Informal Dance Intervention Improves BMI and Functional Gait in an Adolescent With Cerebral Palsy: A Case Report

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Purpose: This case study examined the effects of incorporating Informal Dance Intervention into traditional therapy sessions on body mass index and functional walking in an adolescent girl with cerebral palsy.
Case Description: A 15-year-old adolescent girl, Gross Motor Function Classification System Level II, participated in Informal Dance Intervention twice weekly in 2, 16 session phases. Sixty-minute sessions focused on waltzing, contra dancing, square dancing, and belly dancing to improve timing, endurance, vestibular functioning, and core strength.
Conclusions: Waist circumference decreased, walking speed increased on the 6-Minute Walk Test and Timed Up and Down Stairs, balance confidence increased per the Activities-specific Balance Confidence Scale, and vestibular functioning improved per changes in the Functional Gait Assessment.
Recommendations for Clinical Practice: Incorporating Informal Dance Intervention, in conjunction with therapy, may be motivating and improve overall health for adolescents with cerebral palsy to combat their tendency of increased sedentary lifestyle. (Pediatr Phys Ther 2019;0:1–6)
Key words: adolescence, BMI, case report, cerebral palsy, functional gait, informal dance, obesity

INTRODUCTION

Cerebral palsy (CP) has been defined as "a group of permanent disorders of the development of movement and posture, causing activity limitation … often accompanied by disturbances of sensation, perception, cognition, communication, and behavior … and by secondary musculoskeletal problems."[1(p9)] When age and sex matched with peers who are developing typically, children with CP spend more time in sedentary activities,[2,3] take fewer breaks from sedentary activity,[2] and engage in less moderate, vigorous, and overall activity.[3] Decreased time in physical activity and more time in sedentary activity is associated with elevated blood pressure in children with CP.[4] Similarly, low levels of cardiorespiratory fitness are associated with elevated systolic blood pressure, increased body mass index (BMI), and increased waist circumference.[5]

There has been a recent movement away from traditional approaches in treatment of CP to more activity-based approaches[6,7] to encourage physical fitness,[7,8] decrease the amount of time spent in sedentary activities and the associated complications.[7,8] Simultaneously, recommendations for increasing physical fitness and reducing time spent in sedentary activities are emerging in the treatment of childhood obesity.[9] Recent studies have examined the effects of incorporating dance into obesity prevention programs[10] and using dance as an intervention in children with CP.[11-14] No studies examined the effects of dance on BMI or functional walking ability.

Recent studies on ballet[11,12] and creative dance[13,14] intervention in children with CP have reported positive effects on mobility, locomotion, communication, psychosocial adjustments, and cognitive function as measured by the Functional Independence Measure and the World Health Organization Disability Assessment Schedule.[13] Improvements in balance occurred on the Pediatric Balance Scale[12] and computerized dynamic posturography[14]; however, it was not reported whether these were clinically meaningful changes. Parents and therapists have reported perceived therapeutic benefits of ballet, although parents did not "perceive any improvements in head, trunk, arm, and leg control."[11(p45)] Research on the use of dance in children with CP has been conducted by instructors with formal dance training[11-14] and frequently with multiple volunteers available to assist with positioning and the intervention.[11,12]

0898-5669/00-0001
Pediatric Physical Therapy

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The authors declare no conflict of interest.
DOI: 10.1097/PEP.0000000000000653

For the purposes of this case study, Informal Dance Intervention (IDI) is defined as dance instruction by a therapist untrained in dance with the use of instructional videos in a one-on-one or group setting. All movements are modified by the therapist as necessary and progression is based on individual performance. IDI may be performed in any setting, as it does not have to be performed in a dance studio. Requirements for IDI include the ability to stream video, adequate space to allow for movement throughout the full range of motion, a single administrator, and a willing participant. This case report examines the effects of IDI on BMI and functional walking in an adolescent with CP.

DESCRIPTION

History

Informed consent was obtained from the parent, with verbal assent from the adolescent to change intervention strategies to include dance. AD (adolescent dancer) was a 15-year-old girl with spastic quadriplegia, Gross Motor Function Classification System (GMFCS) Level II.[15] She could walk without an assistive device, but had difficulty ascending and descending curbs, navigating uneven surfaces, and navigating obstacles. AD had a history of bilateral derotational osteotomies (age 4), a selective dorsal rhizotomy (age 5), and repositioning of bilateral feet with use of internal hardware (age 11.5). In the year prior to the intervention, AD had occasional flare-ups of hidradenitis suppurativa resulting in swollen pimple-like bumps in her underarms, groin, and chest that would become painful and pop. She was otherwise healthy. AD had no known allergies and only used over-the-counter medications.

Assessment

AD resided in a 2-story home with her mother, 6 siblings, and infant nephew. She accessed the house using a ramp with a railing. AD's bedroom was on the main floor and she used a bench to allow sitting for dressing. She climbed stairs to color or dance with her sister, using a modified plantigrade position for ascending, with her hands and feet on the stairs, and scooting on her buttocks to descend. AD navigated multiple surface changes in the home without difficulty. AD was home schooled but was resistant to participating in her educational activities and did not participate in activities with peers who were the same age. Community outings consisted of Sunday church, triweekly therapy sessions, and the occasional doctor visit or shopping trip. Assistance for community walking included using her mother's or sister's arm or a shopping cart.

AD was alert and oriented to person, place, and situation, but had difficulty with measures of date and time. Mild cognitive impairments included difficulty with retention, money sense, and academic delays. AD had glasses for astigmatism but wore them inconsistently. Hearing was typical. Her preferred learning styles were visual and kinesthetic.

Vital signs were within typical limits. She had well-healed scars from selective dorsal rhizotomy and bilateral heel surgical procedures. She had adhesions from her hidradenitis suppurativa scars bilaterally in underarms resulting in decreased shoulder range of motion. Reflexes and sensation were grossly intact. AD had a persistent startle reflex. Spontaneous horizontal nystagmus occurred intermittently. In standing, AD presented in a crouched walking stance with right anterior rotation of her pelvis. During walking AD had decreased right dorsiflexion resulting in foot-flat contact and bilateral Trendelenburg compensation. She wore bilateral supramalleolar orthotics and twister cables. AD could do sit-to-stand transfers without the use of arms but required minimum assistance for floor to standing, suggesting decreased strength of gluteal and core musculature. AD used stairs marking time and holding one railing with both hands.

The physical therapist had treated AD biweekly for 4.5 years. Eight months prior to adding IDI, AD began to regress in functional walking that manifested as inability to safely use curbs, walk over uneven terrain, walk more than 500 ft on level indoor surfaces and reported increased falls. Despite no complaints of dizziness, there were complaints of imbalance and feelings of unsteadiness and increased spontaneous nystagmus. Additionally, she began to complain of "burning" in her feet with weight-bearing greater than 3 minutes. Simultaneously, her motivation and willingness to carry out her home exercise program (HEP) regressed and sedentary behaviors increased. Despite decreased compliance with her HEP, AD continued to make minimal improvements with consistent physical therapy.

Due to frequent requests to dance during therapy sessions, the therapist occasionally reserved a few minutes for dancing activities. AD was highly motivated by dancing and improved in the fluidity and coordination of walking and balance following dancing. AD's lack of contraindications, significant cognitive impairments, and motivation with therapy, plus her enthusiasm for dance and the improvements noted when dance opportunities were provided made her an appropriate candidate for adding dance as a component of her therapy.

ASSESSMENTS

Testing occurred at 3 points in time with pretesting the week prior to adding IDI, midterm after 16 sessions, and final assessment after 32 sessions. Testing was conducted in 2 sessions and in the same order. The first testing session consisted of anthropometric measurements,[16,17] administration of the Activities-specific Balance Confidence Scale (ABC),[18] and Functional Gait Assessment (FGA).[19] The second testing session consisted of the Community Balance and Mobility Scale (CB&M),[20,21] Timed Up and Down Stairs (TUDS),[22] and the 6-minute walk test (6MWT).[23] AD wore her orthotics and twister cables for mobility assessments. These assessments were chosen to avoid floor and ceiling effects seen with use of other standardized tests given her functional status. The family was provided a log to record compliance with HEP and outside activities, which was collected after 16 and 32 sessions.

The ABC is a 16-item questionnaire that asks patients to rate their percentage of confidence that they will not lose their balance when performing a variety of activities including bending, reaching, and walking across multiple surfaces in different conditions.[18] The FGA is a 10-item assessment that examines stability during functional walking tasks and incorporates

activities that are challenging for people with vestibular dysfunction such as walking with horizontal head turns.[19] The CB&M is a 13-item assessment that records higher level balance and mobility demands including single-leg stance, tandem stance, crouching, and carrying items while walking.[20,21] The TUDS measures the amount of time required to go up and down a flight of stairs.[22] The 6MWT measures the distance walked in 6 minutes and is a reflection of walking speed, endurance, and cardiopulmonary function.[23]

Assessments were administered following established guidelines[16-23] with the following modifications: weight was measured in standing on a standardized scale; height was measured in the supine position to obtain a true body length and prevent the influence of strength and postural impairments in standing; 6MWT was completed using an 11-m track due to space constraints; the therapist assisted AD in completion of the ABC, while the mother completed it independently; and TUDS was completed using a flight of 6 stairs, as a flight of 14 stairs was unavailable.

INTERVENTION

Informal Dance Intervention was conducted in a therapy gym for 60 minutes, twice weekly, in 2 16-session phases. Sessions consisted of a 10-minute warm-up, 45 minutes of IDI, and 5 minutes of cool-down activities. Warm-up activities were walking training and/or stretching. IDI used streaming YouTube channels with waltz, square dance, contra dance, or belly dancing music and instructional videos. Dance forms were practiced in 2-week increments in the following sequence: waltz, a combination of contra and square dancing, belly dancing, and finally a combination of all dance forms. The same time increment and sequence was used in each 16-session phase. This sequence was chosen based on AD's presentation and the therapist's prediction of AD's success in learning the dances.

Waltz is a ballroom dance performed in triple time, characterized by a rise and fall, as partners turn together as they move around the dance floor. The focus of the waltz was on timing, coordination, and endurance. Contra dance is a folk dance performed with couples standing in 2 long lines as a caller provides instructions as to which dance movements to perform. Couples interact with each other, as they perform a series of movements. As the dance progresses, each couple travels down the line and interacts with the other couples. Square dance is a folk dance performed with couples standing in squares with 3 other couples, facing the middle of the square. As with contra dancing, a caller provides instructions as to which dance movements to perform. Couples interact with each other as they perform a series of movements, many of which are the same in both contra and square dancing. Contra and square dancing were used to improve vestibular function using quick changes in direction and rotational movements. Belly dance is a folk dance performed with a series of movements focusing around the hips, spine, and pelvis, characterized by muscle isolation and elongation. Belly dancing was used to improve core strength, stability, and muscle isolation. The final combination of dance forms was to work on all aspects of functional mobility—timing, endurance, vestibular functioning, and stability. Throughout the intervention, AD and the therapist learned the movements associated with each type of dance and modified them as needed based on AD's ability (Table 1 and the Figure).

AD wore orthotics and twister cables during the intervention for improved lower extremity posture and alignment. A full-length mirror was covered during waltzing, square dancing, and contra dancing to prevent visual feedback and help mitigate vestibular symptoms. It was uncovered to provide visual feedback during belly dancing. Verbal and tactile cues were provided to assist with sequencing, timing, and alignment, and provide physical assistance and stability as needed. Breaks during the intervention were less than 1 minute when the therapist needed to switch videos and were 1 to 3 minutes when AD's vestibular symptoms became a safety concern. Within each session, movements and music were progressed by complexity as well as success with learning the movements. As AD began to fatigue or demonstrate increased vestibular symptoms during the intervention, less complex skills were reintroduced and reviewed.

OUTCOMES

BMI classification of overweight did not change (Table 2); however, BMI for age decreased from the 88th percentile to the 86th percentile compared with peers who are developing typically.[16] Waist circumference decreased by 0.50 inches (Table 2). Distance walked (Table 2) and walking speed improved during the 6MWT, but not endurance. Before intervention, AD continuously walked for 6 minutes. During both postintervention assessments, AD required a 30-second break around the 3-minute mark, verbally indicating fatigue and imbalance. Walking speed improved from 0.625 to 0.639 m/s.

AD's ABC self-confidence ratings improved by 18.75%, while her mother's ratings improved 4.37% (Table 2). There was an 8-point increase on the FGA (Table 2), and a 2-point decrease in CB&M scores (Table 2). During posttest 1, AD lost fixation on the target during Item 8 (Walking & Looking) and fell during Item 11 (Walk, Look, and Carry).[21] Time to go up and down stairs improved by 4.14 seconds (Table 2), while speed improved from 24.74 seconds per step to 24.05 seconds per step.

Per AD's log, following the first 16 sessions, AD did her written HEP 1 to 3 times per week, walked within her house an average of 35.64 min/day, and danced an average of 42.89 min/day. Following the second 16 sessions, HEP was done 3 to 4 times per week, walking averaged 28.29 min/day, and dancing averaged 19.06 min/day (Table 3).

DISCUSSION

Informal Dance Intervention appears to have improved BMI and functional walking in this adolescent with CP GMFCS Level II. While many of the improvements did not meet the established minimum detectable change (MDC), AD demonstrated improvements in body structures and functions as well as activity. Both AD and her mother reported benefit from the intervention, with AD specifically stating her "balance and posture" improved. Some of the improvements may be contributed to increased compliance with HEP and activity recommendations.

TABLE 1
Modifications to Dances

Category of Dance	Modification
Waltz	Physical therapist performed the lead role, patient followed.
	Patient positioned left hand on therapist's shoulder, right hand held with elbows relaxed vs at shoulder height.
	Box step with ¼ turn to left except during episodes of dizziness, then box step only.
Contra dance and square dance	A 132 cm × 132 cm square was outlined on the floor to represent the set for square dancing, demarcate "home," and ensure adequate travel across the floor during movements.
	Physical therapist was in the male's position, patient in the female's position.
	Physical therapist served as patient's partner and corner.
	When calls were for the head couples, movements were performed. When calls were for the side couples, patient and therapist stood in home position.
	Eliminated balancing before swinging[a] due to difficulty maintaining timing with music.
	Decreased speed of rotation of swings[a] with a maximum of 2 rotations performed in a row.
	Verbal cues for looking at therapist's eyes during swings[a] and allemandes.[b]
	Grand right and left was switched to allemande[b] left once and allemande[b] right once.
	During promenade, therapist placed her right hand on patient's right shoulder and held patient's left arm or hand.
	For all join hands and circle right and left, patient and therapist walked around outside of 132 cm × 132 cm square with one hand held. For head couples circle right and left, patient and therapist held one hand and walked within 132 cm × 132 cm square.
	Right-hand and left-hand star were performed by patient holding therapist's wrist and walking behind therapist as therapist walked around in a circle clockwise for right-hand star, counterclockwise for left-hand star.
Belly dance	A chair was initially used to assist with isolation of trunk and chest movements.
	All movements were initially performed with contact guard-to-moderate assistance and assistance was progressively decreased.
	All movements were performed within AD's range of motion with tactile cues to minimize compensatory movements.
	Patient was encouraged to maintain standard position with feet shoulder-width apart, knees slightly flexed, and pelvis tucked. She was unable to maintain 90° of shoulder abduction, so arms were relaxed at sides unless arm movements were being performed.
	Head slides were performed initially and later eliminated due to difficulty.
	Horizontal chest slides were initially performed while seated in an armed chair.
	Hand circles and snake arms were performed using shoulder movements only, as elbow, wrist, and hand isolation was too challenging.
	Balancing on toes was modified to heel raises with contact guard assistance.
	Vertical and horizontal chest circles were initially performed in armed chair.
	Omis[c] became horizontal hip circles.
	Belly rolls were switched to isometric abdominal holds.
	When AD was unable to perform sequences of movements while keeping pace with the video, the therapist adjusted the pace to one that could be maintained.

[a]Swinging/swings: Partners embrace and rotate around each other clockwise in a circle with the patient's left hand positioned on the therapist's shoulder and the patient's right hand held by the therapist near shoulder height.
[b]Allemande(s): Partners hold hands and walk around each other in a circle. For allemande left, the therapist and the patient held left hands and turned counterclockwise. For allemande right, they held right hands and turned clockwise.
[c]Omis: Horizontal hip circles with an abdominal crunch.

Fig. (A) Modified position for waltzing. (B) Modified position for promenade. (C) Positioning for swings. (D) Horizontal chest slides during belly dancing.

TABLE 2

Pre- and Posttest Measurements

	Pretest	Posttest 1[a]	Posttest 2[a]
BMI	25.2	24.6	25.0
WC	31.75″	31.5″	31.25″
6MWT	225 m	231 m	230 m
ABC—mother	60.63%	62.19%	65.00%
ABC—patient	56.25%	61.25%	75.00%
FGA	8/30	13/30	16/30
CB&M	15/96	9/96	13/96
TUDS	2′28.42″	2′21.17″	2′24.28″

Abbreviations: ABC, Activities-specific Balance Confidence Scale; BMI, body mass index; CB&M, Community Balance and Mobility Scale; FGA, Functional Gait Assessment; 6MWT, 6-minute walk test; TUDS, Timed Up and Down Stairs; WC, waist circumference.

[a]Posttest 1 was completed following the first 16 sessions of Informal Dance Intervention. Posttest 2 was completed following the second 16 sessions of Informal Dance Intervention.

It is difficult to determine whether the increase in compliance was due to the addition of an activity AD enjoyed, thus increasing motivation, or a result of AD and mother's awareness that this intervention period would be reported as a case report.

Consistent with the study from Azevedo et al,[10] IDI was beneficial in increasing physical activity and preventing weight gain in AD. While overall classification of BMI did not change, IDI assisted in promotion of physical activity, prevention of weight gain, and effected change in body composition. This has long-term implications for prevention of secondary complications due to sedentary behavior.[4,5]

Despite no improvement in endurance on the 6MWT, distance walked and walking speed did improve (Table 2). The improvement in distance did not meet the MDC of 64.0 m for children with CP GMFCS Level II.[24] Perception of endurance increased over the course of IDI, with complaints of fatigue diminishing between the first and second halves of the intervention period (Table 3).

While there was an improvement in walking as measured by the FGA (Table 2), and the change surpassed the MDC of 6 points for patients with balance and vestibular disorders,[25] overall fall risk did not change as her highest score remains below the predictive fall risk score of 22/30 for older adults.[26] Consistent with the results of the 6MWT, walking speed improved, as did ability to change walking speed, performance of walking with horizontal and vertical head turns, pivot turn, and stepping over obstacles. This suggests improved vestibular functioning that has carried over to functional walking ability.

TABLE 3

Exercise Outside of IDI and Average Time Before First Reported Physical Complaint During IDI

	wk 1-8	wk 9-16
Dancing	42.89 min/d	19.06 min/d
Home exercise program	1-3 times/wk (average 2.38)	3-4 times/wk (average 3.7)
Walking	35.64 min/d	28.29 min/d
Dizziness	36 min	42 min
Fatigue	53 min	56 min
Numbness, pain, burning sensations	37 min	47 min

Abbreviation: IDI, Informal Dance Intervention.

Improvement in walking speed was also demonstrated by decreased time to navigate stairs. Pre-IDI, AD averaged 24.74 seconds per step. Post-IDI, AD averaged 24.05 seconds per step, where peers with CP GMFCS Level II/III average 1.75 seconds per step.[22] AD is not afforded many opportunities to practice using stairs, and when she is, she uses her preferred method for safety and independence. This lack of practice may have contributed to the limited improvement in timing and quality of movement when going up and down in standing.

AD's mother began to report that IDI was helping after only 5 weeks, despite her minimal increase on the ABC assessment. Interestingly, preintervention, AD treated each ABC question as a dichotomy, either she was confident she could perform the activity, or she was confident she could not, and rated her confidence accordingly (100% = yes, 0% = no). Postintervention, AD no longer viewed them as dichotomous. She began to view her balance and ability to perform functional activities as more dynamic and rated her confidence as such on items such as sweeping and walking through a crowded mall. This increase in self-awareness may lead to increased independence and activity and a better understanding of impairments and activity limitations. Generally, these improvements in walking speed, functional walking activities, and balance confidence directly impact activity level.

Based on AD's level of functioning prior to IDI, it was difficult to select appropriate outcome measures as she was too advanced for many commonly used tools, but unable to demonstrate higher level skills required for others. The CB&M may have been too advanced, as AD scored significantly below the range of scores (44-93 points) for peers who are developing typically, ages 8 to 11 years.[27] These low scores may be partially explained by her diagnosis of CP, as well as her BMI. Children who are developing typically who were classified as overweight or obese had lower scores than peers of typical weight classification on the CB&M.[27] During the first posttest of the CB&M, AD fell during one of the test items. While it did not appear to impact her performance on the TUDS and the 6MWT that day, it impacted her performance on those tests during the second posttest. AD verbally demonstrated increased awareness of her limitations and was more cautious across all tests and measures performed on the same day as the CB&M during the second posttest. AD was unable to achieve her pretest score on the CB&M due to limiting her visual fixation on a target as she walked past it. She paused during the TUDS to state that the stairs were easier than previously, but she was taking her time, so she would not fall, and she stated during the 6MWT that she was going to take a break to make sure she would not fall. Despite increased cautiousness, scores on the 6MWT and the TUDS had improved from baseline (Table 2).

AD's functional improvements following IDI were similar to improvements found on the Pediatric Balance Scale,[12] Functional Independence Measure and World Health Organization Disability Assessment Schedule,[13] and on postural control and balance[14] following dance. Consistent with prior studies,[11] both AD and the therapist found IDI an enjoyable activity. In the

authors' experience, children with chronic disabilities begin to demonstrate decreased motivation and willingness to participate in therapeutic intervention around adolescence. Intervention needs to remain fun to keep adolescents engaged. IDI is an affordable and fun adjunct to therapy with implications for long-term improvements in body structure and function and activity. IDI used in conjunction with therapy and individualized for each patient may lead to improved overall health.

As a single-case study, without assessment of long-term effects of IDI, the ability to extrapolate the findings to other individuals is limited. Although assessments were administered over 2 days and administered in the same order to help mitigate fatigue, the number of assessments may have caused fatigue to be a factor in the results. This is especially true for the second assessment day. Large-scale randomized controlled trials are required to examine the short- and long-term effects of IDI on specific functional outcomes and across GMFCS levels. Future studies should expand to include a variety of neuromuscular diagnoses, alternative frequencies and duration, and other styles of dance.

WHAT THIS CASE ADDS TO EVIDENCE-BASED PRACTICE

This is the first case report to examine the effects of IDI on BMI and functional walking ability in an adolescent with CP. It has demonstrated the clinical applicability of IDI in influencing change in body structures and function and activity. IDI is an appropriate adjunct to therapy methods.

ACKNOWLEDGMENTS

The authors would like to thank AD and her mother for their enthusiasm and willingness to participate and for allowing documentation of their experience with IDI.

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