VO_2max	Both exercise intervention groups showed statistical improvements in the time taken of 2-km walking and estimated VO_2max
6.	Ivanova et al. (2015) Acceptance and Commitment Therapy Improves Exercise Tolerance in Sedentary Women	39 sedentary women	Listen to own preference music (using headphones) while exercising. Music tempo: Medium tempo (135–140)	CWR cycle test EG: using ACT-based cognitive techniques and listening to music during the CWR exercise tests, CG: listening to music during the CWR exercise tests.	RPE, Exercise duration	ACT can be used in combination with music to help low-active women to perform high-intensity exercise for longer while.

EG: experimental group; CG: control group; Bpm: beat per minute; SB: sedentary behaviour; PA: physical activity; CWR: constant work rate; ACT: acceptance and commitment therapy; RPE: rate of perceived exertion; VO_2max: oxygen consumption