Social and Functional Characteristics of Receipt and Service Use Intensity of Core Early Intervention Services

Zachary S. Richardson, MA, PhD(c); Mary A. Khetani, ScD, OTR/L; Elizabeth Scully, BS; Jodi Dooling-Litfin, PhD; Natalie J. Murphy, MPH; Beth M. McManus, PT, MPH, ScD

From the Department of Health Systems, Management and Policy (ZS Richardson and BM McManus); Department of Physical Medicine and Rehabilitation (N Murphy), Colorado School of Public Health, Aurora; Department of Occupational Therapy, College of Applied Health Sciences (MA Khetani), University of Illinois at Chicago; and Rocky Mountain Human Services Early Intervention Program (E Scully and J Dooling-Litfin), Denver, Colo
*Drs Richardson and Khetani contributed equally to this work.
The authors have no conflicts of interest to disclose.
Address correspondence to Beth M. McManus, PT, MPH, ScD, Department of Health Systems, Management and Policy, Colorado School of Public Health, 13001 E 17th Pl, MS B119, Aurora, CO 80045 (e-mail: beth.mcmanus@ucdenver.edu).
Received for publication April 14, 2018; accepted February 18, 2019.

ABSTRACT

OBJECTIVE: Describe children's diagnostic, social, and functional characteristics associated with the use of core early intervention (EI) services.

METHODS: The sample included infants and toddlers (N = 2045) discharged from an urban EI program (2014−2016). Adjusted logit models estimated the marginal effects and 95% confidence intervals (CIs) of receipt of any of the 4 core EI services, controlling for the child's developmental condition type, race and ethnicity, primary language, sex, insurance type, age at referral, and functional performance at EI entry. Adjusted median regression estimated EI core service intensity controlling for child characteristics.

RESULTS: The median per-child EI service intensity was less than 3 h/mo (median, 2.7; interquartile range, 2.1−3.5). Children whose primary language was English were 6% more likely to receive occupational therapy (marginal effect = 0.063; 95% CI, 0.010−0.115). Compared to infants, 1- to 2-year-old children were less likely to receive physical therapy and occupational therapy but more likely to receive speech therapy. Compared to infants, 1-year-olds received more intensive speech therapy ($\beta = 0.42$; 95% CI, 0.10−0.70), and 2-year-olds received less intensive occupational therapy ($\beta = -0.70$; 95% CI, −1.35 to −0.10). Children's functional performance at EI entry was significantly associated with the receipt and intensity of EI services.

CONCLUSIONS: Many EI-enrolled children received low-intensity services, a result that was associated with the primary language of the caregiver and the child's age and functional status. Results suggest the need for interventions to improve service delivery for vulnerable EI subgroups.

KEYWORDS: early intervention; functional performance; service use; therapy

ACADEMIC PEDIATRICS 2019;19:722−732

WHAT'S NEW

Early intervention (EI) service intensity is low. Access to most core EI services is related to children's social characteristics and functional performance, and EI therapy service intensity is associated with children's age and some functional performance measures.

PART C OF the Individuals with Disabilities Education Act authorizes states with the incentive of financial support to establish statewide early intervention (EI) systems for infants and toddlers with, or at risk for, developmental delays.[1] There has been a growing demand for EI outcomes research to inform continuous system quality improvement.[2] Until recently, child and family outcomes reporting has not been nationally mandated, resulting in limited opportunities for research on trends in EI service use and how EI service use links with child and family outcomes for quality improvement.

To this end, previous research using local and state-level administrative data suggests that, compared to non-poor and white, non-Hispanic (WNH) children, minority and low-income children not only are less likely to receive EI[3,4] but also receive lower therapy intensity.[5,6] However, these studies have been limited to EI eligibility data (eg, diagnosis). When measures of condition severity are also considered, children with less clinical need receive greater amounts of therapy.[5] Although there are numerous possible explanations for this finding, it suggests that relying on diagnosis alone inadequately captures EI therapy need.

Nationally, states are now required to report to the Office of Special Education Programs on child functional outcomes at EI entry and exit; therefore, child outcomes are becoming common data elements in electronic EI data capture systems.[2] Most states use the Child Outcomes Summary (COS) to generate an estimate of a child's functional performance in 3 domains: social-emotional, cognitive (acquiring and using knowledge and skills), and behavioral/adaptive (taking appropriate action to meet needs).[7] As a baseline measure of function in these 3 areas, COS scores have the potential to be markers for discipline-specific EI service need. To our knowledge, COS data have not yet been included in EI service use studies. In this era of increased EI accountability and fewer federal per-child appropriations,[8] it is critical to leverage COS data for estimating trends and correlates of EI service receipt and intensity.

The purpose of this study is to examine the relationships among developmental, social, and functional characteristics of children and the breadth and intensity of their EI service use.

METHODS

STUDY SAMPLE

The study sample was derived from electronic administrative data at a large EI program that actively serves approximately 1000 families annually. Sample EI-eligible and EI-enrolled children were discharged between October 1, 2014, and September 30, 2016, coinciding with adoption of an expanded electronic data capture system by the EI program. The complete study sample included 2045 EI-eligible children (Table 1). Of those, 342 received a care plan but were discharged after being lost to follow-up, leaving an analytic sample of 1703. Of the 1703 children who had at least 1 billable EI service, 1681 received a core EI service. The remaining 22 children received non-core EI services only. Routine collection of COS data was not mandatory at this program during the study period; therefore, COS information was available for 65% (1326/2045) of children discharged during the study period and 70% (1180/1681) of children who received a core EI service. Multiple-site institutional review board approval was obtained for this study.

MEASURES

The choice of measures was informed by the Aday and Andersen conceptual model of health service access.[9] This model posits that health service utilization and satisfaction are influenced, in part, by characteristics of the eligible population, including their predisposing characteristics, enabling characteristics, and service need (Figure). For this study, we considered how EI service use is influenced by all 3 types of characteristics among the EI-eligible children sampled.

EI SERVICE USE

Total service use was described according to the number of discipline-specific services received (1, 2, 3, or more), number of hours, and duration of services (in months). Service intensity was calculated as total hours divided by total duration of services (in months). EI service use was also described by core discipline: physical therapy (PT), occupational therapy (OT), speech therapy (ST), and developmental intervention (DI). DI is typically provided by someone trained in early childhood or special education and focuses on global play skills and social behaviors. For each core discipline, we estimated 1) any discipline-specific service, and 2) discipline-specific service intensity. The category of any discipline-specific service was contingent on receiving at least 1 billable service from that discipline. Discipline-specific service intensity was calculated by dividing total service hours in that discipline by EI enrollment length, allowing adjustment for varying lengths of EI enrollment.

Table 1. Characteristics of the Study Sample of Children Enrolled in an Urban Early Intervention Program by Predisposing, Enabling, and Need Characteristics (N = 2045)

	Percentages (n)
Predisposing Characteristics	
Child's age at early intervention entry, % (n)	
<12 mo	25.97 (531)
12–24 mo	39.80 (814)
>24 mo	34.23 (700)
Race/ethnicity, % (n)	
White, non-Hispanic	40.73 (833)
Black, non-Hispanic	10.07 (206)
Hispanic	41.91 (857)
Other, non-Hispanic	7.29 (149)
English as primary language, % (n)	75.79 (1550)
Child's sex female, % (n)	36.53 (747)
Enabling Characteristics	
Public health insurance (Medicaid and Child Health Plan Plus), % (n)	55.60 (1137)
Need Characteristics	
Condition type, % (n)	
Developmental delay	89.54 (1831)
Diagnosed condition	10.46 (214)
Number of delay conditions, % (n)	
1	71.78 (1267)
2	12.97 (229)
≥3	15.24 (269)
Entry Child Outcomes Summary (n = 1326), mean (SD)*	
Positive social relationships	4.96 (1.74)
Acquiring and using knowledge and skills	3.91 (1.58)
Taking appropriate action to meet needs	4.42 (1.74)

SD indicates standard deviation.

*Each Child Outcomes Summary subscale score is derived from provider clinical judgment, parent concerns, and developmental assessment results and is measured on a 7-point scale from 1 (very early skills; child does not use any immediate foundational skills related to this outcome) to 7 (all skills expected; there are no concerns about the child's function in this area).

CHARACTERISTICS OF EI-ELIGIBLE CHILDREN SAMPLED

Predisposing characteristics (Figure) are social factors that increase the likelihood of EI access. For this study, these factors included child's race and ethnicity, age, sex (male or female), and language. Race and ethnicity were categorized as white, non-Hispanic (WNH); black,

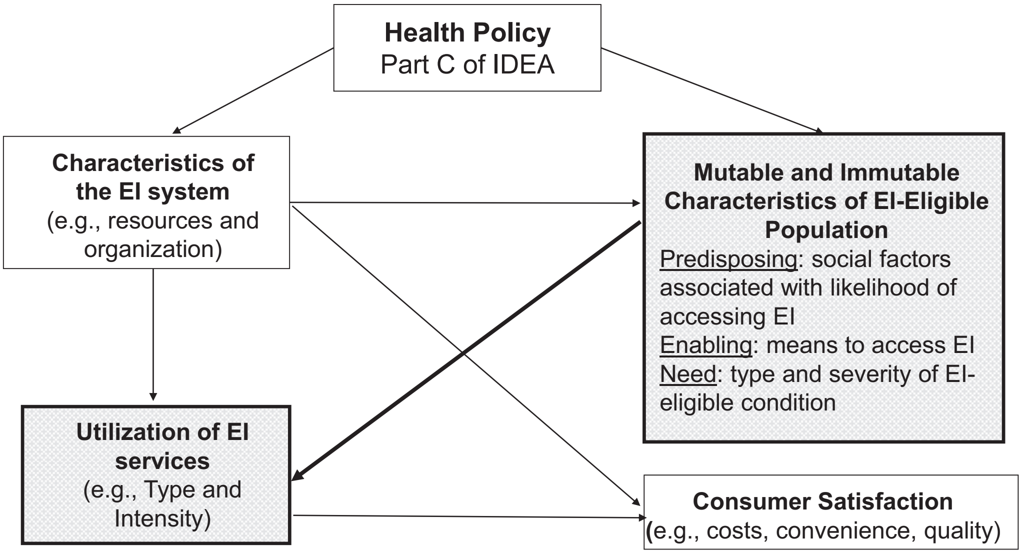

Figure. *Conceptual framework for the study of early intervention utilization (adapted from the Aday and Andersen model).[9] Shaded boxes and darker arrows indicate variables and associations estimated in this study. IDEA indicates Individuals with Disabilities Education Act; EI, early intervention.*

non-Hispanic (BNH); Hispanic; and other race, non-Hispanic (ONH, including Asian, Pacific Islander, and more than 1 race). Age at EI referral was grouped into under 12 months, 12 to 24 months, and greater than 24 months. Language spoken at home was categorized as English versus a language other than English.

Enabling characteristics are those factors that are associated with means to access EI, such as health insurance. For this study, health insurance type was grouped as private or public (includes Medicaid and Child Health Plan Plus). Although health insurance is not required for EI access, insurance type is a marker of income and access to developmental screening and surveillance.[10]

Service need is partially measured through EI eligibility by condition type (diagnosed medical or mental condition vs developmental delay). Children are automatically deemed EI eligible if they have a diagnosed condition that typically results in developmental delay. These conditions are based on federal legislation,[1] with specific diagnoses chosen by states.[11] In Colorado, developmental delay is defined as performing at least 1 standard deviation below the mean on a standardized developmental evaluation.

We also included measures of child function to indicate service need. Child functional characteristics were captured via the 3 EI entry COS score domains: 1) social-emotional skills, 2) cognitive skills, and 3) adaptive/behavioral skills. COS is endorsed by the Office of Special Education Programs as a valid indicator of a child's function.[12,13] EI teams use COS scores to develop a functional profile of the child that is monitored from EI entry to EI exit. These COS domains align with the activity dimension of the International Classification of Functioning, Disability, and Health, an international rehabilitation service framework that guides the estimation of core EI service need.[13−15] Each of the 3 COS scores is a consensus rating informed by provider clinical judgment, parent concerns, and developmental assessment results. COS uses a 7-point scale, from 1 (very early skills; child does not use any immediate foundational skills related to this outcome) to 7 (all skills expected; there are no concerns about the child's function in this area).[13] COS scores directly align with some core EI services and indirectly with others. For example, the social-emotional and cognitive scores directly align with developmental intervention, whereas the adaptive/behavioral function aligns with physical therapy (eg, crawling to a toy), occupational therapy (eg, feeding self with a spoon), and speech therapy (eg, communicating needs).[13]

Because the purpose of this study was to examine the relationships among the developmental, social, and functional characteristics of children and the breadth and intensity of service use, we conducted analyses first on the entire sample and then on the subgroup with complete COS information.

ANALYTIC APPROACH

All analyses were conducted using Stata 15 (StataCorp; College Station, Tex).[16] We first calculated descriptive statistics to describe study sample characteristics and EI service use. We calculated interquartile (IQR) ranges to describe EI service use due to the skewed distribution of data on these variables. Of note, overall EI service use includes all EI services, whereas core EI service use outcomes are conditional on having received that service.

We fit adjusted logit models estimating the likelihood of receipt of any of the core EI services (PT, OT, ST, or DI). Given that odds ratios are not appropriate for non-rare outcomes (ie, they overestimate the association), we present marginal effects (MEs) and 95% confidence intervals (CIs) for each child characteristic.[17,18] Marginal effects, a common effect estimate in health services research, are interpreted as the predicted probability of the outcome occurring with respect to the reference group. Second, we fit adjusted median regression to estimate the association between child characteristics and EI core service intensity due to the skewness of the EI service intensity data. For these models, we present the core EI service median intensity for each model parameter and its 95% confidence interval. Adjusted models included the child characteristics listed above. To determine the influence of baseline functional performance on the receipt and intensity of EI service use, we fit the same multivariable logit and median regression models described above among the subsample of children with complete EI entry COS scores.

RESULTS

SAMPLE CHARACTERISTICS

Of the 1703 children who had at least 1 billable EI service, 1681 received a core EI service. Over 50% of the sample was publicly insured. Nearly 42% of the sample was Hispanic, and 10% was BNH. Over 75% of the sample was from a household where English was the primary language. A little over 30% of the sample was female. The large majority of sample children (89%) were deemed to be EI eligible due to a developmental delay. Mean ± standard deviation COS scores at entry were highest for social-emotional function (4.96 ± 1.70) and lowest for cognitive skills (3.9 ± 1.6). For reference, a COS score of 4 indicates that "the child shows occasional age-appropriate functioning across settings and situations."[13] We found no differences in child characteristics for children with and without complete COS information (results not shown).

EI SERVICE USE AND INTENSITY

As shown in Table 2, ST was the most common core EI service and was accessed by 70% of children sampled. More than 80% of children sampled received multiple EI services concurrently. The median per-child total dosage (hours) of EI services was 12 (IQR, 8.5−17.4) and ranged from 6 (IQR, 3−10) for DI to 19 (IQR, 12.1−25.0) for ST. The median per-child intensity (h/mo) of EI services was 2.7 (IQR, 2.1−3.5) and ranged from 1 (IQR, 1−2) for DI to 4.2 (IQR, 3.5−4.5) for ST.

RECEIPT OF CORE EI SERVICES BY CHARACTERISTICS OF EI-ELIGIBLE CHILDREN AND SERVICE NEED

RECEIPT OF CORE EI SERVICES BY PREDISPOSING SAMPLE CHARACTERISTICS

As compared to infants, 1- to 2-year-olds were 44% less likely (ME = −0.436; 95% CI, −0.496 to −0.376) to receive PT, 8% less likely to receive OT (ME = −0.084; 95% CI, −0.131 to −0.036), and 33% more likely to receive ST (ME = 0.331; 95% CI, 0.276−0.386). Compared to infants, 2-year-olds were 58% less likely (ME = −0.577; 95% CI, −0.630 to −0.524) to receive PT, 14% less likely to receive OT (ME = −0.141; 95% CI, −0.187 to −0.095), and 34% more likely to receive ST (ME = 0.344; 95% CI, 0.287−0.401) (Table 3). In the models including COS scores, Hispanic children were 6% less likely than their WNH peers to receive PT (ME = −0.057; 95% CI, −0.114 to 0.001) which approached statistical significance (*P* = .06) (Table 4). Children whose primary language was English (vs a language other than English) were 5% more likely to receive OT (ME = 0.051; 95% CI, 0.011−0.091) (Table 3).

RECEIPT OF CORE EI SERVICES BY ENABLING SAMPLE CHARACTERISTICS

We found no differences in core services receipt by health insurance type.

RECEIPT OF CORE EI SERVICES BY SERVICE NEED

Children with a diagnosis were 7% more likely to receive OT (ME = 0.070; 95% CI, 0.010−0.131) and 9% more likely to receive DI (ME = 0.088; 95% CI, 0.012−0.165) (Table 3). However, when functional performance at EI entry was included in the model, condition type was no longer statistically significantly associated with receipt of OT or DI (Table 4). There were significant differences in receipt of EI core services for all 3 entry COS scores. A point increase in cognitive COS score was associated with a 5% higher likelihood of receiving PT (ME = 0.049; 95% CI, 0.032−0.065) and 7% lower likelihood of receiving ST (ME = −0.066; 95% CI, −0.087 to −0.046). Children with higher entry behavioral/adaptive COS scores were less likely to receive PT (ME = −0.061; 95% CI, −0.075 to −0.047) and OT (ME = −0.019; 95% CI, −0.033 to −0.004) and more likely to receive ST (ME = 0.028; 95% CI, 0.011−0.044). Children with higher entry COS scores related to positive social relationships were less likely to receive OT (ME = −0.018; 95% CI, −0.035 to −0.001) and DI (ME = −0.037; 95% CI, −0.060 to −0.015) (Table 4).

CORE EI SERVICE INTENSITY BY CHARACTERISTICS OF EI-ELIGIBLE CHILDREN AND SERVICE NEED

CORE EI SERVICE INTENSITY BY PREDISPOSING CHARACTERISTICS OF SAMPLED CHILDREN

Compared to children entering EI as infants, children entering as 2-year-olds received less intensive OT ($\beta = -0.83$; 95% CI, −1.40 to −0.30), and those entering as 1-year-olds received more intensive ST ($\beta = 0.9$; 95% CI, 0.3−1.6) and overall EI services ($\beta = 0.59$; 95% CI, 0.03−1.10). Additionally, children entering EI as 2-year-olds received more intensive ST ($\beta = 0.65$; 95% CI, 0.30−0.90) and overall EI services ($\beta = 0.24$; 95% CI, 0.10−0.40) than those entering as infants (Table 5). BNH children received more intensive OT ($\beta = 0.76$; 95% CI, 0.04−1.50) than their WNH counterparts. Children whose primary language was English received less intensive PT ($\beta = -0.51$; 95% CI, −0.90 to −0.10) and OT ($\beta = -0.69$; 95% CI, −1.20 to −0.20) than their peers whose primary

Table 2. Service Use Characteristics of the Sample of Children Who Received at Least 1 Early Intervention Service (N = 1703)

Characteristic	
Type of early intervention services received, % (n)	
Physical therapy	25.72 (438)
Occupational therapy	20.14 (343)
Speech and language pathology	71.64 (1220)
Developmental intervention	45.80 (780)
Number of early intervention services received, % (n)	
1	20.43 (348)
2	32.71 (557)
≥3	46.86 (798)
Total per-child hours of early intervention services conditional on any use (h), median (IQR)	
All services	12.00 (8.50 to 17.43)
Physical therapy	16.13 (9.00 to 24.00)
Occupational therapy	12.00 (5.00 to 22.33)
Speech and language pathology	19.00 (12.13 to 25.00)
Developmental intervention	6.00 (3.00 to 10.00)
Total per-child early intervention service intensity conditional on any use (h/mo), median (IQR)	
All services	2.69 (2.07 to 3.50)
Physical therapy	3.61 (2.00 to 4.33)
Occupational therapy	3.00 (1.50 to 4.28)
Speech and language pathology	4.20 (3.50 to 4.50)
Developmental intervention	1.00 (1.00 to 2.00)
Total early intervention service use (mo), mean (IQR)	5.50 (3.50 to 6.05)

IQR indicates interquartile range.

language was not English (Table 5). When functional performance was included in the models, the child's primary language was no longer significantly associated with intensity of PT or OT service use (Table 6).

CORE EI SERVICE INTENSITY BY ENABLING CHARACTERISTICS OF SAMPLED CHILDREN

Compared to their privately insured peers, publicly insured children received more intensive DI ($\beta = 0.56$; 95% CI, 0.30−0.80).

CORE EI SERVICE INTENSITY BY SERVICE NEED

Higher baseline social emotional scores were associated with lower DI intensity ($\beta = -0.25$; 95% CI, −0.30 to −0.20), whereas higher baseline cognitive scores ($\beta = 0.10$; 95% CI, 0.01−0.20) and adaptive/behavioral scores ($\beta = 0.11$; 95% CI, 0.02−0.20) were associated with greater DI intensity (Table 6).

DISCUSSION

A growing number of common data elements that are collected and reported annually across states allows greater health services research in early intervention. This is one of the first studies to leverage data on social and functional characteristics of children discharged from a large, urban EI program to show that low rates of EI intensity and core EI service use were both associated with select predisposing factors, as well as service need as indicated by estimates of the child's baseline functioning.

We found a very low intensity of EI services overall—less than 1 h/wk (less than 2.7 h/mo, overall). These results are similar to our prior study, in which service use intensity was both low and variable.[6] There are few national studies to which to compare our results, although a nationally representative sample of EI-enrolled children showed that about 1/3 received less than 1 h/wk, about 1/3 received 1 to 2 h/wk, and about 1/3 received 2 or more hours per week.[19] Children in the current study appear to be receiving less intensive EI services than previously reported, perhaps reflecting a substantial decline in federal per-child appropriations for EI as this cohort study was conducted over a decade ago.

Core service use intensity is consistent with previously reported therapy intensity among EI-enrolled, EI-eligible, and Medicaid-enrolled children.[5] Yet, previous studies were limited by smaller sample sizes and, in the case of Medicaid-enrolled children, an inability to confirm EI participation. Thus, to our knowledge, this is the first study to examine patterns of core service use intensity within a large urban EI program. The service use intensity described in this study falls short of recommendations based on evidence-based models of pediatric therapy service breadth, intensity, and appropriateness.[14,15] States are pressed to provide EI services to increasing numbers of EI-eligible children amid a context of declining federal per-child EI appropriations,[8] which may indirectly affect intensity when creating EI care plans. The choice of service delivery model (eg, primary service provider model) may also influence service intensity.[20−22] Future research should investigate and characterize cost-effective packages of EI service delivery in light of their impact on meaningful child and family outcomes.

PREDISPOSING CHARACTERISTICS

We found that children living in households where the primary language is not English were less likely to receive OT, and Hispanic children were marginally less likely to receive PT. These findings are consistent with prior

Table 3. Adjusted Marginal Effects from Logit Models Estimating Receipt of a Core Early Intervention Service Among a Sample (N = 2045) of Children Enrolled in an Urban Early Intervention Program

Independent Variables	Marginal Effects of Any Physical Therapy ME (95% CI)	Marginal Effects of Any Occupational Therapy ME (95% CI)	Marginal Effects of Any Speech Therapy ME (95% CI)	Marginal Effects of Any Developmental Intervention ME (95% CI)
Condition type				
Diagnosed condition	−0.009 (−0.068 to 0.051)	0.070* (0.010 to 0.131)	−0.005 (−0.079 to 0.068)	0.088* (0.012 to 0.165)
Child's age				
<12 mo	Ref	Ref	Ref	Ref
12–24 mo	−0.436*** (−0.496 to −0.376)	−0.084*** (−0.131 to −0.036)	0.331*** (0.276 to 0.386)	−0.016 (−0.073 to 0.041)
>24 mo	−0.577*** (−0.630 to −0.524)	−0.141*** (−0.187 to −0.095)	0.344*** (0.287 to 0.401)	−0.027 (−0.086 to 0.032)
Race/ethnicity				
White, non-Hispanic	Ref	Ref	Ref	Ref
Black, non-Hispanic	−0.022 (−0.090 to 0.047)	−0.012 (−0.072 to 0.048)	−0.039 (−0.116 to 0.037)	0.070 (−0.010 to 0.151)
Hispanic	−0.026 (−0.079 to 0.026)	−0.042 (−0.085 to 0.001)	−0.042 (−0.099 to 0.015)	0.006 (−0.053 to 0.064)
Other, non-Hispanic	−0.053 (−0.121 to 0.014)	0.096* (0.023 to 0.169)	−0.021 (−0.103 to 0.062)	−0.015 (−0.099 to 0.070)
English as primary language	0.001 (−0.048 to 0.049)	0.051* (0.011 to 0.091)	0.000 (−0.054 to 0.054)	0.012 (−0.044 to 0.069)
Child's sex female	0.037 (−0.000 to 0.074)	−0.024 (−0.056 to 0.008)	−0.052* (−0.095 to −0.010)	−0.030 (−0.073 to 0.014)
Insurance type (Medicaid and Child Health Plan Plus)	−0.027 (−0.073 to 0.018)	−0.014 (−0.053 to 0.025)	−0.002 (−0.053 to 0.048)	−0.007 (−0.059 to 0.045)
Number of observations	2045	2045	2045	2045

ME indicates marginal effects; CI, confidence interval; Ref, reference.
$*P < .05$; $**P < .01$; $***P < .001$.

research involving a statewide cohort of children with developmental disabilities and delays that found that Hispanic children had significantly lower odds of receiving therapies after adjusting for a number of social and clinical characteristics.[5] Similarly, language barriers to pediatric care have been described as limiting access to interpreter services, decreasing caregiver satisfaction with care,[23,24] and increasing miscommunication about the child's diagnosis or treatment plan.[25] As EI endorses a family-centered care approach, providers must be equipped with culturally valid tools for engaging families of diverse backgrounds in care planning and outcomes monitoring.[25–27] A few studies have applied best practice standards to culturally adapt assessments for use in EI and examine feasibility in light of limited organizational resources.[26–29]

Our study findings also confirm previous reports regarding the effects of predisposing factors such as race, ethnicity, and age on EI service use.[5,6] The finding that BNH children were more likely than their WNH peers to receive DI is surprising. This finding is consistent with a previous study that examined disparities in core EI service use.[6] Implications of this finding are not immediately clear. It may be appropriate that BNH children are receiving DI to promote cognitive and social development; however, this finding is problematic if BNH children are receiving DI in lieu of indicated specialized therapies (eg, PT). Future research should explore family preferences for EI core services in light of state EI service provision models to ensure efficient and equitable service delivery.

The American Academy of Pediatrics has developed an algorithm[30] for early identification of developmental concerns and EI referral; thus, pediatricians are instrumental in facilitating EI access and assisting families with advocating for appropriate EI service intensity.[31,32] Moreover, our findings are consistent with previous literature[31,32] suggesting EI access and intensity disparities among important EI subgroups (eg, infants, minority children). This suggests a potential opportunity for pediatricians to provide more intensive shared decision-making with regard to EI access and anticipatory guidance for EI service intensity, particularly for families of children at greater risk for access barriers or low service use.

CHARACTERISTICS OF NEED

Each of the 3 types of children's baseline functional skills appeared to be potential indicators of service need as they contributed to differences in EI service use and intensity. This may help establish the clinical usefulness of COS by examining its connection to service type. Children with higher social-emotional scores were less likely to receive OT and DI and received less intensive DI. DI typically focuses on building children's play skills and social interaction, and OT often focuses on improving self-regulation during social interactions, so it is plausible that these children have less need for DI and OT.

The finding that higher baseline behavioral/adaptive scores were associated with more intensive DI was

Table 4. Adjusted Marginal Effects from Logit Models Estimating Receipt of a Core Early Intervention Service Among a Subsample of Children (N = 1326) with Complete Child Outcomes Survey Information at Early Intervention Entry

Independent Variables	Marginal Effects of Any Physical Therapy ME (95% CI)	Marginal Effects of Any Occupational Therapy ME (95% CI)	Marginal Effects of Any Speech Therapy ME (95% CI)	Marginal Effects of Any Developmental Intervention ME (95% CI)
Condition type				
Diagnosed condition	0.008 (−0.063 to 0.080)	0.057 (−0.021 to 0.136)	0.030 (−0.047 to 0.107)	0.081 (−0.020 to 0.182)
Child's age				
<12 mo	Ref	Ref	Ref	Ref
12–24 mo	−0.328*** (−0.402 to −0.254)	−0.076* (−0.138 to −0.014)	0.218*** (0.147 to 0.290)	−0.046 (−0.120 to 0.027)
>24 mo	−0.468*** (−0.540 to −0.397)	−0.110*** (−0.175 to −0.045)	0.283*** (0.208 to 0.358)	−0.020 (−0.101 to 0.061)
Race/ethnicity				
White, non-Hispanic	Ref	Ref	Ref	Ref
Black, non-Hispanic	0.014 (−0.063 to 0.092)	0.012 (−0.068 to 0.092)	0.005 (−0.086 to 0.095)	0.138** (0.034 to 0.243)
Hispanic	−0.057 (−0.114 to 0.001)	−0.020 (−0.078 to 0.038)	−0.012 (−0.080 to 0.055)	−0.006 (−0.082 to 0.069)
Other, non-Hispanic	−0.036 (−0.110 to 0.039)	0.108* (0.018 to 0.199)	0.023 (−0.065 to 0.111)	−0.008 (−0.113 to 0.097)
English as primary language	0.026 (−0.032 to 0.085)	0.063* (0.010 to 0.115)	−0.040 (−0.105 to 0.025)	−0.006 (−0.080 to 0.068)
Child's sex female	0.047* (0.005 to 0.089)	−0.056** (−0.098 to −0.014)	−0.041 (−0.090 to 0.007)	−0.007 (−0.063 to 0.048)
Insurance type (Medicaid and Child Health Plan Plus)	−0.001 (−0.053 to 0.050)	−0.029 (−0.081 to 0.022)	−0.033 (−0.093 to 0.028)	−0.017 (−0.084 to 0.049)
Entry Child Outcomes Summary†				
Positive social emotional skills	0.006 (−0.011 to 0.023)	−0.018* (−0.035 to −0.001)	0.021 (−0.000 to 0.041)	−0.037** (−0.060 to −0.015)
Acquiring and using knowledge and skills	0.049*** (0.032 to 0.065)	0.005 (−0.013 to 0.023)	−0.066*** (−0.087 to −0.046)	−0.008 (−0.030 to 0.014)
Taking appropriate action to meet needs	−0.061*** (−0.075 to −0.047)	−0.019** (−0.033 to −0.004)	0.028** (0.011 to 0.044)	0.006 (−0.014 to 0.026)
Number of observations	1326	1326	1326	1326

ME indicates marginal effects; CI, confidence interval; Ref, reference.

*$P < .05$; **$P < .01$; ***$P < .001$.

†Each Child Outcomes Summary subscale score is derived from provider clinical judgment, parent concerns, and developmental assessment results and is measured on a 7-point scale from 1 (very early skills; child does not use any immediate foundational skills related to this outcome) to 7 (all skills expected; there are no concerns about the child's function in this area).

Table 5. Results of Adjusted Median Regression Models Estimating Per-Child Intensity of All and Core Early Intervention Services Among Children Enrolled in an Urban Early Intervention Program Who Received at Least 1 Core Early Intervention Service (N = 1681)[†]

Independent Variables	Total Intensity β (95% CI)	Physical Therapy Intensity β (95% CI)	Occupational Therapy Intensity β (95% CI)	Speech Therapy Intensity β (95% CI)	Developmental Intervention Intensity β (95% CI)
Condition type					
Diagnosed condition	−0.037 (−0.341 to 0.266)	−0.142 (−0.494 to 0.211)	0.029 (−0.435 to 0.493)	−0.075 (−0.642 to 0.492)	−0.121 (−0.453 to 0.212)
Child's age					
<12 mo	Ref	Ref	Ref	Ref	Ref
12−24 mo	0.588* (0.033 to 1.142)	−0.017 (−0.351 to 0.318)	−0.307 (−0.727 to 0.113)	0.921** (0.279 to 1.564)	0.245 (−0.026 to 0.516)
>24 mo	0.241** (0.073 to 0.409)	−0.450 (−1.085 to 0.184)	−0.830** (−1.374 to −0.286)	0.652*** (0.339 to 0.964)	0.133 (−0.166 to 0.432)
Race/ethnicity					
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	−0.218 (−0.521 to 0.084)	−0.358 (−1.026 to 0.309)	0.762* (0.036 to 1.488)	0.159 (−0.271 to 0.590)	0.091 (−0.250 to 0.433)
Hispanic	0.367 (−0.354 to 1.087)	−0.187 (−0.633 to 0.259)	−0.095 (−0.570 to 0.381)	0.574 (−0.420 to 1.568)	−0.108 (−0.403 to 0.188)
Other, non-Hispanic	0.219 (−0.103 to 0.541)	0.185 (−0.492 to 0.861)	−0.067 (−0.666 to 0.531)	0.137 (−0.247 to 0.522)	−0.099 (−0.511 to 0.314)
English as primary language	0.152 (−0.647 to 0.952)	−0.505* (−0.928 to −0.081)	−0.685** (−1.201 to −0.169)	0.334 (−0.814 to 1.483)	−0.069 (−0.355 to 0.216)
Child's sex female	0.310 (−0.298 to 0.919)	0.276 (−0.004 to 0.556)	−0.050 (−0.431 to 0.331)	0.404 (−0.482 to 1.289)	−0.272** (−0.469 to −0.075)
Insurance type (Medicaid and Child Health Plan Plus)	0.304 (−0.101 to 0.710)	0.078 (−0.328 to 0.484)	0.003 (−0.445 to 0.451)	0.248 (−0.337 to 0.834)	0.561*** (0.307 to 0.816)
Number of observations	1681	430	332	1210	774

CI indicates confidence interval.

**P* < .05; ***P* < .01; ****P* < .001.

†Core early intervention specific models include children who received that specific service; for example, the model estimating physical therapy intensity includes all children who received any physical therapy.

Table 6. Results of Adjusted Median Regression Models Estimating Per-Child Service Use Intensity Overall and for Core Early Interventions Services Among a Subgroup of Children with Complete Entry Child Outcomes Survey Information Who Received at Least 1 Core Early Intervention Service (N = 1180)

Independent Variables	Total Intensity β (95% CI)	Physical Therapy Intensity β (95% CI)	Occupational Therapy Intensity β (95% CI)	Speech Therapy Intensity β (95% CI)	Developmental Intervention Intensity β (95% CI)
Condition type					
Diagnosed condition	−0.109 (−0.439 to 0.221)	0.004 (−0.439 to 0.447)	−0.185 (−0.740 to 0.370)	−0.001 (−0.559 to 0.558)	−0.284 (−0.634 to 0.065)
Child's age					
<12 mo	Ref	Ref	Ref	Ref	Ref
12–24 mo	0.274* (0.050 to 0.498)	0.076 (−0.319 to 0.471)	−0.318 (−0.802 to 0.166)	0.421* (0.098 to 0.743)	0.087 (−0.271 to 0.444)
>24 mo	−0.016 (−0.681 to 0.649)	−0.044 (−0.832 to 0.743)	−0.702* (−1.347 to −0.057)	0.166 (−0.710 to 1.043)	0.088 (−0.314 to 0.489)
Race/ethnicity					
White, non-Hispanic	Ref	Ref	Ref	Ref	Ref
Black, non-Hispanic	−0.281 (−0.707 to 0.145)	−0.403 (−1.146 to 0.340)	0.353 (−0.386 to 1.092)	0.108 (−0.444 to 0.659)	−0.053 (−0.445 to 0.339)
Hispanic	0.654 (−0.409 to 1.717)	0.095 (−0.442 to 0.632)	−0.180 (−0.742 to 0.383)	0.829 (−0.612 to 2.270)	−0.158 (−0.498 to 0.181)
Other, non-Hispanic	0.405 (−0.038 to 0.848)	0.568 (−0.200 to 1.337)	−0.127 (−0.821 to 0.567)	0.444 (−0.185 to 1.073)	−0.142 (−0.657 to 0.373)
English as primary language	0.410 (−0.827 to 1.646)	−0.381 (−0.942 to 0.180)	−0.590 (−1.203 to 0.023)	0.724 (−1.023 to 2.470)	−0.111 (−0.447 to 0.226)
Child's sex female	0.532 (−0.453 to 1.518)	0.277 (−0.060 to 0.613)	−0.207 (−0.641 to 0.227)	0.726 (−0.644 to 2.095)	−0.316** (−0.529 to −0.103)
Insurance type (Medicaid and Child Health Plan Plus)	0.419 (−0.211 to 1.050)	−0.057 (−0.546 to 0.432)	0.060 (−0.467 to 0.588)	0.529 (−0.442 to 1.500)	0.541*** (0.241 to 0.842)
Entry Child Outcomes Summary†					
Positive social emotional skills	0.206 (−0.247 to 0.659)	−0.044 (−0.184 to 0.097)	−0.153 (−0.327 to 0.021)	0.252 (−0.337 to 0.841)	−0.248*** (−0.336 to −0.161)
Acquiring and using knowledge and skills	−0.331 (−0.972 to 0.310)	0.127 (−0.013 to 0.266)	0.226** (0.056 to 0.395)	−0.509 (−1.368 to 0.350)	0.096* (0.013 to 0.179)
Taking appropriate action to meet needs	0.152 (−0.087 to 0.391)	−0.128 (−0.264 to 0.007)	−0.132 (−0.286 to 0.022)	0.257 (−0.028 to 0.541)	0.109* (0.023 to 0.195)
Number of observations	1180	317	248	912	549

CI indicates confidence interval.

*$P < .05$; **$P < .01$; ***$P < .001$.

†Each Child Outcomes Summary subscale score is derived from provider clinical judgment, parent concerns, and developmental assessment results and is measured on a 7-point scale from 1 (very early skills; child does not use any immediate foundational skills related to this outcome) to 7 (all skills expected; there are no concerns about the child's function in this area).

unexpected but highlights the breadth of DI interventions and of children receiving DI services (children receiving PT or OT are likely more homogeneous groups). We also found that children with higher baseline behavioral/adaptive scores were less likely to receive OT, but if they did it was more intense. Children with higher behavioral/adaptive scores were also less likely to receive PT and more likely to receive ST. Adaptive and behavioral skills relate to a child's capacity to perform practical tasks (eg, feeding self with utensils, moving toward a desired toy, interacting with caregivers and peers). Children with these skills may be able to meet their needs through functional mobility and have less need for PT; instead, these children plausibly have difficulty using expressive language, suggesting higher need for ST, and complex self-care difficulties that warrant intensive OT.

Conversely, children with higher cognitive scores were more likely to receive PT and less likely to receive ST. These children are plausibly referred to EI for motor delays and therefore have greater need for PT and less for ST. Interestingly, children with higher cognitive scores receive more intensive DI. Again, this highlights the diversity of DI interventions and implies the heterogeneity of children receiving DI services.

STUDY LIMITATIONS

Data were ascertained from a single EI program, which could limit the generalizability of findings given the heterogeneity of EI programming; however, many EI programs routinely collect data elements used in this study, thus providing a common framework to employ in understanding service use patterns. We acknowledge that because the study state has relatively generous eligibility criteria the study sample had relatively minor developmental delays. However, our data are consistent with a nationally representative sample of EI-enrolled children where the vast majority had a developmental delay (vs diagnosed condition), and the most common area of delay was language development. Further research should investigate the state policy levers influencing EI service delivery and interventions to improve EI service breadth and intensity.[19] Additionally, we were missing data on COS information for about 30% of the sample. Although we found no differences by measured covariates for children with and without COS information, the possibility exists that the groups vary by unmeasured factors associated with EI access and service use.

In addition, COS scores are consensus ratings informed by parent and provider perceptions of the child's functioning, which could result in variable score estimation. Multiple functional areas are covered in some COS domains, which could compromise face validity. Also, COS items specify how a functional task is performed, which may not differentiate it from an age-normed developmental score; therefore, the required developmental assessment could be weighted heavily versus the optional family assessment, which is not completed by all families. As quality improvement initiatives continue to evolve, it will be important to determine best practices related to COS data collection and use to determine their convergent and divergent validity and clinical utility. For example, COS data that are based on measures of developmental status could be compared to those based on both developmental status and family assessment.[14] COS is a relatively novel measurement and may not be the best determinant of service provision. Although we recognize this as a limitation, we also consider its use an asset to this study as it is untested in the field and shows promising clinical utility for describing EI service need.

CONCLUSIONS

This study leveraged common data elements of children discharged from a large, urban EI program to identify salient characteristics that are associated with service use type and intensity. Overall, EI service use intensity was lower than previously reported national estimates. Results also suggest marked disparities in access to EI core services among Hispanic children and families whose primary language is not English. Core EI service access and intensity appear related to children's social characteristics and functional skills, thus providing new insight into the breadth and intensity of EI service needs for continuous quality improvement.

ACKNOWLEDGMENTS

We thank Briana Rigau for her feedback on earlier versions of this manuscript.

Financial disclosure: B.M.M. and M.A.K. acknowledge funding from the National Institutes of Health (1R03HD084909-01A1) and the Comprehensive Opportunities in Rehabilitation Research Training program (K12 HD05593). These funding sources had no involvement in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the article for publication.

REFERENCES

1. US Government. Individuals with Disabilities Education Act, Reauthorization 2004, PL 108-446. Available at: http://www.copyright.gov/legislation/pl108-446.pdf. Accessed August 8, 2014.
2. Early Childhood Technical Assistance Center. Outcomes. Available at: http://ectacenter.org/eco/pages/fed_req.asp. Accessed February 21, 2018.
3. Feinberg E, Silverstein M, Donahue S, et al. The impact of race on participation in Part C early intervention services. *J Dev Behav Pediatr*. 2012;32:284–291.
4. Twardzik E, Cotto-Negron C, MacDonald M. Factors related to early intervention Part C enrollment: a systematic review. *Disabil Health J*. 2017;10:467–474.
5. McManus BM, Rapport MJ, Richardson Z, et al. Therapy use for children with developmental conditions: analysis of Colorado Medicaid data. *Pediatr Phy Ther*. 2017;29:192–198.
6. Khetani M, Richardson Z, McManus BM. Social disparities in early intervention service use and provider-reported outcomes. *J Dev Behav Pediatr*. 2017;38:501–509.
7. Early Childhood Technical Assistance Center. Child Outcomes Summary (COS) Process. Available at: http://ectacenter.org/eco/pages/cos.asp#COSProcessModule. Accessed March 14, 2018.
8. Early Childhood Technical Assistance Center. Part C Infant and Toddler Program Federal Appropriations and National Child Count 1987-2015. Available at: http://ectacenter.org/~pdfs/growthcomp-partc.pdf. Accessed December 1, 2017.

9. Aday LA, Andersen R. A framework for the study of access to medical care. *Health Serv Res*. 1974;9:208–220.
10. Hirai AH, Kogan MD, Kandasamy V, et al. Prevalence and variation of developmental screening and surveillance in early childhood. *JAMA Pediatr*. 2018;172:857–866.
11. Established Condition Database—Early Intervention Colorado. Medical Diagnosis. Available at: https://docs.google.com/spreadsheets/d/14ZfUsdLaMiv4ULd9oP-xkUVaPkKQQ7KI_yhr-POiFwqA/edit#gid=0. Accessed October 22, 2018
12. Barton L, Taylor C, Spiker D, et al. Validity of the Data from the Child Outcomes Summary Process: Findings from the ENHANCE Project. Available at: http://ectacenter.org/~pdfs/calls/2016/ENHANCEbrief_03-02-16Final.pdf. Accessed October 22, 2018.
13. Early Childhood Technical Assistance Center. Definitions for Child Outcomes Summary (COS) Ratings. Available at: http://ectacenter.org/~pdfs/eco/definitions_outcome_ratings.pdf. Accessed October 22, 2018.
14. Bailes AF, Reder R, Burch C. Development of guidelines for determining frequency of therapy services in a pediatric medical setting. *Pediatr Phys Ther*. 2008;20:194–198.
15. Gannotti M, Christy J, Heathcock J, et al. A path model for evaluating dosing parameters for children with cerebral palsy. *Phys Ther*. 2014;94:411–421.
16. StataCorp. Stata® Release 15. Available at: https://www.stata.com/new-in-stata/. Accessed March 5, 2019.
17. Davies HT, Crombie IK, Tavakoli M. When can odds ratios mislead? *BMJ*. 316:989−991.
18. Brzoska P. Using average marginal effects over odds ratios as measures of effect size in epidemiology. *Ann Epidemiol*. 2017;27:525–526.
19. Hebbeler K, Spiker D, Bailey D, et al. Early intervention for infants and toddlers with disabilities and their families: participants, services, and outcomes. Available at: https://www.sri.com/sites/default/files/publications/neils_finalreport_200702.pdf. Accessed December 1, 2017.
20. Bruder MB, Dunst CJ. Factors related to the scope of early intervention service coordinator practices. *Infants Young Child*. 2008;21:176–185.
21. Dunst CJ, Bruder MB. Early intervention service coordination models and service coordinator practices. *J Early Interv*. 2006;28:155–165.
23. Kingsley K, Mailloux Z. Evidence for the effectiveness of different service delivery models in early intervention services. *Am J Occup Ther*. 2013;67:431–436.
23. Agency for Healthcare Research and Quality. National Healthcare Disparities Report. Available at: https://archive.ahrq.gov/research/findings/nhqrdr/nhdr11/index.html. Accessed October 24, 2018.
24. Data Resource Center for Child & Adolescent Health. 2016 and 2016-2017 Combined National Survey of Children's Health Interactive Data Query. Available at: http://www.childhealthdata.org/browse/survey. Accessed October 24, 2018.
25. Mosquera RA, Samuels C, Flores G. Family language barriers and special-needs children. *Pediatrics*. 2016;138:e20160321.
26. Sousa VD, Rojjanasrirat W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: a clear and user-friendly guideline. *J Eval Clin Pract*. 2001;17:268–274.
27. Beaton DE, Bombardier C, Guillemin F, et al. Guidelines for the process of cross-cultural adaptation of self-report measures. *Spine*. 2000;25:3186–3191.
28. Wild D, Grove A, Martin M, et al. Principles of good practice for the translation and cultural adaptation process for patient-reported outcomes (PRO) measures: report of the ISPOR task force for translation and cultural adaptation. *Value Health*. 2005;8:94–104.
29. Arestad KE, MacPhee D, Lim CY, et al. Cultural adaptation of a pediatric functional assessment for rehabilitation outcomes research. *BMC Health Serv Res*. 2017;17:658.
30. Council on Children with Disabilities. Section on Developmental Behavioral Pediatrics. Bright Futures Steering Committee. Identifying infants and young children with developmental disorders in the medical home: an algorithm for developmental surveillance and screening. *Pediatrics*. 2006;118:405–420.
31. Beckmann KA. Mitigating adverse childhood experiences through investments in early childhood programs.. *Acad Pediatr*. 2017;17(suppl):S28–S29.
32. Litt JS, Glymour MM, Hauser-Cram P, et al. Early intervention services improve school-age functional outcome among neonatal intensive care unit graduates. *Acad Pediatr*. 2018;18:468–474.