

Music, Exercise Performance, and Adherence in Clinical Populations and in the Elderly: A Review

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The purpose of this study was to review a series of studies ($n = 20$) examining the effects of adding music to exercise programs in clinical populations and in the elderly. We found that the addition of music can (a) improve exercise capacity and increase patients' motivation to participate in cardiac and pulmonary exercise rehabilitation programs; (b) lead to improved balance, greater ability to perform activities of daily living, and improved life satisfaction in elderly individuals; (c) enhance adherence and function of individuals suffering from neurological diseases such as Alzheimer's and Parkinson's; and (d) sustain these benefits if continued on a long-term basis. Based on the reviewed studies, a number of methodological concerns were presented, among them the choice of music style. One of the practical implications suggested for clinicians and practitioners was that the type of music should be individualized based on each patient's musical preferences.

Keywords: Music therapy, exercise therapy, activities of daily living, clinical research.

Exercise is widely accepted as a therapeutic method of alleviating symptoms associated with chronic diseases. Exercise can help individuals with cardiac (Taylor et al., 2004) and pulmonary (Moss, 2008) diseases, dementia (Heyn, Abreu, & Ottenbacher, 2004), several types of cancer (Hayes, Spence, Galvao, & Newton, 2009), diabetes (Albright et al., 2000), and obesity (Donnelly et al., 2009). The American College of Sports Medicine (2010) has recently launched the Exercise is Medicine campaign with the purpose of advising clinicians on the importance of physical activity for their patients. Indeed, exercise should be considered as a method of preventing or treating many chronic conditions, and as such should be prescribed by physicians. In addition, if exercise is conducted correctly and under supervision, it has few or no side effects.

Many elderly individuals and individuals who suffer from chronic conditions fail to exercise regularly. In a recent survey of healthy lifestyle habits of adults in the U.S. between the years 1988–2006, it was found that the rate of participation

in physical activity performed 12 times per month or more decreased from 53% to 43% in adults aged 40–74 years (King, Mainous, Carnemolla, & Everett, 2009). In a two-year randomized control trial of 137 sedentary females over the age of 70, only 17% completed the prescribed 150 min (5 times per week, 30 min per session) of exercise (Findorff, Wyman, & Gross, 2009). Lastly, in a study of 131 patients over the age of 65 who attended cardiac rehabilitation sessions after cardiac surgery, one-year adherence rates varied based on their activity level before the surgery. In this study, all 36 patients who led an active lifestyle before surgery reported light physical activity for at least one hour, five days per week, but only 49 of the 95 (51.6%) patients who led a sedentary lifestyle in the year before the surgery reported this amount of exercise a year after surgery (Macchi et al., 2009). Clearly, interventions that can improve adherence to exercise are warranted.

One of the interventions that can be considered by clinicians, therapists, and physicians is the addition of music to the exercise program. Listening to music during exercise and physical activity has been reported to have many possible benefits. For example, music can capture attention, lift spirits, generate emotion, regulate mood, increase work output, and encourage rhythmic movements (Terry & Karageorghis, 2006). In addition, music can divert attention from the sensation of fatigue, serve as a stimulant for exercise, and enhance the acquisition of motor skills (Karageorghis, 1999). It is also likely that the benefits of music can be realized in clinical populations. Motivating individuals who suffer from chronic diseases can promote adherence to an exercise rehabilitation program and by doing so improve the symptoms related to these conditions.

The purpose of this article was to review a series of studies examining the addition of music to exercise programs in clinical populations and in the elderly. A literature search was conducted using two databases (PubMed and SPORT-Discus). The search was limited to peer-reviewed journals written in the English language. Search terms included music AND exercise, music AND exercise AND clinical, and music AND exercise AND rehabilitation. Inclusion criteria consisted of studies on the addition of music to exercise programs in either clinical or elderly populations. Articles were excluded if music was not provided with the exercise. A manual search of the reference lists in the studies found in the computerized search was also conducted. The total search yielded 20 studies that matched the above mentioned criteria.

We decided to conduct a qualitative review and not another type of review, such as a meta-analysis, because in some of the studies (a) the effect sizes were not reported or data were missing, and therefore it would be impossible to calculate these effects; (b) the power values were low due to small sample sizes; (c) a control group was not included; and (d) the measured dependent variables were not the same; in some of the studies quantitative variables were measured and in others qualitative variables were collected. In addition, we wanted to clarify why in some of the studies the treatments did not lead to significant results, and only a narrative review would enable us to discover the possible reasons for the lack of improvements. In other types of reviews, such as a meta-analysis, we would be examining mainly the strength of the treatments. In the current review, our aim was also to emphasize a number of qualitative concepts associated with the use of music in clinical populations and in the elderly, such as the need to individualize the type of music. A summary of the reviewed studies examining the effects of music on exercise in clinical and elderly populations is presented in Table 1.

Table 1 A Summary of the Reviewed Studies Examining the Effects of Music on Exercise in Clinical and Elderly Populations

Study	Design	Population	Methods	Type of Music	Results
Bauldoff et al. (2002)	exp/con	Convenience sample of COPD patients (n = 24). Age 68.1 ± 8 years.	2 groups (music, no music) participated in 8 weeks of unsupervised walking program monitored by pedometers and exercise logs. Various questionnaires and a 6-min walk test were administered at baseline, after 4 weeks, and after 8 weeks.	Music group was given audiocassette tape with four types of music (country, classical, pop, big band) to use in their training program. Music tempo of 90–110 beats-min ⁻¹ .	No differences in amount of exercise over eight weeks between groups. Distance walked in a 6-min walk test increased in the music group from 309.7 m to 444.7 m, and decreased in the no-music group from 342.1 m to 290.8 m. A decrease in perceived dyspnea was seen in the music group but not in the control group.
Becker et al. (1995)	1 group RM	Members of a community-wide senior service facility. Ages 60–101 years (n = 20).	Participants walked a 61 indoor course in the senior facility. Nine trials of 90-s walks. Three music conditions: Mellow, frenetic, blank tape, and three scent conditions: relaxing, stimulating, no scent. Measure: walking distance covered in 90 s	Music developed from survey of staff members. Staff unanimously decided on the music for the mellow and frenetic conditions.	No effect of scent on walking distance. Most participants did not notice scents. Mellow music reduced walking distance compared with frenetic music and blank tape. Example: under no scent condition: Mellow—94.94 ± 25.24 m, Frenetic—97.03 ± 26.30 m, Blank tape—97.10 ± 27.6 m

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Table 1 (continued)

Study	Design	Population	Methods	Type of Music	Results
Brooks et al. (2003)	1 group RM	COPD patients (n = 30). Ages 50- over 70 years.	Each patient completed two 10-min walks—once without music and once while listening to music.	Moderate music tempo. Selections from Baroque works such as Bach's "Brandenburg Concerto No. 3" and Vivaldi's "Four Seasons."	No significant differences between walks in distance covered, level of dyspnea, or anxiety.
Cevasco & Grant (2003)	Exp.1: 1 group RM 2 conditions Exp.2: 1 group RM 4 conditions	Individuals diagnosed with Alzheimer's disease living in an assisted living facility. Exp 1: n = 14, Exp 2: n = 12. No data on age.	Exp.1: 38 therapy sessions over a period of eight months. Each session included several activities with 3 min of movement at the beginning and 3 min of movement at the end. Instruction was either continuous (throughout the 3 min) or single verbal direction before each movement. Participation was observed as the accurate movement shown by the instructor or an approximation of the movement. Exp. 2: 26 therapy sessions of similar arrangement to that of Exp. 1. Four conditions compared: exercise to vocal music or to instrumental music and exercise with instruments to vocal music or to instrumental music.	Vocal and instrumental music from the 1900-1950s.	Exp.1: Continuous verbal cueing led to greater participation compared with single verbal cueing. This was true especially when the required response of the participants was an approximation of the movement shown by the instructor. Exp.2: A trend for greater participation with instrumental music compared with vocal music.

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Table 1 (continued)

Study	Design	Population	Methods	Type of Music	Results
De Bourdeaudhuij et al. (2002)	1 group RM 2 conditions	Severely obese (BMI = 33.5 $\pm$ 4.9). Adolescents (age = 13.1 $\pm$ 2.0 years) in a residential treatment program (n = 30).	10 months of residential treatment. Two incremental treadmill tests at beginning of treatment (end of 2nd month). Two treadmill tests near the end of treatment (end of 8th month). In each two sessions—one with distraction (music) and without distraction. Outcomes: physiological as well as self-reports about body sensations and feelings	Participants brought a tape with their favorite piece of music on it. Music was played on a loudspeaker throughout the treadmill test.	Running time was longer with music compared with no-music. Larger differences between music and no-music groups in beginning of treatment (719 $\pm$ 121 s vs. 664 $\pm$ 133 s, respectively) than at the end of the treatment (782 $\pm$ 117 s vs. 765 $\pm$ 116 s, respectively). HR, RER, and VO ₂ peak higher with music compared with without music.
Emery et al. (2003)	1 group RM	Participants in a 12-week standard university-based cardiac rehabilitation phase II program (n = 33). Age = 62.6 $\pm$ 10.5 years.	Each participant completed two treadmill sessions with one week in between, one with music and one without music (blank tape). Each session consisted of ten minutes of gradual increase in speed and slope to reach 85% of VO ₂ max. Participants continued to exercise at that level until volitional fatigue.	Vivaldi's "Four Seasons" was played using a personal cassette recorder and earphones.	No differences in physiological responses to exercise between sessions. A significant increase in verbal fluency representing cognitive function in the music session compared with the blank tape session.

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Study	Design	Population	Methods	Type of Music	Results
Hagen et al. (2003)	exp/exp/con	Residents in a long-term care facility (n = 60). Mean age = 78.3 years. No severe cognitive impairment or medical problems that prevent them from exercising.	Three groups: control (C), occupational therapy (OT), and exercise to music (ET). Nonrandomized selection. Three weekly sessions over 10 weeks. Measures: cognitive assessment, behavioral assessment, overall dependency, life satisfaction, and physical assessment.	Music from the 1920s, 1930s, and 1940s.	Cognitive and behavioral abilities, overall dependency: deterioration in C group, improvement in OT and ET after 10 weeks, slight decline after 10 weeks follow-up. Physical measures: Balance: OT maintained scores over time while ET improved after 10 weeks with a very slight decline after 10-week follow-up. Finger, hand and wrist function: decline in C group, improvement in OT and ET groups. Elbow, shoulder, and spine function: Decline in C group, improvement in ET group, only some improvement in OT group. Ankle, knee, and hip function: decline in C and OT groups. Improvement in ET group.
Hamburg & Clair (2003)	1 group RM	Participants from a local senior center. Ages = 65-78 (n = 14).	14 weeks of exercise to music program designed to improve balance, flexibility, coordination, and spatial awareness. No control group.	Music synchronized with movements. Professional recording was made and performed on piano, soprano saxophone, string bass, and percussion. Individual music pieces for each movement were recorded in sequence on an audiotape.	Significant improvement in balance, gait speed and functional reach after five weeks. Further improvement after 14 weeks although not statistically significant.

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Table 1 (continued)

Study	Design	Population	Methods	Type of Music	Results
Johnson et al. (2001)	1 group RM	Individuals within the ages of 65–90 with physical frailties who resided in two community living centers and one residential retirement center (n = 19).	Six 20-min exercise sessions with 14 exercises in each session: two with instrumental music, two with vocal music, two without music. Outcome measure was frequency of movements in each session.	Auditory tapes with specific music tracks to match each exercise. Each exercise was preceded by an announcement on the tape followed by five seconds of a metronome beat at the right tempo followed by the song.	No consistency in differences between sessions. Outcome measure could not reveal differences in adherence.
Kim & Koh (2005)	1 group RM 3 conditions	Poststroke patients with hemiplegia (n = 10). Ages between 61–73 years.	Upper-extremity exercise sessions under 3 conditions: music, karaoke, and silence.	Popular Korean music from the 1980s. Music was of moderate tempo (90–100). A total of 16 music pieces were used in the study.	No differences in pain perception during the sessions between conditions. Increased motivation to continue with the exercise program under the music and karaoke conditions.
Marrero et al. (1988)	1 group Pre-post	Adolescents with IDDM ^a . Ages = 12–14 years (n = 10).	12-weeks of home-based aerobic exercise consisting of 30 min of movement to a music routine designed to increase HR over 160 beats·min ⁻¹ . Pre, and posttests of VO2max on a cycle ergometer. No control group.	Audio and videocassettes of the aerobic routine were given to participants. No data on type of music.	87% of the requested 36 sessions were completed. VO2max increased from 40.39 ± 8.87 ml·kg ⁻¹ ·min ⁻¹ to 44.86 ± 12.89 ml·kg ⁻¹ ·min ⁻¹ . HbA1 values also decreased after the 12-week period.

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Study	Design	Population	Methods	Type of Music	Results
Mathews et al. (2001)	1 group	Residents of a special-care unit for persons with dementia (n = 21). Ages = 74–97 years.	Four baseline sessions (no music). Ten sessions with music. Three no-music sessions. Four sessions with music. Each session included 14 exercises.	Each exercise had its own particular music that reflected the movement required. Music styles included country/western, polka, folk, jazz, and blues.	Participation increased from 53% at baseline to 69% in the exercise with music sessions. When music was removed for three sessions—participation dropped to 41% and increased back to 68% when sessions with music resumed. The increase in participation was in a subgroup that was more willing to take part in social activities. The effect was not seen in a group that showed no willingness to participate in social events.
Metzger (2004)	Survey	Participants in a cardiac rehabilitation program (n = 33). No data on age.	Survey to assess needs and use of music in cardiac rehabilitation participants. Responses on a Likert 1 (<i>never</i>)–5 (<i>always</i>) scale.	Not relevant.	Use of music as a distracter while exercising: Mean rating = 3.67. Use music as a motivator while exercising: Mean rating = 3.29. Use of music to alleviate stress symptoms: Mean rating = 3.31. Musical preference varied greatly.

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Table 1 (continued)

Study	Design	Population	Methods	Type of Music	Results
Murrock (2002)	exp/con	Participants in a cardiac rehabilitation phase II program (n = 30). Age = 69.9 years.	Participants divided into two groups—exercise with music, exercise without music. Pretest and posttest included RPE and feeling scale (scale of -5-5). Both groups completed three sessions without music (pretest data from 3rd session) and then 10 sessions in their assigned group (posttest data from 10th session).	Classical music with upbeat tempo (128-160 beats-min ⁻¹) including compositions by Tchaikovsky, Mozart, Bach, Beethoven, Brahms, Bizet, Handel, Mendelssohn, Liszt, and others. Music played over speakers.	No significant differences in RPE between groups. Significantly increased general mood in exercise with music group (pretest: 1.47, posttest: 4.13) compared with exercise without music group in which general mood scores decreased (pretest: 1.13, posttest: 0.33).
Pacchetti et al. (2000)	RCT	Patients with Parkinson's disease (n = 32). Mean age = ~63 years.	Three months prospective, randomized, controlled study. Two groups: physical therapy (PT) group and music therapy (MT) group. UPDRS-MS# used for testing outcomes in each presession and postsession.	Music therapy sessions with some rhythmic music for movement. No data available on type of music.	Significant positive effects on UPDRS-MS with specific regards to bradykinesia after each session and an overall improvement in bradykinesia after three months in the MT group. No differences in UPDRS-MS and bradykinesia scores in PT group. Rigidity scores improved in PT group but not in MT group. MT group showed improvements in ADL% scores, emotional function and quality of life. These improvements were not observed in the PT group. All improvements returned to baseline values after 2-month follow-up.

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Study	Design	Population	Methods	Type of Music	Results
Pfister et al. (1998)	1 group RM	Moderate to severe COPD patients (n = 19).	Each patient completed two 6-min walk tests—once without music, and once while listening to music.	Music played in ear-phones. Participants selected their preferred style of music from these categories: big band, 1960s, country, tropical, or Broadway themes. Music tempo was 119–126 beats·min ⁻¹	No differences between walks in distance covered, RPE, or dyspnea.
Teel et al. (1999)	One treatment, multiple sites	Individuals in regular residential settings (n = 66). Ages = 63–96. Participants from a community group (n = 13), church activity group (n = 13) and two retirement communities (n = 40).	A six-week movement to music program was offered at four sites. Weekly one-hour sessions were offered. Dropout rates and adherence were evaluated. Self reports of participants were qualitatively analyzed.	Music used to support rhythm and mood of participants. New, original music created, so no prior association to music would influence results. Music created by two composers for solo piano and a jazz quartet.	Drop-out rates during weeks 1–2: 23–36%. Adherence rate after week 2: 78–100%. Session attendance: 89–95%. Self-reports of participants revealed perceived benefits such as enhanced posture awareness, improved sense of balance, and increased social interaction.

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Study	Design	Population	Methods	Type of Music	Results
Thornby et al. (1995)	1 group, RM 3 conditions	COPD patients (n = 36) aged 63 ± 8.8 years.	Individualized stress tests with 10–30 min rest in between under three auditory conditions: music, gray noise, and a silent tape. Each test consisting of walking at self-reported comfortable walking speed. Speed and elevation increased by 0.3% mph and 0.5%, respectively every three minutes until termination of test.	Vivaldi's "The Four Seasons."	HR: Music: 104 ± 3 beats·min ⁻¹ , gray noise: 101 ± 3 beats·min ⁻¹ , silent tape: 101 ± 3 beats·min ⁻¹ . Exercise time: Music: 13.9 ± .4 min, gray noise: 11.6 ± .3 min, silent tape: 11.3 ± .3 min. Total work: Music: 11.8 ± 1.1 Kcal, gray noise: 8.2 ± .8 Kcal, silent tape: 7.7 ± .8 Kcal. RPE: Music: 6.2 ± .2, gray noise: 6.5 ± .2, silent tape: 7.1 ± .3
Van de Winckel et al. (2004)	exp/con	Patients with dementia in a psychiatric hospital (n = 25). Mean age = ~82 years.	Three-month intervention: Control group—no exercise, only conversations with therapist. Experimental group—sitting exercises with music.	Music chosen with consideration of age: polka, folk, country/Western.	MMSE* scores increased significantly from 12.87 ± 5.01–15.53 ± 4.44 in the exercise-music group. No changes were observed in the control group (baseline 10.80 ± 5.01 and 11.00 ± 4.30 after three months).

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Study	Design	Population	Methods	Type of Music	Results
Van Nes et al. (20064)	RCT	Patients after stroke (n = 30). Mean age = ~60 years.	Two-armed (exercise to music vs. whole body vibration) randomized control trial. Six-week intervention. Six-week follow-up. Outcomes: balance, trunk control, ADL %.	No data available.	Both treatments improved outcomes variables to the same extent. No differences were found between treatments.

Data Presented as Means $\pm$ SD

Exp/con = a two-group design including one treatment group and one control group. Exp/exp/con = a three-group design—two different treatments and control. RM = repeated measures. RCT = randomized controlled trial.

* MMSE = Mini Mental State Examination—a common cognitive test with a possible score of 30 points; # UPDRS-MS = Unified Parkinson's Disease Rating Scale—Motor Subscale; % ADL = Activities of Daily Living; & IDDM = Insulin Dependent Diabetes Mellitus.

Clinical Populations

The clinical populations included patients with chronic obstructive pulmonary disease (COPD), cardiac patients, stroke patients, individuals with Alzheimer's and dementia, patients with Parkinson's disease, severely obese adolescents, and diabetic adolescents.

Chronic Obstructive Pulmonary Disease (COPD)

Pulmonary rehabilitation in COPD patients has clinically significant positive effects on dyspnea (i.e., shortness of breath), fatigue, and emotional function (Lacasse, Martin, Lasserson, & Goldstein, 2007). Exercise training is considered the "cornerstone" of pulmonary rehabilitation (Bauldoff, Hoffman, Zullo, & Sciruba, 2002), and motivating patients to take part in an exercise program is of primary importance.

Four studies examining the effects of adding music to exercise in COPD patients were found (Bauldoff et al., 2002; Brooks et al., 2003; Pfister, Berrol, & Caplan, 1998; Thornby, Haas, & Axen, 1995). In one study (Thornby et al., 1995), 36 COPD patients completed an exercise stress test under three conditions: music, gray noise (a neutral auditory stimulus), and silence. Exercise time, total work, and heart rate (HR) were higher in the music condition compared with the gray noise and silence conditions. In addition, it was found that the rate of perceived exertion (RPE) was lower in the music condition compared with the gray noise and silence conditions. Results were both statistically and clinically significant; for example, walking distance was higher by approximately 22% and total work was higher by approximately 50% in the music condition compared with the two other conditions. It was suggested in this study that the distractive stimulus (i.e., music) reduced the perception of respiratory effort (Thornby et al., 1995).

In another study (Bauldoff et al., 2002), 24 COPD patients were divided into two groups: music and no music. Both groups completed an eight-week unsupervised home-based walking program. The participants completed several questionnaires regarding their perceived dyspnea in activities of daily living (ADL), anxiety, depression, and health-related quality of life. In addition, a 6-min walk test was conducted at baseline, and after four weeks and eight weeks of training. The music group listened to audiocassettes with a selection of four types of music (big band, classical, country/western, and pop/Motown), while the no-music group completed their training program without listening to music. The distance covered in the 6-min walk test was reduced in the no-music group but increased by 44% in the music group after the eight-week period of time. In addition, the music group experienced a decrease in perceived dyspnea.

In contrast to these studies, no benefits were observed when music was added to exercise in COPD patients in two other studies (Brooks et al., 2003; Pfister et al., 1998). One study (Pfister et al., 1998) found no differences with or without music in distance walked, RPE, or perceived dyspnea during a 6-min walk test in 20 COPD patients. The patients completed the walking tests at their regular rehabilitation sessions once with and once without music. While more participants walked further with music ($n = 11$) than without music ($n = 6$), the differences did not reach statistical significance. The authors suggested that this could have been due to the small sample size and subsequent low power. However, observed power and effect sizes were not reported in this study.

In another study (Brooks et al., 2003), 30 COPD patients were asked to walk for 10 min with music and another 10 min without music. All walks were completed in each participant's home and the order of walks was counterbalanced. No differences in perceived dyspnea, anxiety, or distance covered were found. The type of music was selected by the researchers and was not tailored to each participant. The conflicting results of the four studies can be explained by several methodological and statistical concerns; among them were the choice of music style, which was not tailored to each participant, and the lack of power and effect size values. These concerns are discussed in our review in the section on methodological limitations.

Cardiac Disease

Cardiac rehabilitation (CR) can improve the health and quality of life of cardiac patients. A systematic review and meta-analysis of 48 randomized controlled trials (Taylor et al., 2004) revealed that CR was associated with a reduction in both all-cause mortality (odds ratio = 0.8) and cardiac mortality (odds ratio = 0.74). Reductions in triglyceride and cholesterol levels, as well as in systolic blood pressure, were also found. In addition, a lower self-reported rate of smoking was reported (Taylor et al., 2004). Despite the benefits of CR programs, participation rates in CR exercise programs remained relatively low. For example, a 14% participation rate was reported in one study (Suaya et al., 2007) and 55% reported in another (Witt et al., 2004). While to date no empirical studies have examined the impact of music on the CR drop-out rate, it remains possible that the addition of music to a CR program may potentially increase participation and reduce drop-out rates.

Three studies dealing with the use of music in CR programs were found (Emery, Hsiao, Hill, & Frid, 2003; Metzger, 2004; Murrock, 2002). In one study (Emery et al., 2003), 33 participants completed a treadmill test with music (Vivaldi's *Four Seasons*, through earphones) and without (blank tape, through earphones). Speed and slope increased gradually until 85% of $\text{VO}_{2\text{max}}$, and exercise continued at this intensity until volitional fatigue. No differences in physiological variables or in measures of depression and anxiety were found. Nonetheless, cognitive function as measured by verbal fluency (i.e., naming as many words as possible starting with a specified letter in the alphabet in one minute) before and after the treadmill exercise was higher at the end of the music session (27.4 ± 1.1 words) compared with the beginning of the session (26.6 ± 1.1 words), while no differences were found before (26.4 ± 1.0 words) or after (26.7 ± 1.2 words) the no-music session. While the difference was statistically significant, representing an improvement of 3%, in absolute numbers it meant an increase of less than one word per minute. This improvement is unlikely to be clinically or practically significant. It is possible that different results and improved physiological variables in the music group would have been found if the participants had been allowed to individually choose a type of music that would motivate them.

In another study (Murrock, 2002), changes in RPE and general mood were examined in two groups that each performed one session of CR. Each session lasted 40 min and each patient exercised according to his or her regular routine. One group listened to classical music with a tempo of 128–160 beats·min⁻¹, while the other group exercised without music. There were no significant differences between the groups in RPE, but the music group showed increased general posi-

tive mood while the no-music group showed a small decrease in general mood. As was argued by the authors of this study, compliance to the program depends, at least in part, on the pleasure associated with it (Murrock, 2002). These results have practical implications in a CR program.

In the previous studies mentioned, no effort was made to select the favored style of music for each of the participants. Individuals experience music differently; music that motivates some people will not necessarily motivate others (see Karageorghis, 1999, for a review on the selection of the "right" style of music). In one study (Metzger, 2004), an attempt was made to assess the use of music by participants in a CR program. A survey of 33 participants revealed that many used music as a distracter and as a motivator during exercise. In addition, most participants enjoyed music in their daily lives and were interested in learning more about the benefits of music therapy. As expected, the musical preferences of the participants varied considerably. In this case, big band music was most preferred, followed by country/western, classical, religious, popular, rhythm and blues, jazz, and rock music. The results of this survey suggest that music should be selected individually for each participant. It is up to the clinical staff to consult with the participants as to which music they prefer, so that their motivation to participate in the exercise program will be increased.

Stroke

Two studies examined the addition of music to exercise in stroke patients (Kim & Koh, 2005; Van Nes et al., 2006). In one randomized controlled trial in poststroke patients (Van Nes et al.), no differences in functional improvement in ADL, balance, or trunk control were found between a six-week program of exercise therapy with music and a second program of a whole-body vibration therapy (a relatively new method of somatosensory stimulation) that did not include music. Participants exercised five days per week. Music was recorded on five compact discs for each day of the week. The music group performed regular trunk, arm, and leg muscle exercises while standing on the whole-body vibration apparatus. No information was given on the type of music used. Both programs produced similar improvements in all outcomes.

In another study (Kim & Koh, 2005), the effects of music on pain perception during upper extremity joint exercises in poststroke individuals were examined. Ten participants served as their own control under three testing conditions: (a) music, (b) karaoke, and (c) silence. No differences among the three conditions were observed in the perception of pain during the exercise sessions. The lack of differences may have been due to some methodological issues, as pointed out by the authors. First, the sample size ($n = 10$) was probably too small, although no power values were reported. Second, the participants suffered from the stroke more than three years before the study and the sensation of pain can become somewhat dull over the years. Third, the participants may have had problems in following and/or completing the exercises. Nevertheless, one noteworthy finding emerged from this study. All sessions were videotaped, and it appeared that in the music and karaoke sessions, participants showed strong motivation to continue the exercise program even after the study ended, but this was not true for the silent sessions. This observation is an important outcome, as it may lead to greater adherence in stroke patients.

Dementia and Alzheimer's Disease

While adherence to exercise programs can be challenging to healthy individuals, it is even more of a problem for individuals with dementia. These individuals can leave the room during an exercise session without an apparent reason, or simply discontinue their participation if the context of the exercise session fails to motivate them to stay (Mathews, Clair, & Kosloski, 2001). The addition of music to exercise sessions attended by individuals with dementia may improve adherence and increase participation. It was found in one study of 21 participants with dementia living in a special-care residential facility that participation in exercise sessions increased from 50% to 70% when music was added (Mathews et al., 2001). In their data analysis, the authors divided the participants into two subgroups: socially active and nonsocially active. Interestingly, the increase in participation was found only in the group that voluntarily took part in social activities.

In another study (Van de Winckel, Feys, De Weerd, & Dom, 2004), cognitive function using the Mini Mental State Examination (MMSE) was examined in two groups of psychiatric hospital patients with dementia. The experimental group participated in sitting exercises with music while the control group had only one-on-one talks with a therapist. Statistically—and clinically—significant improvements in the MMSE scores were found in the sitting exercise with music group (effect size = 0.5). No improvements were observed in the control group. While this finding is promising, it cannot be concluded that the music per se was the variable that led to the improvement. Since the control group did not exercise, it is possible that exercise alone (without music) would have led to similar improvements in MMSE scores.

In a two-experiment study (Cevasco & Grant, 2003), different methods of using music for individuals with Alzheimer's disease were examined. In these experiments, movement-to-music was incorporated into a general music therapy session. The movement-to-music sections were three minutes near the beginning and three minutes near the end of each session. In Experiment 1, it was found that continuous verbal cueing throughout each movement resulted in greater participation than single verbal cueing at the beginning of each movement. In Experiment 2, it was found that listening to instrumental music resulted in greater participation when compared with listening to vocal music. While these findings may have practical significance, it should be noted that the sample sizes of both experiments were rather small (Experiment 1: $n = 14$, Experiment 2: $n = 12$). In addition, it is possible that in Experiment 1 the continuous verbal cueing alone would have been enough to elicit greater participation, even without the music. Patients with Alzheimer's disease may need the continuous verbal cueing to maintain their participation in a task. Unfortunately, no control groups that completed the same sessions without music were available.

Parkinson's Disease

Only one study was found that examined the influence of music therapy on patients with Parkinson's disease (Pacchetti et al., 2000). In this three-month prospective and randomized controlled study, the effectiveness of weekly music therapy (MT) sessions on both motor abilities and emotional status were compared with standard weekly physical therapy (PT) sessions. Each MT session lasted two hours and included listening to relaxing music, choral singing, breathing exercises, active

music participation involving collective invention and improvisation, at least 30 min of rhythmic movements, and 20–30 min of free body expression to music. While no differences in the Unified Parkinson's Disease Rating Scale-Motor Subscale (UPDRS-MS) scores, emotional scores, or ADL scores were found in the PT group, the MT group improved in all of those scores. The PT group improved only at rigidity scores. In a follow up after two months, all improvements were lost. This fact highlights the importance of maintaining MT on a long-term basis. Whether passive MT would have elicited similar results to the ones in this study is unclear, since the movement-to-music program was part of other long sessions also involving listening to music and performing actions to music. Nevertheless, the results suggest that MT that includes 50–60 min of rhythmic and free movements to music can improve the motor and emotional status of patients with Parkinson's disease.

Adolescents

Two studies dealing with the effects of music on exercise in adolescents were found (De Bourdeaudhuij et al., 2002; Marrero, Fremion, & Golden, 1988). One study on severely obese adolescents (De Bourdeaudhuij et al., 2002; age = 13.1 ± 2.0 years, BMI = 33.5 ± 4.9) reported that running time and positive physiological variables during an incremental treadmill test were higher when listening to music compared with a no-music condition. Testing was conducted at the end of the second and eighth months of a 10-month interventional program. Unlike other studies, each subject was asked to bring a tape of his or her favorite piece of music. It has been suggested that when there is variety in the choice of music, interest in the activity will be maintained (Karageorghis, 1999). While differences were mostly stable throughout the 10-month period, there was a trend for the differences between the music and the no-music conditions to decrease toward the end of the treatment period. This finding may require further research to determine whether the positive effects of music dissipate over time.

In another study (Marrero et al., 1988), a group of 10 diabetic adolescents was tested on a cycle ergometer before and after a 12-week, home-based aerobic exercise with music program. Seven out of the nine participants improved their VO_{2max} by over 5%. In addition, HbA1 values significantly decreased after the 12-week program. No control group exercising without music was included in the study, and therefore it is not clear whether it was the music per se that improved the compliance to the program.

The Elderly

It has been found that physical activity can prevent the development of chronic diseases and can improve psychological and cognitive states in the elderly (Chodzko-Zajko et al., 2009). If the addition of music can help motivate individuals of older age to participate in an exercise program and to do the maximum in each exercise session, then improved quality of life can follow. Five studies examining the effects of music and exercise in the elderly population were found (Becker, Chambliss, Marsh, & Montemayor, 1995; Hagen, Armstrong-Esther, & Sandilands, 2003; Hamburg & Clair, 2003; Johnson, Otto, & Clair, 2001; Teel, Carson, Hamburg, & Clair, 1999).

In a study of 60 residents of a long-term care facility it was found that, compared with a control group without music, exercise-to-music led to improvement in balance, joint flexibility, cognitive abilities, behavioral ratings, and life satisfaction (Hagen et al., 2003). The exercise-to-music group was also compared with an occupational therapy group. While many of the improvements in the exercise-to-music group were found in the occupational therapy group as well, improvements in balance, life satisfaction, and ankle/knee/hip flexibility were observed only in the exercise-to-music group. The authors of this study pointed out that the feasibility of such programs is questionable in long-term care facilities, where the budget and staff usually are limited. While this is a valid point, it is a matter of priorities. An exercise-to-music program does not have to cost a great deal of money, nor does it have to rely on additional personnel. Once the importance of such a program is understood, application can soon follow.

The benefits reported in the study by Hagen et al. (2003) were supported by a study on 14 seniors (age = 65–78) who enrolled in an exercise-to-music group at their local senior center (Hamburg & Clair, 2003). The music in the program was synchronized with the rhythm of their movements. Improvements in balance, functional reach, and gait speed were reported after five weeks of one-hour weekly sessions of an exercise program designed to improve balance, breathing, coordination, flexibility, and spatial awareness. After 14 weeks, no further improvements were found. No control group was included in this study.

The exercise-to-music program described above was named Motivating Moves Program in a study by Teel et al. (1999). This program is somewhat different from the traditional aerobic or strength type programs, since it emphasizes wellness and enjoyment. Enjoyment of the program can allow for greater adherence, which can in turn lead to enhanced physiological and psychological benefits. While examining adherence to the program over six weeks, the researchers reported an attrition rate of approximately 30% during weeks 1–2, but a retention rate of 78–100% in weeks 2–6. In addition, session attendance was 90–95% (Teel et al.).

The effectiveness of music-during-exercise sessions on adherence in an exercise rehabilitation program was examined in a study of 19 elderly individuals with physical frailties (Johnson et al., 2001). Participants resided in two community living centers and one residential retirement center. The participants completed six physical therapy sessions: two without music, two with instrumental music, and two with vocal music. Each session lasted 20 minutes and was comprised of 14 exercises. In the music sessions, each exercise was accompanied by a different song. Results were not consistent: while music was associated with increased frequency of movements in some exercises, no music was associated with increased frequency of movements in other exercises. It is possible that the measure of adherence (i.e., frequency of movements during session) was not suitable. As the authors of this study suggested, the fact that a participant performed more motions during an exercise session did not mean that the motions were performed correctly.

Lastly, the effects of frenetic versus mellow music and stimulating versus relaxing scents on walking distance were examined in 20 older adults (ages = 60–101 years; Becker et al., 1995). Participants walked for 90 seconds with scented (peppermint, chamomile, no scent) headphones that played either frenetic music,

mellow music, or a blank tape. It was found that mellow music reduced walking distance compared with both a blank tape and frenetic music. No differences were found between the blank tape conditions and the frenetic music conditions. Similarly, scent did not affect walking distance.

Methodological Limitations and Research Concerns

Based on the reviewed studies, four methodological limitations and research concerns are discussed, including (a) the choice of music style, (b) the lack of information on statistical procedures, (c) the lack of a control group, and (d) the lack of longitudinal studies.

The Choice of Music Style

While music is enjoyed by people all over the world, the association of music enjoyment with improved exercise performance, as well as with the motivation to participate in exercise programs, is dependent upon several factors. Among these factors are the rhythmic response to the music, melodic and harmonic aspects, cultural factors, variety, and volume (Karageorghis, 1999). In addition, the connection a person has to music during exercise is individual and unique (Priest, Karageorghis, & Sharp, 2004). In order for the music to be effective, it must be chosen with care. In most of the reviewed studies, music was selected intuitively or arbitrarily by the researchers (e.g., Cevalco & Grant, 2003; Emery et al., 2003; Hagen et al., 2003; Murrock, 2002; Pacchetti et al., 2000; Thornby et al., 1995). This may be one of the main reasons for the conflicting results in the reviewed studies. It is possible that the specific music used in some of the studies simply did not motivate the participants or only motivated some of them. Future studies should use a more scientific method for selecting the right style of music for the participants. For example, a method of choosing music known as the Brunel Music Rating Inventory (Karageorghis, Priest, Terry, Chatzisarantis, & Lane, 2006; Karageorghis, Terry, & Lane, 1999) can be used as a tool for matching the style of music to the participants' preferences.

The Lack of Information on Statistical Procedures

Power and effect sizes were rarely reported in the reviewed studies. These values are important and should not only be included in the results section, but also elaborated upon in the discussion section. Having information on these values can allow researchers and practitioners alike to conclude whether the treatment used was practically and clinically significant.

The Lack of a Control Group

In some of the reviewed studies (e.g., Hamburg & Clair, 2003; Marrero et al., 1988) a control group was not included. Other studies included a control group that did not isolate music as the variable influencing the differences between groups (e.g., Pacchetti et al., 2000). In addition, in some studies, movement-to-music as part of a larger, passive music therapy session was used (e.g., Cevalco & Grant, 2003).

This can reduce the evidence level of the net and positive effects of music when it is added to exercise programs. A control group that is similar to the experimental group in all aspects except for the music should be used in future research.

The Lack of Longitudinal Studies

Most of the reviewed studies were cross-sectional or lasted less than three months. Whether the increased adherence rates and exercise performance in some of those studies would have lasted over a longer period is not known. Indeed, in the study that lasted 10 months (De Bourdeaudhuij et al., 2002), the improved performance that was reported after the second month lessened after the eighth month of the training program. It is possible that participants began to be desensitized to the initially novel music, and that, as suggested by Karageorghis (1999), variety in the music is important to maintain the motivation to participate.

Practical Implications for Clinicians and Practitioners

Three practical suggestions for clinicians and practitioners are provided below, including (a) the choice of music style, (b) the type of delivery, and (c) the long-term use of music.

The Choice of Music Style

To benefit most from the inclusion of music in the exercise program, individuals should be provided with the opportunity to select the style of music that they prefer to listen to. The use of the Brunel Music Rating Inventory (Karageorghis et al., 1999; Karageorghis et al., 2006) by the clinician can help direct the individual in his or her selection process.

The Type of Delivery

Music can be delivered to each individual via headphones or to the group as a whole via external speakers. If the social interactions in the group are important, individual delivery via headphones may not be a good choice. In this case, care should be taken to match the selected music or at least musical genre to the preferences of the majority of the group members. On the other hand, if social interactions are not of importance, it is recommended that headphones be used for the music when exercising.

The Long-Term Use of Music

To increase adherence to an exercise program, individuals are encouraged to listen to music throughout the entire training program. Practitioners should make sure that the music is motivating the participants throughout the program. In long-term programs, music selection may need to change from time to time to maintain the interest of the participants. Practitioners are advised to periodically question the

participants about whether they enjoy the music and whether it motivates them to perform the exercise routine.

Conclusion

Music appears to provide a number of benefits when it is included in an exercise program. It is suggested that clinicians and practitioners who conduct rehabilitation or work with clinical populations and the elderly consider adding music to their exercise programs. Out of the 20 studies in our review, 16 reported at least one of the following benefits: better exercise performance, higher program adherence, and higher motivation to participate in the program. Although these results are promising, the methodological limitations and research concerns mentioned earlier, as well as the limited number of studies, should be taken into account by both researchers and practitioners.

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