



Published in final edited form as:

Arch Phys Med Rehabil. 2020 May ; 101(5): 815–821. doi:10.1016/j.apmr.2019.10.188.

Early intervention service intensity and change in children's functional capabilities

Zachary S. Richardson, MA¹, Elizabeth A. Scully, BA², Jodi K. Dooling-Litfin, PhD², Natalie J. Murphy, MPH³, Briana Rigau, MS^{4,*}, Mary A. Khetani, ScD^{5,*}, Beth M. McManus, ScD¹

¹Department of Health Systems, Management and Policy, University of Colorado at Denver, Denver, CO, USA

²Rocky Mountain Human Services, Denver, CO, USA

³Department of Physical Medicine and Rehabilitation, University of Colorado at Denver, Denver, CO, USA

⁴Children's Participation in Environment Research Lab (CPERL), University of Illinois at Chicago, Chicago, IL, USA

⁵Departments of Occupational Therapy and Disability and Human Development, University of Illinois at Chicago, Chicago, IL, USA

Abstract

Objective—To estimate correlates of early intervention (EI) service dosage and gains in children's functional capabilities from EI entry and discharge.

Design—Retrospective cohort study

Setting—Secondary analyses of a subset of data (n=1,005) collected from an EI administrative database on children discharged from a large, urban EI program between 10/1/2014 and 9/30/16.

Participants—Children who were EI eligible due to developmental delay, had received an EI care plan and at least 1 billable EI service, and had outcomes data at EI entry and exit.

Measured child characteristics included age (49.0% 12–24 months [*n*=492]), sex (36.0% female [*n*=362]), number of developmental delays (76.1% had one developmental delay [*n*=765]), and number of EI services received (78.5% received multiple [*n*=789]).

Intervention—N/A

Corresponding author: Mary A. Khetani, Sc.D., OTR/L, Departments of Occupational Therapy and Disability and Human Development, College of Applied Health Sciences, University of Illinois at Chicago (UIC), 1919 West Taylor Street, Room 316A, Chicago, IL 60612-7250, Phone: 312-996-0942, mkhetani@uic.edu.

*Co-senior authors (listed alphabetically)

Conflict of Interest: The authors of this study have no conflict of interest to declare.

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Main Outcome Measures—Outcomes were EI service intensity (hours per month) and change in functional capabilities as measured via the state-mandated Child Outcomes Summary (COS). Adjusted quantile median regression estimated EI intensity. Adjusted linear regression estimated change in function for social-emotional, cognitive, and adaptive domains of the COS. Measures of children’s developmental delay severity, age at EI entry, race and ethnicity, sex, and language.

Results—Children older than 24 months old experienced significantly higher EI service intensity ($b=0.40$, 95% CI: 0.18, 0.63). Child age and EI service intensity were significantly linked to gains in social and cognitive COS score changes from EI entry to exit.

Conclusion(s)—Older children receive a higher intensity of EI services. EI service intensity and age were linked with positive changes in functional gains.

Keywords

early intervention; activities of daily living; cognition; social skills

Early intervention (EI) is a system that provides access to rehabilitation services for approximately 2–3% of infants and young children with developmental needs nationally.¹ EI emphasizes family-centered, coordinated care often delivered using a transdisciplinary team approach and within the child’s natural learning environments (e.g., home, community)^{2–4}, because a primary goal of EI is to help children optimally function in their homes and communities. Disparities in EI service access and intensity are related to children’s social (e.g., child age) and clinical (e.g., developmental delay) characteristics.^{5,6} Yet, there is limited evidence about how child characteristics and EI services relate to outcomes.

A results-driven accountability system provides unprecedented opportunity to examine the adequacy of EI services relative to outcomes. EI now calls for states to report on child functional outcomes at service entry and exit⁷. Most states choose to use the child outcomes summary (COS) to report on a child’s activity competence according to their social-emotional, cognitive, and adaptive capabilities at EI entry and exit. Since COS outcomes are aligned with contemporary pediatric rehabilitation frameworks that emphasize children’s activity competence as a key rehabilitation outcome, COS data can be used to build evidence about rehabilitation relevant outcomes for EI populations.^{8–10}

While activity competence is a commonly quantified outcome in pediatric rehabilitation, few studies have examined the association between EI service use and gains in activity competencies.¹¹ A number of large sample studies have established the significant role of young children’s activity competence on their participation in valued home and community activities.^{12,13} Even among preschoolers who received EI, children’s activity competencies were negatively associated with participation difficulty across most community activities.¹⁴ While these studies have not been conducted longitudinally, they suggest longer-term consequences of poor activity competence at EI discharge. Therefore, there is need to examine factors associated with children’s activity competence while accounting for EI service use.

As compared to efficacy studies carried out in controlled research conditions, COS data can be paired with other rehabilitation relevant data elements routinely collected by EI programs

to estimate the role of EI service use on activity competence. When COS data are paired with data on social and clinical characteristics of EI eligible children and families, and the type and amount of EI services rendered, it becomes possible to estimate the relative impact of EI services on children's functional progress. However, to our knowledge, only one study has used these data in combination to estimate child functional progress as a function of EI service use, conditional on select child and family characteristics. In this study, Noyes-Grosser and colleagues⁷ established children with Autism Spectrum Disorder received higher intensity EI and made functional gains in one or more COS domains at EI exit. Since nearly two-thirds of children receiving EI services present with developmental delay (no diagnosis)¹⁵, there is critical need to understand EI service use and functional outcomes among the majority of children who receive EI.

The purpose of this study was to estimate child and family characteristics associated with EI service intensity (aim 1), and to examine the impact of child and family characteristics and EI service intensity on changes in children's activity competence by EI discharge (aim 2). We hypothesized child age at EI entry, functional abilities, and higher EI intensity will be associated with change in social-emotional, adaptive, and cognitive functioning by EI exit.

Methods

Setting and Participants

Multi-site institutional ethics approval was obtained prior to data extraction. The study sample was ascertained from electronic administrative data at a large EI program in Colorado that enrolls approximately 1,000 families annually.¹⁶ Data were originally extracted from records of children who were discharged between 10/1/2014 and 9/30/16, following the adoption of an expanded electronic data capture system by the EI program (n=2,045). As shown in Figure 1, this study leverages a subset of data (n=1,005, 66%) on children who were EI eligible due to developmental delay (i.e., sample children did not have a concomitant developmental disability), had received an EI care plan and at least 1 billable EI service, and had COS data at EI entry and exit. In Colorado, developmental delay is defined as 25% or greater delay in one or more areas of development based on standardized developmental assessments administered by the EI team¹⁷

Measures and Framework

The choice of measures was primarily informed by existing participation related constructs in a contemporary conceptual framework highlighting children's cognitive, physical, and social-emotional skills and independence when executing discrete tasks according to an expected standard (i.e., their activity competence).^{9,18,19} As a participation-related construct, a child's activity competence can be measured according to their use of skills and abilities in a daily environment and is influenced by extrinsic factors to the child, like the EI service context that includes rehabilitation and developmental therapies that focus on function.^{8,20,21} For this study, we considered how changes in children's activity competence from EI entry to exit were influenced by child and family characteristics and EI service intensity.

Change in Activity Competence—Change in a child’s activity competence (i.e., their functional capabilities) was measured as the difference in COS scores²² generated at EI entry and exit for three domains: 1) social-emotional (“positive social emotional skills, including social relationships”), 2) cognitive (“acquisition and use of knowledge and skills, including early language/communication and early literacy”), and 3) adaptive (“use of appropriate behaviors to meet their needs”). The three COS scores are endorsed by the Office of Special Education Programs and are used to develop a functional profile of the child that is monitored from EI entry to EI exit. Each of the three COS scores is derived from a team consensus rating process in which caregiver and EI practitioner observations of a child’s functional capabilities, as well as a child’s assessment results inform the team’s rating of the child’s functional capabilities. Each score is on a 7-point scale, from 1=very early skills (i.e., child does not use any immediate foundational skills related to this outcome) to 7=all skills expected (i.e., there are no concerns about the child’s function in this area). A 13-point scale (ranging from –6 to 6) was used to represent change in functional capabilities for each domain as the exit COS score minus the entry COS score.

EI Service Intensity—EI service intensity was operationalized as total hours per month of core EI services (i.e., occupational therapy [OT], physical therapy [PT], speech therapy [ST] and developmental intervention [DI]) divided by EI enrollment length (in months), to estimate total EI service hours per month. To increase interpretability in the final models estimating the association between EI service intensity (i.e., service dosage) and change in activity competence, we created categories of EI service intensity (i.e., less than 2 hours per month, from 2 and up to 3 hours per month, from 3 and up to 4 hours per month, and 4 or more hours per month). Generally, service intensity did not change over time for individual children (J. Litfin, personal communication).

Child Characteristics—We included select child and family characteristics as informed by prior studies on social disparities in EI access^{23–26}, service utilization⁵, and functional outcomes.^{14,15} Predisposing characteristics²⁷, which are social factors that increase the likelihood of EI access, included the child’s ethnicity, age at EI entry, sex, and language. Child ethnicity was categorized as white, non-Hispanic (WNH); black, non-Hispanic (BNH); Hispanic; and other, non-Hispanic (ONH; includes Asian, Pacific Islander and children reporting more than one ethnicity). Age at EI entry was grouped into infants (under 12 months), 1-year-olds (12–23 months), and 2-year-olds (24–36 months). We also included a measure of child sex (male, female), and primary language spoken at home (English versus a language other than English). For this study, the enabling characteristic²⁷, which is a factor associated with means to accessing EI services, was health insurance type, categorized as private versus public (Medicaid or CHP+). To describe service need, the number of developmental delays (e.g., gross and fine motor delay) was included as a proxy for condition severity [1, 2, 3 or more].

Statistical Analysis

Analyses were conducted in Stata 14.2. Descriptive statistics were used to summarize sample characteristics and EI service use according to service dosage and number of core EI services. For continuous variables, sample means, medians, and standard deviations were

calculated. Due to skewed distribution, inter-quartile ranges (IQR) were used to describe EI service utilization. Sample proportions were calculated for categorical variables.

To estimate the association between child and family characteristics and EI service intensity (aim 1), we fit an adjusted median quantile regression model, which estimates the median rather than the mean, and accounts for the skewed distribution of the outcomes data on EI service utilization. For these models, we report the beta coefficient and the 95% confidence interval (CI). These coefficients are interpreted as the association between an additional hour per month of EI service intensity and each child characteristic, relative to the reference group.

To estimate the association between EI service use intensity and change in activity competency (aim 2), we fit an adjusted linear regression model. Specifically, we estimated the association between the difference in COS scores from EI entry to exit and EI service intensity and child and family characteristics. For these models, we report the beta coefficient and the 95% CI. These coefficients are interpreted as the association between a one-unit change (i.e., an additional COS score point) in function for each category of service intensity and each child characteristic, relative to the reference group.

Results

Sample Characteristics

As shown in Table 1, over half of the sampled children were from an ethnic minority group or publicly insured. A total of 388 children (38.6%) were Hispanic, 94 children (9.4%) BNH, and 362 children (36.0%) were female. Most children (76.1%) had a developmental delay in 1 of 5 areas of standardized assessment, while 12.4% had a delay in three or more developmental areas. In 789 households (78.5%), English was the primary language.

Average COS scores at EI entry were highest for social-emotional ($M=5.07$, $SD=1.65$) and lowest for cognitive ($M=3.96$, $SD=1.53$). In comparison, average COS scores at exit were similar for the three areas at EI exit: 1) social-emotional ($M=4.62$, $SD=2.77$); 2) cognitive ($M=4.29$, $SD=2.66$); and 3) adaptive ($M=4.55$, $SD=2.73$).

As shown in Table 2, 78.5% of the children sampled received multiple EI services. ST was the most common core EI service and was accessed by 80.7% of children sampled. Median [IQR] per child total dosage (i.e., hours) of EI services was 10.76 [6.47, 18.58]. Median [IQR] per child intensity (hours per month) of EI services was 2.30 [1.70, 3.23].

EI Service Intensity (Aim 1)

As compared to infants, 2-year-olds received more intensive EI ($b=0.404$ [0.178, 0.631]). Also, as compared to WNH children, children from an ethnicity categorized as other, non-Hispanic received more intensive EI ($b=0.656$ [0.180, 1.132]) (see Table 3). However, these results on ethnic differences in EI service intensity should be interpreted with caution, as children from an ethnicity categorized as other, non-Hispanic represent only 6.5% of the study sample.

Change in Activity Competence (Aim 2)

There were significant associations between EI service intensity and change in children's activity competence (i.e., their functional capabilities) for two of the three domains assessed (see Table 4).

Social-Emotional—Compared to children who received less than 2 hours of EI services per month, those who received 2–3 hours per month ($b=0.767$ [0.226, 1.309]), 3–4 hours per month ($b=0.653$ [0.046, 1.260]), and greater than 4 hours per month ($b=0.645$ [0.022, 1.269]) demonstrated greater gain in social-emotional capabilities by EI discharge. As compared to infants, 1-year-olds ($b=0.590$ [0.074, 1.106]) and 2-year-olds ($b=0.847$ [0.311, 1.382]) demonstrated greater gain in social-emotional capabilities by EI exit.

Cognitive—Compared to children who received less than 2 hours of EI services per month, those who received 2–3 hours per month ($b=0.621$ [0.077, 1.165]), or 3–4 hours per month ($b=0.694$ [0.080, 1.308]) demonstrated greater cognitive gains at EI discharge. Compared to infants, 1-year-olds ($b=1.175$ [0.653, 1.697]) and 2-year-olds ($b=1.383$ [0.851, 1.914]) demonstrated greater gain in cognitive capabilities by EI exit.

Adaptive—There were no differences in the amount of change in adaptive capabilities by EI service intensity or across predisposing and enabling child characteristics.

Discussion

This single-site study examined the relationship between EI service utilization and changes in children's capabilities to perform functional tasks of everyday life. Study results partially support study hypotheses, mainly that child age at EI entry and EI service intensity were linked to gains in children's capabilities. Results provide rationale and framework for conducting scale-up studies of EI effectiveness, with an eye toward improving rehabilitation care quality within EI.

Previous studies have reported on a range of EI service intensity from less than 2 hours per month¹⁵ to over 8 hours per month⁷. There are many factors that influence service intensity, including state variability in programming (e.g., primary service provider model implementation), sample or population, and individual child characteristics. The sample in this study was found to be on the lower end of the established range, receiving an average of 2.3 hours per month of EI services. This finding might be reflective of the transition to a primary service provider approach to EI service provision.²⁸

Similar to previous research^{5,6,29}, child age at EI entry was significantly correlated with EI service intensity, whereby 2-year-olds experienced a significantly higher intensity of EI services. One possible explanation for this finding is 2-year-olds are closer to transitioning out of EI, as children are no longer eligible to receive services through EI once they turn 3-years-old. As compared to infants, 2-year-olds may require a broader scope of service delivery. Thus, a child's care team may recommend a higher intensity of service provision to enable the child to meet developmental milestones and family goals prior to transitioning out of EI services.

This study extends knowledge about the role of child age at EI entry and EI service intensity on functional outcomes. Prior studies have shown child age at EI entry is associated with social-emotional functioning³⁰, both cross-sectionally and from the parent perspective.³¹ Prior studies have also shown EI service use is associated with cognitive COS scores.⁷ However, this is the first study to show that children who are older and those receiving a higher intensity of EI services experience significant gains in their activity competence from EI entry to exit, for all but one domain assessed (i.e., adaptive). It is possible child age at EI entry and EI intensity were linked to social-emotional and cognitive gains because of the types of EI services received. ST was the most common EI service received, which typically emphasizes social communication and cognition as compared to adaptive behavior. Alternatively, these findings may be related to challenges of generating a valid COS score for adaptive capabilities. Relative to the other two COS domains, the adaptive domain contains fewer items and is broader in scope, including motor items such as mobility (e.g. crawling). The scope could result in greater discrepancy when generating a COS score by EI team consensus. In subsequent work using data collected prospectively, testing associations between COS scores and scores from the Pediatric Evaluation of Disability Inventory Computer Adaptive Test³⁰ will help further validate COS scores, particularly within the adaptive domain.

It remains unclear if these findings on EI service use and outcomes will replicate in studies that capture EI service use quality. Rehabilitation services, particularly during early childhood, are commonly rendered in the child's natural environment (e.g., home) and should be family-centered^{2,32} to foster gains in the child's cognitive, social-emotional, and adaptive capabilities. However, in this study, we were limited to estimates of EI service intensity rather than EI service quality, such as the extent to which services are family-centered and thereby responsive to family priorities. Future studies could benefit from data drawn from valid measures of service quality, such as the Measure of Processes of Care (MPOC)³², which has been scaled for implementation across Ontario³³, or the New York Impact on Child Scale³⁴ and National Center for Special Education Accountability Monitoring Family Centered Services Scale³⁵ that have been scaled for statewide implementation.⁴ The MPOC in particular was developed within pediatric rehabilitation and affords for both parent and provider perspectives of EI service quality.³² EI programs that do not administer service quality measures could alternatively leverage their programmatic data on collaboration time to capture EI service quality, since most children receive multiple EI services and need collaborative service provision.

Study Limitations

There are several study limitations related to sampling and timing of data collection. First, data were drawn from a large but single EI program; therefore, results warrant replication within and across states that vary in terms of EI eligibility and approaches to service delivery.²¹ Despite limits to generalizability, most states use COS to report on child outcomes nationally, so this study provides a scalable framework to further leverage these data for outcomes research to drive quality improvement at a more local level, such as regional or county level comparisons. Second, this study leveraged data on a subsample of children with COS data (~70% of the total sample). This is higher than prior studies⁷, but

nevertheless is a subsample. We tested for differences between the subsample with and without complete COS scores, and found no significant differences on measured child characteristics (those shown in Table 1) between these groups. However, results could vary by unmeasured factors related to child outcomes, such as intensity of other non-EI services received, or level of family engagement during care planning when COS ratings are generated. Finally, data in this study were drawn prior to the implementation of GO4IT, a statewide quality improvement initiative to help providers to systematically synthesize multiple sources of assessment data to design and monitor function-focused care, which often includes generating COS scores to estimate a child's functional status. Therefore, replication of this study in programs where GO4IT is being implemented may benefit from more precise COS estimates.

Conclusions

This study leveraged data on children discharged from a large, urban EI program with complete outcomes data, to estimate factors related to EI service use and gains in functional outcomes between service entry and exit. Child age at EI entry was significantly linked with EI service use intensity, and both child age at EI entry and EI service intensity were significantly linked to gains in the COS social-emotional and cognitive capabilities by EI discharge. The study framework can be used across EI programs to harmonize administrative data capture, conduct research on EI service use and outcomes, and apply results to improve EI care quality and value.

Acknowledgements

Research reported in this publication was supported by funding from the National Institutes of Health (1R03HD084909-01A1 and P2CHD065702) and the Comprehensive Opportunities in Rehabilitation Research Training program (K12 HD05593). We thank Vera Kaelin and Andrea Gurga from the Children's Participation in Environment Research Lab for helping to interpret main results and provide critical feedback on earlier versions of this manuscript as well as assist with manuscript preparation. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies. We thank members of the High Value Early Intervention Research Group for their critical review of this manuscript.

List of abbreviations

EI	early intervention
COS	child outcomes summary
OT	occupational therapy
PT	physical therapy
ST	speech therapy
DI	developmental intervention
WNH	white, non-Hispanic
BNH	black, non-Hispanic
ONH	Other, non-Hispanic

IQR	inter-quartile ranges
CI	confidence interval
MPOC	Measure of Processes of Care

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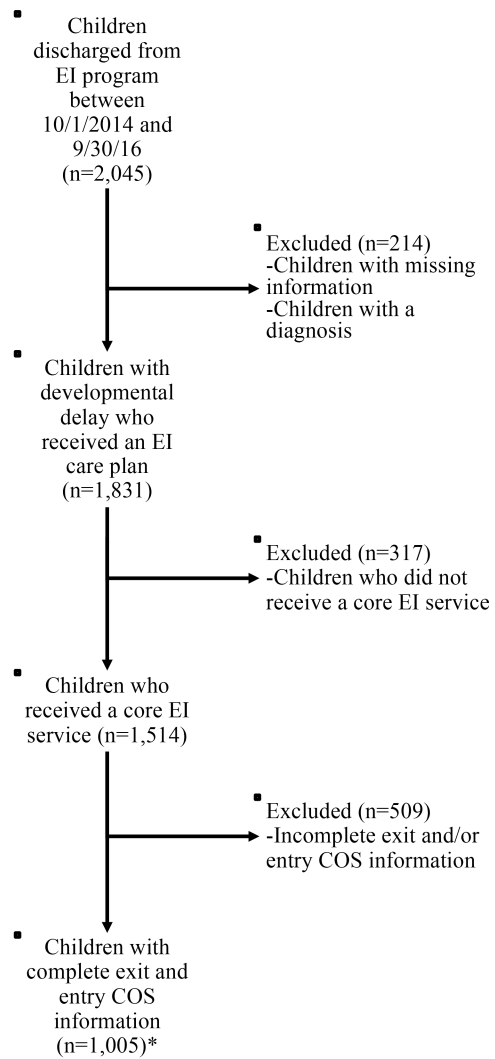
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*Final analytic sample

Figure.
Enrollment diagram
COS = Child Outcomes Summary; EI= early intervention

Table 1.

Child predisposing and clinical characteristics and service need

	<u><i>n</i> (%)</u>
Number of Delay Conditions	
1	765 (76.1)
2	115 (11.4)
3 or more	125 (12.4)
Child's Age (months)	
< 12	199 (19.8)
12–24	492 (49.0)
>24 Months	314 (31.2)
Ethnicity	
White, non-Hispanic	458 (45.6)
Black, non-Hispanic	94 (9.4)
Hispanic	388 (38.6)
Other, non-Hispanic	65 (6.5)
Primary Language, English	789 (78.5)
Child Sex, Female	362 (36.0)
	<u>Mean (SD)</u>
Entry COS	
Positive Social-Emotional Skills	5.07 (1.65)
Acquiring and Using Knowledge and Skills	3.96 (1.53)
Taking Appropriate Action to Meet Needs	4.58 (1.65)
Exit COS	
Positive Social-Emotional Skills	4.62 (2.77)
Acquiring and Using Knowledge and Skills	4.29 (2.66)
Taking Appropriate Action to Meet Needs	4.55 (2.73)
Difference in COS (Exit COS - Entry COS)	
Positive Social-Emotional Skills	-0.45 (2.90)
Acquiring and Using Knowledge and Skills	0.33 (2.87)
Taking Appropriate Action to Meet Needs	-0.04 (2.84)

COS = Child Outcomes Summary.

Table 2.

Early intervention service use

Characteristic	n (%)	
Type of EI Services Received		
PT	241 (24.0)	
OT	191 (19.0)	
ST	811 (80.7)	
DI	450 (44.8)	
Number of EI Services Received		
1	216 (21.5)	
2	313 (31.1)	
3 or more	476 (47.4)	
EI Service Use Intensity (hours per month)		
< 2	171 (17.0)	
2-3	430 (42.8)	
3-4	192 (19.1)	
4 or more	212 (21.1)	
	Mean (SD)	Median [IQR]
EI Child Service Use, Conditional on Any Use		
Total Per Child Hours of EI Services	11.92 (6.47)	10.76 [6.47, 18.58]
Total Per Child EI Service Intensity	2.42 (1.02)	2.30 [1.70, 3.23]
Length of EI Services (Days)	149.50 (74.29)	164.50 [151.00, 179.00]

EI = early intervention; PT = physical therapy; OT = occupational therapy; ST = speech and language therapy; DI = developmental intervention

Table 3.

Adjusted per child intensity of early intervention services

Independent Variables	Total EI Service Intensity
Number of Delay Conditions	
1	<i>ref</i>
2	-0.459 [-1.184, 0.267]
3 or more	-0.491 [-1.219, 0.238]
Child Age (months)	
< 12	<i>ref</i>
12–24	0.644 [-0.182, 1.469]
> 24	0.404 *** [0.178, 0.631]
Ethnicity	
White, non-Hispanic	<i>ref</i>
Black, non-Hispanic	-0.331 [-0.748, 0.086]
Hispanic	0.706 [-0.534, 1.946]
Other, non-Hispanic	0.656 ** [0.180, 1.132]
Primary Language, English	0.565 [-0.932, 2.063]
Child's Sex, Female	0.489 [-0.487, 1.466]
Insurance Type, Medicaid and CHP+	0.485 [-0.285, 1.255]

CHP+ = Child Health Plan Plus; EI = early intervention

p<0.001**
p<0.01*
p<0.05

Table 4.

Change in children's functional capabilities as a function of child and family characteristics and early intervention service use intensity

<i>Independent Variables</i>	Child Outcomes Summary (COS) Domains		
	<i>Social-Emotional⁽¹⁾</i>	<i>Cognitive⁽²⁾</i>	<i>Adaptive⁽³⁾</i>
EI Service Intensity (hours per month)			
< 2	<i>ref</i>	<i>ref</i>	<i>ref</i>
2–3	0.767 ** [0.226, 1.309]	0.621 * [0.077, 1.165]	0.487 [–0.061, 1.036]
3–4	0.653 * [0.046, 1.260]	0.694 * [0.080, 1.308]	0.425 [–0.193, 1.044]
4 or more	0.645 * [0.022, 1.269]	0.413 [–0.211, 1.037]	0.261 [–0.368, 0.891]
Number of Delay Conditions			
1	<i>ref</i>	<i>ref</i>	<i>ref</i>
2	0.071 [–0.507, 0.648]	–0.051 [–0.596, 0.495]	–0.154 [–0.721, 0.414]
3 or more	0.448 [–0.052, 0.948]	–0.063 [–0.512, 0.386]	0.057 [–0.448, 0.562]
Child Age (months)			
<12	<i>ref</i>	<i>ref</i>	<i>ref</i>
12–24	0.590 * [0.074, 1.106]	1.175 *** [0.653, 1.697]	–0.221 [–0.736, 0.294]
> 24	0.847 ** [0.311, 1.382]	1.383 *** [0.851, 1.914]	–0.242 [–0.780, 0.296]
Ethnicity			
White, non-Hispanic	<i>ref</i>	<i>ref</i>	<i>ref</i>
Black, non-Hispanic	–0.020 [–0.675, 0.636]	–0.123 [–0.803, 0.558]	–0.207 [–0.872, 0.458]
Hispanic	–0.168 [–0.633, 0.297]	–0.423 [–0.877, 0.032]	–0.315 [–0.787, 0.158]
Other, non-Hispanic	0.556 [–0.132, 1.244]	0.373 [–0.371, 1.117]	0.406 [–0.288, 1.100]
Primary Language, English	–0.124 [–0.628, 0.380]	0.182 [–0.293, 0.656]	0.014 [–0.498, 0.525]
Child Sex, Female	–0.121 [–0.496, 0.254]	–0.210 [–0.581, 0.160]	0.197 [–0.171, 0.566]

p<0.001

**
p<0.01

*
p<0.05

⁽¹⁾ Difference in Positive Social-Emotional Skills (PSE) (Exit PSE Score - Entry PSE Score)

⁽²⁾ Difference in Acquiring and Using Knowledge and Skills (AUK) (Exit AUK Score - Entry AUK Score)

⁽³⁾ Difference in Taking Appropriate Action to Meet Needs (TAAM) (Exit TAAM Score - Entry TAAM Score)