An Examination of the Effectiveness of Ballet on Gross Motor Function in Children with Intellectual Developmental Disabilities

Corinne Marascio

TEXAS CHRISTIAN UNIVERSITY
The Boller Review: Vol. 7. 2022-23

ACKNOWLEDGEMENTS

I would first like to thank the ABC family for inviting me into your space as an intern in the summer of 2021 and earning your trust to perform my research and instruct your students the following summer. I have grown so much as a person and future occupational therapist through working with your students and learning from your exceptional staff. I would especially like to thank Mrs. Gruender for inspiring and guiding me as I developed this project. I feel so fortunate to have had someone so knowledgeable and intentional in my life as I navigated this project and graduate school applications. Lastly, I must acknowledge the students of ABC that I spent two incredible summers with. You all have taught me more than I could ever teach you.

I would also like to thank Dr. Cantu and Dr. O'Donald for taking the time to be my research committee members. Not only did you both inspire me to continue pursuing this project, but you also gave me a greater perspective on the world. I will be a better occupational therapist because of what I have learned from each of you.

I would also like to thank my parents, Jim and Terri Marascio, my sister, Anna Marascio, and Cole Picarazzi for always supporting me even when I chose a school sixteen hours away. Without your support, I would not have been able to seize the opportunities TCU and the past four years have afforded me.

Lastly, I would like to thank Dr. Esposito for always challenging me to be a better student, leader, teacher, and person. I will forever be grateful for the opportunities you have provided me from being a Physical Activity and Disability Practicum teacher's assistant to attending the 2023 AOTA Inspire Conference. Your involvement in my time at TCU has taught me perseverance and confidence, and I know I am set up for success at MUSC because of these qualities.

TABLE OF CONTENTS

INTRODUCTION

Intellectual Developmental Disability

In 2017, one in six American children suffered from an intellectual developmental disability (IDD) (CDC, 2021). An IDD is a disorder, genetic abnormality, or condition that affects a child's intellectual functioning, adaptive behavior, and/or physical movement (U.S. Department of Health and Human Services, 2021). IDDs impact the nervous and sensory systems, metabolism, and/or rate of development (U.S. Department of Health and Human Services, 2021). As a result, children with an IDD often excel at a rate slower than that of a typically developing child in school and social settings. These children are also at risk for health conditions, especially when inactive (CDC, 2021; Albin, 2016). Common IDDs impacting children around the world include Down Syndrome, Autism Spectrum Disorders, and Cerebral Palsy (U.S. Department of Health and Human Services, 2021).

Schools and Physical Activity Outlets

Schools designed for children with IDDs are often tailored to teach at a pace that is unique for every child (National Association of Special Education Teachers, 2022; American Association of Intellectual and Developmental Disabilities (AAIDD), 2018). Specialized schools aim to help individuals achieve personal, academic, physical, psychological, and social goals (AAIDD, 2018). These learning atmospheres foster community and often become a primary space for student socialization. Additionally, students at these schools participate in most of their physical activity while at school or in their home. This is because many organized sports teams, dance and gymnastics classes, and group fitness activities are ill-equipped to instruct a child with an IDD (Albin, 2016; Stanish et al., 2015). A lack of physical activity outlets for children with IDDs leads to a decrease in the child's quantity of daily physical activity as well as a greater reluctance to participate in individual exercise for positive health outcomes (Albin, 2016; Stanish et al., 2015). Without physical activity to sustain bone density, muscular strength, and power in a growing child, critical gross motor skills such as balance, postural control, gait, and limb mobility are repeatedly affected and unable to develop sufficiently with age (López-Ortiz et al., 2012).

Mental Health

The mental health of children with IDDs are also negatively affected by present day societal systems which can lead to poorer quality of life, decreased motivation to pursue life goals, and negative self-image (Sphigelman and HaGani, 2019). One way to combat these

threats to mental health is via sociability and communication, which are necessary life skills that foster decision-making, consent, and positive self-worth. Children with IDDs can experience natural challenges surrounding social interactions, such as difficulty with verbal communication, obstacles in reading social cues, and discomfort in social environments (Albin, 2016). In addition, strained communication and the inability to make decisions can lead to feelings of unworthiness and isolation. By building relationships, a child learns what makes them unique, happy, and fulfilled, leading to positive self-worth. As a result, it is critical that a child with an IDD be exposed to social circumstances where they are given the freedom to interact with others and explore the formation of personal relationships (Albin, 2016). Group physical activity settings are a potential opportunity for psychological self-growth via the vast opportunity for communication and socialization.

Dance Therapy

With a growing population of children with IDDs lacking outlets for their physical, social, and mental development, dance therapy targets not only one but all three of these critical formative elements (Dipasquale, 2020; Joung, 2020; Dow, 2010; Humphrey, 2016). Dance therapy gives children with an IDD the opportunity to play alongside their typically developing peers while aiding in the development of their gross motor skills (Dow, 2010). In twenty-two scholarly researched articles, there is a common theme of gross motor deficits in children with an IDD. These articles support dance therapy as a successful intervention for improving gross motor skills such as balance, bilateral coordination, and postural control (López-Ortiz et al., 2012; McGuire et al., 2019; McCarty et al., 2010; Joung et al., 2020). Dance therapy has also been shown to have positive impacts on the social development and mental health of children with an IDD. Examples include improved communication, self-advocacy, and emotions of pride and self-worth (Salgado et al., 2010; Matzner et al., 2015; Canefield, 2019). One form of dance that may provide these benefits is ballet.

Ballet Therapy

Ballet, an art founded on symmetry, dynamic balance, and harmony, extends far beyond the typical theater production (Sorabella, 2004). American football players have learned ballet to develop more succinct and graceful movements that improve flexibility, agility, and balance on the field (Maleki et. al., 2019). Similarly, ballet has also been incorporated into adult physical activities to combat falls and maintain full-body strength (Thomsen et al., 2021). Children, regardless of ability level, can also reap these physical benefits as they practice ballet.

Ballet incorporates all muscle groups and is taught in a manner that targets specific gross motor movements. As a ballerina progresses through their practice, ballet moves are performed mutually with an emphasis placed on posture, precision, and mobility. Fine motor movements are also involved with the use of the hands to elongate and accentuate movements. A prominent feature in a ballet studio is the *barre,* which can be especially useful for those who have delayed gross motor function, as the *barre* provides safety and additional stability. Moves performed at the *barre* can then be performed in the center of the room which can provide evidence for improvements in balance and strength.

While ballet is excellent for improving physical components of the body, ballet also has impacts on anatomical awareness, coordination, confidence, communication, and socialization (Barnet-López et al., 2015). Ballet often requires the dancer to move extremities in opposite directions or at different times. As a result, careful attention to each aspect of a move facilitates a deeper connection with the anatomy and physiology of musculoskeletal functions and thus anatomical awareness (Barnet-López et al., 2015). Furthermore, as moves are strung together, a greater level of coordination is necessary as students experience continuous movement throughout a space (Joung, 2019). When engaging in performance ballet, students are required to have confidence and an active memory to accurately perform a routine in front of an audience (Humphrey, 2016). Through the process of learning, memorizing, and refining a ballet dance, students can explore confidence within themselves which can then translate to other areas in their lives. Finally, ballet is a group sport at the youth level and can serve as a mode for socialization (Humphrey, 2016; Canfield, 2019; Dipasquale, 2020). Ballet studios often bring children of the same age and school year together, allowing them to move through class levels alongside one another, fostering lifelong friendships. Dance studios can also bring together children with similar backgrounds or disabilities, creating a space that aids in communication skill development in those with IDDs. Communication flourishes in this setting not only verbally but also through body language as dancers rely on their instructor's cues during dances. Overall, ballet may appear to be a strict and rigid outlet for physical activity, but instead is an excellent source for developing physical strength, anatomical awareness, coordination, self-esteem, and communication skills (Humphrey, 2016; Barnet-López et al., 2015).

Overview of Methodology

Participants were recruited to participate in this study from a summer camp for children with IDDs. Thirty-minute ballet classes were held biweekly as a part of the camp day with pre- and post-tests occurring during the first and final weeks of the intervention. The classes

consisted of a warm-up, "*barre,*" across the floor, *allegro*, and concluded with a five-minute free dance portion. Ballet components were arranged into applicable gross motor functions and implemented into classes systematically to ensure children were receiving instruction aimed at improving a variety of gross motor areas. The gross motor components of the Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition, (BOT-2 test) were used to assess children prior to and immediately after the intervention. A dependent t-test examined participant's change in gross motor function.

Project Significance

Dance therapy offers children with an IDD the opportunity to play alongside their typically developing peers while aiding in the advancement of gross motor skills. The opportunity for socialization during participation in dance therapy can foster greater self-esteem and the development of critical social skills. A ballet-centered research intervention will give children the opportunity to explore their physical abilities while also encouraging gross motor function, facilitating a positive sense of self, and inspiring creativity. Students involved in this study will learn the basic principles of ballet and a ballet dance. Through learning a ballet dance, students will explore how different moves intertwine to create seamless movement. While practicing, students will interact with one another, explore movement throughout a space, and assess the implications of their movement with others around them (Joung, 2020). Students will also experience preparing for a performance by memorizing choreography and experiencing emotions tied to live performance. The performance will likely challenge self-confidence and could lead to feelings of reward and pride thus developing a positive sense of self (Humphrey, 2016). The free dance opportunities for students will also serve to inspire creativity and allow students the chance to explore movement in their own manner. The results of this study will be useful in understanding the frequency and duration of ballet classes necessary for improvement in gross motor function in children with IDDs. Lastly, this study will also provide valuable knowledge on the impacts of ballet therapy in a group setting.

Purpose and Hypothesis

The purpose of this intervention was to examine how ballet could be used as a form of therapy to improve gross motor function in children with intellectual developmental disabilities. The following hypotheses were proposed for this study:

H_1: Children with intellectual developmental disabilities would perform below average on a gross motor function test.

H_2: Ballet instruction would improve upper-limb coordination, bilateral coordination, balance, agility, strength, and overall gross motor function in children with IDDs.

A secondary objective of this study was to examine changes in fine motor control, although changes were not expected to be attributed to the ballet intervention. The researcher also aimed to make improvements in participant socialization, creativity, and temperament throughout the ballet classes, however, these specific factors were not formally assessed.

METHODS

Participants

Participants were comprised of 10 boys and 4 girls aged between 4 to 12 years old. The mean age of the intervention group was 6 years and 1 month. Figure 1 shows the characterization of the participants.

Figure 1

Characterization of the participants

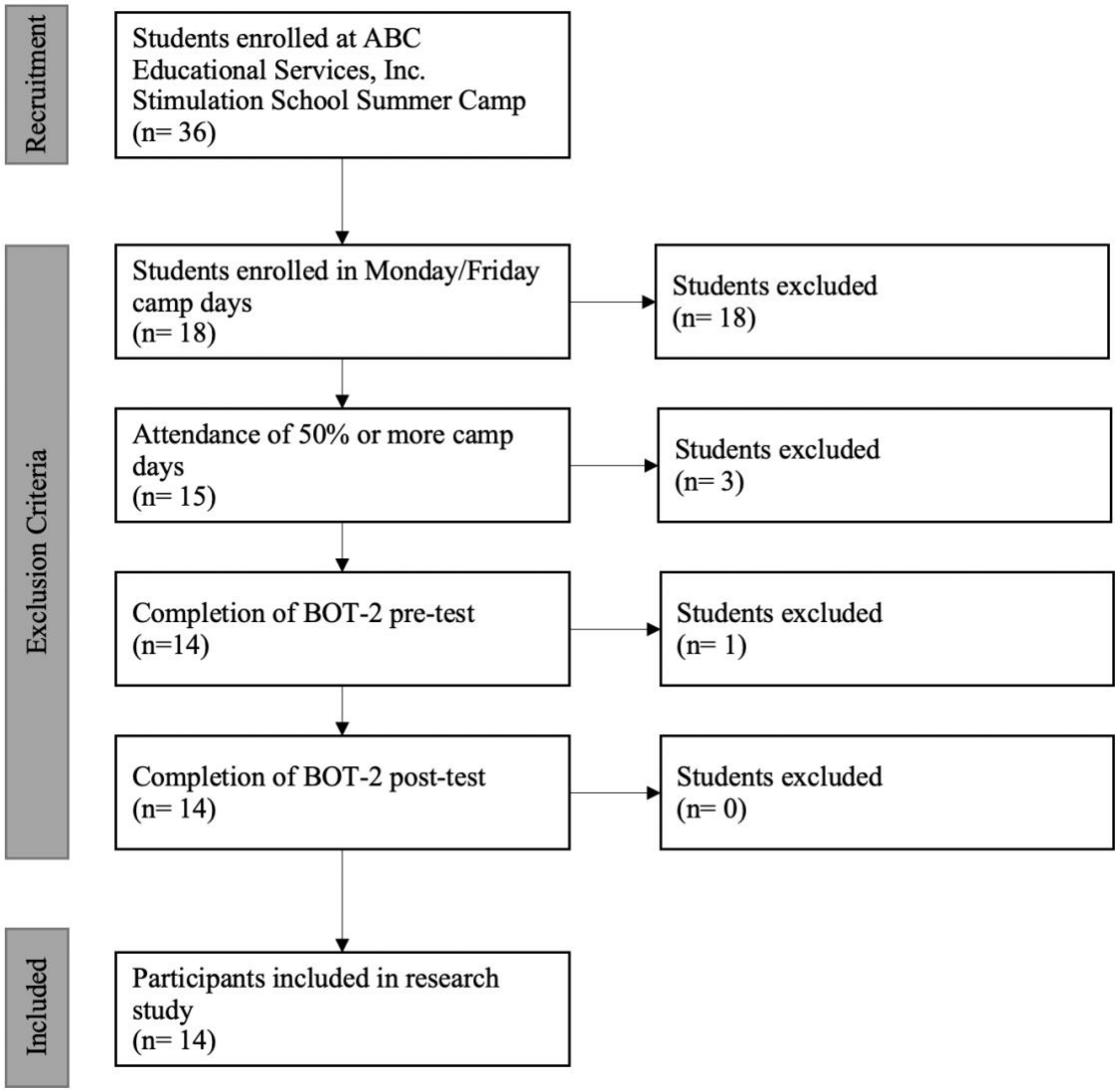
Participant	Sex	Age Pre-Test (Years)	Preferred Drawing Hand	Preferred Throwing Hand/Arm	Preferred Foot/Leg
1	M	5.83	R	R	R
2	M	5.92	R	R	R
3	M	4.50	R	R	R
4	M	4.25	R	R	R
5	F	5.50	R	R	R
6	F	5.92	R	R	R
7	M	8.08	L	L	L
8	M	6.33	R	R	R
9	M	6.83	R	R	R
10	M	6.08	R	R	R
11	F	7.50	L	L	L
12	M	8.17	R	R	R
13	F	8.92	L	L	L
14	M	8.58	R	R	R
Mean ± SD		6.60 ± 1.41			

Participants were recruited from ABC Educational Services, Inc. Stimulation School Summer Camp. Children considered for this study had to meet the following criteria: 1) enrolled in Monday and Friday camp days, 2) attendance of at least 50% of the ballet classes, and 3) completion of the gross motor pre- and post-tests. Campers enrolled in ABC Educational Services, Inc. Stimulation School Summer Camp were either formally diagnosed with an IDD or suspected of having an IDD. Five of fourteen campers had been enrolled in school at ABC Education Services, Inc. the previous school year. The other nine campers had attended either public or private schools during the previous school year. Eighteen participants were originally

recruited; however, three campers were excluded because they missed over 50% of the ballet classes and one was excluded because they were unable to complete the motor function pre-test. Participant selection methodology is shown in Figure 2.

Figure 2

Participant selection criteria



All the subjects' legal guardians attended an information session prior to the study that explained all protocols and risks associated with the intervention. Furthermore, all legal guardians signed a university-approved informed consent agreement, participants completed a university-approved assent form, and the study obtained the approval of the Institutional Review Board. Voluntary participation was stressed throughout the intervention, and the researcher asked participants if they wanted to take part in the activities at the beginning of each ballet class. Legal guardians received a copy of the informed consent form and the researcher's

contact information in the event that their child did not want to continue, or the legal guardian wanted to withdraw their child from the study.

Instrument

The Bruininks-Oseretsky Test of Motor Proficiency, 2nd Edition (BOT-2) measures fine and gross motor skills in long and short formats. This easily administrable test is comprised of game-like activities that each take under one minute to perform. The BOT-2 is one of the most widely used tests to measure fine and gross motor deficits and is often used to evaluate the following IDDs: cerebral palsy, autism spectrum disorders, and attention deficit hyperactivity disorder (Wuang & Su, 2009). The short form of the BOT-2 was used for this study due to time constraints from the camp day. Fine motor test items included: drawing lines through crooked paths, folding paper, copying a square, copying a star, and transferring pennies. Gross motor test items included: synchronized jumping in place, synchronized feet and finger tapping, walking forward on a line, standing one-legged on a balance beam with eyes opened, one-legged stationary hop, dropping and catching a ball with both hands, dribbling a ball alternating hands, knee push-ups, and sit-ups. There was a total of five fine motor and nine gross motor tasks. Each task had different raw score ranges that were converted into point scores to be summed to calculate a total score. Equipment used included BOT-2 assessment sheets, 20 pennies, painter's tape, a balance beam, and a tennis ball. As summary of the BOT-2 short form assessment is shown in Appendix A.

Procedure

The BOT-2 test was performed during the first week of the study. Participants then attended 30-minute ballet classes twice a week for 6 weeks for a total of 12 classes and 6 hours of ballet therapy. The author, a former ballet dancer and instructor, taught the ballet classes. Versions A through F were each included twice during the intervention. Each class version built on the previous and progressively incorporated new and more challenging moves. Figure 3 displays the intervention curriculum by week. Appendix B details the moves taught within each class by version. A post-BOT-2 test was performed during the ninth and final week of the study. An overview of the intervention layout is shown in Figure 3. During week 3, ABC Educational Services, Inc. Stimulation School Summer camp was not held for the Fourth of July holiday.

Figure 3

Intervention curriculum by week

Week	Monday	Friday
0	Pre-test day 1	Pre-test day 2
1	**Version A**	**Version B**
2	**Version A**	**Version B**
3	OFF	OFF
4	**Version C**	**Version D**
5	**Version C**	**Version D**
6	**Version E**	**Version F**
7	**Version E**	**Version F**
8	Post-test day 1	Post-test day 2

Each ballet therapy class began with a five-minute warm-up, followed by approximately seven-and-a-half minutes of "*barre*" and seven-and-a-half minutes of ballet movement across the floor. The class concluded with a five-minute *allegro* followed by five minutes spent dancing to "silly songs" or participating in free dance.

Warm-up. As the participants entered the dance space, they found a dot on the floor to sit on. Warm-ups were performed stationary to help students focus on one area of their body at a time. Warm-ups consisted of isolated movements that focused on the ankle, knee, hip, shoulder, and neck joints. The aim of these movements was to help prepare the body for greater gross motor movements which would incorporate multiple large muscle groups at a time. Appendix B outlines the specific exercises used during the warm-up for each session.

"Barre." The warm-up was followed by a portion of class which used a wall, chair, or table for support. While a traditional ballet *barre* was not used during the study, a solid surface or object served to support standing movements similar to a ballet *barre*. As a result, this section of the dance class is termed "*barre*." The aim of the use of the "*barre*" was to help students gain confidence in their abilities as well as begin to use large muscle groups and improve balance. Appendix B outlines the specific exercises used at the "*barre*" for each session.

Across the Floor. During Across the Floor, students were given a variety of different exercises that incorporated full body movements and muscle engagement to aid in gross motor function. Students performed series of movements one-by-one and were given two or three attempts to practice each exercise. Proceeding one by one allowed for the instructor to stay next to the participant the entire time for safety, encouragement, and immediate feedback. Appendix B outlines the specific exercises used during Across the Floor for each session.

Allegro. *Allegro*, meaning "brisk, lively" (Gail, 1982), aids in enhancing the cardiovascular system and is the most intense part of the ballet class. Major muscle groups were used together to facilitate quick movements and increase muscle endurance. Appendix B outlines the specific exercises used during *allegro* for each session.

"Silly songs"/free dance. The ballet class concluded with "silly songs" which allowed the children to cool down while also ending on a fun and enjoyable note. This part of class also involved free dance and dance themed games. Appendix B outlines the specific songs used during the "silly songs" portion of the dance classes.

Throughout the entire ballet class, students were encouraged to participate and were given rest and water breaks when requested. If students were removed from the class for more than half of the class time, they were counted absent for that day.

Statistical Analysis

All data were analyzed using SPSS version 20 (IBM © Corp., Armonk, NY, USA). Results will be presented as means and standard deviations. The primary analysis used a dependent sample t-test comparing pre- to post-test scores. Using t-tests to compare scores is an appropriate procedure for comparing pre- and post-test differences with samples of less than 30 participants. To account for the increased potential of a Type I error, a p-value of 0.05 was used to determine statistical significance.

Due to the small sample size and probability values being highly affected by sample size and variance, Cohen's d effect sizes were calculated. Cohen's d is a commonly used effect size measure that quantifies the difference between two groups' means in terms of the standard deviation of the population. In the context of this intervention, Cohen's d can be used to determine the magnitude of the intervention's effect. A Cohen's d value of 0.2 is considered a small effect size, 0.5 is a medium effect size, and 0.8 or above is a large effect size.

RESULTS

Descriptive statistics and a dependent t-test were used to compare changes in each of the BOT-2 subtests pre- to post-intervention. Figure 4 shows each participant's pre- and post-subtest scores, total scores, standard scores, and percentiles.

Figure 4

Participant's 1-7 Results

Subtest	Participant													
	1		2		3		4		5		6		7	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
1	2	2	4	3	0	0	1	3	3	8	2	2	1	0
2	5	4	8	9	0	0	0	3	5	5	0	1	5	4
3	1	3	3	3	2	3	1	1	1	0	0	5	0	2
4	2	3	0	4	0	2	6	3	3	3	0	0	6	0
5	6	4	5	6	5	5	5	5	4	4	0	2	2	1
6	2	1	2	2	2	2	1	1	1	1	0	0	0	0
7	0	3	4	5	2	0	4	1	0	0	0	0	5	5
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total score	18	20	26	32	11	12	18	17	17	21	2	10	19	12
Standard score	32	31	36	38	36	34	48	43	26	29	20	21	24	21
Percentile	4	3	8	12	8	6	42	24	1	2	0	0	1	0

Participant's 8-14 Results

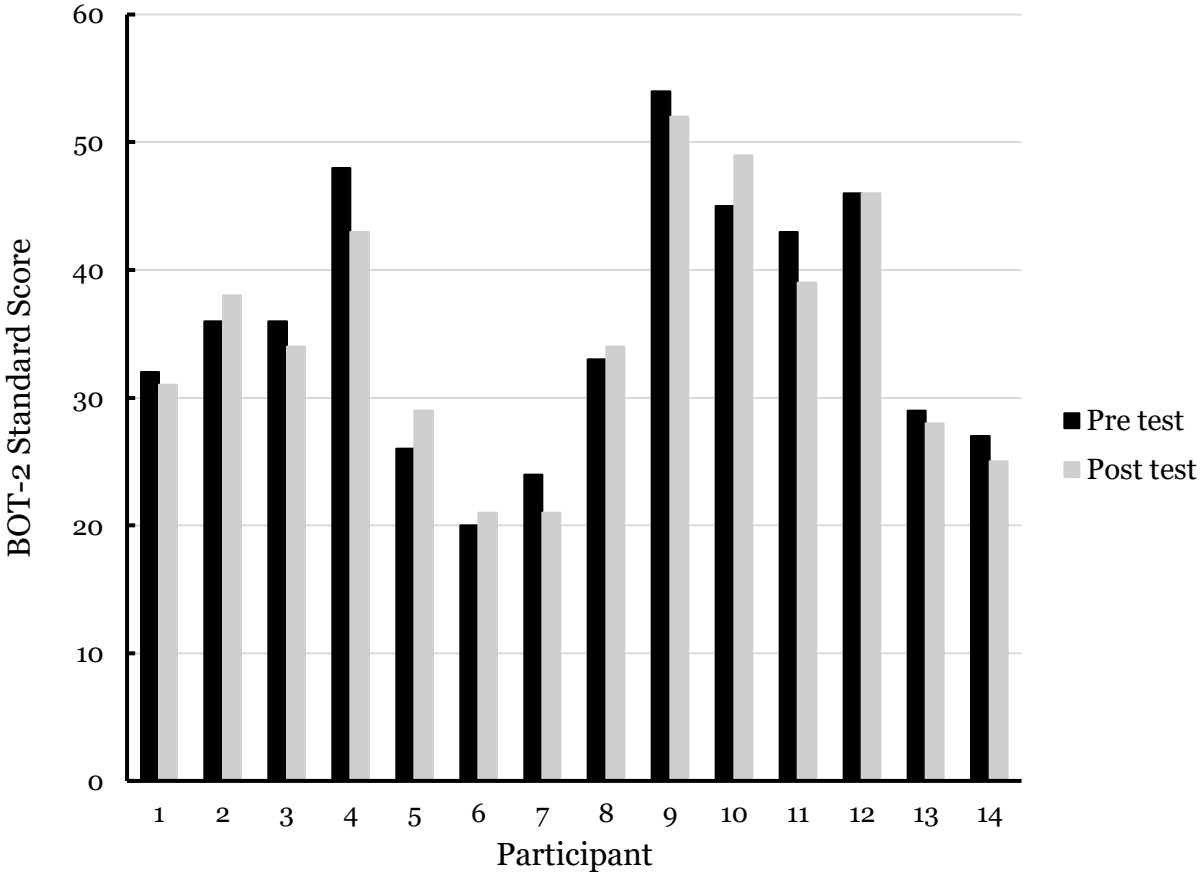
Subtest	Participant													
	8		9		10		11		12		13		14	
	Pre	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*	*Pre*	*Post*
1	3	2	12	11	6	7	9	8	6	7	6	4	2	2
2	0	5	10	10	8	8	9	9	9	10	5	5	4	3
3	3	5	4	5	3	4	6	6	5	6	2	3	2	2
4	4	0	7	7	7	7	7	7	7	13	5	3	4	3
5	6	5	6	6	7	8	5	8	8	8	5	6	4	2
6	3	6	8	6	8	9	9	9	9	9	8	9	2	1
7	8	5	12	12	5	6	10	8	12	9	5	6	10	9
8	0	0	0	0	0	0	3	1	6	0	0	0	0	0

Total score	27	28	59	57	44	49	58	56	62	62	36	36	28	22
Standard score	33	34	54	52	45	49	43	39	46	46	29	28	27	25
Percentile	5	6	66	58	31	46	24	14	35	35	2	1	1	1

Figure 5 displays each participant's standard score pre- and post-intervention. The standard scores were selected to be graphically displayed because the BOT-2 categorizes scores within three-month periods. Over the eight weeks, ten of the participants aged into the succeeding three-month age group. Of the fourteen participants, five maintained or improved their standard score while nine participant's standard scores moderately declined. Participant number five saw the greatest improvement in standard score with an increase of 3 points. Participant number four saw the greatest decline in standard score with a decrease of 4 points.

Figure 5

BOT-2 Standard Scores Pre- and Post-Intervention



The dependent t-test revealed that changes in only one of the eight subtests were significant. None of the total scores, standard scores, nor percentiles changed significantly. Subtest three, which analyzed manual dexterity, was found to be significant ($p = 0.02$). The results of the pre- and post-subtests as well as the total scores, standard scores, and percentiles are shown in Figure 6.

Figure 6

BOT-2 Pre- and Post-Test Results

Subtest	Pre-test	Post-test	t	p
1	4.07 ± 3.39	4.21 ± 3.38	-0.31	0.77
2	4.86 ± 3.68	5.43 ± 3.28	-1.39	0.22
3	2.36 ± 1.78	3.43 ± 1.83	-2.79	0.02
4	4.14 ± 2.74	3.93 ± 3.56	0.26	0.80
5	4.86 ± 1.99	5.00 ± 2.25	-0.38	0.71
6	3.93 ± 3.56	4.00 ± 3.76	-0.23	0.82
7	5.50 ± 4.29	4.93 ± 3.79	1.17	0.26
8	0.64 ± 1.74	0.07 ± 0.27	1.30	0.22
Total Score	30.36 ± 18.88	31.00 ± 18.15	-0.57	0.58
Standard Score	35.64 ± 10.20	35.00 ± 9.96	0.92	0.38
Percentile	18.92 ± 20.81	17.33 ± 19.31	0.68	0.51

$^{*}\alpha = 0.05$

Due to the small sample size of only 14 participants, effect size was used to further analyze the data and provide more meaning to the changes seen during the test. According to Sullivan and Feinn, "effect size is the magnitude of the difference between groups" (2012). The p-value is useful in statistics for identifying significance; however, the effect size is independent of sample size, thus providing more insight into how powerful the observed changes were (Sullivan & Feinn, 2012).

A positive effect size means that the effect increased the mean whereas a negative effect size implies that the changes decreased the mean. Effect size for subtest 3 (manual dexterity) was the highest at 0.59 followed by subtest 2 (fine motor integration) at 0.16. Of the eight subtests, five had positive effect sizes. In addition, the total score had a positive effect size of 0.03. The percent change presents the overall change in score between the pre- and post-subtests. Six of the percent changes were positive. One outlier was present in subtest 6 with a percent change of -814%. Effect size and percent change are shown in Figure 7.

Figure 7

Effect Size and Percent Change in BOT-2 Results

Subtest	Effect Size	Percent Change
1	0.04	3%
2	0.16	10%
3	0.59	31%
4	-0.07	-5%
5	0.07	3%
6	0.02	2%
7	-0.14	-12%
8	-0.46	-814%
Total Score	0.03	2%
Standard Score	-0.06	-2%
Percentile	-0.08	-9%

DISCUSSION

Children with IDDs often face challenges to their intellectual functioning, adaptive behavior, and/or physical movement, causing them to reach developmental milestones at a rate slower than that of a typically developing child (CDC, 2021; U.S. Department of Health and Human Services, 2021). Participation in physical activity is critical in aiding in a child's development of their gross motor, social, and emotional skills (Johnson, 2009). Unfortunately, fun and engaging forms of physical activity lack widespread development and accessibility for children with an IDD (Albin, 2016; Stanish et al., 2015).

The purpose of this study was to examine how ballet could be used as a form of therapy to improve gross motor function in children with IDDs. Two hypotheses were developed to examine the level of gross motor function in children with an IDD before and after the incorporation of ballet into their weekly schedule, short term.

Hypothesis 1

Hypothesis 1 states that children with IDDs would perform below average on a gross motor function test. This hypothesis is rejected because only nine of fourteen participants earned a pre-test standard score that placed them at below average or well-below average in the BOT-2 test. The remaining five participants were categorized as average-based on their standard score. These findings suggest that not all children with an IDD must perform below average on a gross motor function test to classify as intellectually developmentally disabled. Furthermore, diagnoses may vary in degree of severity, resulting in variability of motor proficiency.

The results of the study found that percent change varied widely across participants but did not frequently reflect changes in descriptive categorization. The descriptive category of only one participant changed pre- to post-test—from average in the pre-test to below average in the post-test. The decrease in the participant's percentile, thus their change in descriptive score, could have been due to uncontrollable factors. Firstly, the mood and temperament of the participant on the pre- and post-test days could have varied, impacting the participant's performance negatively. Attention deficits as well as individual emotions could have also changed performance by limiting focus and willingness to participate. Secondly, the age and norm-referencing scoring of the BOT-2 could be responsible for variability of change. As mentioned previously, over the course of the eight weeks, ten of the fourteen participants aged into the following BOT-2 scoring category. Of the eight weeks that encapsulated the intervention, only six weeks included active ballet instruction, and some students received less due to absences (albeit all participants passed the inclusion criteria for number of ballet classes

attended). While the BOT-2 requires improvements in performance to maintain the same percentile through three-month age progressions, some students may not have received sufficient instruction or had enough time to develop motor skills at the same rate the BOT-2 expects. Age and norm-reference scoring in the BOT-2 is further discussed in the corresponding subsection below.

Hypothesis 2

Hypothesis 2 states that ballet instruction would improve upper limb coordination, bilateral coordination, balance, agility, strength, and overall gross motor function in children with IDDs. This hypothesis was not accepted since a statistically significant correlation using an alpha of 0.05 was not found for any of the anticipated gross motor function areas and their corresponding subsections. Furthermore, statistically significant correlations were not found between total score, standard score, or percentiles. Subtests 1 through 3 examined fine motor skills, and subtests 4 through 8 examined gross motor skills. Only one of the eight BOT-2 subtests was statistically significant: subtest 3, which examined the fine motor skill of manual dexterity.

While there is no evidence that the ballet intervention produced changes in gross motor performance, this intervention still provided valuable insight into the development of a ballet intervention. This study can also provide future researchers with guidance on how to further analyze the relationship between ballet and gross motor function, especially within the IDD population. Anticipated limitations for this research, which led to the rejection of Hypothesis 2, as well as implications for future studies are discussed in more depth below.

Age and Norm-Reference Scoring in BOT-2

The BOT-2 scoring is dictated by sex and age. After discriminating by sex, the age categories are then divided into three-month periods, with each subsequent three-month age group associated with higher subtest scores. In a typically developing child, a consistent increase in motor performance every three months would yield a similar percentile, thus allowing researchers to examine a child's motor proficiency throughout the growth period.

The participants in this study exhibited pre-test percentiles ranging from 0 to 66%. The largest positive percentile change was an increase of 15%. The largest negative percentile change was a decrease of 18%. Variability in percentile change could have been due to participant performance but may have also been a result of an increase in participant age. Aging moved participants to the following norm-referenced three-month age group. As discussed in

Hypothesis 1, during the six weeks of intervention, some children may not have had sufficient time to adapt their motor skills from the ballet instruction. Yet the participants were expected to experience increases in their scores based on their ages. While age and norm-referenced scoring are useful for determining developmental level and progression, these standards may have negatively impacted the appearance of improvement in the ten participants whose ages fell into a new three-month category by the conclusion of the study. It is important to note that the BOT-2 does require the researcher to record the raw total scores which are not impacted by age or gender; however, when examining percentile, only standard scores can be used.

BOT-2 Short Form Subsection Reliabilities

The BOT-2 short form is useful for assessing the fine and gross motor skills of children in a quick, fun, and controlled manner. While the BOT-2 is standardized and useful for children of all ages, skill levels, and developmental milestones, the BOT-2 has been found to contain subtests that are more reliable than others. In a pilot study performed by Nocera and colleagues in 2021, the authors concluded that five of the fourteen subtest assessments have poor reliability for youth with Down syndrome. Poor reliability was defined as an intraclass correlation coefficient (ICC) less than 0.40 (Nocera et. al., 2021). The assessments found to have poor reliability included folding paper, copying a square, standing on one leg on a balance beam (eyes open), one-legged stationary hops, and knee push-ups (Nocera et. al., 2021). Decreased or unchanged performance between these pre- and post-BOT-2 subtests may be explained by their poor reliability. Additionally, six of the fourteen subtests were found to have fair to good reliability with an ICC ranging from 0.40 to less than 0.75, and three were found to have excellent reliability with an ICC of 0.75 or greater (Nocera et. al., 2021). The three subtests with excellent reliability were drawing lines through paths (crooked), walking forward on a line, and sit-ups (Nocera et. al., 2021). When considering the reliabilities of the BOT-2 short form, approximately 21% of the subtests had excellent reliability. As a result, the findings of this study may have been negatively impacted by the BOT-2 short form design.

On the contrary, the overall score and percentile rankings for the BOT-2 short form were both found to have excellent reliability for children with Down syndrome (Nocera et. al., 2021). This evidence shows that while the test may be comprised of less reliable subtests, the BOT-2 in its entirety can still hold validity. These various findings are important to consider when comparing between individual subtests and overall scores and are useful for understanding discrepancies encountered when using the BOT-2.

Limitations

In a peer-reviewed article written by Koch and colleagues (2014), the authors noted that their small population size and many exclusion criteria limited their findings. Additional authors also suggested that fewer exclusion criteria and a larger sample size would yield more valuable and significant results (Canefield, 2019; Koch et. al., 2014; Marouli et. al., 2021). As a result, when developing this study, these recommendations were considered when formulating the participant selection methodology. Despite following future directions of the current literature on this topic, the limitations of this study still included a small sample size (n=14). Limitations also included too broad of exclusion criteria. Since the exclusion criteria focused solely on age group and class attendance, distinguishing whether results from this study were more significant for certain IDD populations or skewed based on age and previous enrollment at ABC Educational Services, Inc. Stimulation School Summer Camp became more difficult. Furthermore, the diagnoses of the participants were not recorded as many students had not yet been formally diagnosed or were in the process of an IDD diagnosis. As a result, the researcher was unable to interpret the data based on medical diagnoses. Additionally, there was no control group as all campers who met the inclusion criteria at ABC Educational Services, Inc. Stimulation School Summer Camp completed the study.

Another limitation was the time frame in which the BOT-2 test was administered. Firstly, all participants performed the BOT-2 test in the same week; however, participants' moods, fatigue, and concentration levels throughout different parts of the day could have impacted the BOT-2 test results. Secondly, the intervention portion of the study only lasted six weeks and the BOT-2 tests were taken eight weeks apart from one another. Due to the short-term nature of the intervention, gross motor skills may not have had sufficient time to change from ballet instruction. As a result, any changes seen between the pre- and post-BOT-2 tests were examined carefully in consideration of outside, uncontrollable factors.

Future studies should address these limitations to provide deeper knowledge on the impacts of ballet for specific groups of children with IDDs and improve reliability of data.

Implications

These targeted dance therapy findings are a valuable resource for dance studios, schools, inclusive physical education programs, and occupational and physical therapists when creating curriculum designed to improve gross motor function for the pediatric IDD community (Canfield, 2019). Dance studios can open their doors to an even larger population when introducing dance classes for children with IDDs. By incorporating disabled children into

existing classes alongside typically developing peers, dance classes can enhance learning outcomes for children with an IDD. Dance studios can also provide classes designated for children with IDDs which can foster community and serve as a critical physical activity outlet for those facing IDDs. In addition, authors of physical education curriculum can gain insight into different techniques for developing activities to fit the needs of children with IDDs. Physical education programs can introduce curriculum specific for students with IDDs in schools where many of their classmates may be typically developing. IDD-centered curriculum can also allow children with IDDs to still be involved in physical education programs, such as field days or schoolwide tournaments, alongside typically developing peers. Furthermore, occupational and physical therapists can use dance therapy in their treatment sessions to target gross motor deficits in a fun and meaningful format. Through inclusive dance therapy programs, all children can experience the psychological, physical, and social benefits of dance.

Future Directions

Further research should be done to gain a deeper understanding on the implications of long-term ballet therapy. Increases to class frequency, duration, and intervention duration may provide greater insight into the extent to which ballet therapy can aid in gross motor development. Furthermore, incorporating a control group could reveal additional impacts of ballet therapy on physical and psychosocial elements. Lastly, research should consider the effects of ballet therapy on specific IDD populations. Currently, ballet and dance therapy are not widely studied therapeutic practices and should be explored alongside other forms of dance therapy within the IDD population.

APPENDIX A

Bruininks-Osterestky Test of Motor Proficiency, Second Edition, Short Form Summary

Subtest of Motor Proficiency	Subtest Assessment	Summary of Assessment Criteria
1: Fine Motor Precision	• Drawing lines through crooked paths • Folding paper	• Must draw inside of the maze lines, points deducted for drawing outside of the lines or touching the lines • Folds must align with fold lines on the paper, points are deducted for not aligning with the fold lines
2: Fine Motor Integration	• Copying a square • Copying a star	• Specific criteria regarding the basic shape, lines closure, edges, orientation, and overall size for the square and star
3: Manual Dexterity	• Transferring pennies	• Pick up penny with left hand, transfer penny to right hand and then to box. The number of pennies transferred in 15 s is recorded. Trial does not count if participant deviates from proper form.
4: Body Coordination	• Jumping in place (same sized synchronized)	• Jumps must have arm and leg on the same side synchronized, count up to 5 correct jumps.

		Jumps with improper form, such as arm n leg are not synchronized, do not count.
	• Tapping feet and fingers (same sides synchronized)	• Tapping feet and fingers on the same side up to 10 correct taps. Taps do not count if movement is not continuous or the participant fails to tap the same side.
5: Balance	• Walking forward on a line • Standing on one leg on a balance beam with eyes open	• Count the number of correct steps on a straight line up to 6 steps. Steps do not count if the participant is off the line or hands not on hips. • Count the number of seconds the participant stands using proper form. Timer is stopped if the participant fails to keep leg raised or falls off beam.
6: Running Speed and Agility	• One-legged stationary hops	• Count the number of correct hops in 15 s. Hops not counted if the raised foot touches the floor or if the participant stumbles off of the starting point.
7: Upper-Limb Coordination	• Dropping and catching a ball with both hands	• Count the number of catches up to 5. Catch

		does not count if the participant misses the ball or traps the ball to the body.
	• Dribbling a ball with alteration hands	• Count the number of correct dribbles up to 10. Dribble does not count if the participant does not alternate hands or if there is more than one bounce between dribbles.
8: Strength	• Push-ups (full or knee) • Sit-ups	• Count the number of correct push-ups in 30s. Push-ups do not count if hips are lifted or if the arms do not reach 90 degrees. • Count the number of correct-sit ups in 30s. Sit-ups do not count if the participant pushes up with elbows or pulls body up using clothing.

Note. Nocera et. al., 2021

APPENDIX B

Ballet exercise intervention curriculum by week

Version A	Version B
Warm up – *5 minutes* • Make a pizza straddle activity • Knees toes grow a rose activity Barre – *7.5 minutes* • Learn first and second feet positions • Plie • Tondu Across the Floor – *7.5 Minutes* • Bourrée • Chasse • Jeté Allegro – *5 minutes* • Sauté when music playing; freeze when music stops • Two-foot jumps from dot to dot "Silly songs"/free dance – *5 minutes* • Silly songs from *Kids in Action* • Free dance	Warm up – *5 minutes* • Point and flex exercises • Star jumps Barre – *7.5 minutes* • Plie • Tondu • Arabesque Across the Floor – *7.5 Minutes* • Step passe • Chaines • Jeté Allegro – *5 minutes* • Echappe • One-leg to one-leg hops "Silly songs"/free dance – *5 minutes* • Silly songs from *Kids in Action* • Freeze dance game

Version C	Version D
Warm up – *5 minutes* • Animal poses activity • Learn first and second arm positions Barre – *7.5 minutes* • Plie • Tondu • Arabesque Across the Floor – *7.5 Minutes* • Jeté • Chasse	Warm up – *5 minutes* • Make a pizza straddle activity • Learn third foot position Barre – *7.5 minutes* • Plie • Tondu • Dégagé Across the Floor – *7.5 Minutes* • Chaines • Bourre

• Step, arabesque jump Allegro – *5 minutes* • Jumps in first and second position "Silly songs"/free dance – *5 minutes* • "Simon Says" game with ballet moves learned in class • Silly songs from *Kids in Action*	Allegro – *5 minutes* • Jump sequence "Silly songs"/free dance – *5 minutes* • Free dance

Version E	**Version F**
Warm up – *5 minutes* • Knees toes grow a rose activity • Paint the rainbow activity Barre – *7.5 minutes* • Plie • Tondu • Ron de jambe Across the Floor – *7.5 Minutes* • Chasse • Review arabesque without "*barre*" • Step, arabesque jump Allegro – *5 minutes* • Freeze dance with jumps "Silly songs"/free dance – *5 minutes* • Silly songs from *Kids in Action* • Freeze dance game	Warm up – *5 minutes* • Point and flex exercise • Learn fourth- and fifth-foot positions Barre – *7.5 minutes* • Plie • Tondu • Pas de bourre Across the Floor – *7.5 Minutes* • Pas de chat • Jeté • Gran jeté Allegro – *5 minutes* • Jump sequence "Silly songs"/free dance – *5 minutes* • Silly songs from *Kids in Action* • Free dance

"Silly songs" from *Kids in Action* by artist Greg & Steve included: "Bop 'Til You Drop", "Beanie Bag Dance", "Can You Leap Like A Frog?", and "Goin' On A Bear Hunt".

REFERENCES

Albin, C. M. (2016). The benefit of movement: Dance/movement therapy and Down syndrome. *Journal of Dance Education, 16*(2), 58-61.

American Association of Intellectual Developmental Disabilities. (2018, February 14). *Education*. https://www.aaidd.org/news-policy/policy/position-statements/education

Barnet-López, S., Pérez-Testor, S., Cabedo-Sanromà, J., Gozzoli, C., Oviedo, G. R., & Guerra-Balic, M. (2015). Developmental items of human figure drawing: Dance/movement therapy for adults with intellectual disabilities. *American Journal of Dance Therapy*, *37*(2), 135–149. https://doi.org/10.1007/s10465-015-9201-1

Canfield, J. (2019). The Effects of Dance on Gross Motor Skills and Strength in Students with Down Syndrome.

Centers for Disease Control and Prevention (CDC). (2022, May 16). Increase in developmental disabilities among children in the United States. *Centers for Disease Control and Prevention*. Retrieved September 29, 2022, from https://www.cdc.gov/ncbddd/developmentaldisabilities/features/increase-in-developmental-disabilities.html

Dipasquale, S., Canter, B., & Roberts, M. (2020). Integrative Dance for Adults with Down Syndrome: Effects on Postural Stability. *International Journal of Exercise Science, 13*(3), 1317.

Dow, C. B. (2010). Young Children and Movement: The Power of Creative Dance. *Young Children*, 31.

Grant, G. (1982). Technical manual and dictionary of classical ballet. *Atlantic Provinces Special Education Authority, Library*.

Humphrey, E. (2016). Let's Dance: Dance Therapy Workshop for Children with Disabilities.

Johnson, C. C. (2009). The benefits of physical activity for Youth with Developmental Disabilities: A Systematic Review. *American Journal of Health Promotion, 23*(3), 157–167. https://doi.org/10.4278/ajhp.070930103

Joung, H. J., Park, J., Ahn, J., Park, M. S., & Lee, Y. (2020). Effects of creative dance-based exercise on gait performance in adolescents with cerebral palsy. *Journal of Exercise Rehabilitation, 16*(4), 332.

Koch, S. C., Mehl, L., Sobanski, E., Sieber, M., & Fuchs, T. (2015). Fixing the mirrors: a feasibility study of the effects of dance movement therapy on young adults with autism spectrum disorder. *Autism: the international journal of research and practice*, *19*(3), 338–350. https://doi.org/10.1177/1362361314522353

López-Ortiz, C., Gladden, K., Deon, L., Schmidt, J., Girolami, G., & Gaebler-Spira, D. (2012). Dance program for physical rehabilitation and participation in children with cerebral palsy. *Arts & health*, *4*(1), 39–54. https://doi.org/10.1080/17533015.2011.564193

Maleki, M; Rund, P; Stirton, K; and Lockard, M. (2019). Improving Balance, Flexibility, and Agility Using Ballet Training for Football Players: A Pilot Study. *International Journal of Exercise Science: Conference Proceedings*: Vol. 8: Iss. 7, Article 45.

Marouli, E. A., Kaioglou, V., Karfis, V., Kambas, A., Koutsouba, M., & Venetsanou, F. (2021). The Effect of a Greek Traditional Dance Program on the Motor Competence of Children with Autism Spectrum Disorder. *European Journal of Physical Education and Sport Science, 7*(3).

Matzner, J. (2015). Sitting Ballet: A Pilot Program Designed to Include Children with Physical Disabilities in the Private Studio Environment. *Journal of Dance Education, 15*(3), 116-121.

McCarty, D., McClenaghan, B., Blanck E., Fritz S.L. (2010) Examining Dance Therapy as an Adjunct Therapy for Selected Measures of Postural Stability, Gait, and Sensory Processing for Children with Mild to Moderate Cerebral Palsy. *Journal of Student Physical Therapy Research,* 3 (1)1-13.

McGuire, M., Long, J., Esbensen, A. J., & Bailes, A. F. (2019). Adapted Dance Improves Motor Abilities and Participation in Children With Down Syndrome: A Pilot Study. *Pediatric Physical Therapy: the official publication of the Section on Pediatrics of the American Physical Therapy Association*, *31*(1), 76–82. https://doi.org/10.1097/PEP.0000000000000559

Nocera, V.G.;Wood, A.P.; Wozencroft, A.J.; Coe, D.P. The Test–Retest Reliability of the Bruininks–Oseretsky Test of Motor Proficiency-Short Form in Youth with Down Syndrome—A Pilot Study. *Int. J. Environ. Res. Public Health,* 2021, *18*, 5367. https://doi.org/10.3390/ijerph18105367

Salgado, R., & de Paula Vasconcelos, L. A. (2010). The use of dance in the rehabilitation of a patient with multiple sclerosis. *American Journal of Dance Therapy, 32*(1), 53-63. https://doi.org/10.1016%2Fj.heliyon.2018.e00584

Shpigelman, C. N., & HaGani, N. (2019). The impact of disability type and visibility on self-concept and body image: Implications for mental health nursing. *Journal of psychiatric and mental health nursing*, *26*(3-4), 77–86. https://doi.org/10.1111/jpm.12513

Sorabella, J. (2004, October). *The Ballet*. The Met's Heilbrunn Timeline of Art History. https://www.metmuseum.org/toah/hd/balt/hd_balt.htm

Stanish, H. I., Curtin, C., Must, A., Phillips, S., Maslin, M., & Bandini, L. G. (2016). Physical Activity Enjoyment, Perceived Barriers, and Beliefs Among Adolescents With and Without Intellectual Disabilities. *Journal of Physical Activity and Health, 13*(1), 102-110. https://doi.org/10.1123/jpah.2014-0548

Sullivan, G. M., & Feinn, R. (2012). Using Effect Size-or Why the P Value Is Not Enough. *Journal of graduate medical education*, *4*(3), 279–282. https://doi.org/10.4300/JGME-D-12-00156.1

Thomsen, M. J., Liston, M., Christensen, M. G., Vestergaard, P., & Hirata, R. P. (2022). Dancing Against falls iN Community-dwElling older adults (DANCE): a study protocol of a stratified, block-randomised trial. *Injury prevention: journal of the International Society for Child and Adolescent Injury Prevention*, *28*(1), 93–101. https://doi.org/10.1136/injuryprev-2021-044224

U.S. Department of Health and Human Services. (2021, November 9). About intellectual and developmental disabilities (IDDs). *Eunice Kennedy Shriver National Institute of Child Health and Human Development (NICHD).* https://www.nichd.nih.gov/health/topics/idds/conditioninfo

Wuang, Y. P., & Su, C. Y. (2009). Reliability and responsiveness of the Bruininks-Oseretsky Test of Motor Proficiency-Second Edition in children with intellectual disability. *Research in developmental disabilities*, *30*(5), 847–855. https://doi.org/10.1016/j.ridd.2008.12.002