

# The Effect of Aquatic Therapy on Functional Mobility of Infants and Toddlers in Early Intervention

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**Purpose:** The purpose of this study was to determine the effect of aquatic therapy (AT) as an adjunct to home-based early intervention (EI) on differences in children's functional mobility. **Methods:** Thirty-seven children of ages six to 30 months ( $x = 24.2$ ;  $SD = 8.5$ ) with delayed functional mobility participated in this study. The AT group ( $n = 15$ ) received weekly AT in a community pool in addition to home-based EI with a physical therapist (PT) or occupational therapist (OT). A randomly selected comparison group ( $n = 22$ ) received home-based EI with a PT or OT. Baseline and postintervention scores on the Gross Motor Subsection of the Mullen Scales of Early Learning were compared between the AT and comparison group. **Results:** The AT group demonstrated significantly greater ( $p < 0.05$ ) gains in functional mobility than the comparison group. **Conclusion:** AT is a useful adjunct to EI to improve children's functional mobility. (*Pediatr Phys Ther* 2007;19: 275–282) **Key words:** child, early intervention, developmental disabilities, exercise therapy, infant, physical therapy, water

## INTRODUCTION

Children with developmental delays and disabilities are often recommended to participate in aquatic therapy (AT) to supplement clinic, early intervention (EI), or school-based physical therapy or occupational therapy. The buoyant forces of water are said to reduce joint loading and facilitate antigravity movements, resistive properties promote postural and extremity strengthening, and the increased capacity for heat transfer in water when compared with air may reduce tone and nonvolitional movements.<sup>1</sup>

AT programming for children can be characterized as recreational or therapeutic.<sup>2</sup> Recreational aquatic programs promote fun, fitness, and community access, but often water instructors are not trained to address the unique needs of children with disabilities or to provide appropriate information to parents about recognizing atypical movement patterns and facilitating improved mobility in the water. Therapeutic programs designed and implemented by pediatric physical therapists (PTs) and occupational therapists (OTs) often incorporate neurophysiologic principles and facilitation, but have been criticized for not promoting skills transfer and community integration.<sup>2</sup>

Research to determine the effects of AT on functional mobility of children is sparse.<sup>3,4</sup> Although limited by their methodological rigor, two case studies have investigated the effect of AT on children with neuromuscular disabilities.<sup>5,6</sup> Peganoff<sup>5</sup> described a 14-session AT program, which focused on swim stroke skill acquisition for a 14-year-old girl with cerebral palsy (CP) (spastic right hemiparesis). Preintervention and postintervention measures demonstrated gains in upper extremity active and passive range of motion, improved postural control and balance reactions, and improved self-image.<sup>5</sup>

Figures<sup>6</sup> described individual AT sessions as an adjunct to home-based physical therapy for a boy, aged 12 months, who was diagnosed at six months of age with

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spinal muscle atrophy type I. The child presented with negligible antigravity movement throughout and compromised respiratory function. The author reported that AT seemed to be associated with initial improved active motion of upper and lower extremities in the water; however, these gains demonstrated a plateau throughout the duration of AT. Additional benefits seemed to be increased ease of handling and positioning during activities of daily living (ADL) including bathing, which contributed to the child's increased ability to interact socially during these activities.<sup>6</sup>

Quasi-experimental designs, considered more rigorous than case reports due to increased sample size and presence of a comparison group, have been used to investigate the effect of AT among children with juvenile idiopathic arthritis (JIA)<sup>7</sup> and CP.<sup>8</sup> Baldwin<sup>7</sup> investigated the effect of an AT group program compared with an individual home exercise program on quadriceps strength and range of motion and weight-bearing capacity of 12 children (aged nine to 18 years) with JIA. In this crossover design study, children were allocated to two treatment groups and all children participated in a 20-week group AT program, had no therapy for nine weeks, and received an individual home exercise program for 20 weeks. In Baldwin's study, the group AT sessions consisted of two 15-minute periods of hip and knee-strengthening exercises, that is, sessions consisted of a general aquatic curriculum rather than individualized physical therapy plans of care. The results suggest that a clinic-based AT group program is associated with not only improved quadriceps strength, but also sustained treatment benefits during the period of no therapy. However, greater improvements in hip and knee range of motion were associated with the individual home exercise program. The author attributed these findings to more frequent and consistent opportunity for the PT to identify and treat stiff joints during treatment sessions tailored to individual joint mobility status. Despite the promising effects of AT, the study was limited by a focus on impairments rather than functional mobility and a clinic-based treatment protocol that does not address the community integration needs of children with JIA. Further, given the mixed results related to range of motion, the author recommended that AT programs include a land-based home exercise program and routine measurements of mobility.<sup>5</sup>

Hutzler et al<sup>8</sup> investigated the effect of AT on children, aged five to seven years, diagnosed with CP. Specifically, the effect of a six-month swimming program, which promoted water orientation skills (ability to achieve and maintain swim positions such as standing against the pool edge, floating, etc.) as well as a weekly land-based therapy group was compared with four, 30-minute weekly physical therapy sessions that utilized a neurodevelopmental treatment protocol. The results of this study suggest that the combined water and land-based treatment is associated with significantly greater gains in vital capacity than land-based treatments alone. Further, the combined water and land sessions were associated with greater gains in water orientation skills, which the authors suggest may reflect improved motor control in the water.

In one experimental study,<sup>9</sup> the researchers investigated the effect of an AT program implemented in a community pool on functional mobility and quality of life among children (aged five to 13 years) with JIA. The authors found no significant improvements in physical fitness, quality of life, or functional ability associated with participation in a 20-session AT program compared with land-based usual care by a PT. The authors report that the lack of positive findings could be explained, in part, by short program duration or frequency as well as a lack of concurrent land-based therapy.

The current study seeks to expand the existent literature on the effect of AT among children with neuromuscular and developmental delays and disabilities. No study thus far has investigated the effects of a recreational and therapeutic AT program on differences in functional mobility of young children with developmental and neuromuscular delays and disabilities. The purpose of this study was to evaluate the effect of an AT program as an adjunct to EI home-based physical therapy and occupational therapy services on differences in children's functional mobility. The EI setting was chosen for this research because it allowed for (1) a cohort of young children with a variety of developmental and neuromuscular delays and disabilities, (2) close geographic proximity of EI families to a community pool, and (3) children who would receive serial developmental assessments independent of their participation in the AT program. Further, successful collaboration between EI and community pool staff may foster similar relationships among other EI programs to expand service delivery for infants and toddlers with developmental and neuromuscular disabilities.

We hypothesize that an AT program, which facilitates peer socialization, and motor skill development within a community environment, would improve children's functional mobility to a greater extent than would EI home visits alone.

## METHODS

### Participant Recruitment

Study participants were recruited for a larger study to investigate parent perceptions of EI service delivery and differences in developmental outcomes of children with known or suspected developmental disabilities. Families were recruited from a regional EI program that serves approximately 200 families from 11 communities in northeastern Massachusetts. Participants were recruited from January 1 through January 31, 2004. Criteria for the child's eligibility included (1) receiving home visits through EI, (2) not in protective custody, (3) having completed at least one EI developmental assessment before January 1, 2004, and (4) participating in one additional EI developmental assessment before May 31, 2004. The analyses for this article are further restricted to children who (1) were receiving home visits by a PT or OT, and (2) were identified by at least one EI developmental assessment as having delayed functional mobility, that is, more than 1 standard deviation

from the EI assessment's mean functional mobility score (described in greater detail later in the article). All study participants received a \$10.00 gift card in appreciation for their participation. The Boston University Institutional Review Board approved this study.

### Intervention Group

The AT program was a collaboration between the EI and community center staff. The community center provided numerous recreational and educational programs for children and adults with and without disabilities. The AT program had been in existence since January 2003. AT occurred in a pediatric pool that was approximately 30' long and 15' wide and kept at 89°F. The pool depth ranged from 1' to 2'. During an AT session, there were two therapists (one PT and one OT), and two children in the water to allow for individual treatment as well as peer socialization and modeling. Children spent 30 minutes weekly in the pool. The authors chose 30-minute intervals for the AT sessions based on the previously described studies<sup>7,8</sup> that used this duration. Further, 30 minutes was hypothesized to be appropriate to positively affect children's functional mobility without causing excessive fatigue. For about half of the children, either a parent or a sibling was in the pool for the AT session. Intervention strategies included standing play, gait training, kneeling, squatting, dynamic balance activities on floating mats, stepping activities using an underwater bench, and resistive play with weighted toys and water currents. Strategies implemented during AT were derived from goals developed on the child's Individualized Family Service Plan (IFSP),<sup>10,11</sup> a developmental plan of care created by the parents and EI team. At the time of the study, families of children then participating in the AT program since at least September 2003 were invited to participate. At the initiation of the study, 15 families were enrolled in the AT program. Of those 15 families, all consented to participate and all met the study eligibility requirements related to developmental assessments, home visits by a pediatric PT or OT, and enrollment in EI until at least March 31, 2004. Thus, the analyses for this study describe a 36-week combined aquatic and land-based therapy program among a convenience sample of 15 families. Thirty-six weeks was chosen as the study duration because previous literature<sup>9</sup> suggested that 24 weeks was an insufficient duration to effect change in motor skills. The authors hypothesized that nine months would be long enough to positively influence functional mobility skills without creating an undue participation commitment burden for families.

During the 60-minute weekly home visits running concurrent with this study, PTs or OTs implemented strategies delineated in the IFSP.<sup>10,11</sup> For example, all the children in the study had mobility difficulties and their therapy goals included increasing the distance and improving the quality of gait. AT activities to support these goals included supported cruising and walking with varying buoyant forces (ie, different water heights), standing play activities that incorporated dynamic reaching with and without the

resistance of water currents, and sitting activities on floating mats to promote postural strengthening.

### Control Group

Sixty families were randomly selected from the EI program's client database. These 60 families received a letter describing the study and requesting permission to be approached for participation. Forty-eight (80%) families returned the letter and all 48 consented to participate. Of the 48, three were missing data on developmental evaluations, and six did not meet eligibility criteria: two children were in protective custody and four would not have a follow-up developmental evaluation because they were either moving or becoming three years of age. Therefore, the control group for the larger program evaluation research included 39 subjects. Of these 39 children, 22 were receiving home visits by a PT or OT and were identified by an EI developmental assessment as having delayed functional mobility. Thus, the final control group for the current study consisted of 22 children. The authors chose to maintain unequal experimental and comparison groups to maximize the power of the study. In study designs in which AT participants were selected and a comparison group was randomly selected from a cohort of similar children who would be eligible for AT, power would be increased with case-to-control ratios greater than 1:1.<sup>12</sup>

These analyses evaluate the effect of 36 weekly 60-minute home visits by a PT or OT. The home visit was similar to that received by the AT group and included activities described in the IFSP<sup>10,11</sup> to increase children's functional mobility (ie, gait training, stair climbing, and play-based activities to promote postural control, extremity strengthening, and improved movement patterns).

### Measurement

**Functional Mobility.** Functional mobility was conceptualized as movement associated with participation in age appropriate ADL. For infants and toddlers, examples of functional mobility include moving in and out of sitting, creeping, walking on even and uneven surfaces, running, climbing stairs, moving in and out of small chairs.<sup>13</sup> Functional mobility was measured by the Gross Motor Subscale of the Mullen Scales of Early Learning (MSEL).<sup>14</sup> The MSEL is a comprehensive developmental assessment consisting of five subscales: visual reception, receptive language, expressive language, fine motor, and gross motor behaviors. The MSEL is a standardized assessment tool for which normative data are available derived from a sample of 866 children from birth to 69 months of age.<sup>15</sup> It is one of two developmental assessments mandated for state-wide EI program use by the Massachusetts Department of Public Health, which oversees EI services in the state. The MSEL has been used in previously published literature to evaluate differences in the development of young children with autism spectrum disorder,<sup>16</sup> congenital hypothyroidism,<sup>17</sup> tuberous sclerosis,<sup>18</sup> and infants born with low birth weight.<sup>19,20</sup> MSEL has been shown to have good interrater reliability ( $r = 0.99$ ), test-retest reliability ( $r = 0.83-0.98$ ),<sup>15</sup>

good concurrent validity with several child assessment tools,<sup>15</sup> and good sensitivity (77%) for identifying developmental delays and detecting change over time<sup>16,18</sup> in populations at high risk.<sup>15,20</sup>

In this EI program, the MSEL is routinely administered to all children every six months by PTs and OTs and developmental specialists who have received extensive training in administration and scoring of the MSEL. The Gross Motor subscale evaluates up to 33 items of functional mobility such as rolling, sitting, creeping, pulling to stand, walking, kicking a ball, squatting, ascending or descending stairs, jumping, and transitional movements to and from the floor. Preassessments and postassessments were both completed by the child's primary home-visit EI therapist who was extensively trained in administration of the MSEL. Further, because of the retrospective nature of data collection therapists were blind to the study purpose and design. Gross Motor subscale skills were scored present (1) if child was able to perform the task or absent (0) if the child was unable to perform the task. The highest of three successfully completed items correspond to the child's basal score. Test administration continued until the child did not successfully complete three consecutive test items, which represents the ceiling score.<sup>14</sup> Functional mobility data were derived by a two-step process. First, MSEL gross motor subscale raw scores were ascertained from a one-time review of participants' EI chart. Baseline functional mobility raw data were collected for all participants from EI assessments closest to September 1, 2003. Follow-up functional mobility raw data were collected from EI assessments closest to May 31, 2004. In the second step, functional mobility raw scores were converted to age-adjusted normalized scores according to the MSEL manual.<sup>14</sup> Age-adjusted scores have a mean of 50 and a standard deviation of 10. Delayed functional mobility was defined, according to tables supplied in the MSEL manual, as greater than one standard deviation from the mean.

## Data Analysis

The AT group ( $n = 15$ ) and controls ( $n = 22$ ) were compared on demographic characteristics using  $t$  tests and chi squared tests of association. Mean baseline and follow-up age-adjusted normalized gross motor subscale scores were compared between the AT and comparison groups using a one-tailed paired  $t$  test. Specifically, the change in mean age-adjusted normalized gross motor subscale score between baseline and follow-up was calculated for each group. Next, the difference in the mean change scores for the AT group and the comparison group were compared for statistical significance, assuming a null difference of zero. All analyses were performed using SAS v8.1 and the significance level was  $\leq 0.05$ .

## RESULTS

### Characteristics of Study Participants

Diagnostic and demographic characteristics of study participants are presented in Table 1. Participants were

**TABLE 1**  
Characteristics of Study Participants

Characteristic	AT Group*	Comparison Group‡
Diagnosis (n)		
Cerebral palsy	2	2
Muscular myopathy	2	1
Prematurity (<37 weeks)	2	5
Chromosomal anomaly	3	4
Myelomeningocele	1	1
Sensory system/integration deficits	2	2
Hypotonia	1	1
Developmental delay	2	6
Age in months; $\times$ (SD)		
Baseline	17.8 (6.2)	13.8 (8.9)
Follow-up	26.4 (6.3)	21.1 (8.8)
Gender (n)		
Male	9	9
Female	6	11
Health insurance funding; n (%)		
Private	12 (80.0%)	17 (77.2%)
Public	3 (20.0)	5 (22.7%)
Race; n (%)		
White, non-Hispanic	14 (93.3%)	20 (90.9%)
Other	1 (6.7%)	2 (9.1%)

\* The AT Group received 36 weekly aquatic therapy sessions in a community pool with a PT or OT and one other child as well as 36 weekly home-based PT or OT treatment sessions.

‡ The Comparison group received 36 weekly home-based treatment sessions with a PT or OT.

overwhelmingly white, non-Hispanic, and a majority was from nonpoor families (defined as private versus public source of payment for health insurance); however, these characteristics did not differ significantly between the AT and comparison group ( $p > 0.05$  for both variables). The majority of AT participants were male (60.0%), while the opposite was observed for the comparison group, in which the gender distribution was 59.1% female. The mean age at baseline of children in the AT group was 17.8 months ( $SD = 6.2$ ), and mean age at follow-up was 26.4 months ( $SD = 6.3$ ). Mean age at baseline for the comparison group was 13.8 months ( $SD = 8.9$ ) and mean age at follow-up was 21.1 months ( $SD = 8.8$ ). There were no statistically significant differences between the groups on either baseline ( $p = 0.13$ ) or follow-up age ( $p = 0.06$ ).

Clinical characteristics for the study participants are presented in Table 2. Diagnostic and qualitative information regarding the functional mobility skills of the participants were ascertained from the EI chart review. These data are intended to provide readers with specific diagnoses as well as information about the general functional mobility skills and physical therapy and occupational therapy needs of children in the AT and comparison groups.

### Gross Motor Skills

Baseline and follow-up age-adjusted normalized scores on the MSEL for each group are presented in Table 3. Baseline scores were not statistically significantly different between the two groups ( $p = 0.16$ ). Age-adjusted normalized scores for the AT group increased from 27.5 (9.8)

**TABLE 2**

Comparison of Diagnoses and Qualitative Functional Mobility of Children in AT (N = 15) and Comparison Groups (N = 22) Reported in EI Developmental Evaluation

Diagnosis	Age at Follow-Up	Functional Mobility Qualitative Data
AT Group (N = 15)		
Cerebral palsy	20 months	R hemiplegia; ambulates with ankle-foot-orthoses (AFOs) and hands held, poor balance
	30 months	Spastic diplegia: ambulates with AFOs, decreased endurance and poor balance
Muscular myopathy	28 months	Movement disorder characterized by decreased strength and atypical movement patterns; ambulates independently, decreased balance and motor planning
	35 months	Progressive muscular myopathy; ambulates independently, immature pattern on stairs, decreased lower extremity (LE) strength
Prematurity (<37 weeks gestation)	32 months	Extreme prematurity (<32 weeks): ambulates independently, decreased strength and balance; immature movement patterns
	32 months	Generalized weakness and decreased balance; ambulates independently; not yet jumping or ascending/descending stairs
Chromosomal anomalies	28 months	Rare chromosomal anomaly associated with severe motor delays; stands with AFOs and support and is beginning to take steps with posterior walker
	30 months	Rare chromosomal anomaly associated with moderate motor delays; ambulates with supramalleolar orthoses (SMOs), ataxic gait and poor balance
	15 months	Rare chromosomal disorder characterized by profound motor delays; not yet sitting or rolling independently; presents with spasticity and poor motor control
Myelomeningocele	24 months	Low level lesion associated with mild motor delays: ambulates independently, reduced LE strength and decreased balance and endurance
Sensory system/sensory integration (SI) impairments	15 months	Visual deficits characterized by poor depth perception, presents with hypotonia and poor balance; stands with support
	24 months	Ambulates independently, decreased balance and poor motor planning
Hypotonia	20 months	Significant hypotonia throughout; ambulates with hands held, poor strength and balance
Developmental delay	31 months	Generalized weakness and decreased balance; ambulates with SMOs; not yet jumping or ascending/descending stairs
	25 months	Generalized weakness and decreased balance; ambulates with SMOs; not yet ascending stairs; poor endurance
Comparison Group (N = 22)		
Cerebral palsy	8 months	Moderate Spastic diplegia: maintains prone extension briefly, not yet sitting independently; shifts weight toward toys while prone
	27 month	Mild spastic diplegia: ambulates with bilateral AFOs; ascends stairs holding a rail; kicks a ball with help, stoops to pick up toys from the floor; mild-moderately decreased dynamic balance and LE motor control
Muscular myopathy	16 months	Progressive muscular myopathy associated with profound motor delays: extremely poor postural and motor control; has minimal head control; not able to sit independently or roll toward toys
Prematurity (<37 weeks' gestation)	6 months	Decreased postural control and prone extension strength; not yet rolling or sitting
	15 months	Extreme prematurity (<32 weeks): sits independently; stands with support; transitions to quadruped; decreased postural strength and motor control
	13 months	Decreased postural control; sits independently with decreased dynamic sitting balance, pulls to stand against furniture with immature pattern and stands with support
	11 months	Decreased postural control; sits independently with decreased dynamic sitting balance, pulls to stand against furniture with immature pattern
Chromosomal anomalies	10 months	Decreased postural and motor control; reaches for toys while prone and sits independently with decreased dynamic balance for reaching; not yet transitioning to quadruped
	34 months	Rare chromosomal anomaly associated with profound motor delays: extremely poor postural and motor control; not able to sit independently or stand with support; rolls toward toys
	13.5 months	Rare chromosomal anomaly associated with profound motor delays: extremely poor postural and motor control; not able to sit independently or stand with support; tolerates prone extension play briefly
	32.5 months	Rare chromosomal anomaly associated with moderate generalized hypotonia and joint laxity; walks independently, stands on one foot for brief periods; ascends stairs and jumps from small heights with immature pattern
	14 months	Common chromosomal anomaly associated with hypotonia, joint laxity, and reduced postural and extremity motor control; reaches for toys in prone; sits independently with poor dynamic balance for reaching

(Continued)

**TABLE 2**

Continued

Diagnosis	Age at Follow-Up	Functional Mobility Qualitative Data
Myelomeningocele	23 months	Low-level lesion; decreased LE motor control; walks with bilateral AFOs; poor balance to negotiate obstacles; reduced endurance for mobility
Sensory system/sensory integration deficits	29 months	Visual deficits include poor depth perception; presents with general mild hypotonia; ambulates independently; runs and jumps with immature pattern; climbs stairs holding a rail and with cueing
	28 months	Decreased postural strength and motor control; ambulates independently; ascends/descends stairs with help, decreased dynamic balance and poor safety awareness
Hypotonia	24 months	Moderate hypotonia throughout; ambulates with orthotics; stoops to pick up toys from the floor, runs with immature pattern and kicks a ball with help
Developmental delay	23 months	Generalized weakness and decreased balance; ambulates independently; ascends stairs with help, beginning to run, not yet jumping or descending stairs with help
	26 months	Generalized weakness and decreased balance; ambulates independently; ascends stairs with help, beginning to run, emerging unilateral balance for kicking a ball; stoops to pick up toys from the floor; not yet jumping or descending stairs with help
	27 months	Generalized weakness and decreased balance; ambulates independently; stoops to pick up toys from the floor, beginning to ascend stairs with help
	36 months	Generalized weakness and decreased balance; ambulates independently; runs with immature patters; stoops to pick up toys from the floor, ascends stairs with rail and descends with rail and help
	24 months	Generalized weakness and decreased balance; ambulates independently; runs and kicks a ball with immature pattern; stoops to pick up toys from the floor, ascends stairs with rail and descends with rail and help
	24 months	Generalized weakness and decreased balance; ambulates independently; runs and kicks a ball with immature pattern; stoops to pick up toys from the floor, ascends stairs with rail

**TABLE 3**

Comparison of Baseline and Follow-up Mean Functional Mobility Scores Measured by Mullen Scales of Early Learning (MSEL) for AT and Comparison Group

	Mean Functional Mobility Measure (SD)	
	AT Group*	Comparison Group†
MSEL raw score		
Baseline	15.2 (7.0)	12.6 (8.3)
Follow-up	21.3 (6.6)	18.0 (8.5)
MSEL age-adjusted normalized score		
Baseline	27.5 (9.8)	32.5 (9.6)
Follow-up	30.6 (11.2)	28.4 (10.1)
Change between baseline and follow-up	2.6 (9.3)	-2.6 (8.7)
Change over time in MSEL age-adjusted normalized score		
Difference in change scores	5.2 (8.9)‡	

\* The AT Group received 36 weekly aquatic therapy sessions in a community pool with a PT or OT and 1 other child as well as 36 weekly home-based PT or OT treatment sessions.

† The comparison group received 36 weekly home-based treatment sessions with a PT or OT.

‡  $p < 0.05$ .

at baseline to 30.5 (11.2) at follow-up (Table 3). Age-adjusted normalized scores for the controls decreased from 32.5 (9.6) at baseline to 28.4 (10.1) at follow-up. The mean change score for the AT group was 2.6 (9.3) points indicating a relative increase in functional mobility among the AT group participants during the study period. The mean

change score for the comparison group was -2.6 (8.7) indicating a relative decrease in functional mobility among controls during the study period. The difference in mean change scores was 5.2 (8.9), which was statistically significantly different from zero ( $t$  statistic = 1.7) when compared with one-tailed  $t$  distribution with 35 degrees of freedom.

**DISCUSSION**

This study examined the effect of AT, as an adjunct to home-based EI services provided by a PT or OT, on differences in functional mobility of children with neuromuscular and developmental delays and disabilities. The results show that children who participate in weekly AT with a PT or OT, in addition to home visits by these disciplines, demonstrate greater gains in functional mobility than similar children who receive only home visits by a PT or OT.

The paucity of literature regarding AT among young children precludes us from drawing comparisons with similar studies. This study offers evidence to support the benefit of implementing physical therapy interventions in a community pool for children with delayed functional mobility. The retrospective nature of the study design created a baseline date of September 1, 2003. At that time, the AT group had been in existence for nine months. Some of the children enrolled in the study had already been participating in AT before the study initiation. Because the mean duration of follow-up for both groups was not statistically significantly different, the implication is that some of the advantages of AT may have occurred before the baseline date. The magnitude of the observed effects may, therefore, be a diminished representation of the true effect of AT.

Second, the Gross Motor Subsection of the MSEL is part of a full developmental evaluation, and addresses significant gross motor milestones. It delves little into the quality of the child's movements, the consistency of the skills across environments, or the time or effort required to complete the motor task. Given that quality, consistency, and endurance of movement patterns and mobility are promoted during AT, but not captured by the assessment tool, the true effect of AT may be attenuated. The children receiving AT also received home-based physical or occupational therapy, so it was not possible to differentiate to what extent the observed differences were a result of the AT alone or the additive effect of the twice weekly therapy sessions. The control group with motor delay demonstrated an overall decline in normal scores of gross motor skills, which is suggestive of a strong influence of AT in augmenting services of children with neuromuscular and developmental delays and disabilities.

Improved functional mobility has important implications for overall health and development of young children with disabilities. Children with physical disabilities are less likely than their peers who are developing typically to engage in a variety of leisure activities. Further, recreational activities of children with physical disabilities tend to be more passive and occur within the home.<sup>21</sup> Children with developmental and neuromuscular delays and disabilities are at increased risk for secondary complications such as decreased pulmonary function, contractures, obesity, and poor self-image and self-esteem due to restricted activity patterns.<sup>22</sup> AT programming appears to meet the challenges of improving functional mobility and may potentially prevent future secondary complications. Anecdotal testimonials from parents of AT participants in this study included report of child's improved movement around the home and outside as well as increased ease of passive stretching believed to be due to muscle elongation that occurred in the warm water. In addition, parents shared an increased willingness to bring their children to community pools and playgrounds as well as an overall increased sense of hope and happiness attributable to both the child's progress, the child's apparent enjoyment of the AT activities, and the ease with which their child participated in an activity in which children who are developing typically routinely participate. Thus, AT programming appears to be a beneficial adjunct to EI services for young children with delayed functional mobility to address current therapy and recreational needs as well as to potentially promote improved patterns of participation in physical activities.

There are several limitations to this study. First, the small sample size limited the power of the study and prevented further subanalyses of children with specific diagnoses such as CP, myelomeningocele, or prematurity. Post hoc analyses revealed that the study was "underpowered," that is, power to detect a statistically significant difference at the 0.05 level was only 45%. However, this research achieved its purpose of initiating a study of the effect of AT in EI, and more research with larger sample sizes is needed to validate the results of this study.

The second limitation to this study is a lack of generalizability. The study cohort was predominantly white and nonpoor, limiting the generalizability of these results to families in all EI programs, especially those residing in urban areas. Further research is needed to conduct a study that includes ethnically and economically diverse populations. A fourth limitation of the study is the lack of randomization in intervention group allocation. The AT group participants were self-selected based either on recommendation of a PT or OT or on parental knowledge of the group from the EI program newsletter. The AT groups and controls may be different on unmeasured variables, which allow them to leave the house each week to attend the AT session. Potential confounding factors associated with AT group participation may include better maternal mental health, increased motivation, or financial resources for transportation and childcare. These variables could confound the observed association between AT and improved functional mobility. However, a post hoc analysis revealed that approximately 50% of the comparison group participated in an EI parent child group that was either led or co-led by an EI developmental specialist. These groups typically included library groups, playgroups at community centers, or parent support groups. Given the high rate of parent-child group participation among the comparison group, potential confounders unlikely explain the observed differences in children's functional mobility. A fifth limitation of the study is that the authors did not utilize a well-accepted measure of functional mobility. However, the MSEL has been shown previously to have strong psychometric properties and to be valid tool to assess differences in neurodevelopment among young children at high risk. Because the MSEL is routinely administered through the EI program, use of these data prevented the burden of additional developmental evaluations for children and families. However, EI PTs or OTs in some states are beginning to more frequently utilize well-accepted measures of functional mobility<sup>23</sup> (ie, Peabody Scales of Motor Development, Gross Motor Function Measure, and Pediatric Evaluation of Disability Index) to supplement the EI developmental evaluations. Further research on the effects of AT using these more well accepted measurement tools is warranted.

Despite these limitations, this article provides evidence that AT can be a very useful adjunct to EI services to improve functional mobility of children with a variety of neuromuscular and developmental delays and disabilities.

## CONCLUSION

Collaboration between PTs and OTs working in EI and community pool staff can have beneficial results on children's functional mobility. This was a single-site study without random allocation to the intervention group. Although the results of this small study are promising, further research utilizing larger, more diverse samples or a multicenter design is needed. AT promotes gains in children's functional mobility and it provides opportunities for children with physical delays and disabilities to participate

in a recreational activity with their peers who are developing typically in a community setting. This study also suggests that EI home visits may not be enough to promote improved functional mobility for all children. Pediatric PTs and OTs who treat children with physical disabilities, primarily in the home, need to be cognizant of promoting opportunities, in a variety of settings, to enhance children's functional mobility and community integration.

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