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Therapeutic Instrumental Music Playing in Hand Rehabilitation for Older Adults with Osteoarthritis: Four Case Studies

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The purpose of this study was to examine the effects of keyboard playing on the management of hand osteoarthritis in older adults. Four participants, with diagnoses of hand osteoarthritis, met the investigator 4 days a week, for approximately 30 minutes, for 4 weeks. Participants played folk and big band melodies on a Yamaha PSR-510 touch-sensitive electronic keyboard for 20 minutes each session. Evaluation included pre and poststudy occupational therapy measures of finger pinch meter, and range of motion. Participants assessed arthritic discomfort using a visual Likert scale (0–10) before and after each session. A MIDI sequencing computer program, Master Tracks Pro, *measured finger velocity, before and after each session. Results indicated that finger pinch meter and range of motion were positively increased by keyboard playing. Two participants recorded significant decreases in arthritic discomfort after playing, while three participants showed significant improvement in finger velocity and hence, finger strength/dexterity due to treatment. Participants enjoyed the treatment with enjoyment ratings of 3 or higher on a 5-point Likert scale. Additional benefits included improved structure of leisure time and increased socialization for older adults with osteoarthritis who tend to isolate themselves due to disease deterioration.*

Arthritis is a crippling disease that consists of more than 100 different conditions, and affects 36 million Americans (Bernard, 1992). The most common form of arthritis, osteoarthritis, affects more than 16 million Americans, is the single most common cause of lost time from work and leisure activity, and is responsible for

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more impairment in the elderly than any other single diagnosis (The Arthritis Society, 1998; Calfas, Ingram, & Kaplan, 1997; Swedberg & Steinbauer, 1992).

Osteoarthritis is a degenerative disease of the cartilage of joints, with a diverse etiology and obscure pathology. With osteoarthritis the joint structure weakens and corrodes causing the cartilage, which cushions the ends of bones, to crack. Bits of cartilage break off, irritating soft tissue and interfering with movement causing changes in joint structure and consequently immobility and pain (The Arthritis Society, 1998). Osteoarthritis is limited to the joints affecting the hands, hip, spine, knee, and foot (Harris, 1993). The prevalence of hand osteoarthritis increases as both genders age with 64–78% of the male population, and 78–99% of the female population over 65 affected (Harris, 1993).

Chronic pain, such as that found in people with osteoarthritis, can severely impair social, vocational, and recreational functioning. This pain disrupts or delays normal daily activities, financial stability, and contributes to increased aggression and deterioration of relationships with family and friends. Research, however, has shown that individuals who exert some control over their pain are better able to mediate the pain experience (DePalma & Weisse, 1997).

Nonprescription and prescription drugs provide temporary relief from osteoarthritis pain, but have side effects, cause complications, and are not adequate substitutes for daily regimes of exercise (The Arthritis Society, 1998; Blechman, Roth, & Wilske, 1992; Hench, Moore, & Pinals, 1994). Exercise is painful but crucial (Dekker, Tola, Aufdemkampe, & Winckers, 1993) since immobility leads to loss of strength, joint failure, and disability (Swedberg & Steinbauer, 1992). Pain and disability due to osteoarthritis limits an older adult's functioning, independence and consequently compromises well-being and quality of life (Blechman et al., 1992; Zimmer, Hickey, & Searle, 1997).

Finding exercise regimes, however, that are beneficial and motivating for older adults can be difficult. Activities of bowling, tennis, or golf can cause pain, joint damage, decreased function and range of motion, that can possibly lead to surgery. Conversely, activities of daily living are not effective substitutes for exercises, which must become an integral part of the patient's life (Blechman et al., 1992). Therefore, an exercise regime that focuses specifically on the affected joints, motivates and encourages compliance, distracts from pain, and provides effective results, is needed.

Gaston (1968, p. 17) stated that "rhythm is the organizer and the energizer" of music. Accordingly, rhythm has the potential to energize and bring order (Gaston, 1968). Individuals commonly use music when exercising. Self-reports reveal that listening to music during exercise creates a diversion from painful workouts because music provides the motivating stimulus needed to complete exercises.

In a study conducted by Beckett (1990) individuals who listened to music during aerobic walking, reported preference and higher levels of motivation for music stimulus vs. silence. MacNay (1995) also found a decrease in perceived exertion and increase in motivation when using music with individuals in a cardiac rehabilitation exercise program. Thornby, Haas, and Axen (1995) found that music significantly decreased perceived symptoms of respiratory discomfort in people with moderate chronic obstructive pulmonary disease (COPD), which allowed them to exercise at a higher intensity within a rehabilitation program. Nonambulatory children with profound mental retardation benefited from verbal praise and music as a reinforcer for physical exercise in lifting a weight with the upper extremities (Landrieu-Seiter, French, Silliman, & Tynan, 1995). Sobczak (1997), a trained nurse, reported how music within an exercise program for older adults increased circulation, reduced swelling, promoted skin healing and eased tired legs. Other anecdotal reports reveal that music encourages adherence to an exercise regime (Clair, 1996).

Lee and Nantais (1996) studied the use of music in rehabilitation of gross and fine motor skills involving spinal cord injury patients in Toronto, Canada. Participants demonstrated how an exercise device attached to electronic music equipment encouraged emotional expression, a sense of control over rehabilitation, motivation, and improvement in physical skills.

Staum (1983) studied the application of rhythmic auditory stimuli in facilitating proprioceptive control of rhythmic gait with subjects of varying gait disorders. Through auditory stimuli received via headset all 25 subjects evidenced gains in rhythmic, even walking and/or consistency in walking speed. The most improvement was found in individuals with hemiparetic strokes, spastic disorders, and painful arthritic or scoliostic conditions.

Thaut and colleagues (Hurt, Rice, McIntosh, & Thaut, 1998;

Thaut et al., 1996; Thaut, Rice, & McIntosh, 1997) have further assessed the use of rhythmic auditory stimuli in gait rehabilitation of stroke, Parkinson's disease, and Traumatic Brain Injury (TBI) patients. Results of studies show the use of rhythm to improve velocity, cadence, and stride length in TBI patients, and also symmetry in stroke and Parkinson's disease patients. He has developed a training program for music therapists working in neurologic music therapy, and has coined the phrase TIMP (Therapeutic Instrumental Music Playing) to describe the therapeutic use of instrumental music playing to rehabilitate patients with neurological needs (Thaut, 1999).

The application of keyboard playing as a form of therapeutic instrumental playing was illustrated in a study by Pascual-Leone et al. (1995), who demonstrated the acquisition of fine motor skills in adults. The researchers discovered that among adults with no prior keyboard experience a combination of mental and physical practice led to greater performance than physical practice alone. This research suggests how mental imaging of movement enhances the effects of physical practice on the motor system, an important addition for learning and maintaining new motor skills in temporarily immobilized patients and patients with neurological rehabilitation needs.

While various studies illustrate the effectiveness of music as a rehabilitative tool, little research exists on the use of music in managing arthritis; however, two studies provide reason for further investigation of music's effects on arthritic management. Jacobi (1995) evaluated the effectiveness of Guided Imagery and Music (GIM) on medical-physical, psychosocial, and behavioral functioning of 27 individuals with rheumatoid arthritis. The researcher concluded that the Bonny Method of Guided Imagery and Music appeared to effectively reduce pain and psychological symptomatology and hence could lead to improvement in the quality of life of individuals with rheumatoid arthritis.

In the second study, Bernard (1992) tested the effects of music on increasing motivation for participation in an exercise regime of older adults with osteoarthritis between the ages of 65 and 99 years. Alternating between no music and music conditions, Bernard found that the data "approached" significance in favor of using music as an exercise tool for older adults with osteoarthritis. Limited sample size, choice of music, and lack of entrainment to the music's rhythm were factors cited as reasons data were not statistically significant.

Many studies presented here illustrate music's effectiveness in rehabilitation due to its motivating, reinforcing, and engaging ability to manage pain. The lack of research, however, on the effect of music on managing osteoarthritis warrants further investigation.

Older osteoarthritic adults desperately need an exercise/rehabilitation regime that is purposeful, motivating, and allows for engagement to distract from pain. Maintenance of their daily living skills depends on their abilities to commit to an exercise regime that will strengthen and flex muscles around the affected joints in the hand. The author hypothesizes that music can be an effective rehabilitative tool for managing osteoarthritis in older adults due to its abilities to motivate, reinforce, and provide an engagement for pain. Therefore, the purpose of this study was to determine the effectiveness of keyboard playing on management of hand osteoarthritis in older adults.

Method

Participants

Four female residents from an independent living section, in a residential facility in a Midwestern town, met the following criteria: (a) age 65 or older, (b) diagnosis of hand osteoarthritis, (c) identified by staff as cognitively aware of surroundings, (d) able to follow simple fine motor tasks, and (e) voluntary participation. Before beginning the experiment the investigator oriented each participant individually to the purpose and procedures of the study. After the orientation, four participants who met the criteria signed a consent form.

Three of the four participants were 84 years old, while the fourth was 88 years of age. All participants had grandchildren and were or had been married. Education among the four participants ranged from a high school diploma to graduate degrees. Musical education ranged from public school to private music lessons. Participant 1 owned a *Wurlitzer* organ and had previously taken lessons, while participants 2, 3, and 4 had little to no experience playing the keyboard.

Apparatus/Equipment

An occupational therapy student, supervised by a registered occupational therapist used a pinch meter to measure finger pinch strength for all fingers; both hands, in three ways: Lateral, tip to tip, and palmar. The occupational therapy student also used a goniometer to measure finger joint range of motion.

Participants used a visual Likert type (0–10) scale to measure arthritic discomfort, where 0 indicated the absence of arthritic discomfort and 10 the highest degree of arthritic discomfort. These measurements were manually recorded by the investigator.

One touch-sensitive, Yamaha PSR-510 keyboard connected to a Macintosh Powerbook 190-Series lap-top computer, using the MIDI computer program *Master Tracks Pro,* measured keynote finger velocity before and after each session. A MIDI cable cord was used to connect the keyboard to the computer to transfer the input of data from the keyboard to the computer. The computer program *Master Tracks Pro* is a MIDI sequencing program that measures finger velocity; however, the result of increased velocity is improved finger strength/dexterity. Keynote velocity was measured on a scale of 0–127, where 0 indicated the absence of velocity and 127 the greatest amount of keynote velocity possible.

A table was used to hold the keyboard and computer. This table, along with a chair cushion was used to create appropriate keyboard playing posture. A stopwatch was used to record participant playing time during the sessions. Throughout the experiment the investigator noted in writing participants' comments regarding their reactions to keyboard playing.

Design and Procedure

A pilot study was conducted to test the protocol. Data collected in the pilot were not included in the analysis. Each subject served as her own control. Two days prior to the start of keyboard sessions, the occupational therapy student, recorded pinch meter and goniometer measurements for all participants to establish a baseline.

Participants met the investigator in the independent retirement facility's chapel approximately 4 days weekly, for 30 minutes over 4 weeks. Participants 2, 3, and 4 completed 15 sessions, while Participant 1 completed 14.

Participants began each 30-minute session by assessing their baseline state of arthritic discomfort via a visual Likert discomfort scale. The investigator handed the participants the Likert discomfort scale where they appropriately placed the sliding indicator between 0–10 to indicate their degree of arthritic discomfort.

The investigator led the participants in a simple five-finger pretest. The investigator demonstrated the finger exercise on the keyboard and the participants imitated. Upon a second investigator-led demonstration, the participants initiated the finger exercise, and the data were recorded via the *Master Tracks Pro* computer program.

After the pretest, the investigator led each participant through a series of folk songs using both hands and all five fingers for each melody. The investigator ensured each participant played for 20 minutes across the total number of sessions by recording the time with a stopwatch. The investigator began Session 1 by teaching all participants the folk song, *Row, Row, Row, Your Boat,* through rote melodic phrase imitation. After this initial song was taught the investigator adapted each session to meet the participant's individual learning style.

Because Participant 1 had extensive keyboard experience, she could read musical notation from the *Alfred Adult Beginner Method Book,* and brought her own sheet music to play. Participants 2, 3, and 4 learned folk and big band melodies via a number method, after initially learning *Row, Row, Row, Your Boat* and *When the Saints Go Marching In,* through melodic phrase and rote imitation, during the first three sessions. Examples of folk and big band songs used were *Marianne, Blue Moon,* and *Sentimental Journey* among others. The investigator charted each song by typing the correct finger numbers on a piece of paper. All the songs fell within, or one note outside, the five finger *C* position of the left hand and the five finger *C* position of the right hand.

At the conclusion of the 20-minute playing session the investigator handed the participants the Likert discomfort scale where they rated their degree of arthritic discomfort. As in the pretest baseline, the investigator demonstrated the same five finger exercises. Participants were asked to imitate and data were collected via the *Master Tracks Pro* computer program. At the conclusion of all sessions in the study, the occupational therapy student collected pinch and goniometer measurements for all participants.

Measurement and Evaluation

The occupational therapy student recorded three pinch meter trials for each of the measurements for both hands: Lateral, tip to tip, and palmar. From these three trials, means were derived and visually displayed in pounds of pressure.

The occupational therapy student measured joint range of motion for both hands with a goniometer. She asked the participants to make a fist in each hand and measured the distance from the tip of the fingers to the distal palmar crease. When full closure was not obtainable the student occupational therapist measured the distance from the fingers to the palm in centimeters. These measurements were taken within 2 days prior to keyboard playing sessions and replicated again within 2 days after each participants' completion of all keyboard sessions.

Data were collected at the beginning and at the end of each keyboard session using the *Master Tracks Pro* keynote velocity program. A randomized complete block, with fingers and treatment as factors, was used to analyze keynote finger velocity data between initial pretest and final posttest of the study for each individual participant. Individual finger change was defined as the comparison of finger velocity between the ten fingers across each participants' sessions. This measurement was used to observe any change in individual fingers across treatment. Treatment was defined as the difference between pretest 1 and the final posttest of the study, to determine the effectiveness of the intervention.

The visual 0–10, Likert discomfort scale, where 10 indicated the most discomfort and 0 the least, was administered at the beginning (pretest) and the end (posttest) of each session. These data were computed using a paired-sample t test which measured participant's arthritic discomfort between the initial pretest and final posttest of the study.

Likert investigator-designed questions regarding keyboard enjoyment, current arthritic disability, and perceived benefit of keyboard playing were asked by the investigator one week after the conclusion of the study. Participants rated their answers on a scale of 1–5, where 5 was the highest and 1 the lowest, to the following three questions:

1. On a scale of 1–5, with 5 being the highest and most enjoyable and 1 the lowest and least enjoyable how would you rate your enjoyment of playing the keyboard in the study?
2. On a scale of 1–5 with 5 being the most and 1 the least debilitating how would you rate how arthritis affected your daily living skills?

TABLE 1

Pinch Meter Measurements: Participant 1

Measurement	Prestudy		Poststudy	
	Right	Left	Right	Left
Lateral	12.33 (75th)	10.16 (50th–75th)	12.16 (75th)	10.5 (50th–75th)
Tip to tip	7.5 (25th)	7.6 (25th–50th)	8.6 (25th–50th)	7.5 (25th–50th)
Palmar	9.33 (50th–75th)	7.83 (50th)	9.83 (50th–75th)	10.0 (75th–90th)

Note. Numbers in parentheses indicate percentile rank of participant in relationship to norm data.

(Daily living skills were referred to as using hands to button clothing, make coffee, open jars, or any other task requiring use of the hands in day to day living.)

3. On a scale of 1–5, with 5 being helped the most and 1 the least, how would you rate how keyboard playing helped your osteoarthritis?

Results to data are presented in Table 10.

Results

Pinch Meter Measurements

Pinch meter measurements for Participants 1 and 2 remained fairly consistent from pre to poststudy, though Participant 1 had slight increases (see Tables 1 and 2). Means for Participant 3 decreased from

TABLE 2

Pinch Meter Measurements: Participant 2

Measurement	Prestudy		Poststudy	
	Right	Left	Right	Left
Lateral	9.16 (25th–50th)	8.0 (25th–50th)	9.83 (25th–50th)	8.0 (25th–50th)
Tip to tip	7.5 (25th)	4.33 (10th)	5.83 (10th)	4.6 (10th)
Palmar	7.83 (25th–50th)	5.66 (25th)	8.16 (50th)	5.0 (25th)

Note. Numbers in parentheses indicate percentile rank of participant in relationship to norm data.

TABLE 3
Pinch Meter Measurements: Participant 3

Measurement	Prestudy		Poststudy	
	Right	Left	Right	Left
Lateral	6.16	3.5	4.3	4.16
	(below 10th)	(below 10th)	(below 10th)	(below 10th)
Tip to tip	4.83	2.33	2.83	1.83
	(below 10th)	(below 10th)	(below 10th)	(below 10th)
Palmar	7.16	3.16	4.16	3.0
	(25th–50th)	(10th)	(10th)	(10th)

Note. Numbers in parentheses indicate percentile rank of participant in relationship to norm data.

pre to poststudy, with the exception of the left lateral which slightly increased, and the left palmar which remained consistent (see Table 3).

Participant 4 experienced considerable improvement across all pinch meter measurements for both hands with the exception of the left lateral which remained consistent. She made the most improvement across all participants by increasing percentile ranks for the following pinch meter measurements: Right hand lateral, left hand tip to tip, and right and left hand palmar (see Table 4).

Goniometer Measurements

All four participants had full left and right composites for both the pre and poststudy with the exception of Participant 2. Participant 2 had a full left composite, but a two centimeter distance from the tip of the fingers to the distal palmar crease for the right hand.

TABLE 4
Pinch Meter Measurements: Participant 4

Measurement	Prestudy		Poststudy	
	Right	Left	Right	Left
Lateral	5.83	7.16	6.83	7.0
	(below 10th)	(25th)	(10th)	(25th)
Tip to tip	3.83	4.0	4.16	6.0
	(below 10th)	(10th)	(below 10th)	(25th)
Palmar	4.6	3.83	7.16	7.0
	(10th–25th)	(10th–25th)	(25th–50th)	(50th)

Note. Numbers in parentheses indicate percentile rank of participant in relationship to norm data.

TABLE 5
Likert-Arthritic Discomfort Statistics

	Pretest					Posttest	
Participant	*M*	*SD*	*t*	*p*	*df*	*M*	*SD*
1	1.58	.78	-1.34	.20	13	2.10	1.06
2	2.55	1.97	4.88	<.001	14	1.66	1.40
3	.33	.44	–.16	.87	14	.35	.30
4	1.86	.96	6.47	<.001	14	.95	.81

Note. 0 represented the minimum, and 10 represented the maximum.

Poststudy measurements revealed Participant 2's full left composite remained intact with an improvement of 0.5 centimeters, from the tip of the fingers to the distal palmar crease from pre to poststudy for the right hand.

Likert Arthritic Discomfort Scale

The Likert Discomfort scales for Participant 1 revealed a slight increase in arthritic discomfort after keyboard playing but not significantly so ($t = -1.34$, $p = .20$) (see Table 5). Data revealed a significant decrease in arthritic discomfort for Participant 2 ($t = 4.88$, $p < .001$) and Participant 4 ($t = 6.47$, $p < .001$) after keyboard playing (see Table 5). Participant 3 did not experience a statistically significant decrease in arthritic discomfort after keyboard playing ($t = -.16$, $p = .87$) (see Table 5). Self-reports from the participants also reflect these statistics.

Keynote Finger Velocity

Participant 1 was the only participant who experienced a statistically significant change in finger improvement, but all fingers did not improve to the same degree across the 14 sessions ($F = 2.62$, $p = .034$) (see Table 6). Variability was shown in the right hand with mean differences as high as 55.00 for finger 4 and as low as 33.50 for finger 2. Participants 2, 3, and 4 did not experience a statistical difference between individual finger velocity for either the right or left hand ($F = 1.18$, $p = .358$), ($F = 1.70$, $p = .152$), ($F = 1.03$, $p = .446$) respectively (see Tables 7–9).

Data revealed that finger velocity for Participants 1, 2, and 4 significantly increased from pre to posttest due to treatment ($F = 51.62$, $p < .001$), ($F = 13.56$, $p = .001$), ($F = 83.50$, $p < .001$) (see Tables 6, 7, and 9). Data for Participant 3, however, show a significant

TABLE 6

Keynote Finger Velocity—Randomized Complete Block Statistics: Participant 1

	SS	*df*	MS	*F*	*p*-Value
Individual fingers	3,810.72	9	423.41	2.62	.034
Treatment	8,323.22	1	8,323.22	51.62	<.001
Interaction	2,432.52	9	270.28	1.67	.160
Within	3,224.52	20	161.22		
Total	17,790.98	39			

decrease in treatment from pre to posttest ($F = 28.10$, $p < .001$) (see Table 8).

Discussion

Results are varied from participant to participant. Participant 1's finger muscle strength, was well within the average range for her age at the beginning of the study. Therefore it is not surprising little improvement was shown in finger muscle strength for Participant 1. Participants 1 and 2 made small gains in finger muscle strength as measured with the pinch meter. Participant 2 improved her right hand range of motion. Participant 3's decrease in finger muscle strength, may have been due to muscle spasms in her arm for which she saw a physical therapist, and general decline in health experienced during the study.

Three of the four participants made statistically significant improvements in finger strength/dexterity as recorded through the keynote finger velocity program *Master Tracks Pro.* Coinciding with pinch meter results, Participant 3 decreased significantly in finger muscle strength from the pretest to the posttest. This was attributed to her overall health deterioration during the course of the study.

Participants 2 and 4 showed statistically significant reductions in self-reported arthritic discomfort after keyboard playing. Data from

TABLE 7

Keynote Finger Velocity—Randomized Complete Block Statistics: Participant 2

	SS	*df*	MS	*F*	*p*-Value
Individual fingers	807.02	9	89.66	1.18	.358
Treatment	1,030.22	1	1,030.22	13.56	.001
Interaction	542.02	9	60.22	.79	.626
Within	1,519.50	20	75.97		
Total	3,898.77	39			

TABLE 8

Keynote Finger Velocity—Randomized Complete Block Statistics: Participant 3

	SS	*df*	MS	*F*	*p*-Value
Individual fingers	1,470.90	9	163.43	1.70	.152
Treatment	2,689.60	1	2,689.60	28.10	<.001
Interaction	421.40	9	46.82	.48	.864
Within	1,914.00	20	95.70		
Total	6,495.90	39			

Participant 3 did not show a statistically significant reduction in self-reports, however, she consistently did not indicate much discomfort at the beginning of each session. Therefore, she reported only slight change in discomfort after the keyboard sessions.

Results from the Likert scale items suggest that the participants generally enjoyed the keyboard playing, with ratings of 3 or higher on a 1 to 5 point scale. Their perceived benefits from the keyboard playing may have helped determine their enjoyment ratings since participants' keyboard enjoyment and perceived benefit ratings were similar. These data are consistent with comments volunteered by the participants. Participant 1 referred to a time 19 years ago, when her osteoarthritis became so debilitating that she took cortisone shots to manage the pain. She told the investigator that she believed playing her *Wurlitzer* organ approximately 2 hours a day for a couple of years helped her manage the osteoarthritis, because her osteoarthritic symptoms diminished, and cortisone shots were no longer needed. At the time of the study Participant 1 was not doing anything for management of her osteoarthritis.

Even though Participant 3 did not show statistically significant improvements due to the keyboard sessions, she told the investigator that her hobby of jewelry making, in working with small beads, was made easier by the keyboard playing. Perhaps more impor-

TABLE 9

Keynote Finger Velocity—Randomized Complete Block Statistics: Participant 4

	SS	*df*	MS	*F*	*p* Value
Individual fingers	892.02	9	99.11	1.03	.446
Treatment	7,980.60	1	7,980.62	83.50	<.001
Interaction	938.62	9	104.29	1.09	.411
Within	1,911.50	20	95.57		
Total	11,722.78	39			

TABLE 10
Participant Responses to Likert Treatment Questions

	Keyboard enjoyment	Arthritis debilitation	Perceived benefit
Participant 1	3	2	3
Participant 2	4	2	3
Participant 3	5	3	3
Participant 4	5	3	5

Note. 1 represents the minimum, 5 represents the maximum.

tantly for her, the keyboard sessions provided a cognitive challenge and another opportunity to socialize with residents of the facility. Evidence of this was shown through her eagerness and enthusiasm in playing the melodies correctly, and comments on how beneficial the keyboard playing was to maintaining her cognitive capabilities. She seemed to enjoy visiting with the other participants who were waiting for their turn, and took pride in learning how to play the keyboard by keeping her children and husband informed of what songs she was learning.

In comparison to the other three participants, Participant 4 showed the most improvement across all measures taken. Throughout the sessions the investigator observed improved use of the participant's fifth right hand finger. During the beginning sessions the participant explained that she had injured her fifth right hand finger as a child and had compensated during her career as a secretary by using the fourth instead of the fifth finger while typing. At first the participant was hesitant to use the fifth finger to play but encouraged by the investigator to do so. By the end of the study the participant was using the fifth finger readily with no hesitation. Throughout the study, during the administration of the Likert discomfort scale, Participant 4 reported that her fingers felt "loosened up," and "were more nimble" and "relaxed" after keyboard playing. This was a significant improvement, as the participant regularly complained of stiffness when she arrived for the sessions. Similarly, during the exit interview, the participant reported an absence of stiffness in her fingers since quitting the study.

Implications for Music Therapy

Data from this study indicate that playing keyboard may be an effective means to help manage hand osteoarthritis in older adults by increasing finger muscle strength/dexterity and decreasing perceived arthritic discomfort. Voluntary comments by participants suggest that social and leisure interaction among older adults with osteoarthritis may be increased as well. While using keyboard playing as a means to manage arthritis may be effective for some, it is not effective for all. As with any treatment, other factors such as health-related conditions and pleasure derived may contribute to efficacy of treatment.

These results support research literature that maintain the necessity of exercise in older adults and the use of music as an exercise tool (Beckett, 1990; Dwyer, 1995; Posner, 1992). Specifically these results have drawn a connection between the benefits of using music as a motivator to improve, rehabilitate and manage a common disease, osteoarthritis, that afflicts older adults. These results have also supported goals physicians ascribe to successful treatment of arthritis: controlling pain, maintaining function, maintaining independence, and provision of adequate social and psychological support (Creamer & Hochberg, 1997; Swedberg & Steinbauer, 1992).

This case study research developed the clinical protocol and showed the flexibility of keyboard playing as an intervention in osteoarthritis. Replication with a larger sample size is recommended. It is also suggested that a weighted keyboard with a full range of 88 keys be used. Because a weighted keyboard has more touch resistance, it may result in even more finger muscle strengthening/dexterity, and improved benefit for the participant. Caution, however, must be taken when using such a keyboard as the increased resistance may be more discouraging to participants and cause more arthritic discomfort. More research involving use of such a keyboard, may answer whether the motivating factors of music would compensate for this.

Adapting the keyboard lessons to fit the individual learning style of the participant was essential to the success of the study. This includes preferred music that serves as a motivator for engagement in participation and a skill adapted approach that provides a positive musical experience. Therefore considerations of each participant's musical history, current musical interests, and musical competencies are essential. Combining various teaching methods, that incorporated visual, aural, and tactile stimulation, seemed the most effective for those participants who had little to no keyboard experience.

Conclusions

Results from this study suggest that active music making, in the form of keyboard playing, is an effective method to help manage hand osteoarthritis in older adults. Improved finger muscle strength/dexterity which impedes the breakdown of cartilage and further deterioration, is one benefit of active keyboard playing. Similarly, for some, less arthritic discomfort may be experienced during this rehabilitation regime, which suggests compliance, adherence, and consequently management of a disease that afflicts older adults. Applications of the results of this study in music therapy practice indicate improved fine motor dexterity in those who have osteoarthritis. Furthermore, music therapists should also consider the benefits of improved structure of leisure time and increased socialization from active music making as a therapeutic outcome. Specifically, this form of active music making is beneficial for older adults with osteoarthritis who tend to seclude themselves and hinder management of their disease by being less active.

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