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ORIGINAL ARTICLE

School Placement Outcomes Following Early Intensive Behavioral Intervention in a Routine Clinical Care Setting

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Abstract

Early intensive behavioral intervention is designed to establish critical social, cognitive, and adaptive repertoires and to close the developmental gap prior to entry into school systems. Previous research studies have documented that approximately half of children experiencing EIBI enter school with age typical cognitive or language skills and/or a general education placement. The current study examines the placement outcomes achieved in a routine clinical care setting for children completing EIBI services. Data were collected on several measures of school readiness prior to discharge and school placement following discharge from services between August 2022 and November 2023. The majority of children graduating from services entered school spending most or all of their time in general education settings, while the majority of those who exited services prematurely to enter school spent most or all of their time in special education settings or alternative school placements. In addition, scores on standardized measures were predictive of school placement. The school placement results for this organization are comparable to prior studies examining this outcome. Remaining in treatment services until a recommended discharge increased the probability of being placed in general education, which has been calculated to have significant cost savings.

Keywords Autism · Early intervention · School placement · Outcome

Applied behavior analysis (ABA) is an evidence-based intervention that is frequently recommended for individuals diagnosed with Autism Spectrum Disorder (ASD) (Reichow et al., 2018; Wergeland et al., 2022). This approach to treatment involves using behavioral learning principles and procedures to teach new skills and tolerance for various social and sensory experiences while changing environment(s) to support those progressive changes in behavior and learning (Council of Autism Service Providers, 2024; Klintwall & Eikeseth, 2014). Early intensive behavioral intervention (EIBI) refers to a model of ABA in which services begin early (e.g., beginning at ages 2–6) and intensively (e.g., 30–40 h per week) and last for a number of years (Virués-Ortega, 2010). Comprehensive (i.e., targeting all facets of functioning and externalizing behaviors) and customized programming is developed by a behavior analyst and implemented by caregivers and trained technicians (CASP, 2024).

The comprehensive EIBI model is designed to establish critical social, cognitive, and adaptive repertoires and to close the developmental gap prior to entry into school systems (Klintwall et al., 2015; Peters-Scheffer et al., 2011). Thus, early diagnosis and early intervention offer greater opportunities to acquire skills at a young age, and greater opportunities to build on these skills throughout childhood and into the school years (Clark et al., 2018). Several studies have found that EIBI produced significant improvements on a variety of standardized measures of cognitive and intellectual functioning, adaptive functioning, and language (Eldevik et al., 2009; Frazier et al., 2021; Klintwall & Eikeseth, 2014; Waters et al., 2020) with effects that have maintained at follow up at spans of 3 to 10 years (Howard et al., 2014; Smith et al., 2021) making this intervention soundly evidence based as a treatment for those diagnosed with ASD.

Effective EIBI can substantially reduce the lifetime costs for serving people with ASD due to reduced use of services such as special education (SE), adult assistance programs or residential care, emergency medical services,

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and elimination of lost parent productivity (Buescher et al., 2014; Chasson et al., 2007; Jacobson et al., 1998; Peters-Scheffer et al., 2012; Ungar & Tsiplova, 2022). Jacobson et al. (1998) estimated the costs and benefits to the state of Pennsylvania of EIBI assuming proportional outcomes based on Lovaas (1987) (i.e., served in a regular education setting without support—47%; served in a less intensive SE setting—42%; served in an intensive SE setting-11%). The cost savings ranged from $187,000 to $203,000 per child for ages 3–22 years and from $656,000 to $1,082,000 per child across the span of 3–55 years. Chasson et al. (2007) compared the costs associated with 18 years of SE to the costs for 3 years of EIBI and calculated that with a success rate of 72%, the state of Texas would save $208,500 per child across the span of school services. Buescher et al. (2014) calculated the U.S cost saving for EIBI treatment of ASD as the cost differential between lifetime care for a person with ASD and Intellectual Developmental Disability (IDD) versus only ASD and found a differential savings of $1 million per person.

School Placement Following EIBI

During early childhood important fundamental communication, motor, cognitive, and social skills are developed. The development of these skills is essential for, and predictive of, later school success (Panter & Bracken, 2009; van Hartingsveldt et al., 2015). Thus, the degree to which a child exhibits readiness to meet the academic, social-emotional, and behavioral demands of formal education impacts later school success (Pentimonti et al., 2014). Longitudinal studies have suggested that skills at kindergarten entry are the most relevant predictors of their future academic performance (Claessens et al., 2009).

Children completing EIBI have an increased likelihood of entering school in a general education (GE) placement or with age-typical cognitive, adaptive, or language skills compared to those who experience eclectic or less intensive treatment (Eldevik et al., 2009; Frazier et al., 2021; Klintwall & Eikeseth, 2014; Makrygianni et al., 2018; Reichow, 2012; Reichow et al., 2018; Rodgers et al., 2021). Although most outcome studies have focused on standardized test scores as outcome measures, some have reported educational placements at the end of treatment or at follow-up as an outcome measure. Educational placement is influenced by the child's functioning along with various extraneous factors such as advocacy efforts, school district policy, and education trends (Smith et al., 2000). Although multi-determined and out of the control of the EIBI provider, educational placement provides an important measure of outcome that has been described as "real world" (Kazdin & Weisz, 1998) in its importance to families who pursue early intervention services and to the overall lifetime costs of care.

Early Efficacy Studies

Although most studies of EIBI have reported standardized measures that might be correlated with subsequent school placement (e.g., intellectual or developmental quotients, adaptive behavior scores), some studies have directly reported school placements at follow up. The terms used to describe the placement outcomes have differed based on the specific terminology of the time (e.g., self-contained classroom, inclusion), but have generally focused on GE or SE as the primary placement. Lovaas (1987) reported that 9 of the 19 participants in EIBI (i.e., 47%) had a first-grade GE placement while 10 others had placements typical of SE services and terminology of that era. In comparison, only one child from either of the two control groups was in a GE placement. Smith et al. (2000) reported post-treatment classroom placements following either an EIBI program or a parent training program. The intensively treated group had significantly less restrictive school placements (i.e., 6/15 GE with or without support; 40%) than did the parent training group (i.e., 3/14 GE with support; 21%). In addition, Cohen et al. (2006) reported that of 21 participants who received community-based EIBI, six were fully included in GE without assistance and 11 were fully included with support (i.e., 80% in GE with or without support), while only one child in the non-EIBI community treatment comparison group was placed primarily in GE (i.e., 5%).

These early studies are best characterized as initial efficacy studies, which typically occur in well-resourced and controlled research settings to provide an evaluation of whether an intervention "can work" to produce "more good than harm under ideal circumstances" (Haynes, 1999, p. 676). In contrast, effectiveness studies evaluate whether interventions work in the context of ongoing routine clinical care to determine how often or how well the intervention works under typical care conditions for participants with diverse life circumstances (e.g., socioeconomic status, racial and ethnic diversity).

Effectiveness Studies in Routine Care Settings

Effectiveness studies of EIBI in routine care settings have included a wider array of ages at the start of services and greater variability in the intensity of services (e.g., Eikeseth et al., 2002, 2007; Waters et al., 2020; Wergeland et al., 2022). Effectiveness studies are less likely to include control conditions as comparisons instead focusing on differing versions of effective treatment or on the impact of treatment variables on outcome.

In one of the first community care evaluations of EIBI, Sallows and Graupner (2005) reported school placement outcomes for participants after EIBI in a "community-based program operating without the resources, support, or supervision of a university center" (p. 419). Two groups of participants received EIBI, but the primary source of program direction and implementation was either a clinic-based team or the parent. The parent-directed group received less supervision and oversight, but was still EIBI services (i.e., all young age, all receiving 30 + hours per week of behavioral treatment). The school placement results for the combined groups were comparable to those from Lovaas (1987) with approximately half of the participants described as rapidly learning (11/23, 47.8%) with placements in regular education first or second grade classes. The other participants were described as having moderate rates of learning with four in regular (i.e., GE) classes with an aide and modified curriculum (17.4%), six splitting their day between GE and SE (26.1%), and two in full-time SE classes (8.7%).

More recently, Waters et al. (2020) conducted an effectiveness study in community care and found that participants in EIBI, including those enrolled at later ages (i.e., 4–7 years), improved significantly more than those in "treatment as usual" on cognitive, adaptive, and academic achievement measures during treatment. At follow up, significantly more participants in the EIBI group were placed primarily in GE with or without supplemental support (36/48, 75%) than in the services as usual group (7/45, 15.5%). In addition, Frazier et al. (2021) reported the post-discharge placements of 131 participants in routine clinical care EIBI services with approximately 38% of participants in a no or minimal support educational placement, 28% in a significant SE placement, and the remaining 34% requiring ongoing significant intensive behavioral intervention or educational support.

Increased awareness, early identification, and insurance mandates requiring health plan coverage of ABA services in all 50 states (Autism Speaks, n.d.) has resulted in improved access to community-based ABA services. Additional research is needed to inform our understanding of the school-based outcomes that are achieved with EIBI provided in routine clinical care settings for diverse samples with ASD. This experimental evaluation extends the literature by describing the school placement outcomes of a large, diverse sample of children with ASD served in a community care setting. Participants were not excluded based on age, prior access to services, or intensity of services. In addition, this study extends the literature by examining the extent to which school placement can be predicted by a school readiness assessment.

Methods

All assessment, treatment, and discharge activities occurred as part of ongoing care without influence by the primary researcher. Consent for analysis of archival data occurred during the consent for services process. This archival study was reviewed and approved by the WCG Institutional Review Board and was conducted in compliance with the ethical guidelines of the Behavior Analyst Certification Board® and in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments.

Participants

The participants included 193 (148 males, 45 females) children with ASD who had been enrolled in an EIBI program for at least 6 months with a discharge date between August of 2022 and November of 2023 and whose parents responded to a follow up survey on school placement. There were no other inclusion or exclusion criteria. Age at the start of services ranged from 1.7 to 9.4 years with a median age of 4.5 years and a mean age of 4.7 years (standard deviation = 1.4). Approximately 85% of participants entered services below the age of 6 years with 15 participants (7.7%) aged 6 at entry to services and an additional 15 (7.7%) older than age 6 at the outset of services. See Table 1 for a detailed analysis by age band. Participant age at discharge from services ranged from 3.0 to 10.93 years (M = 5.8, sd = 1.4 years).

Ethnicity information was available for 86% of the families with 57 identifying as White (29%), 36 as Asian (19%), 33 as Hispanic/Latin(a)/(o) (17%), 30 as Black/African American (16%), 4 as American Indian/Alaska Native (2%), 5 as "Other" (3%), and the remaining 28 (14%) providing no ethnicity information. The primary language spoken in the household was English for the vast majority of families

Table 1 Participants age at entry to services

Age band	Number of participants	Percentage of sample
Below age 3	11	5.7%
Age 3.0–3.11	53	27.5%
Age 4.0–4.11	58	30.0%
Age 5.0–5.11	41	21.2%
Age 6.0–6.11	15	7.7%
Age 7.0–7.11	9	4.7%
Age 8.0–8.11	3	1.5%
Age 9.0 and up	3	1.5%
Total	193	99.8%*

*Due to rounding, the total does not add up to exactly 100%

(n = 184, 95%) with 1 Spanish-speaking family (less than 1%), and 8 speaking another unspecified language (4%).

All participants had an independently conferred diagnosis of ASD from a qualified provider using either the Diagnostic and Statistical Manual of Mental Disorders-Fifth Edition (American Psychiatric Association, 2022) or the International Classification of Diseases-Tenth Edition (World Health Organization, 2016). Results of the diagnostic tools used by the evaluating clinician were available in the medical record for some of the participants and are provided below to describe the sample. Those results are presented as severity or likelihood descriptors so that similar information can be presented across tools, but this information was not used in the statistical analysis. A diagnostic severity or likelihood measure was available for 150 of the 193 (77.7%) participants. The Childhood Autism Rating Scale-Second Edition (CARS-2; Schopler et al., 2010) results were available for 98 participants with seven scores in the minimal to no symptoms of ASD range, 59 scores in the mild to moderate symptoms of ASD range, and 32 scores indicating severe symptoms. The Autism Diagnostic Observation Scale-Second Edition (ADOS-2; Lord et al., 2012) was available with either standard or modified administration (due to the Covid-19 pandemic) for 52 participants. Of the 22 participants who had an ADOS-2 Module 1–3 comparison score with standard administration, five scores were in the low range, 12 were in the moderate range, and five were in the high range. Of the six participants who had an ADOS-2 Toddler Module with standard administration, one score was in the mild to moderate range of concern and five were in the moderate to severe range of concern. Of the 24 participants who had an ADOS-2 with modified administration, one was scored as minimal to no differences and 23 were scored as definite differences.

Model of Treatment

The organization (name redacted for blind review) provides EIBI treatment services in 6 states in the United States. Approximately 90% of children are served in centers and 10% are served in their homes. Services are frequently paid for by state Medicaid agencies or private health insurance. Based on the results of an individual evaluation that includes functional behavioral assessment, skills assessment, adaptive behavior assessment, and family collaboration interviews, the behavior analyst requests authorization (i.e., request to the funder to allow and pay for services at a certain level for a specified duration of time) for direct treatment services for the child, supervision and protocol design, and family guidance sessions for the parents/caregivers. The typical length of the authorization period was 6 months, but this interval varied by funding source and could have been shorter than 6 months or as long as 1 year.

The request for services varied based on individual need, but was typically consistent with the CASP guidelines (CASP, 2024) with approximately 30–40 h per week of direct treatment for the child, as well as 15–20% supervision by the behavior analyst, and at least 2 family guidance contacts per month. The process was repeated if services continued beyond the initial authorization period. The number of treatment hours per week may have been lower in the first authorization for a very young child or in the final authorization period for a child of any age as the focus of services shifted to transition to school. Over 80% of participants (i.e., 159 of 193) followed this pattern of treatment intensity. See Table 2 for the authorized weekly direct treatment hours per authorization interval (i.e., the approved duration of services by the funder). Authorization fulfillment (i.e., the percentage of recommended direct treatment hours that actually occurred) ranged from 81 to 83% in each authorization period across all children served in that period.

Children were typically scheduled to attend behavioral treatment sessions for 6–8 h per day, 5 days per week. Treatment was provided in a one-to-one ratio in both individual and small group instruction settings using structured and natural environment behavioral teaching procedures designed to be fun, engaging, and play-based (Geiger et al., 2012; Tuna, 2024) and consistent with an assent-based model of care (Breaux & Smith, 2023). Parents typically attended parent guidance sessions twice per month to observe sessions, collaborate on goal and intervention selection, learn teaching strategies, and receive consultation for newly emerging concerns (e.g., sleep issues, new topographies of challenging behavior, safety concerns).

Measures

School Placement Survey

Beginning January 2023, families that had discharged at least 4 months previously received an electronic survey via email. The 11-item survey asked about their child's current

Table 2 Treatment intensity per authorization period

Hours per week	First (N = 193)	Second (N = 179)	Third (N = 87)	Fourth (N = 25)
30–40	165 (85.5%)	135 (75.4%)	61 (70.1%)	14 (56%)
20–29	24 (12.4%)	39 (21.8%)	22 (25.3%)	10 (40%)
Below 20	4 (2.1%)	5 (2.8%)	4 (4.6%)	1 (4%)

services including school placement. See Appendix for the full survey. The email was sent weekly for three consecutive weeks or until the family responded. Families that did not respond to the electronic survey within the first three weeks received a call from a research assistant to offer to conduct the survey on the phone. If the parent answered and indicated that they would like to complete the survey on the call, the research assistant read the instructions and each item and response option verbatim and entered the parent's responses as they were being provided.

Adaptive Functioning

Vineland Adaptive Behavior Scales-Third Edition, (Vineland-3) Caregiver Rating Form, Comprehensive The Vineland-3 (Sparrow et al., 2016), Caregiver Rating form is a norm-referenced parent questionnaire used to evaluate adaptive skills in individuals of all ages. The comprehensive form includes 381 items that the caregiver scores for how often their child performs skills (0 = never, 1 = sometimes, 2 = usually or often). In addition to the summary measure (i.e., Adaptive Behavior Composite), communication, socialization, daily living skills, and motor skills domain scores are calculated. The Vineland-3 is commonly used to assess adaptive skills in children and adults with ASD and IDD and can be used to evaluate change in adaptive behavior over time. Reliability and validity indices are high (i.e., internal consistency for the Adaptive Behavior Composite average = 0.99 across age groups). The majority of test–retest and interrater reliability coefficients fall within the excellent range and validity is also well supported, with subdomain raw scores generally aligning with expected developmental trends in adaptive behavior (Sparrow et al., 2016). The Vineland-3 is completed every 6–12 months as required by the funder. Adaptive behavior composite scores of 85 or higher indicate that overall adaptive functioning is within one standard deviation of same-aged peers.

School Readiness

Prior to May 2023, scores on the Vineland-3, progress on behavior reduction goals, and progress on curricular measures informed clinician recommendations about discharge or continuation of services. Beginning in May 2023, the organization required that discharge decisions be based on a three component school readiness battery for participants aged 4.5 to 7.5 to inform their recommendation for continuation or transition of services. The school readiness battery was completed at a child' birthday and half birthday and included the Vineland -3 and the following two other measures.

Bracken School Readiness Assessment The Bracken School Readiness Assessment, Fourth Edition; BSRA-4, Bracken, 2022) is an individually administered standardized assessment that provides a brief evaluation of school readiness (i.e., the social, behavioral, cognitive and motor skills) in terms of understanding of basic concepts that are strongly related to development and early academic achievement in elementary school. The BSRA-4 evaluates basic concepts (i.e., colors, letters, numbers/counting, sizes in one to three dimensions/comparisons, shapes in one to three dimensions, self/social awareness) using a multiple-choice format, in which a child selects their choices among multiple options. Scores are based on a normal distribution with a mean of 100 and standard deviation of 15. Thus, a score of 85 or higher would indicate readiness that is within one standard deviation of the normative sample of entering first graders. The BSRA-4 is reliable (i.e., test–retest stability coefficients ranging from 0.76 to 0.92) and has demonstrated good convergent and construct validity (i.e., predicting at risk educational status at 90.7% accuracy) (De Almeida Maia et al., 2022; Panter & Bracken, 2009). This assessment was administered when children were in the age range appropriate for normative comparisons (i.e., older children were not assessed with the BSRA-4).

Behavior Problem Inventory for Individuals with Intellectual Disabilities—Short Form (BPI-S) (Rojahn et al., 2012a, 2012b). The Behavior Problems Inventory—Short Form (BPI-S) is a 30-item informant-based behavior rating instrument to assess the frequency and seriousness of commonly occurring challenging behaviors in persons with IDD, including ASD. The informant scores both frequency and seriousness of self-injurious behavior, stereotyped behavior, and aggressive/destructive behavior over the prior 2 months. The BPI-S subscales have fair to excellent internal consistency, and the overall measure has demonstrated good convergent, discriminant, and construct validity (Rojahn et al., 2012b).

The behavior analyst completed the BPI-S sections on self-injurious behavior and aggression and destructive behavior, omitting the section on stereotypy. The behavior analyst reported the highest single item score on the most highly scored section resulting in a range of scores of 0–4. A score of 0 indicated that neither category of behavior was ever occurring. A score of 1 indicated that the most concerning behavior (i.e., SIB or aggression/destructive behavior) occurred monthly or at a mild severity. A score of 2 indicated that the most concerning behavior occurred weekly or at moderate levels. A score of 3 indicated that the most concerning behavior occurred daily and/or severely and a score of 4 indicated that the behavior occurred hourly and at severe levels. Scores of 0 or 1 indicate no behavior or well-managed behavior.

Discharge Recommendations and Categories

Near the end of each authorization period, the behavior analyst completed an assessment, including the school readiness battery, and made a recommendation for: (a) continuation of EIBI services, (b) graduation to school services, or (c) transition to school services without graduation. Continuation of EIBI services was recommended when scores were more than 1 standard deviation below the mean on the BSRA-4 and Vineland-3 or at 2 or higher for the BPI-S. That is, continuing treatment services might increase their readiness for school and result in additional gains with respect to challenging behavior. These families either chose to continue in treatment services, consistent with the recommendation, or elected to discharge from services to begin school (i.e., chose school against recommendation). Graduation to school services was a warranted recommendation when a child scored at a standard score of 85 or higher on both the BSRA-4 and Vineland -3 and a 0 or 1 on the BPI-S. That is, scores in the typical range on standardized measures indicate that the gap in overall development had been overcome and that the child exhibited skills predictive of success in school without substantial interfering behavior that might jeopardize a GE placement. A transition to school services (without graduation) was recommended if at least one of three criteria were not met, usually for a school-aged child, but the maximal benefit of EIBI had been achieved and school was deemed the appropriate environment of care.

Statistical Analyses

We used a Bayesian logistic regression model (GLM) to investigate how discharge categories (i.e., graduated, chose school against recommendation, recommended exit to school without graduation) relate to school placement (i.e., primarily GE, primarily SE or alternative placement). This approach allowed us to provide more intuitive and informative results compared to traditional methods. Instead of relying on a single estimate and a confidence interval that can be difficult to interpret (Morey et al., 2016), Bayesian inference gives us a range of plausible values (known as credible intervals) that capture the uncertainty around our findings. Specifically, we will focus on 95% credible intervals, which indicate that we are 95% confident that the true value lies within this range. A relatively narrow credible interval that does not overlap with zero provides stronger confidence in the findings.

In order to conduct the Bayesian GLM, we first specified priors (i.e., our a priori guess as to the effect) equivalent to a 50% chance of having either a GE placement or SE placement for each of the three discharge categories. Survey response rates differed across the three discharge categories, so we integrated this information into the model by normalizing weights (i.e., weights sum to one), where weights were calculated as the inverse of the nonresponse rate. By using inverse response rates as weights, we applied a conservative weighting scheme that gave relatively lower weight to discharge categories with lower survey response rates. This approach resulted in greater uncertainty in our model estimates compared to other weighting schemes. After the prior is combined with the data, the model's result is referred to as the posterior distribution. In contrast to traditional frequentist approaches, where a single p-value is calculated to indicate the significance of an effect (typically compared to $\alpha = 0.05$), Bayesian inference provides a posterior distribution that reflects all possible values of the estimated parameter, incorporating both prior knowledge and observed data. To understand our model results, we used a statistical technique called Markov Chain Monte Carlo (MCMC) to estimate the parameters. This process involved creating four separate chains, each consisting of 2,000 iterations (with the first 1,000 considered as 'warm-up' and not included in the analysis). By analyzing these chains, we ensured that our results were stable and reliable. All R-hat values were close to one (Vehtari et al., 2021) and Effective Sample Sizes (Bürkner, 2017) exceeded 1000, indicating that our MCMC convergence was satisfactory.

The Bayesian GLM was estimated using the R Statistical language (version 4.4.1; R Core Team, 2024) on macOS 15.0.1 with the brms package (version 2.21.0; Bürkner, 2017). Other primary packages used included easystats (version 0.7.3; Lüdecke et al., 2022), modelsummary (version 2.1.1; Arel-Bundock, 2022), bayestestR (version 0.14.0; Makowski et al., 2019), marginaleffects (version 0.21.0; Arel-Bundock et al., 2024), and ggplot2 (version 3.5.1; Wickham, 2016).

Results

School Placement

A total of 446 children were in treatment services for at least 6 months and were discharged in the categories of graduation, clinical recommendation to exit, or chose school when the recommendation was to continue services. Responses to the survey were received from parents of 193 (33.1%) of these children, and some families did not provide a response to every question. The response rate differed by discharge category and higher response rates were observed for those who graduated (113 surveyed, 63 responded; 55.8%) followed by those who were recommended to exit to school without graduation (57 surveyed, 28 responded; 49.1%) and those who chose school against the clinical recommendation (276 surveyed, 102 responded; 37%). A chi-square test of independence was

conducted to determine whether the response rate was associated with discharge category. The observed data were compared to the expected frequencies calculated under the assumption that response rates are uniform across categories. Effect sizes were labelled following Funder and Ozer's (2019) recommendations. The Pearson's Chi-squared test of independence between suggests that the effect is statistically significant (i.e., response rates were not uniform across categories), and small ($\chi 2 = 12.45$, $p = 0.002$; Adjusted Cramer's $v = 0.15$, 95% CI [0.04, 1.00]) according to Funder & Ozer's (2019) recommendations.

The average time between discharge and completion of the first follow up survey was 7. 2 months (range 3–20 months). The majority of participants (N = 146; 75.6%) had an individualized education program. The majority of participants (N = 156; 80.8%) were in Pre-Kindergarten (N = 44), Kindergarten (N = 75) or 1st Grade (N = 37) at follow up. The next largest number of participants were Not in School (N = 17) followed by 2nd Grade (N = 7), 3rd Grade (N = 6), 4th Grade (N = 4), and 5th Grade (N = 3). The questions on current ABA, occupational therapy (OT), and speech language services were answered for 175 participants. Few (N = 19, 10.9%) were receiving ABA services at follow-up. For OT, 75 (42.9%) received services at follow-up and for speech language services, 129 (73.7%) received services at follow-up.

All families responded to the question on educational placement with approximately 54% of children served primarily in a GE after discharge and approximately 46% were served primarily in SE or an alternative school placement. See Table 3 for school placement by survey response option. Additionally, 32 participants had a response to a second survey an average of 5.5 months after the first response (range 3–13 months). The majority (i.e., 28 of 32, 87.5%) maintained their initial school placement while 3 of 32 (9.3%) moved from primarily SE or an alternative school placement to primarily GE and 1 of 32 (3.1%) moved from primarily GE to primarily SE.

School placement at follow up differed across discharge category. See Table 4 and Fig. 1. When the behavior analyst recommended discharge to school with or without graduation, the majority of participants were placed primarily in GE. Over 70% of graduated children (45 of 63) were spending the majority or all of their school day in GE while 60% of children who were clinically recommended to exit (17 of 28) spent the majority or all of their school day in GE. Children in the latter category were, on average, older at the age

Table 3 School placement outcomes

Category	Survey response	Number of participants (%)
Primarily GE	Full time GE with no supports	31 (16.1)
	Full time GE with paraprofessional support	55 (28.5)
Split between GE and SE with more time in GE	Split between GE and SE with more time in GE	19 (9.8)
	Total	**105 (54.4)**
Primarily SE/	Split between GE and SE with more time in SE	17 (8.8)
Alternative	SE with the inclusion for specials (e.g., art, music, recess, PE, lunch)	19 (9.8)
Placement	Full time SE	24 (12.4)
	Private school for children with ASD	15 (7.7)
	Home school	13 (6.7)
	Total	**88 (45.6)**

The bolded numbers are sum totals of the subcategories included in that overarching category

GE General Education, *SE* Special Education, *ASD* Autism Spectrum Disorder, *PE* Physical Education

Table 4 School placement by discharge category

Discharge category	Total responses	Primarily GE	Primarily SE/alternative
Graduated	63	45 (71.4%)	8 (28.6%)
Clinical recommendation to exit	28	17 (60.7%)	11 (39.3%)
Chose school against recommendation	102	43 (42.2%)	59 (57.8%)

GE General Education, *SE* Special Education

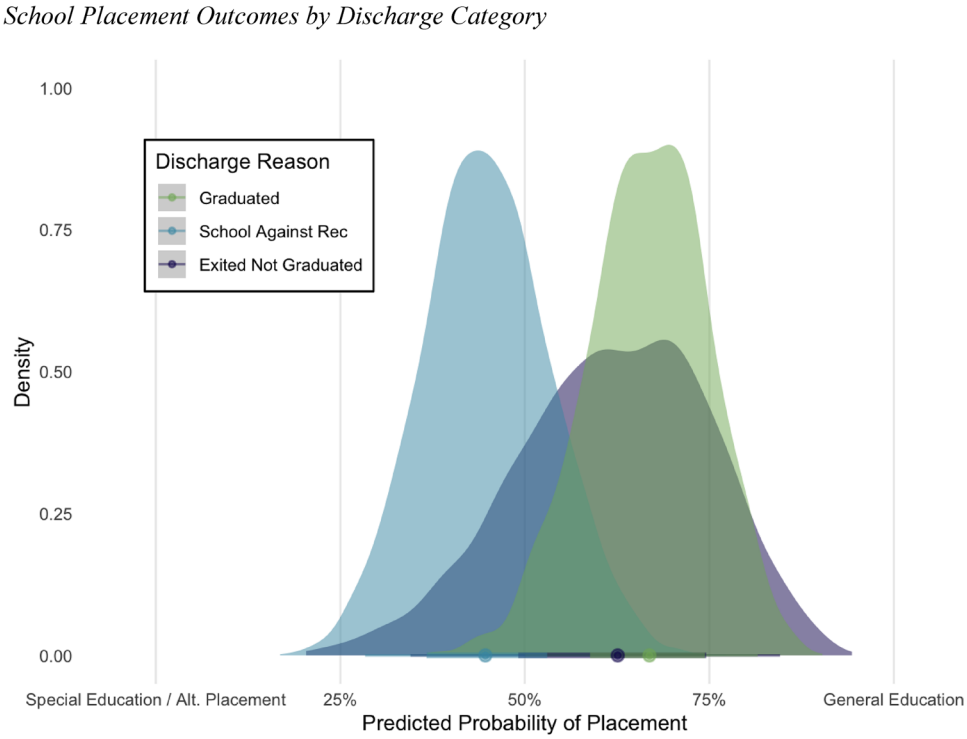

Fig. 1 School placement outcomes by discharge category

of discharge (M = 6.3) than those who graduated (M = 5.9) and were in services longer (M = 434 vs 385 days). In contrast, when families elected to discontinue services to begin school in spite of the behavior analyst's recommendation to continue services, the majority (57.8%; 59 of 102) spent the most or all of their school day in SE or an alternative school placement. These participants were similar in age (M = 5.8) and duration of services (M = 383 days) to those who graduated.

The results of our Bayesian model provide the log odds of being placed in GE compared to SE, but these values aren't directly meaningful when we're interested in understanding the actual probability of getting placed in GE versus SE. Instead, we report the predicted probabilities and a range within which we expect the true value to lie (with 95% confidence). This range is like a "plausibility zone" for the true effect size. Figure 1 shows these median probabilities and 95% credible intervals (dot and line) and the *entire posterior distribution* (i.e., all possible values). For those who graduated, the model predicted a median probability of 67% (95% CI [51%, 82%]) of GE placement. For those who chose school against clinical recommendation, the model predicted a median probability of 45% (95% CI [29%, 62%]) of GE placement. Finally, for those who exited to school with or without graduation, the model predicted a median probability of 63% (95% CI [36%, 85%]) of GE placement. The model had an $R^2 = 0.05$ (95% CI [0, 0.14]), which, while low, is contextualized by the inclusion of only one predictor variable to examine the direct relation between discharge category and school placement. We tested an exploratory extension of this model adding in age at discharge as an additional predictor, but found this model did not substantially add predictive validity nor fundamentally alter the results compared to the simpler model (i.e., there was evidence the actual effect of age at discharge on school placement was zero).

Practically, we are also interested in the proportion of the posterior sample that exceeds 50% (i.e., more likely to be placed in GE). We determined this Probability of Direction by calculating the proportion of the posterior distribution that exceeds 50%. This is most easily seen in Fig. 1 where we examine how much of the distribution is above the 50% probability midline. For those who graduated, 97.5%[1] of the posterior distribution exceeded 50% and for those who exited to school with or without graduation, we found 81.4% of the posterior distribution exceeded 50%, while only 26.7% of the posterior distribution exceeded 50% for those who chose school against clinical recommendation (i.e., 73.3% of the posterior distribution fell below 50%). This suggests that choosing to attend school against recommendation significantly reduced the likelihood of being placed in GE, whereas graduating or exiting to school with or without graduation was associated with a higher probability of placement in GE.

[1] This corresponds to a frequentist *p*-value equal to 0.05.

School Readiness as a Predictor

For 89 of the 193 participants, all three components of the school readiness assessment (i.e., BPI-S, BSRA-4, Vineland-3) were completed at least once prior to their discharge. For three participants it was completed a second time approximately 5 months later. Scores on the second administration were very consistent for two of the three participants (0–3 pt difference in normed scores) while the third participant scored lower on the BPI-S (i.e., less behavior and less severe behavior) and also scored higher on the BSRA-4 (i.e., 16 pt difference in normed scores). The use of the three criteria for discharge in conjunction resulted in a 43.8% accuracy in prediction of subsequent placement. See Table 5 for the confusion matrix. The criteria were designed to minimize false positives (i.e., team recommends discharge from services due to prediction of successful placement in GE, but the child is actually placed in SE or an alternative placement). In terms of the proportion of true positive cases the criteria identified, sensitivity was low at 19.6%. Contrast this with specificity, or the proportion of true negatives the criteria identify, which was 84.8% suggesting the criteria were good at identifying true negatives (i.e., recommended continued services due to prediction that the child would be placed in SE and the child was placed in SE). In particular, when a child was recommended to exit services without meeting all three criteria, they were most likely to be placed in GE (i.e., false negative) when the BSRA-4 was high, and the Vineland-3 was slightly below the criterion score.

The estimated correlation between the BSRA-4 score and the subsequent placement result, and the Vineland-3 and the placement result was calculated using rho, which is equivalent to Pearson's r. The correlation was 0.25 (95% CI [0.06, 0.43]), indicating that the correlation is likely positive and not close to zero with a Probability of Direction equal to 99.35%, providing strong evidence the correlation is not zero. None (i.e., 0%) of the posterior distribution falls within the Region of Practical Significance (ROPE; between − 0.05 and 0.05), suggesting the correlation is both statistically and practically significant. The Bayes Factor (BF) compares the model where the correlation is non-zero to the null model (correlation = 0). The BF was 5.44, which indicates moderate evidence in favor of a non-zero correlation between the BSRA-4 score and placement in GE or SE. The estimated correlation between the Vineland-3 scores and the placement result was 0.35 (95% CI [0.17, 0.50], indicating a moderate to strong positive association. The Probability of Direction equaled 99.98%, which provides very strong evidence that the relationship is positive and meaningful. None (i.e., 0%) of the posterior distribution lies within the ROPE, further confirming that the correlation is practically significant. The BF was 133.27, which provides decisive evidence in favor of a non-zero correlation between the Vineland-3 score and placement result. Thus, the BSRA-4 score has a positive correlation with the placement result, with moderate evidence supporting this relationship (BF = 5.44), while the Vineland-3 score showed a stronger positive correlation with placement with decisive evidence (BF = 133.27) of a substantial association between the Vineland-3 score and placement in either GE or SE.

Table 5 Confusion matrix for discharge criteria

Outcome	Predicted GE	Predicted SE or alternative
GE	11 (TP)	45 (FN)
SE or Alt. Placement	5 (FP)	28 (TN)

GE General Education, *SE* Special Education, *TP* True Positive, *FP* False Positive, *TN* True Negative, *FN* False Negative

Discussion

School placement represents a "real world" valued outcome of EIBI that can influence access to social and learning environments as well as cost of care (Chasson et al., 2007; Haynes, 1999). Initial efficacy studies suggested that approximately half of children treated in EIBI were in a GE placement at follow-up while significantly fewer children in control conditions experienced this outcome (Cohen et al., 2006; Lovaas, 1987; Smith et al., 2000). Recent effectiveness studies have examined school placement outcomes resulting from EIBI in routine clinical care settings, which enhances our understanding of what is achieved in typical care rather than what can be achieved under optimal circumstances (Wergeland et al., 2022).

The current analysis examines the school placement outcomes after EIBI in routine clinical care for a large, diverse sample of children with ASD. Many previous studies have either reported no data on race or ethnicity (Sallows & Graupner, 2005; Waters et al., 2020) or reported on samples with a higher percentage of White participants (46%, Smith et al., 2000; 78% Frazier et al., 2021). The current sample included similar sized groups of participants who identified as Asian (19%), Hispanic/Latin(a)/(o) (17%), and Black/African American (16%) with only a slightly larger group who identified as White (26%). This more representative distribution is to be expected from a routine care setting across multiple states as compared to prior studies that have generally reported outcomes from a single geography. Nonetheless, it is important that the research base includes and describes increasingly diverse samples in order to explore the effects or absence of effects of those variables on behavioral outcomes (Jones et al., 2020).

In two recent community care effectiveness studies, Waters et al. (2020) reported 75% of their participants were in GE at follow-up while Frazier et al (2021) reported that 38% of their participants were served in GE at follow up. In our own sample, just over half of all children (i.e., 54%) were spending the majority or all of their day in GE with or without support. These outcomes are comparable to those achieved in earlier university-based and grant-funded efficacy studies (e.g., Cohen et al., 2006; Lovaas, 1987; Sallows & Graupner, 2005; Smith et al., 2000) and fall between the results reported by Waters et al. (2020) and Frazier et al. (2021). While the average span of treatment services was longer than 1 year (M = 392 days), the minimum duration of services for inclusion was only 6 months, which is shorter than has been required in some meta-analyses (Eldevik et al., 2024). In efficacy studies, participants who leave services prior to the completion of the study (i.e., the full course of treatment, often 2–3 years) are often described as "attrition" or "dropout" and may not be included in the summarized results. The inclusion of participants with a shorter duration of services as well as those who elected to leave services when the behavior analyst recommended continuation of services (i.e., chose school against recommendation category) allows examination of outcomes that represent the full continuum experienced by families in treatment services, even when the delivery of treatment was not considered optimal from a clinical perspective.

The inclusion of participants that discharged prior to clinical recommendation allowed us to examine outcomes by discharge category. The majority of participants graduating from services entered school spending most or all of their time in GE settings (71%), while the majority of those who chose to enter school early against the recommendation to continue services spent most or all of their time in SE settings or alternative school placements (58%). The decreased probability of placement in GE was uniquely associated with the discharge category rather than simply with the duration of services. That is, the duration of treatment services was not differentially associated with placement outcome within discharge category while discharge category was associated with and predictive of different placement outcomes. These findings speak to the fact that children require different durations of treatment to achieve their optimal outcome and that duration of services and the clinical recommendation to discharge should be individualized based on progress rather than standardized based on previous empirical findings.

This study extends the literature by examining the extent to which subsequent school placement can be predicted prior to discharge by an evaluation of school readiness using standardized measures. The three measures, used in conjunction and with cutoff scores within 1 standard deviation of the mean, were accurate about 44% of the time in predicting subsequent placement. The confusion matrix revealed only a small number of false positives (i.e., prediction of GE but subsequent primarily SE or an alternative placement), but a larger number of false negatives (i.e., recommendation to continue treatment services to increase the likelihood of GE placement, but subsequent placement was primarily GE). Although these measures were only available for a subset of participants, the BSRA-4, an assessment specifically designed for school readiness, had a positive correlation with the placement result with moderate evidence supporting this relationship (BF = 5.44). In addition, the Vineland-3, designed to evaluate overall adaptive functioning, had a stronger positive correlation with placement with decisive evidence (BF = 133.27) supporting the relationship between scores and placement in either GE or SE. Both measures were related to and predictive of placement outcome and can add to the information used by clinicians to evaluate readiness for discharge from EIBI services. Future studies might examine whether different cutoff scores (e.g., Vineland-3 score of 80), in isolation or conjunction with other scores, increase the predictive accuracy for subsequent placement. Standardized measures of cognitive and language functioning used in other studies were not included in this analysis, so it is unclear whether those measures would be more or less predictive than the ones that were included.

Several limitations and caveats are worthy of note. First, follow up information was not available for all discharged participants. Only families that responded to the survey, either electronically or by phone, could be included in the analysis and the response rates were below 60% for every discharge category and differed across categories. The families that did not respond may or may not have experienced different placement outcomes than those who did respond. In addition, these data on school placement are based on parent response rather than review of official school records. There may have been some degree of error in parents' report of school placement outcomes and supports, although no specific sources of systematic error are suspected. As an additional limitation, we did not have uniform measure of ASD symptom severity that could be used to evaluate whether symptom severity was a predictor of school placement outcome. Finally, the data from the school readiness battery were only available for a subset of participants based on age and time of discharge. Thus, the sample size on which these findings are based is smaller than the overall sample for the study. It will be important to replicate the findings related to prediction of school placement with additional and larger samples.

In summary, these findings add to a growing number of studies that document the beneficial effects of comprehensive EIBI on subsequent school placement outcomes. Although school placement is only one measurable outcome of these services, the opportunity to participate in a GE classroom as the least restrictive placement is an important

and often desired outcome for families. In addition, this outcome significantly lowers the total cost of education as well as lifetime costs of care (Chasson et al., 2007; Haynes, 1999). As such, effective EIBI that shifts the probability of educational placements can provide significant benefits to the individual with ASD and their family as well as cost savings benefit and return on investment for state, federal, and private healthcare funders. These findings, while preliminary, also inform our understanding about how standardized assessments, in conjunction with other progress metrics, can predict placement and guide decisions about the timing of discharge from services to best enhance access to GE.

Appendix

School Placement Survey.
Identifying information:

1. Email
2. Child Name

Placement Questions:

3. School Year Start

   2022
   2023
   2024

4. School Year End

   2022
   2023
   2024
   2025

5. What grade is your child in for the selected school year?

   Not in school
   Pre—K
   1st grade
   2nd grade
   3rd grade
   4th grade
   5th grade
   6th grade
   7th grade
   8th grade

6. Which best describes your child's current school placement?

   All in person
   All virtual
   Combination of in person and virtual

7. Does your child have an Individualized Education Program (IEP)?

   Yes
   No

8. Which best describes your child's current learning environment?

   Full time general education with no supports
   Full time general education with paraprofessional support
   Split between general education and special education with more time in general education
   Split between general education and special education with more time in special education
   Special education with inclusion for specials (e.g., art, music, recess, PE, lunch)
   Full time special education
   Private school for children with ASD
   Home School

9. Does your child receive speech and language services at school?

   Yes
   No

10. Does your child receive occupational therapy at school?

    Yes
    No

11. Does your child receive ABA at school?

    Yes
    No

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Data Availability Text descriptions of the treatment model and diagnostic confirmation information are similar to other manuscripts on treatment outcomes from this organization.

Declarations

Competing interests The first two authors have equity in and are employed by Action Behavior Centers. The third author is employed by Action Behavior Centers. The fourth author is a statistical consultant to Action Behavior Centers. No other potential COIs are noted.

Ethical Approval This study was reviewed and approved by the WCG Institutional Review Board and has been conducted in compliance with the guidelines of this board as well as ethical guidelines of the Behavior Analyst Certification Board® and in accordance with the ethical standards as laid down in the 1964 Declaration of Helsinki and its later amendments. Consent for use of data was obtained at the outset of services.

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