



PARENTS' EVALUATION OF DEVELOPMENTAL STATUS – REVISED® (PEDS-R®): **PSYCHOMETRIC RESEARCH**

**FRANCES PAGE GLASCOE, PHD
VIKRAM VISHNUBHAKTA, MPH, MBA**

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Reference Citation for *PEDS:DM®*: Glascoe FP, Robertshaw NS. *PEDS:Developmental Milestones®*. Nolensville, Tennessee: ©PEDStest.com, LLC, 2016. www.pedstest.com

Reference Citation for *PEDS:DM® Professionals' Manual*: Glascoe FP, Robertshaw NS, Woods SK. *PEDS:Developmental Milestones®, Professionals' Manual, 3rd Ed.* Nolensville, Tennessee: ©PEDStest.com, LLC, 2016. www.pedstest.com

Reference Citation for *PEDS:DM—AL®*: Glascoe FP, Robertshaw NS. *PEDS:DM—Assessment Level®*. Nolensville, Tennessee: ©PEDStest.com, LLC, 2016. www.pedstest.com

TABLE OF CONTENTS

I.	PEDS-R® RESEARCH AND PSYCHOMETRIC SUMMARY	3
II.	Standardization Studies	7
	STANDARDIZATION SUMMARY	22
III.	Reliability Studies	23
	RELIABILITY SUMMARY	25
IV.	Validation Studies	26
	VALIDATION SUMMARY	32
V.	Accuracy Studies	33
	ACCURACY SUMMARY	41
VI.	COPYRIGHT INFORMATION	42
VII.	CLINICAL GUIDANCE AND FAQ'S FOR RESEARCHERS	42

PEDS-R® RESEARCH AND PSYCHOMETRIC SUMMARY

DESCRIPTION

PEDS-Revised® (*PEDS-R*®) is an update to *PEDS*® that refines its original Paths, enabling professionals to view discrete types of risk, i.e., for developmental delays/disorders (DD), mental health/emotional/behavioral (MEB), or a combination of the two (MEBDD). Thus *PEDS-R*® divides the original *PEDS*® Paths into:

- **Path A: High MEBDD Risk**
- **Path A: High DD Risk**
- **Path B: Moderate MEBDD Risk**
- **Path B: Moderate DD Risk**
- **Path C: Mild to Moderate MEB Risk**
- **Path C: Mild DD Risk**
- **Path D/E: Low DD Risk and Low MEB Risk**

STANDARDIZATION

- *PEDS-R*® was standardized in English and Spanish on a nationally representative sample of 262,310 North American children, whose ages ranged from birth to 8 years.
- Families with psychosocial risk factors (e.g., limited education, poverty and non-English-speaking) were as able as those without psychosocial to raise concerns. Those with psychosocial risk tended to have children with higher DD, MEB and MEBDD risk.
- Risk rates on *PEDS-R*® varied considerably by age of child. Children 4½ years of age and older had 4 times the risk compared to children less than 18 months of age.
- The much higher risk rates in older children, compared to prior norming studies, seem due to the adverse impact of the COVID-19 quarantine. Even so, younger children were also affected. For example, MEBDD risk was three times higher for 3-year-olds in 2020 as compared to 2-year-olds in 2019, and 3-year-olds had much higher MEBDD risk in both 2020 and 2021 than in 2018 and 2019.
- In comparing the performance of boys to girls on *PEDS-R*®, boys had 1½ times the risk for DD, MEB or MEBDD than did girls. Psychosocial risk rates were comparable across gender.
- Gender of caretaker/informant on *PEDS-R*®, did not result in performance differences. Fathers, step-fathers and grandfathers were as capable of identifying risk as mothers, step-mothers and grandmothers.
- After adjusting for age-differences in the Spanish-speaking sample (which had many more very young children), there were no differences in identification of risk on *PEDS-R*® whether administered in English or Spanish.

RELIABILITY

- **Internal Consistency** among *PEDS-R*® items revealed modest to moderate intercorrelations, i.e., no highly significant correlations reflecting redundancy. This means that each item contributes uniquely to the measure as a whole.
- **Test-retest Reliability** was 93% for re-administrations within 1 week, and 88% for administrations between 1 week and 4 weeks. Note that *PEDS-R*® is interactive: When professionals are able to effectively address parents' concerns, there are often fewer issues raised at the subsequent administration, which lowers test re-test agreement. Thus results are in keeping with prior reliability studies.
- **Inter-rater Reliability** was 82% for re-administrations within 1 week and 86% for administrations between 1 week and 4 weeks. Again, because professionals are often able to effectively address concerns, inter-rater reliability is expected to have lower agreement between first and second administrations. In addition, when parents do not speak English, repeat screens often involve a different examiner who is bilingual -- also leading to lowered inter-rater agreement.

- **Inter-method Reliability** compared professional scoring to parent reporting, specifically when parents raised concerns whether they marked “a little” or “concerned”. In only 6% of cases did professionals need to change “not concerned” to “concerned”. The remaining 489 cases were correctly reported by the parents and clinicians completing *PEDS-R*®. Thus inter-method agreement was 94% (N = 489/515).
- **Stability.** Comparing risk levels on *PEDS-R*® when rescreening over longer time intervals had 80% agreement for younger children and 82% agreement for older children. Lowered risk levels in subsequent administrations illustrate the effectiveness of interventions including professional advice. As a consequence, improved status was found in 49% of younger children and 30% of older children who were initially at risk. Even so, developmental/mental health risk remains a “moving target”, i.e., risk of developmental and mental health problems increase the older the child.

VALIDITY

- **Content Validity.** *PEDS-R*®’s content validity derives from questions eliciting parents’ comments in each of well-established developmental-behavioral/mental health domains.
- **Concurrent Validity.** *PEDS-R*® has close associations with comparable sub-domains on an assessment level measure.
- **Construct Validity.** *PEDS-R*® factors were closely associated with similar factors on mid-level assessment and diagnostic measures. Social-emotional and behavioral concerns on *PEDS-R*® were correlated with a range of deficits on in-depth tools – suggesting that when referrals are made, professionals should measure children’s skills across multiple domains.
- **Discriminant Validity.** Findings from several different studies illustrate that: a) parents’ concerns reflect problems in the same domain on in-depth, milestones-focused measures, b) Risk on *PEDS-R*® also served as an indicator of other DD/MEBDD risks; and c) there are unique performance patterns on *PEDS-R*® for various categories of disabilities (e.g., ASD, motor impairment, learning disabilities). Nevertheless, speech language impairment and mental health diagnoses shared the same pattern, confirming prior research: Children with ongoing language disorders are at greater risk of mental health problems.
- **Predictive Validity/Predictive Sensitivity.** Among children who eventually received a diagnosis and thus enrolled in IDEA/special education, prior screening with *PEDS-R*® revealed risk in 82%. *PEDS-R*® detected problems on average 21 months earlier than age at diagnosis.

ACCURACY

- *PEDS-R*®’s sensitivity is high, 93%, as is specificity, 92%, especially when applying to Path B: Moderate DD risk results, additional predictors such as *M-CHAT-R* or *PEDS:DM*® (screener) results, minority status and child’s age.

UTILITY

Readability. *PEDS-R*® questions were assessed for readability via different formulas. Response options were omitted because including these can falsely lower indices of reading difficulty/intelligibility:

- Flesch Reading Ease score: 88.2, i.e., easy to read
- Gunning Fog: 3.7, i.e. easy to read
- Flesch-Kincaid Grade Level: 2.9 (high second to early third grade level)
- The SMOG Index: 2.7 (high second to early third grade level)
- Automated Readability Index: 1.4, Grade level: 6-8 yrs old (First and Second Graders)
- Linsear Write Formula: 3rd Grade level

Administration Time. Answering questions on *PEDS-R*® takes an average of 2 minutes (range = 1 – 11 minutes). Parents with few or no concerns complete *PEDS-R*® in 1 - 3 minutes while parents with abundant concerns often require 9 - 11 minutes. If using the *PEDS*® *Online* Parent Portal, 0 minutes of professional time are needed.

Scoring Time. In print, *PEDS-R*® takes 2 minutes to score. With *PEDS*® *Online*, 0 minutes are required due to automated scoring.

Time Required to Write Referral Letters and Take-Home Parent Summaries. A scant minimum of 5 minutes is needed for each of these tasks when using *PEDS-R*® in print. With *PEDS*® *Online*, 0 minutes are needed because referral letters and parent summaries are automatically generated.

Material Costs.

- In print, *PEDS-R*® costs \$1.04 per administration. Unlike past iterations of *PEDS*®, which had two separate pads of forms plus a separate booklet of directions, *PEDS-R*® combines all components into a single perforated fold-over protocol. Within are directions for administration, the *PEDS-R*® questions/ space for parents' comments, *Score and Interpretation Form* [including how to incorporate findings from the *PEDS:DM*® (screener) and *M-CHAT-R*], and a *Current Findings* table for documentation of results and selection of recommendations.
- *PEDS*® *Online* costs \$4.00 per administration and includes the *PEDS:DM*® and *M-CHAT-R* along with automation of scoring, results, referral letters and take-home parent summary report.

Reimbursement/Billing. *PEDS-R*® [as well as the *PEDS:DM*® (screener) and *M-CHAT-R*] are eligible for payment from Medicaid/private insurance via the 96110 code (multiplied by 3 if all measures are given). The average reimbursement per screen is \$8.00, rendering a substantial profit margin for practices.

Integration with Electronic Records. *PEDS*® *Online* can be seamlessly and securely integrated with electronic records via an Application Programming Interface (API). Because sophisticated programming skills are needed, professionals wanting integration will need to prompt vendors at the national level to contact us: Amy@pedstest.com.

OTHER BENEFITS AND GUIDANCE

Impact/Stakeholder Uptake.

- Eliciting and addressing parents' concerns is an essential component of caring for children and their families. Prior studies show that parents much appreciate professional attention to their worries and thus are far more likely to keep future appointments.
- Professionals find that use of *PEDS-R*® reduces late-arising concerns. These disruptions leave no time for preparation or for gathering information handouts/brochures about referral resources. The time allotted for encounters is often exceeded, and this results in irritation to other families who must wait longer than expected.
- When parents' concerns are elicited, professionals find it easier to deliver difficult news because parents' worries can be confirmed thus providing motivation to seek intervention.

Compliance with Policy Recommendations.

The combination of *PEDS-R*®, *PEDS:DM*® (screener) and the *M-CHAT-R* offer evidence-based compliance with [American Academy of Pediatrics' recommendations](#) to: Elicit and address parents' concerns, measure milestones and periodically screen for autism spectrum disorder.

Compliance for Medicaid Patients.

The Centers for Medicare and Medicaid Services (CMS) requires evidence that billable screening tests were administered, scored, interpreted and appropriate action steps taken. To successfully survive a Medicaid audit:

- Print users can scan or print out the completed (front and back) for patient records. This shows parents' comments on the *PEDS-R® Response Form* and *Current Findings*, i.e., results and action steps.
- *PEDS® Online* users can paste or attach results to each patient's electronic record.

Translations.

PEDS-R® is printed in English and Spanish. *PEDS® Online* is offered in English, Spanish and Chinese. These and nearly 65 other translations have been thoroughly vetted and shown to work well. Translations are freely offered to *PEDS® Online* users and can be licensed by print users. Contact: Translations@pedstestonline.com.

PEDS-R® STANDARDIZATION AND PILOT VALIDATION STUDIES

2017 PILOT STANDARDIZATION STUDY

Rationale for PEDS-R®. Per prior research on *PEDS*®, parents with psychosocial risk factors (meaning: poverty, non-English speaking, or less than a high school education) are less likely to raise concerns spontaneously than are parents who are educated, more affluent, and English-speaking. The original *PEDS*® questions equalized much of “the playing field” and ensured that parents with psychosocial risk factors were as able as parents without such risks to state their concerns. Nevertheless, *PEDS*® still required parents to raise concerns about global/cognitive and health spontaneously and without specific probes. *PEDS-R*®, in contrast, provides questions asking about global/cognitive and health concerns.

2017 Pilot Study Findings. *PEDS-R*® was trialed in 2017, with 845 Spanish-speaking families grouped into those: 1) administered the traditional (10 question) version of *PEDS*® (N = 545); or 2) administered *PEDS-R*® with its additional two questions (N = 300). As hoped, parents administered *PEDS-R*® raised more concerns about cognition [OR = 7.5, 95%CI (2.75 – 20.46)] and health [OR = 3.6, 95%CI (1.92 – 6.72)].

Children administered *PEDS-R*® versus *PEDS*® were at elevated psychosocial risk and understandably more likely to have Path A results (6% versus 1%) or Path B results (13% versus 9%). Children were equally likely to have Path C results on *PEDS-R*® or *PEDS*® (5.0% versus 4.8%). Those administered *PEDS-R*® were less likely to have a no risk result (76% versus 85%). Nevertheless, *PEDS-R*® families were already on high or moderate risk paths with or without cognitive or health concerns and so changes to risk levels only increased by 1%.

There were significant differences in the frequency of concerns between groups [an average of 2.4 (range 1 – 9) for *PEDS-R*® versus an average of 1.5 concerns for *PEDS*® (t (150) = 3.19, *p* < .002). *PEDS-R*® was also better at prompting providers to administer other screens within *PEDS*® Online: Clinicians using *PEDS-R*® were more likely to administer the *PEDS:DM*® (38% versus 0% for *PEDS*®). The *M-CHAT-R* was administered with equal frequency whether using *PEDS*® or *PEDS-R*®.

2019 Pilot Standardization Replication and Pilot Validation Study #1

Goals. A major intent of *PEDS-R*® is to better differentiate types of risk, refine the original *PEDS*® Paths, and better help providers to hone types of referrals and parenting information needed. The purpose of this study was to; a) view broad categories of risk types on *PEDS-R*®, i.e., **DD** (Developmental Delay/Disorder); **MEBDD** (Mental Health, Emotional, Behavioral plus DD); and **MEB** (Mental Health, Emotional, Behavioral risk without DD); and b) view the relationship among *PEDS-R*® categories with other measures.

Methods and Demographics. Using 2019 data from *PEDS*® Online, parents or professionals working with 25,550 children were administered (in English, Spanish or other languages): *Parents' Evaluation of Developmental Status-Revised* (*PEDS-R*®) or *PEDS*® and *PEDS: Developmental Milestones*® (*PEDS:DM*®). *The Modified Checklist of Autism in Toddlers—Revised* (*M-CHAT-R*) was also administered to children in the 18-30 month age range (33%; N = 8510/25550). Children were 50% male and 50% female, ranging in age from birth to 8 years with a mean age of 31 months (sd = 23.75). Family demographics included: 16% Black/African-American, 22% Latino, 2% American Indian/Native American, 3% Asian, 1% Pacific Islanders, 2% other races/ethnicities, and 54% White. Settings, 15% of which were rural, included Head Start/Early Head Start, preschools/day care, public schools and primary health care. Sites were located across 15 U.S. States and represented all four U.S. Census Bureau Regions.

PEDS-R® and *PEDS*® performance was categorized and defined as follows: DD risk was assigned if there were one or more concerns about Expressive Language, Receptive Language, Fine Motor, Gross Motor, School, Global/cognitive and/or Health. MEB risk was assigned if there were one or more concerns about Behavior, Social-Emotional, Self-help; and MEBDD risk was assigned if both DD and MEB were present. DD risk was found in 16% (N = 4178), MEB risk in 6% (N = 1418), and MEBDD risk in 10% (N = 2538).

Findings. Via discriminant function analyses, each risk category was used as the grouping variable with performance on each of the *PEDS:DM*® milestones as predictors. DD risk was significantly associated with unmet developmental milestones on the *PEDS:DM*® in Receptive Language (.76), Expressive Language (.67), Academics (.67) and Fine Motor (.65) but not with MEB milestones on the *PEDS:DM*®, i.e., Social-emotional and/or Self-help [$\chi^2(7) = 1314.82$; $p < .0001$]. MEBDD risk was significantly associated with unmet developmental milestones on the *PEDS:DM*®: Receptive Language (.69), Expressive Language (.61), Fine Motor (.67), Academics (.58) but also with unmet milestones correlated with MEB risk on the *PEDS:DM*®: Self-help (.54) and Social-emotional (.55) [$\chi^2(7) = 2463.78$; $p < .0001$].

MEB risk on *PEDS*®/*PEDS-R*® was associated with MEB risk on the *PEDS:DM*®, i.e., unmet milestones in Social-emotional (.79) and Self-help (.67), but unmet Fine Motor milestones were also predictive of MEB (.54) [$\chi^2(3) = 135.20$; $p < .001$]. Overall, 7% of children at risk for MEB had one unmet milestones on the *PEDS:DM*®. It may be tempting to think that fine motor skills, given their association with self-help skills, explains why deficits in fine motor predict MEB risk on *PEDS*®/*PEDS-R*®. Nevertheless, parents with only behavior or social-emotional concerns had children with 2½-3 times the risk of unmet fine motor milestones [OR range = 2.5 – 3.0; (95%CI range = 2.39 – 3.13); $p < .001$]. One hypothesis is that children with fine motor difficulties tend to act out behaviorally and/or have challenges with well-being due to frustrations with writing, drawing, use of scissors, mastery of eating utensils, etc.

The majority of children, 68% (N = 17416) scored on Path D/E: Low DD and Low MEB Risk, but this group was not completely immune from difficulties on the *PEDS:DM*®: 7% (N = 1289) had two or more unmet developmental milestones and 14% had unmet MEB milestones.

Of the 16% with two or more unmet milestones of any type (N = 2723), the most common were Fine Motor (14%) and Receptive Language (12%). Overall, only 11% of the sample (N = 2723/25,550) had difficulties not detected by *PEDS*®/*PEDS-R*®.

The *M-CHAT-R* was administered to 13,409 children of whom 6% (N = 806) had failing scores. Of this group, MEBDD risk on *PEDS*®/*PEDS-R*® was most closely associated with *M-CHAT-R* failures (42%). Any risk on *PEDS*®/*PEDS-R*® identified 70% of *M-CHAT-R* failures. Although 70% sensitivity of *PEDS*®/*PEDS-R*® to *M-CHAT-R* failures is valuable, autism spectrum disorders (ASD) are expensive to treat and should be detected and treated as early as possible. For this reason, periodic use of an autism specific screen is recommended.

Comment on 2019 Pilot Studies #1. The findings show that the three broad categories of risk on *PEDS*®/*PEDS-R*® had distinct associations with performance on other measures: a) DD risk was highly correlated with unmet developmental milestones on the *PEDS:DM*® but not with its MEB milestones; b) MEBDD risk was associated with both unmet developmental and MEB milestones on the *PEDS:DM*® but also with failing results on the *M-CHAT-R*; and c) MEB risk was associated with unmet MEB milestones on the *PEDS:DM*® but also with unmet fine motor milestones; and d) 11% of those without risk on *PEDS*®/*PEDS-R*® had unmet milestones on the *PEDS:DM*® or *M-CHAT-R* failure.

For those with only MEB risk or at low risk (Path D/E) on *PEDS*®/*PEDS-R*®, it bears emphasizing that the policy of the American Academy of Pediatrics is wise: At each well visit, professionals should elicit and address parents' concerns, measure milestones and use an autism screen periodically, i.e., at 18-, 24- or 30- months.

Reformulation of *PEDS*® Paths into *PEDS-R*® Paths. The three broad categories of risk (DD, MEB, and MEBDD) were then assigned to *PEDS-R*® Paths. The intersection differentiated the original *PEDS*® Path A into Path A: High DD Risk versus Path A: High MEBDD Risk. Similarly the original Path B bifurcates into Path B: Moderate DD Risk and Path B: Moderate MEBDD Risk. Path C divides into Path C: Mild DD Risk versus Path C: Mild to Moderate MEB Risk. Path D/E: Low Risk for DD or MEB remains the same.

2021 Pilot Replication Studies

Background and Goals. In 2018 through 2020, *PEDS-R*® was administered in Spanish only. Starting in mid-2021, *PEDS-R*® was administered in both English and Spanish. Of the 53,202 cases in 2021, *PEDS*® was

administered to 31,703 children and *PEDS-R*® to 21,499. To assess how best to compare the *PEDS-R*® and *PEDS*® groups, the below analyses were conducted:

Concerns about Global/Cognitive and Other/Health Concerns. Global/Cognitive concerns were raised by 3% of the sample (N = 1460). Of this group, 91% had completed *PEDS-R*® and the remaining 9% were administered *PEDS*® [OR = 15.9; 95%CI (13.26 – 19.22); $p < .0001$]. Health issues were a concern for 4% of families (N = 2268). Parents were somewhat more likely to raise health concerns if administered *PEDS-R*® (52% versus 48% on *PEDS*®) [OR = 1.6; 95%CI (1.49 – 1.76); $p < .001$].

Age Comparison. Children were grouped by ages as defined by scoring changes in *PEDS*®/*PEDS-R*® and then by which screen was administered. Those in the 0 through 17 month range accounted for 26% of the sample (N = 14,028) and 38% were administered *PEDS-R*®. The 18 through 35 month range comprised 37% (N = 19,406) with 38% administered *PEDS-R*®. Children in the 36-53 month range accounted for 22% (N = 11,968), with 39% screened with *PEDS-R*®. Children 4½ years and older comprised the remaining 15% (N = 7,800) with 53% administered *PEDS-R*®.

English versus Spanish Administrations. On both *PEDS*® and *PEDS-R*®, Spanish- and English-speaking parents had the highest numbers of concerns when their children were in the 18-35 month age range. On either measure, both language groups had fewer concerns for their 0-17 month children. English-speakers had more concerns for their 4½- through 7-year-olds while Spanish-speakers had higher rates for their 36-53 month-old children.

Psychosocial Risk Comparison. Psychosocial risk has a known adverse effect on development and often increases rates of DD, MEB and MEBDD. Psychosocial risk was defined as having both of the following risk factors: 1) Parents with limited education (less than a high school diploma or equivalent) and; 2) Poverty (at or below federal poverty thresholds). Not speaking English is a risk factor but already accounted for by the language in which *PEDS*®/*PEDS-R*® was administered.

In 2021, two risk factors were present in 20% of families. Children in the 18-35 and 36-53 month range accounted for 71% of those with psychosocial risk factors, while younger and older age groups were less likely to have psychosocial risk (18% and 10% respectively). Those administered *PEDS-R*® were more likely to have psychosocial risk than those administered *PEDS*® (38% versus 21%), probably due to the impact of COVID-19.

Identification of Optimal Predictors of MEB, MEBDD, and DD Risk. Given demographic differences in the *PEDS*® versus *PEDS-R*® samples, discriminant function analysis was used to determine which variables best predicted MEB, MEBDD and DD risk. Variables included age of child, language spoken by parents, whether *PEDS*® or *PEDS-R*® was administered, and presence/absence of psychosocial risk factors. Children's age was the only correlate (.99) making all other variables non-predictive [$\chi^2(4) = 1127.91, p < .0001$]. This means that results of both screens can be combined if performance is analyzed by age. Thus, the new Paths for *PEDS-R*® were applied to *PEDS*® and both referred to as *PEDS-R*®. The impact of *PEDS-R*®'s two additional questions is analyzed separately.

FULL STANDARDIZATION STUDY: 2018 - 2021

Sites and Settings. Data for the current standardization study (N = 262,310) were collected from 2018 through 2021 via [PEDSTestOnline.com](https://www.pedstest.com). More than 1600 professionals from diverse disciplines participated. Settings included: General pediatric clinics (55%), Family medicine clinics (37%); Developmental-behavioral or hospital-based subspecialty services (2%); Regular preschool education settings such as day-care or Head Start (1%); Federally Qualified Health Centers, community, public health and Indian Health Service clinics (4%); and parenting specialists answering non-emergency crisis calls such as United Way's 2-1-1 Los Angeles warm line (1%). A negligible percent of sites (0.01%) were families' homes or public libraries where self-selected parents completed measures on their own.

Locations. Sites outside North America comprised 1% of the sample and included: Albania, Antigua & Barbuda, Argentina, Australia, Bahamas, Bangladesh, Barbados, Brazil, Chile, China, Costa Rica, Denmark, Ecuador, France, Germany, Ghana, Greece, Hong Kong, Japan, India, Ireland, Lithuania, Malaysia, Malta, Nepal, Netherlands, Nigeria, Pakistan, Philippines, Romania, Saudi Arabia, Singapore, Sri Lanka, South Africa, Thailand, Turkey, United Arab Emirates and the United Kingdom.

North American sites comprised the remaining 99% of the sample and included Mexico, Canada and the USA. The sample from Canada included two provinces, Mexico included one State, and the US sample embraced 32 US States, several Tribal Nations, all four US Census Bureau Regions, and all nine Census Bureau Divisions. The South Atlantic and West South Central Divisions were over-represented due to Delaware's Developmental Screening Initiative and Texas Health Steps (Children's Medicaid services).

Family Demographics. Parents and/or professionals had the option of answering demographic questions such as language spoken at home, level of education, family zip code, ethnicity/race, child gender, current services received by the child, etc. Parents and guardians served as initial informants and included fathers/step-fathers (14%), mothers/step-mothers (84%), grandparents (2%), and foster parents/other/friends/relatives (1%).

Child Characteristics. Females comprised 49% of the sample and males 51%. Children ranged in age from birth through 96 months (mean = 31 months, SD = 22.24). If born 3 or more weeks premature and less than 24 months of age, chronological age was adjusted for prematurity (occurring in 4% of encounters). Children were grouped by year of age and also by age ranges for which the four scoring changes on *PEDS*/*PEDS-R* occur: 0 – 17 months, 18 – 23 months, 24- 35 months, 36 – 53 months, and 54+ months.

Languages. [PEDSTestOnline.com](https://www.pedstest.com) offers measures in English, Spanish and Chinese (Traditional). Professionals working with families speaking/reading any other languages were offered freely available, thoroughly vetted, digital translations in ~65 other languages to use alongside [PEDSTestOnline.com](https://www.pedstest.com). Parents or professionals opted to administer *PEDS-R* in Spanish in 2% of encounters – although this is an underestimate because many professionals interviewed Spanish-speaking parents, back-translated the questions from English to Spanish and then typed comments in English. Also some parents selected English, began writing in English but then switched to Spanish mid-way through!

Administration of Measures. Parents completing *PEDS-R* on their own (via self-selection or via the *PEDS* Online parent portal), accounted for 11% of administrations. The remaining 89% were professionally administered. In all cases, if items were skipped or no comments provided, *PEDS* Online does not score but instead prompts for completion. Professionals are encouraged to add their own concerns before submitting findings for scoring.

Comparison of Sample with US Demographics. Parents or professionals answered one or more demographic questions ~ 45% of the time. When individual demographics were missing, Census Bureau data per clinic zip code were substituted ([QuickFacts](#)). **Table 2-1** compares the US population to the standardization sample.

Table 2-1. Comparison of Standardization Sample to the US Population.

Demographics	US Population %	Standardization Sample %
White (alone)	59%	53%
Latino/Hispanic	19%	28%
Native Hawaiian or Other Pacific Islander	0.3%	0.5%
American Indian or Alaska Native	1.3%	1.2%
African American/Black	14%	19%
Asian	6%	4%
High School Diploma or Equivalent	88%	73%
Bachelor's Degree or higher	33%	24%
Poverty	11%	15%
Not Speaking English at Home	22%	32%
TOTAL	329,500,000	262,310

Comparing the study sample to US population parameters revealed no statistically significant differences for any variable: Ethnicity, education, poverty or non-English speaking ($p = NS$). Although nationally representative of the US, there are slight departures due to Medicaid mandates for screening. Subsequent analyses view differences in types of concerns by age, *PEDS-R*® performance by language used in administration, and by ethnicity/race, gender, and psychosocial risk factors.

Concerns by Year of Age. Table 2-2 shows the frequency of concerns according to children's age in years. Bolded text identifies the more common concerns.

Table 2-2. Frequency of Concerns by Year of Age.

FREQUENCY OF CONCERNS										
AGE OF CHILD	Expressive	Receptive	Fine Motor	Gross Motor	Behavior	Social-Emotional	Self-Help	School	Global/Cognitive	Health
0-11 months N = 54,831	2%	1%	2%	5%	3%	2%	2%	0.5%	0.5%	4%
Year 1 N = 61,669	12%	3%	2%	4%	7%	4%	2%	2%	1%	3%
Year 2 N = 55,526	18%	5%	2%	2%	10%	6%	3%	4%	1%	3%
Year 3 N = 27,820	20%	7%	2%	3%	12%	8%	5%	5%	1%	3%
Year 4 N = 27,535	19%	7%	3%	2%	13%	8%	5%	6%	1%	3%
Year 5 N = 13,435	22%	11%	4%	3%	19%	13%	8%	12%	2%	4%

FREQUENCY OF CONCERNS										
Year 6 N = 11,550	20%	10%	4%	3%	22%	14%	9%	15%	1%	4%
Year 7 N = 9,914	18%	11%	4%	4%	23%	14%	9%	14%	1%	4%
TOTAL N = 262,310	14%	5%	2%	3%	10%	6%	4%	4%	1%	3%

As shown in **Table 2-2**, the frequency and types of concerns change with age. Some concerns, such as gross motor wane as children get older. Other concerns, like expressive and receptive language, behavior, social-emotional, self-help, and school rise with age.

Examples of Verbatim Concerns. To exemplify the content of concerns and how these can inform professionals, **Table 2-3** shows a selection of actual comments in answer to the *PEDS-R*® question probing expressive language, “Do you have concerns about how your child talks or makes speech sounds?” A sample of comments by select ages is presented. Comments were sorted by: a) lack of certainty about what is typical for a child’s age/requests for information; b) awareness/descriptions of typical development without concerns; c), awareness/descriptions of typical development with concerns; and d) oral motor and voice issues. Within, professionals’ back-translations, comments and sometimes recommendations are often visible.

Table 2-3. Sample of Expressive Language Concerns by Selected Ages.

Age of Child	CATEGORIES WITHIN AND EXAMPLES OF EXPRESSIVE LANGUAGE COMMENTS
0–5 months (N= 10,458)	<p>Uncertainty about What is Typical Development/Information Needs and Requests <i>Words are hard to understand a lot of the time; When will she babble more? Should he be making other sounds than just ahh/ohh sound?; Is it normal for him to make so many noises with his mouth completely closed? How much should she be talking? Is he speaking enough?; First time mom, not sure if [child’s] playful screams or high pitched coos [should be] a concern. Mother concerned patient does not say more than 10 words; Words are hard to understand a lot of the time</i></p>
	<p>Awareness/Descriptions of Typical Development Without Concerns <i>Working on making sounds; When I talk to him, he tries to do the same; Too young [to talk] at this point; She is only 2 months [and] I feel she talks a lot [and] is very alert; She babbles and makes "motorcycle" sounds - she also laughs and giggles; She can say mama every time she’s hungry; She already made sound [and] I reply her same sounds; She coos a lot</i></p>
	<p>Awareness of Typical Development With Concerns <i>She used to babble a lot and then stopped making sounds; She doesn't really make noises; No dada or mama sounds yet; No speech sounds; No vowels; He makes very odd sounds, but not mimicking any sounds he may hear; Doesn't do the ba, ga cooing sounds; Doesn't babble as much; Doesn't make much noise beyond crying; Child is taking speech therapy</i></p>
	<p>Oral Motor and Voice Issues <i>Sometimes makes grunting noises; very loud; Raspy- snores at times and breaths loudly; screeches; screams; hoarse; grunts; Makes gasping sound on occasion; Makes weird coo gag sound; Pitch-requested ENT consult; Talks so low</i></p>

Table 2-3. continues on next page

Table 2-3. cont'd

Age of Child	CATEGORIES WITHIN AND EXAMPLES OF EXPRESSIVE LANGUAGE COMMENTS
<p>2½ Years (N = 7146)</p>	<p>Uncertainty about What is Typical Development/Information Needs and Requests <i>Concerned about 'r' sounds; A little bit of a lisp with "S" sounds; Can't pronounce "L" sounds; Stutters when talking; [Trouble] Blending; pronunciation of last syllable; can't speak clearly; Does not speak in complete sentences; When I use flashcards he can identify a lot of the pictures, orange, apple, snake, etc.); Mixes up some letters "th" with "f" and "L" with "w" (ie "wuv" not "love"); Most of the time, he only pronounces one syllable of multi-syllabic words; Not all words seem clear; Not sure if he's progressing properly with his speech; Not sure if she's where she should be developmentally; Not sure if words should be clearer at this age; Not sure what is normal; Not sure what level of pronunciation she should have; Progressing properly?; Questions about articulation; Sometimes [I'm concerned about] her sounds but not sure if it's because of age; Sometimes doesn't speak proper language; Sometimes he repeats a lot the syllables; some words she gets confused like "im full" she says in meaning "im hungry"; Pt.s' mother states that she is not sure if it is a concern or not but, Pt. speaks few words on Mixteco, few words on English and some more words on Spanish. Pt.s' language is reduced and not clear; Per mom the only words that pt. is saying is mama & papa, mom is not concerned about it because sister started talking when she was 3 or 4 and now talks well; not as advanced as his sister; will often talk in phrases instead of sentences; can read flash card but hasn't been able to communicate with us other than calling mama or papa when we insist he try; Want to make sure he's as clear as he should be by his age; Autism?; Sometimes words are backwards; Should he be talking clearer?; Repeats the last word someone says; Refers to self in the third person; Not really [concerned], but we just want to make sure his speech and language/vocabs are normal with kids same age; Mom states that she understand only half of what pt. says; Case worker has concerns about speech, guardian does not; Concerned about 'r' sounds; She stutters sometimes-not with sounds but repeats the whole word</i></p>
	<p>Awareness of Typical Development Without Concerns <i>Speech delay at one time, has since caught up; Speaks Portugese and English so took a bit more to start to speak; Sometimes hard to understand but [I'm] not really concerned; completed speech therapy and now doing fine; Sometimes hard to understand but not really concerned; Per mom pt. is using like 50 clear words is starting to combine some and a lot of sounds like talking; Late to talk but now says lots of words in all three languages; Mom understands 90% of his speech. Can count to 5. Knows 5 colors; Mother shared that pt. is using 2 words in a sentence; Using sentences to communicate with others; She's talking more with 2-3 sentence words, examples: Mom, I'm hungry. Mom, I'm scared</i></p>
	<p>Awareness of Typical Development With Concerns <i>Parents shared Pt did not have any language prior to attending daycare. Since May, Pt saying simple words. Only sounds observed at Appt; Speech has improved. CO has affected our development slightly; speaks gibberish; does not repeat what is said to him except rarely; She's trying to say words but sometimes doesn't want to learn or repeat; Isn't putting words together; She has started talking quite a bit more since starting daycare, but she's still behind - She's more at the parrot stage now; Doesn't talk; Only has 4-5 words; She does not speak any words at all - She does try to imitate animals sounds like lion, dog, cat etc. but with no clarity - Was a normal baby but changed after about 14 months; Is in Speech therapy; Patient. is saying some words but not combining them; Mainly points at what she wants; I'm teaching her the right words but she doesn't follow or repeat after me; [I'm} unable to understand what she says; Tested and found to be delayed; Does not communicate with other kids; Barely wants to speak; Pt. says few one word sentences. Milestone expectations are 2 word sentences; Pt currently receiving services - Mother noticing regression in language; Per mom, she speaks [foreign language] to pt., but pt. is not speaking [that language] any more; Not progressing with speech or vocabulary; Not talking yet but recently diagnosed with Autism, starts speech therapy [soon]; Need to have him seen by Easter Seals but I have no vehicle or a way to get there will go after I get a vehicle; not improving; hearing difficulty; He repeats word, but don't use them; Makes these finger hand movements whenever he wants something; Just repeating things [does]not understands what he is saying; Can talk but does not ask for things; [During Covid] supposed to get speech therapy online but I don't have a computer; Only babbles; Apraxia</i></p>
	<p>Oral Motor and Voice Issues <i>Drools a lot; only whispers; talks through her teeth; Dentist says she's tongue-tied; talks very low; screams; squeals; yells a lot; has to push his voice; weird noises; mouth breathing; No words - Just grunts and moans; Makes sounds as if hes deaf - hums and makes a lot of noises; doesn't separate words, runs speach together; Whining; Slurred words</i></p>

Comment on Concerns: Verbatim comments, from both parents and professionals, offer a rich source of information on children's development. Parents' concern sometimes identify disordered development - information not rendered by milestones-focused screens (e.g., "uses three words at a time but says the same ones over and over.") Professional's comments add meaning, significance and sometimes specific diagnoses to parents' observations. Services received, progress, and descriptions of typical versus delayed

development are also useful for making referral decisions and selecting types of parenting information to dispense.

Overall, parents' verbatim comments offer professionals a rich source of information including parents' needs for guidance on child development. Parents' comments sometimes identify disordered development - information not rendered by milestones-focused screens. Services received, progress, and descriptions of typical versus delayed development are also useful for making referral decisions and selecting types of parenting information to dispense.

In the 0-5 month age range, many parents asked for information about typical development or needed guidance understanding what are age-appropriate vocalizations and "conversations". Others provided delightful descriptions of what their children were "saying" and imitating. Parents with concerns were often aware that limited or odd vocalizations were problematic.

At 2½ years of age, many parents needed guidance about age-appropriate articulation skills, vocabulary, syntax and normal stuttering. Parents providing descriptions of typical language development often commented on dual-language learning, length of utterances, and ability to communicate with words. Concerned parents noted absence of progress, regression, conditions associated with speech-language delays/disorders, child's lack of interest in talking, and continued use of jargon instead of real words. Many children were enrolled in speech therapy with some parents sharing ongoing worries while others noted improvements due to intervention.

Performance on PEDS-R® by Paths and Children's Age Group. The percent of children scoring on the various PEDS-R® Paths/Risk Levels by age group is shown in **Table 2-4**. Visible are increases, the older the child, in both high to moderate DD risk as well as MEB and MEBDD risk.

Table 2-4. Performance on PEDS-R® by Path/Risk Levels and Age Ranges

PEDS-R® PATHS/RISK LEVELS	AGE GROUPS			
	0 through 17 months N 75,550	18 through 35 months N 96,506	3 to 4½ years N 49,080	4½ to 8 years N 41,174
Path A: High MEBDD Risk	1%	3%	5%	10%
Path A: High DD Risk	0.3%	2%	2%	3%
Path B: Moderate MEBDD Risk	3%	4%	4%	7%
Path B: Moderate DD Risk	5%	11%	11%	12%
Path C: Mild to Moderate MEB Risk	2%	5%	5%	9%
Path C: Mild DD Risk	4%	1%	0.5%	--
Path D/E: Low DD and Low MEB Risk	85%	74%	72%	59%
OVERALL DD RISK* (without MEB risk)	9%	14%	13%	15%
OVERALL MEB RISK* (without DD Risk)	2%	5%	5%	9%
OVERALL MEBDD RISK* (both DD and MEB Risk present)	4%	7%	10%	17%
TOTAL ANY RISK*	15%	26%	28%	41%

*Risk on PEDS-R® includes children who need referral to IDEA/special education services as well as those needing other types of professional attention (e.g., parent training, Head Start, quality preschool).

Comment on Risk by Age. Overall, 25% of children were at risk for DD, MEB or MEBDD. Note: The finding of 25% at risk on PEDS-R® is not an indicator of need to refer all to IDEA/special education. More than half of those at risk deserve other types of professional attention including developmental-behavior promotion and/or non-IDEA services such as Early Head Start or parent training.

While generally comparable to 2013 standardization findings (shown in *Collaborating with Parents, 2nd Edition*), risk rates found in the current study are substantially higher for 4½- to 8-year-olds than in the past. See the section below on the impact of the COVID-19 quarantine as a likely explanation.

DD risk without MEB risk was found in 12% (N = 32717) of children whose mean age was 2 years, 9 months (sd = 22.29 months). MEB risk without DD risk was found in 5% of children (N = 12864) who had a mean age of 3 years, 4 months (sd = 24.65 months). MEBDD risk was present in 8% of children (N = 20958) who had an average age of 3 years, 8 months (sd = 24.82). The findings show that DD risk emerges before MEB risk and that combination risk, MEBDD, tends to emerge slightly later and accumulates with time.

PERFORMANCE ON *PEDS-R*® IN CHILDREN WITH PSYCHOSOCIAL RISK FACTORS

Psychosocial risk factors were explored as follows:

Parents with/without Facility with English. Children whose parents did not speak English comprised 3% of the sample and were similar in age to those of English-speaking parents. Children of non-English speakers were as likely as those of English-speakers to have DD risk (12% versus 12%) and MEB risk (4% versus 5%) but had higher rates of MEBDD risk (11% versus 8%) [OR = 1.4; (95%CI 1.29 – 1.52); $p < .001$].

Families with/without Poverty. Children living with poverty comprised 19% of the sample and were similar in age to those without poverty (mean = 30 months versus 31 months). There were no significant differences in DD risk between groups (13% versus 12%) or in MEBDD risk (7% versus 8%). Non-impovertised families were somewhat more likely to have children with MEB risk than poor families (5% versus 3%) [OR = 1.5; (95%CI 1.47 – 1.61); $p < .001$].

Parents with/without Limited Education. Children whose parents had not graduated from high school were found in 21% of the sample and were comparable in age to children of more educated parents (30 months versus 32 months). Children of parents without high school diplomas when compared to those who had graduated from high school, had similar rates of DD risk (12% versus 13%), MEB risk (4% versus 5%) and MEBDD risk (7% versus 9%). Similarly when comparing families without high school diplomas to those with college degrees, there were no significant differences in rates of DD, MEB, or MEBDD, although more educated parents tended to have children with marginally higher rates for each type of risk on *PEDS-R*®.

Interaction of Poverty Risk with Education Levels. Parents with less than a high school education had the highest poverty rates (46%). Those with a high school education with or without some college coursework had somewhat lower poverty rates (39%), while parents with college degrees or higher had the lowest poverty rates (15%). Poverty rates and education levels are highly correlated, i.e., redundant, meaning poverty levels also serve as a marker for education levels. Thus, poverty (and language spoken) are used as psychosocial risk factors in subsequent analyses, while education level is not.

Overall, the two psychosocial risk factors: families in poverty or parents who were non-English speaking parents were found in 19% of the population. One or both of these factors were associated with risk on *PEDS-R*®. The findings also show that parents with psychosocial risk factors were as able as parents without risk factors to express their concerns on *PEDS-R*®.

Impact of the COVID-19 Quarantine. The COVID-19 pandemic increased families' economic and emotional stress, decreased parents' access to higher education, and reduced children's participation in preschool, elementary school and group play. Also, almost a quarter of 1 million children have a deceased parent due to the pandemic. The ramifications on child development are enormously worrying: A review article in *Nature* noted that the emergence of delays due to privations and isolation takes about two years to develop and include deficits in language, motor, social-emotional and cognitive skills. Thus performance problems (for children born prior to the pandemic) became highly visible in late 2020 and throughout 2021. See this article in [Nature.com](https://www.nature.com).

Comparing data from 2018 - 2019 to 2020 - 2021, there were significant decreases in parents' facility with English (1% versus 4%) [OR = 2.6; (95%CI 2.52 – 2.80); $p < .0001$] and increased rates of not graduating

from high school (31% versus 44%) [OR = 1.57; (95%CI 1.68 – 1.74); $p < .0001$]. Poverty rates increased only marginally (18% versus 20%), probably due to the US Coronavirus Aid, Relief, and Economic Security Act (CARES Act).

Performance differences on *PEDS-R*® were compared over time. Across all age groups, Low Risk for DD/MEB (PathD/E) scores decreased considerably between 2019 (59%) and 2021 (41%). Parents raising concerns had more concerns in 2020 (mean = 2.21) than in 2019 (mean = 2.04). As an example of ongoing risk, children who were 4-years-old in 2020 were compared to children 5-years-old in 2021. DD/MEB, or MEBDD risk on *PEDS-R*® rose from 31% in 2020 to 35% in 2021.

Comment on COVID-19. The problematic consequences of the quarantine or COVID itself are apparent. In a prior study with *PEDS*® conducted during a malarial outbreak in Tanzania, almost all parents were understandably worried about their children’s development. Thus *PEDS-R*® also seems responsive to health care crises. The authors of the Nature article are optimistic about children’s resilience, but also suggest careful monitoring and support for the cohort born prior to or during the early pandemic.

Performance on *PEDS-R*® in Spanish versus English Administrations. *PEDS-R*® was administered in Spanish to 2% of families (N = 6,170). English was used with remaining 98% (N = 256,140).

Spanish-speakers had few children in the oldest age range and so only performance on *PEDS-R*® in the youngest three age ranges were compared to English speakers. Children of Spanish speakers were at higher risk for DD compared to English speakers (0 – 17 months = 26% versus 21%)(18 – 35 months = 43% versus 41%)(36 – 53 months = 22% versus 20%). MEB risk was higher (0 – 17 months = 17% versus 13%)(18 – 35 months = 49% versus 38%)(36 – 53 months = 26% versus 20%) as was MEBDD risk (0 – 17 months = 19% versus 13%)(18 – 35 months = 39% versus 30%)(36 – 53 months = 28% versus 23%). Overall, children of Spanish-speakers had 1 1/3 times the risk of DD, MEB or MEBDD as compared to English speakers [OR = 1.3; 95%CI (1.19 – 1.34); $p < .001$]. The results indicate that *PEDS-R*®, whether administered in Spanish or English, was effective at eliciting parents’ concerns and determining risk.

Ethnicities/Races and Psychosocial Risk: Performance on *PEDS-R*®. Using only parents self-reported demographics, the following analyses have smaller N’s than the entire sample. Consequently, some ethnic groups were collapsed as shown in **Table 2-5**. Ethnicity/race was identified by 58,194 families.

Table 2-5. Risk Rates for DD, MEB, or MEBDD Across Ethnicities/Races* and Psychosocial Risk (one or more factors).

AGE GROUPS				
ETHNICITIES/RACE	0 through 17 months	18 through 35 months	3 to 4½ years	4½ to 8 years
NATIVE AMERICAN/AMERICAN INDIAN/ALASKA NATIVE (N = 2197)				
DD Risk (N = 349)	10%	16%	18%	20%
MEB Risk (N = 228)	4%	14%	13%	7%
MEBDD Risk (N = 292)	6%	12%	16%	20%
TOTAL: ANY DD and/or MEB RISK (N = 869)	20%	42%	46%	46%
Psychosocial Risk (N = 1927)	76%	86%	94%	92%
ASIAN (N = 2138)				
DD Risk (N = 337)	18%	19%	14%	16%

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Table 2-5. cont'd

AGE GROUPS				
MEB Risk (N = 116)	4%	6%	5%	10%
MEBDD Risk (N =257)	6%	14%	19%	13%
TOTAL: ANY DD and/or MEB RISK (N = 746)	28%	40%	39%	39%
Psychosocial Risk (N = 76)	2%	3%	8%	3%
BLACK/AFRICAN AMERICAN (N = 7074)				
DD Risk (N = 985)	11%	14%	18%	12%
MEB Risk (N = 370)	3%	6%	7%	6%
MEBDD Risk (N =654)	4%	9%	14%	15%
TOTAL: ANY DD and/or MEB RISK (N = 2009)	18%	29%	39%	33%
Psychosocial Risk (N = 433)	6%	7%	6%	4%
LATINO/HISPANIC (N = 26,248)				
DD Risk (N = 3188)	9%	14%	13%	12%
MEB Risk (N = 1077)	2%	5%	4%	5%
MEBDD Risk (N =2040)	4%	8%	10%	13%
TOTAL: ANY DD and/or MEB RISK (N = 6405)	16%	27%	28%	30%
Psychosocial Risk (N = 8213)	24%	32%	37%	33%
TWO OR MORE ETHNICITIES//OTHER RACES (N = 2197)				
DD Risk (N = 370)	12%	16%	15%	12%
MEB Risk (N = 140)	4%	6%	6%	7%
MEBDD Risk (N =260)	5%	10%	16%	23%
TOTAL: ANY DD and/or MEB RISK (N = 770)	22%	32%	37%	42%
Psychosocial Risk (N = 219)	8%	10%	10%	5%

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Table 2-5. cont'd

AGE GROUPS				
WHITE (N = 17,860)				
DD Risk (N = 2085)	13%	16%	15%	16%
MEB Risk (N = 998)	3%	7%	8%	7%
MEBDD Risk (N = 1834)	6%	9%	17%	22%
TOTAL: ANY DD and/or MEB RISK (N = 5492)	22%	32%	39%	45%
Psychosocial Risk (N = 1388)	5%	8%	12%	9%

*The Pacific and Native Hawaiian sample was too small to merit breakdown by risk types, age groups or psychosocial risk but overall, 43% of the total (N = 119) were at risk for DD, MEB or MEBDD.

Comment on Performance by Ethnicity/Race and Psychosocial Risk and Pilot Validation Study #2.

Over all, 28% of this sample had DD, MEB, or MEBDD risk. Any such risks were lower in the 0-17 month age range (19%) and much higher in the older three age groups (30%, 33% and 36% respectively).

Risk of DD, MEB, or MEBDD was highest in the Native American/American Indian/Alaska Native particularly for children 1½ years of age and older (45%). For all age groups psychosocial risk was alarmingly high (88%). Of children in this ethnic group, 45% had either 1 or more unmet milestones on the *PEDS:DM*® or failed the *M-CHAT-R*.

Asian and Other Races had elevated DD, MEB or MEBDD risk (35% and 30%) but relatively low rates of psychosocial risk (4% and 9%). Among children of Asians, 34% had either 1 or more unmet milestones on the *PEDS:DM*® or failed the *M-CHAT-R*. Among children of Two or More/Other Races/Ethnicities, 31% had either 1 or more unmet milestones on the *PEDS:DM*® or failed the *M-CHAT-R*.

Children in White families had overall risk rates on *PEDS-R*® of 31%, psychosocial risk of 8%, and 28% had either 1 or more unmet milestones on the *PEDS:DM*® or had failed the *M-CHAT-R*. Children in African-American/Black families had overall risk rates on *PEDS-R*® of 28%, psychosocial risk of 6%, with 29% having either 1 or more unmet milestones on the *PEDS:DM*® or a failed the *M-CHAT-R*.

Children in Latino/Hispanic families were significantly younger than those in all other ethnicities but when viewing the three oldest age groups, any risk on *PEDS-R*® was found in 28%, psychosocial risk in 34%, and 26% had either 1 or more unmet milestones on the *PEDS:DM*® or a failed the *M-CHAT-R*.

Summary of Pilot Validation Study #2. Ethnicities/races with low rates of psychosocial risk tended to have less risk on *PEDS-R*®. Higher psychosocial risk was associated with higher risk on *PEDS-R*®, especially in Native American/American Indian/Alaska Natives, but less so with Hispanic/Latinos. For each ethnicity/race, overall risk found on *PEDS-R*® was comparable to problematic performance on the *PEDS:DM*® or *M-CHAT-R*. Although parents of various ethnicities/races often have differing expectations for their children's performance and behavior, cultural differences within or across ethnicities/races are less than explanatory: Concerns raised on *PEDS-R*® are closely associated with measurable difficulties on other measures.

CHILD GENDER: PERFORMANCE ON PEDS-R®

Child gender was reported by 221,822 parents. Performance by gender is shown in **Table 2-6**.

Table 2-6. Risk Rates for DD, MEB, or MEBDD and Psychosocial Risk Rates by Child Gender.

RISKS	0 through 17 months	18 through 35 months	3 to 4½ years	4½ to 8 years
Female (N = 107,795)				
DD Risk (N = 11,796)	8%	12%	11%	14%
8%MEB (N = 4988)	2%	5%	5%	5%
MEBDD Risk (N =6613)	3%	5%	7%	14%
TOTAL: ANY DD and/or MEB RISK (N = 23,397)	14%	21%	22%	36%
Psychosocial Risk (N = 21,539)	16%	20%	33%	10%
Male (N = 114,027)				
DD Risk (N = 15,951)	9%	16%	15%	17%
MEB Risk (N = 6052)	2%	5%	6%	9%
MEBDD Risk (N =11,651)	4%	8%	13%	22%
48%TOTAL: ANY DD and/or MEB RISK (N = 35,614)	16%	29%	34%	48%
Psychosocial Risk (N = 22,987)	16%	20%	34%	11%

Comment on Gender. Psychosocial risk rates were identical for male and female children (20% versus 20%). Male children had one and a half times the overall DD, MEB and MEBDD risk as compared to female children (30% versus 22%)[OR = 1.5; 95%CI(1.48 – 1.54);p < .0001]. Males had somewhat higher rates of DD (14% versus 11%), similar rates of MEB (5% versus 5%), but substantially higher rates of MEBDD (10% versus 6%)[OR = 1.7; 95%CI (1.68 – 1.79); p < .0001].

PARENT/CARETAKER GENDER: PERFORMANCE ON PEDS-R®

Of the 17,367 caretakers identifying their relationship to each child, 85% were mothers, stepmothers or grandmothers (N = 14,823). Fathers, stepfathers and grandfathers accounted for 14% (N = 2417). The remaining 1% (N = 127) were relatives, family friends and foster parents (a group too small for analysis). **Table 2-7** shows performance on *PEDS-R®* divided by gender of caretaker.

Table 2-7. Risk Rates for DD, MEB, or MEBDD and Psychosocial Risk Rates by Relationship to Child.

RISKS	0 through 17 months	18 through 35 months	3 to 4½ years	4½ to 8 years
MOTHERS, STEPMOTHERS AND GRANDMOTHERS (N = 14,823)				
DD Risk (N = 2486)	15%	19%	17%	16%
MEB (N = 831)	4%	7%	7%	7%
MEBDD Risk (N = 1503)	6%	10%	16%	19%
TOTAL: ANY DD and/or MEB RISK (N = 4820)	25%	36%	39%	41%
Psychosocial Risk (N = 409)	3%	3%	2%	4%
FATHERS, STEPFATHERS AND GRANDFATHERS (N = 2417)				
DD Risk (N = 401)	14%	19%	15%	18%
MEB Risk (N = 114)	3%	6%	5%	8%
MEBDD Risk (N = 230)	5%	11%	16%	14%
TOTAL: ANY DD and/or MEB RISK (N = 745)	22%	35%	36%	40%
Psychosocial Risk (N = 47)	1%	2%	3%	4%

Comment on Caretaker Gender. Overall, there were no significant differences in DD, MEB, or MEBDD risk whether caretakers were female or male (32% versus 31%; $p = NS$). Psychosocial risk rates were low for both groups and too small for comparison.

COMPARING PEDS® TO PEDS-R®

PEDS® versus PEDS-R®: Comparison by Psychosocial Risk. One or more psychosocial risk factors were present in 19% of the sample (N = 50,276). Of this group 90% were administered PEDS® and 10% completed PEDS-R®. Of those at psychosocial risk, 1% raised global cognitive concerns with 0.4% from PEDS® administrations versus 6% when given PEDS-R® [OR = 16.5; 95%CI (13.98 – 19.41); $p < .0001$]. Health concerns were raised more often by those with psychosocial risk factors administered PEDS-R® (4% versus 2%) [OR = 1.9; 95%CI (1.61 – 2.14); $p < .001$].

Families with psychosocial risk factors were marginally more likely to have DD, MEB or MEBDD risk on PEDS-R® than on PEDS® (23% versus 21%) but these differences were not significant ($p = NS$). These findings indicate that the two new questions in PEDS-R® did not increase risk rates but instead offer professional's informative details about parents' specific global/cognitive and health issues.

Overall Effects of PEDS-R®'s Extra Questions. As a further check on how whether PEDS-R® contributed to excessive identification of DD, MEB and MEBDD risk, a forward step discriminant function analysis was used with the following independent variables: PEDS® versus PEDS-R® administered, language spoken, poverty status, children's age group. For DD and MEBDD risk, age of child was the only predictor (.97 and .97), meaning that language spoken, whether PEDS® or PEDS-R® was given and poverty were non-

contributory [$\chi^2(4) = 854.96; p < .001$] [$\chi^2(4) = 7170.32; p < .0001$]. For MEB risk, age (.92) was the main predictor but absence of poverty contributed modestly (-.38) suggesting that wealthier parents of older children were more likely to have behavioral, social-emotional or self-help concerns than poorer parents. [$\chi^2(4) = 2554.56; p < .0001$].

HIGHLIGHTS OF PILOT AND STANDARDIZATION STUDIES

Differences in *PEDS-R*® versus *PEDS*®

- *PEDS-R*® adds to original *PEDS*®, two questions probing global/cognitive and health concerns. The new questions facilitated comments by families with psychosocial risk factors, a group that rarely raised such concerns spontaneously.
- The two new questions did not elevate risk levels significantly because 98% families raising global/cognitive or health concerns were already on a moderate or high risk Path.
- *PEDS-R*® offers an extraordinarily useful opportunity for professionals to view parents' verbatim issues - enabling advice to be honed to topics of high interest to parents. Parents' comments seem to fall into three categories: a) need for information on typical development; b) aware of children's difficulties but satisfied with services; and, c) aware of difficulties and in need of referrals and/or care coordination. [*"The Book"*](#) houses downloadable parenting information in English and Spanish and includes links to printable handouts in many other languages.
- *PEDS-R*® refines the original *PEDS*® paths, enabling professionals to view discrete types of risk, i.e., for developmental delays/disorders (DD), mental health/emotional/behavioral (MEB), or a combination of the two (MEBDD).

- Thus *PEDS-R*® divides the original *PEDS*® Paths into:

Path A: High DD Risk

Path A: High MEBDD Risk

Path B: Moderate DD Risk

Path B: Moderate MEBDD Risk

Path C: Mild DD Risk

Path C: Mild to Moderate MEB Risk

Path D/E: Low Risk for DD or MEB

- Pilot validation studies showed that:
 - o *PEDS-R*®'s discrete Paths are associated with unique performance patterns on other measures. Thus *PEDS-R*® Paths help specify whether to refer and to what types of professionals, when to advise parents, and whether to monitor routinely or vigilantly.
 - o Parents of children with Path C: Mild to Moderate MEB Risk, struggling as they are with behavior, social-emotional and/or self-help challenges, sometimes overlooked developmental issues— about 6% of children in this group had unmet developmental milestones on the *PEDS:DM*®. Fine motor delays were the most common.
 - o Similarly 7% of parents whose children were on Path D/E: Low DD and Low MEB Risk, had unmet milestones on the *PEDS:DM*® with fine motor and receptive language delays being the most common.
 - o Although *PEDS-R*® appears to have adequate sensitivity to *M-CHAT-R* failures and unmet milestones on the *PEDS:DM*®, the American Academy of Pediatrics recommendations are wise: At each encounter, elicit and address parents' concerns, measure milestones and use an ASD screen periodically. This combination of measurement methods improves early detection, helps professionals best address parents' concerns and tailor referrals.

STANDARDIZATION STUDIES SUMMARY

- Following a series of pilot studies, *PEDS-R*® was standardized on 262,310 North American children from the US, Mexico and Canada.
- Children ranged in age from birth to 8 years of age. The majority of the sample, 65%, were less than 3 years of age.
- The sample does not differ significantly from the US population, although is slightly more representative of those receiving Medicaid -- with elevated rates of psychosocial risk factors and greater representation of ethnic/racial minorities.
- Various ethnicities/races were compared along with rates of psychosocial risk. Groups included: Native American/American Indian/Alaska Natives, Asian-Americans, Black/African-Americans, Hispanic/Latino, White, and Two or More/Other Races. Overall, groups with lower psychosocial risk had fewer children at risk on *PEDS-R*®.
- Families with psychosocial risk factors (e.g., limited education, poverty and non-English-speaking) were as able as those without to raise concerns. Those with psychosocial risk tended to have children with higher DD, MEB and MEBDD risk.
- 25% of the sample were at risk on *PEDS-R*® with DD risk found in 12%, MEB risk in 5%, and MEBDD risk in 8%. Note that risk on *PEDS-R*® includes children eligible for IDEA/special education as well as children needing other kinds of assistance (e.g., Early Head Start, parent-training, after-school tutoring).
- *PEDS-R*® Risk rates varied considerably by age of child. Children 4½ years of age and older had 4 times the risk compared to children less than 18 months of age.
- Types of concerns increased and varied by age, with expressive language, behavior, and social-emotional emerging at 12 months and increasing thereafter.
- Frequencies of risk and types of concerns on *PEDS-R*® were similar to those found in the 2013 psychometric studies on *PEDS*® with the exception of children 4½ years and older whose risk rates were almost twice as high as in the past.
- The much higher risk rates in older children seem due to the adverse impact of the COVID-19 quarantine. Even so, younger children were also affected. For example, MEBDD risk was three times higher for 3-year-olds in 2020 as compared to 2-year-olds in 2019, and 3-year-olds had much higher MEBDD risk in both 2020 and 2021 than in 2018 and 2019.
- Psychosocial risk increased significantly during the COVID pandemic and surely contributed to higher DD/MEB/MEBDD risk. Nevertheless, even families with few risk factors had increased worries, as is common during health crises.
- In comparing the performance of boys to girls on *PEDS-R*®, boys had 1½ times the risk for DD, MEB or MEBDD than did girls. Psychosocial risk rates were comparable across gender.
- Gender of caretaker/informant on *PEDS-R*®, did not result in performance differences. Fathers, step-fathers and grandfathers were as capable of identifying risk as mothers, step-mothers and grandmothers.
- After adjusting for age-differences in the Spanish-speaking sample (which had many more very young children), there were no differences in identification of risk on *PEDS-R*® whether administered in English or Spanish.

PEDS-R® RELIABILITY STUDIES

INTERNAL CONSISTENCY

Cronbach's alpha was used to assess the relationship among *PEDS-R*® items in order to discern whether each item reflects a unique developmental-behavioral domain. The complete standardization sample of 262,310 families was analyzed. As shown in **Table 3-1**, items have only modest correlations, even between like domains (e.g., Expressive Language and Receptive Language). This means that each item contributes uniquely to overall scores and that no items are so highly correlated as to be redundant.

Table 3-1. Inter-Item correlations between *PEDS-R*® items

ITEM/DOMAIN	Expressive Language	Receptive Language	Gross Motor	Fine Motor	Behavior	Social-Emotional	Self-help	School	Health	Global
Expressive Language	--	.440	.250	.181	.345	.306	.326	.347	.393	.204
Receptive Language	.440	--	.328	.213	.407	.386	.468	.418	.368	.222
Gross Motor	.250	.328	--	.328	.292	.284	.372	.289	.268	.211
Fine Motor	.181	.213	.328	--	.189	.214	.242	.194	.223	.177
Behavior	.345	.407	.292	.189	--	.529	.395	.395	.338	.248
Social-Emotional	.306	.386	.284	.214	.529	--	.408	.394	.339	.221
Self-help	.326	.468	.372	.242	.395	.408	--	.505	.393	.261
School	.347	.418	.289	.194	.395	.394	.505	--	.415	.231
Health	.393	.368	.268	.223	.338	.339	.393	.415	--	.325
Global	.204	.222	.211	.211	.247	.248	.221	.231	.325	--

TEST-RETEST RELIABILITY

Between One Day and One Week. In the 2018-2021 period, 228 unduplicated children (who ranged in age from birth to 95 months of age, mean age = 41 months) were screened twice with *PEDS-R*® between one day and one week (i.e., between 1 and 7 days) by the same examiner and with the same method. Note that only the initial and second screen were assessed among children that had more than two screens completed. Of these children, 160 (70.2%) were rescreened between 1 and 3 days after the initial screen and 68 (29.8%) were rescreened between 4 and 7 days after the initial screen.

At Time 1, 66.7% were at low risk while 33.3% had elevated risk. At Time 2, 3.9% of children at low risk had elevated risk results, while 11.8% of children with elevated risk had low risk scores. Test-Retest agreement between intervals was 93.4% (Kappa = 0.85, $p < .001$).

Between One Week and One Month. In the 2018-2021 period, 326 unduplicated children (who ranged in age from birth to 93 months of age, mean age = 17 months) were screened twice with *PEDS-R*® between one week and one month (i.e., between 8 and 30 days) by the same examiner and with the same method. Note that only the initial and second screen were assessed among children that had more than two screens completed. Of these children, 60 (18.4%) were rescreened between 8 and 14 days after the initial screen; 63 (19.3%) were rescreened between 15 and 21 days after the initial screen; and 203 (62.3%) were rescreened between 22 and 30 days after the initial screen.

At Time 1, 77.0% were at low risk while 23.0% had elevated risk. At Time 2, 5.6% of children who were at low risk at Time 1 had elevated risk results at Time 2, while 32.0% of children with elevated risk at Time 1 had lower risk scores at Time 2. Test-Retest agreement between intervals was 88.3% (Kappa = 0.66, $p < .001$).

When viewing performance by type of risk, those with DD risk at Time 1 ($n = 32$; 9.8%) were generally likely to also have DD risk or no risk reported at Time 2. Those with MEBDD risk at Time 1 ($n = 28$; 8.6%) also tended to have MEBDD risk at Time 2.

INTERRATER RELIABILITY

Between One Day and One Week. Overall, 55 unduplicated children (who ranged in age from 5 to 72 months, mean age = 30 months) were screened by different examiners at the initial and second screen in which these two screens occurred between one day and one week (i.e., between 1 and 7 days)

Among children who had different examiners at Time 1, 61.8% were at low risk while 38.2% had elevated risk. At Time 2, 8.8% of children at low risk had elevated risk results, while 33.3% of children with elevated risk had low risk scores. The Interrater agreement between examiners was 81.8% (Kappa = 0.60, $p < .001$).

Between One Week and One Month. Overall, 302 unduplicated children (who ranged in age from birth to 92 months, mean age = 17 months) were screened by different examiners at the initial and second screen in which these two screens occurred between one week and one month (i.e., between 8 and 30 days)

Among children who had different examiners, 83.4% were at low risk while 16.6% had elevated risk at Time 1. At Time 2, 7.9% of children at low risk had elevated risk results, while 44.0% of children with elevated risk had low risk scores. The Interrater agreement between examiners was 86.1% (Kappa = 0.49, $p < .001$).

INTER-METHOD RELIABILITY

PEDS-R®, like *PEDS®*, encourages a collaboration between parents and professionals. Professionals are prompted to add their own concerns before scoring and, if parents have expressed a concern but checked “not concerned,” to change that response to “a little concerned” or “concerned.” To emulate parent-professional collaboration, 515 randomly selected cases of children whose results were scored by *PEDS® Online*, were then scrutinized by a professional skilled in use of *PEDS-R®*. Of the 515 children [who ranged in age from birth through 96 months (mean age = 37 months)], 31 parents raised concerned but marked “not concerned.” The remaining 489 cases were correctly reported by the parents and clinicians completing *PEDS-R®*. Thus inter-method agreement was 94% ($N = 489/515$).

STABILITY

In these analyses, the constancy of parents' concerns was evaluated by viewing whether risk on *PEDS-R®* changed over lengthy periods of time. Children screened again two to six months later were included ($n = 5,672$). These children were then segmented into two age categories: a “younger” age component consisting of children birth to 30 months of age at their initial screen ($n = 4,715$) and an “older” age component comprising of children 31 to 96 months of age at their initial screen ($n = 957$). The average age among the younger group at Time 1 was 15 months ($SD = 6.1$) while at Time 2, the average age was 19 months ($SD = 6.8$), producing an average duration of 4 months. Among the older age group, average age at Time 1 was 47 months ($SD = 15.2$) while at Time 2, the average age was 51 months ($SD = 15.1$); this also generated an average duration of 4 months.

Among younger children, 80.8% were at low risk while 19.2% had elevated risk at Time 1. At Time 2, 12.6% of children at low risk had elevated risk results, while 49.1% of children with elevated risk had low risk scores. Stability, i.e., test-retest agreement over time, was 80.4% (Kappa = 0.38, $p < .001$).

Among older children, 68.3% were at low risk while 31.7% had elevated risk at Time 1. At Time 2, 13.0% of children at low risk had elevated risk results, while 29.7% of children with elevated risk had low risk scores. Stability, i.e., test-retest agreement over time, was 81.7% (Kappa = 0.58, $p < .001$).

SUMMARY OF RELIABILITY STUDIES

RELIABILITY

- **Internal Consistency** among *PEDS-R*® items revealed modest to moderate intercorrelations, i.e., no highly significant correlations reflecting redundancy. This means that each item contributes uniquely to the measure as a whole.
- **Test-retest Reliability** was 93% for re-administrations within 1 week, and 88% for administrations between 1 week and 4 weeks. Note that *PEDS-R*® is interactive: When professionals are able to effectively address parents' concerns, there are often fewer issues raised at the subsequent administration, which lowers test re-test agreement. Thus results are in keeping with prior reliability studies.
- **Inter-rater Reliability** was 82% for re-administrations within 1 week and 86% for administrations between 1 week and 4 weeks. Again, because professionals are often able to effectively address concerns, inter-rater reliability is expected to have lower agreement between first and second administrations. In addition, when parents do not speak English, repeat screens often involve a different examiner who is bilingual -- also leading to lowered inter-rater agreement.
- **Inter-method Reliability** compared professional scoring to parent reporting, specifically when parents raised concerns whether they marked "a little" or "concerned". In only 6% of cases did professionals need to change "not concerned" to "concerned". The remaining 489 cases were correctly reported by the parents and clinicians completing *PEDS-R*®. Thus inter-method agreement was 94% (N = 489/515).
- **Stability.** Comparing risk levels on *PEDS-R*® when rescreening over longer time intervals had 80% agreement for younger children and 82% agreement for older children. Lowered risk levels in subsequent administrations illustrate the effectiveness of interventions including professional advice. As a consequence, improved status was found in 49% of younger children and 30% of older children who were initially at risk. Even so, developmental/mental health risk remains a "moving target", i.e., risk of developmental and mental health problems increase the older the child.

PEDS-R® VALIDATION STUDIES

CONTENT/FACE VALIDITY

PEDS-R’s content validity derives from questions eliciting parents’ comments in each of well-established developmental-behavioral domains. These same domains appear in many theories of child development and in broad-band measures. Although some theories and instruments lump, for example, fine and gross motor into a broad motor category or expressive language/articulation and receptive language into a broad communication category, *PEDS-R*® probes each sub-domain. In addition, *PEDS-R*® includes a question about health concerns because these are sometimes associated with developmental/mental health problems, and because many *PEDS-R*® users are health care professionals in a position to treat/address issues with sleep, feeding, hearing, vision, etc. For more information see *Collaborating with Parents, 2013*, www.PEDStest.com.

CONCURRENT VALIDITY

Concurrent Validity Study #1

Demographics. Children (N = 515) ranged in age from birth through 96 months (mean age = 37 months, SD = 22.27 months). Boys accounted for 58% of the sample and girls, 42%. Only 7% (N = 35) had psychosocial risk factors, including parents not speaking English or living below federal poverty thresholds. Only 8% of parents had not graduated from high school and 60% had a bachelor’s degrees or higher. Among caretakers/parents, 86% were female (mothers, grandmothers, step-mothers), 11% were male (fathers, step-fathers, grandfathers) and 3% were of unknown gender (relatives, foster parents). Ethnicity/race of family included: 8% Black/African-American; 2% Native American; 63% White; 9% Hispanic/Latino; and 18% Asian.

Sites and Settings. Participating families resided in 19 different US States with all four US Census Bureau Regions represented. Measurement occurred in the following settings: 19% general pediatrics; 22% regular education services; and 20% were self-selected parents working from home or on public computers. The remaining 39% were measured in medical subspecialty follow-up clinics/research protocols for children with specific conditions potentially associated with developmental-behavioral difficulties (e.g., genetic disorders, in-born metabolic errors). Overall, 61% of the sample were non-referred. Only 3% had had prior diagnostic testing rendering them eligible for special education services.

Measurement. Children were first administered *PEDS-R*® followed by the (optional) *Modified Checklist of Autism in Toddlers- Revised (M-CHAT-R)*, and then *PEDS:Developmental Milestones–Assessment Level*® (*PEDS:DM-AL*®). The *PEDS:DM-AL*® is used to determine eligibility for special education services, for progress monitoring, curriculum placement, and in research studies. The measure presents multiple items in the following domains: Expressive Language, Receptive Language, Fine Motor, Gross Motor, Social-Emotional, Self-Help, Academics, and Cognitive. For each domain, raw scores, age equivalents, percent of skills mastered and percent of delay are produced. Normed on a nationally representative sample of 19,607 children, the *PEDS:DM-AL*®’s validation studies illustrated high correlations with like domains on diagnostic measures such as *The Bayley Scales of Infant Development – III*, *Wechsler Preschool and Primary Scale of Intelligence – 3*, *Autism Diagnostic Observation Schedule*, *Adaptive Behavior Assessment System*, etc. Reliability studies revealed high test-retest and inter-rater reliability. Inter-method reliability (between parent self-administration and professional administration) showed high concordance with a 1 point difference between the two.

Administration Methods. *PEDS-R*® and the *M-CHAT-R* were administered by interview or parent-self report. The *PEDS:DM-AL*® includes some interview/self-report items but also enables hands-on elicitation of children’s skills by parents or professionals. Whether parent or professionally administered, all used *PEDS*® *Online* to complete measures. *PEDS*® *Online* prevents administration errors (e.g., skipped items, missing comments), and for the *PEDS:DM-AL*® also establishes a basal and ceiling for each domain. For all measures, *PEDS*® *Online* provides automated scoring and results. Of the 515 participating families, 12% were administered measures in Spanish.

Procedures. Due to the binary nature of *PEDS-R*® variables and the continuous nature of *PEDS:DM-AL*® results, Discriminant Function Analysis (DFA) was used to determine associations between the two measures. **Table 4-1** shows performance on *PEDS-R*® and how types of concerns and types of risk are correlated with performance on the *PEDS:DM-AL*®. Bolded, are the highest correlations (> .65 and higher).

Table 4-1. Pooled-Within-Groups Correlation Coefficients Between Discriminating Variables (Types of Concerns and Risk on *PEDS-R*®) and Canonical Discriminant Functions (Performance by Sub-Domains on the *PEDS:DM-AL*®).

<i>PEDS-R</i> ® TYPES OF CONCERN/RISK	CORRELATES WITH <i>PEDS:DM-AL</i> ® SUB-DOMAINS							
	Expressive Language	Receptive Language	Fine Motor	Gross Motor	Social- Emotional	Self-Help	Academic	Cognitive
Expressive N = 335/515 65%	.74	.70	.65	.22	.75	.51	.37	.76
Receptive N = 218/515 42%	.61	.88	.66	.67	.74	.54	.49	.73
Fine Motor N = 139/515 27%	.63	.77	.78	.83	.81	.70	.42	.79
Gross Motor N = 135/515 26%	.48	.64	.67	.91	.70	.62	.24	.62
Behavior N = 306/515 59%	.59	.46	.68	.68	.93	.50	.51	.70
Social-Emotional N = 249/515 48%	.47	.51	.51	.46	.88	.48	.40	.60
Self-Help N = 186/515 36%	.62	.77	.76	.66	.84	.56	.36	.74
School N = 193/515 37%	.68	.71	.76	.59	.88	.54	.47	.79
Global N = 151/515 29%	.67	.55	.58	.45	.88	.36	.39	.68
Health N = 123/515 24%	.42	.43	.54	.19	.74	.34	.01	.56
DD RISK N = 22/515 4%	.57	.54	.72	.76	.91	.74	.32	.69
MEB RISK N = 22/515 4%	.90	.91	.63	.52	.62	.67	.66	.95
MEBDD RISK N = 330/515 64%	.69	.65	.70	.56	.93	.54	.46	.78
ANY RISK N = 435/515 84%	.62	.48	.58	.44	.84	.35	.38	.70

Comment on Concurrent Validity Study #1.

Types of concerns on *PEDS-R*® had close associations with the comparable sub-domains on the *PEDS:DM-AL*®. The relative exception is Academic Skills (combined Reading and Math scores) but this may be due to the small numbers of children old enough to complete the sub-test (39%, N = 202/515).

The results shown in **Table 4-1** suggest that the concerns parents raise are often broad-markers of deficits in a range of sub-domains on milestones focused measures, in this case, *PEDS:DM-AL*®. For example, fine motor concerns on *PEDS-R*®, although associated predictably with fine and gross motor deficits on the *PEDS:DM-AL*®, were also associated with deficits in receptive language, self-help, cognitive and social-emotional skills.

Of interest is that social-emotional performance on the *PEDS:DM-AL*® is highly associated with each type of concern and risk type on *PEDS-R*®. This speaks to the transactional nature of learning – mediated by interactions with caretakers. The same phenomena is visible in MEB Risk on *PEDS-R*®, which had high correlations with not only social-emotional and self-help skills on the *PEDS:DM-AL*® but also with a variety of its developmental sub-domains (e.g., expressive/receptive language, academic and cognitive skills).

Concurrent Validity Study #2

Procedures. Parents and professionals were asked whether children were or had been enrolled in intervention services. Answering such questions is optional within *PEDS*® *Online* and fewer than 1% (N = 924/262,310) of parents/professionals responded. Performance on *PEDS-R*® was compared to outcome variables as follows: 1) tested and found to be within normal limits/enrolled in the past but dismissed due to progress (N = 292); and 2) currently receiving services (N = 682). Goodman and Kruskal's gamma coefficient revealed a strong association between risk of any type on *PEDS-R*® and outcome status ($r = .72, p < .0001$). Children at risk on *PEDS-R*® were 6 times more likely to be currently enrolled in services than those deemed ineligible/treated and dismissed [OR = 6.2; 95%CI= 4.60 – 8.46; $p < .0001$].

CONSTRUCT VALIDITY

The factor structure of *PEDS-R*® was established on the full data set of 262,310 administrations. Six factors accounted for 78% of total variance: #1) Self-Help (.77) and School (.76); #2) Behavior (.79) and Social-Emotional (.85); #3) Fine Motor (.61) and Gross Motor (.90); #4) Expressive Language (.92) and Receptive Language (.54); #5) Global (.99); and, #6) Health (.99). Discriminant Function Analysis (DFA) was to predict each *PEDS-R*® factor by like clusters of *PEDS:DM-AL*® subtests, as shown in **Table 4-2**.

Table 4-2. Pooled-Within-Groups Correlation Coefficients Between Discriminating Variables (*PEDS-R*® Factors) and Canonical Discriminant Functions (*PEDS:DM-AL*® Similar Domains).

<i>PEDS-R</i> ® FACTORS	CORRELATES WITH <i>PEDS:DM-AL</i> ® DOMAIN CLUSTERS				
	Academic & Self-Help	Social-Emotional	Expressive & Receptive	Fine Motor & Gross Motor	Cognitive
Self-Help & School	.38	.94	.80	.87	.83
Behavior & Social-Emotional	.32	.95	.60	.74	.73
Fine Motor & Gross Motor	.59	.80	.75	.98	.76
Expressive & Receptive Language	.59	.84	.88	.60	.86
Global/Cognitive	.03	.83	.63	.56	.65
Health	.17	.84	.52	.47	.64

Comment on Construct Validity. Although most *PEDS-R*® factors were closely associated with similar subtests on the *PEDS:DM-AL*®, *PEDS-R*® factors were also associated with seemingly unrelated performance clusters on the *PEDS:DM-AL*®. For example, there were strong correlations between motor concerns on *PEDS-R*® and motor skills on the *PEDS:DM-AL*®. Nevertheless, there were also high correlations between motor concerns on *PEDS-R*® and the *PEDS:DM-AL*®'s social-emotional scale, as well as its combined receptive and expressive language scale, cognitive scale and academic/self-help scales. These results illustrate that parents' concerns are strong indicators of specific skill deficiencies, but that professionals following up with diagnostic or assessment-level tests should measure children's skills across multiple domains.

DISCRIMINANT VALIDITY

Discriminant Validity Study #1.

The *PEDS:DM-AL*’s sub-tests factor into three recognizable patterns of performance: #1) Academics plus Expressive and Receptive Language skills; #2) Fine Motor and Self-help skills; and #3) Gross Motor and Social-Emotional skills. Discriminant Function Analysis (DFA) was to predict each *PEDS-R* concern and type of risk by *PEDS:DM-AL* factors. All DFAs were significant a $p < .001$ with the exception of health concerns as shown in **Table 4-3**.

Table 4-3. Pooled-Within-Groups Correlation Coefficients Between Discriminating Variables (*PEDS-R* Factors) and Canonical Discriminant Functions (*PEDS:DM-AL* Factors).

<i>PEDS-R</i> TYPES OF CONCERNS	CORRELATES WITH <i>PEDS:DM-AL</i> FACTORS		
	Academic & Communication	Fine Motor & Self-Help	Gross Motor & Social-Emotional
Expressive	.98	.75	.72
Receptive	.93	.83	.76
Fine Motor	.75	.85	.96
Gross Motor	.68	.80	.99
Behavior	.51	.68	.99
Social-Emotional	.59	.68	.99
Self-Help	.78	.80	.96
School	.76	.79	.97
Global	.62	.62	.99
Health	--	--	--
DD RISK	.48	.79	.93
MEB RISK	.75	.26	.01
MEBDD RISK	.74	.74	.97
ANY RISK	.69	.63	.97

Comment on Discriminant Validity Study #1. The highest correlations are between *PEDS-R*’s types of concerns/risk and those *PEDS:DM-AL* factors embracing comparable content (e.g., gross motor and social-emotional concerns on *PEDS-R* and the Gross Motor + Social-Emotional factor on the *PEDS:DM-AL*). Nevertheless, there are also high correlations between *PEDS-R*’s types of concerns/risk and seemingly unrelated factors on the *PEDS:DM-AL* (e.g., MEB risk and the Communication/Academic factor). These findings suggests that parents’ concerns reflect problems in the same domain on milestones-focused measures, but also serve as an indicator of other DD/MEBDD/ risks.

Pervading the associations between measures were social-emotional concerns on *PEDS-R* and performance on the *PEDS:DM-AL*’s social-emotional scale. The transactional, interactive nature of child development is definitely apparent as is the co-occurrence of developmental delays/disorders and mental health/emotional/behavioral problems.

Discriminant Validity Study #2. The goal of this study was to identify children with various diagnoses in order to determine whether *PEDS-R* revealed unique performance patterns by type of disability. All children in this sample were seen in primary care. Parents and professionals’ comments on *PEDS-R* were scrutinized for mention of specific conditions, using search terms such as “autism”, “ASD”, “syndrome”, “developmental delay”, “speech-language impairment”, “learning disability.” Because families describe diagnoses in a variety of ways, indexing comments was not exhaustive but served instead to create a sufficiently large sample for analysis. In 3427 cases, one or more diagnoses were mentioned: 90 children had two or more diagnoses: a) autism spectrum disorder (N = 827); b) speech-language/hearing impairment without ASD (N = 1667); c) unspecified developmental delay due to very low birthweight, traumatic brain injury or syndromes associated with disabilities such as Klinefelter or Kabuki (N = 248); d) physical impairment (N = 169); e) learning disabilities (N = 122); and f) mental health diagnoses such as depression, bipolar or anxiety disorder (N = 537). Children averaged 48 months of age (SD = 23.00; range = 0 – 96 months).

Because all diagnosed children were enrolled in IDEA services, they had been administered a range of measures to determine eligibility. **Table 4-4** shows the range of tests administered and general eligibility criteria.

Table 4-4. Measures used to determine eligibility for children enrolled in IDEA services

DIAGNOSTIC/ELIGIBILITY MEASURES FOR ENROLLMENT IN SPECIAL NEEDS PROGRAMS
<p>All children enrolled in special needs services through the Individuals with Disabilities Education Act (IDEA) are tested for eligibility. Selection among approved measures per US State is based on children's age and at the discretion of a multi-disciplinary team. A battery of diagnostic measures is typical and designed to be comprehensive, i.e., to assess communication, adaptive behavior, social-emotional, cognitive, and motor domains. Older children are typically assessed for deficits in academic achievement such as types of reading problems, math and written language skills. Test batteries usually include a measure of intelligence/cognition plus measures focused on the domain(s) of suspected deficit. Eligibility criteria are strict and well-defined in each US State (e.g., a diagnosis of Learning Disabilities requires academic performance 1 to 1½ SDs below IQ). Informed clinical opinion (e.g., of disordered language, a health condition that limits vitality or school attendance, or physical impairment such as cerebral palsy) may be used to override discrepancy formulas.</p>
DIAGNOSTIC TESTS
<p>Measures of Intelligence/Cognition</p> <ul style="list-style-type: none"> • <i>Bayley Scales of Infant and Toddler Development, Third Edition</i> www.pearsonassessments.com • <i>Wechsler Intelligence Scale for Children, Fifth Edition (WISC-V)</i> www.pearsonassessments.com • <i>Wechsler Preschool & Primary Scale of Intelligence, Fourth Edition (WPPSI-IV)</i> www.pearsonassessments.com • <i>Kaufman Assessment Battery for Children, Second Edition, Normative Update (KABC-II NU)</i> www.pearsonassessments.com • <i>Woodcock-Johnson IV Tests of Cognitive Abilities –Fourth Edition (WJ-IV COG)</i> www.riversideinsights.com <p>Broad Measures Including Adaptive Behavior</p> <ul style="list-style-type: none"> • <i>Vineland Adaptive Behavior Scales, Third Edition</i> www.pearsonassessments.com • <i>Battelle Developmental Inventory Dash -3 (BDI)</i> www.riversideinsights.com <p>Measures of Mental Health, Emotional Well-being, and Behavior</p> <ul style="list-style-type: none"> • <i>Bayley Scales of Infant and Toddler Development Social-Emotional and Adaptive Behavior Questionnaire, Third Edition</i> www.pearsonassessments.com • <i>Behavior Assessment System for Children, Third Edition (BASC-III)</i> www.pearsonassessments.com <p>Measures of Motor Skills</p> <ul style="list-style-type: none"> • <i>Peabody Developmental Motor Scales (Fine and Gross Motor)</i> www.wpspublish.com • <i>Bruininks-Oseretsky Test of Motor Proficiency (BOTMP)</i> www.pearsonassessments.com <p>Measures of Speech Language Skills</p> <ul style="list-style-type: none"> • <i>The Rosetti Infant –Toddler Language Scale</i> https://assessments.academictherapy.com/ • <i>Preschool Language Scales Fifth Edition (English/Spanish)</i> www.pearsonassessments.com • <i>Oral and Written Language Scales-II (OWLS)</i> www.wpspublish.com <p>Measures of Academic Achievement</p> <ul style="list-style-type: none"> • <i>Kaufman Test of Educational Achievement, Third Edition (KTEA-3)</i> www.pearsonassessments.com • <i>Woodcock-Johnson Tests of Achievement (WJ-IV)</i> www.riversideinsights.com • <i>Mullen Scales of Early Learning</i> www.pearsonassessments.com <p>Specific Measures for Autism and ADHD</p> <ul style="list-style-type: none"> • <i>Autism Diagnostic Observation Schedule (ADOS)</i> https://www.wpspublish.com/ • <i>Childhood Autism Rating Scale (CARS-2)</i> https://www.wpspublish.com/ • <i>Vanderbilt ADHD Diagnostic Rating Scale (VADRS)</i> https://psychology-tools.com • <i>Conners – 4</i> www.pearsonassessments.com
MID-LEVEL ASSESSMENT AND SCREENING TESTS
<p>IDEA, Part C (Early Intervention: birth to 3 years)</p> <p>Some Part C programs use mid-level assessment or detailed screening measures to determine eligibility. Commonly used tools are:</p> <ul style="list-style-type: none"> • <i>Developmental Assessment of Young Children, Second Edition (DAYC-2)</i> www.proedinc.com • <i>Brigance Screens - III</i> www.curriculumassociates.com • <i>PEDS: Developmental Milestones – Assessment Level® (PEDS:DM-AL®)</i> www.pedstest.com • <i>Developmental Profile – 4</i> www.wpspublish.com • <i>Battelle Developmental Inventory Screening Test-3 (BDIST-3)</i> www.riversideinsights.com

Discriminant Function Analyses were used to view associations across each type of disability and types of concerns on *PEDS-R*®. Global and Health concerns were omitted due to insufficient frequency. All six DFA's were significant at $p < .001$ or higher. Only significant correlations ($> .45$) are shown in **Table 4-5**.

Table 4-5. Pooled Within-group Correlates of Various Disabilities by Types of Concerns.

<i>PEDS-R</i> ® TYPES OF CONCERN/RISK:	DIAGNOSES					
	Autism Spectrum Disorder	Speech- Language/ Hearing Impairment	Developmental Delay/ Syndromes	Physical Impairment	Learning Disabilities	Mental Health
Expressive	--	.56	--	--	--	.67
Receptive	.77	--	.51	--	--	--
Fine Motor	.52	--	.54	.61	--	--
Gross Motor	--	--	.54	.58	--	--
Behavior	.70	--	--	--	--	--
Social- Emotional	.46	.49	--	--	--	.67
Self Help	.70	--	.66	--	--	--
School	.56	--	.49	--	.69	--

Comment on Discriminant Validity Study #2. Almost all conditions were associated with unique performance patterns: ASD and Developmental Delay embraced the greatest number and variety of concerns. Predictably, Learning Disabilities were associated with concerns about school skills, while Physical Impairments were associated with fine and gross motor concerns. Of interest is that Speech Language Impairment and Mental Health diagnoses had identical patterns – worries about expressive language and social-emotional skills. This pattern is consistent with prior research showing that the majority of young children presenting for psychiatric care had both mental health problems and speech-language impairment, and that children with ongoing language disorders are at greater risk of mental health problems (e.g., ncbi.nlm.nih.gov and [PubMed.nih.gov](http://pubmed.nih.gov)). These findings suggest that initiatives focused on detecting and addressing mental health challenges should also embrace developmental assessment and related interventions.

PREDICTIVE VALIDITY/PREDICTIVE SENSITIVITY

Prior Studies. Detailed in the *PEDS*® *Manual, Collaborating with Parents (2013, PEDStest.com)*, are several predictive validity studies that continue to be applicable to *PEDS-R*®. Note that prior studies are actually predictive sensitivity – meaning that percent detected is reported rather than correlations. Given that developmental-behavioral risk rises with age, predictive sensitivity is typically weaker than concurrent. Even so, detection rates (and thus associations) were strong. A few highlights include:

- 1) a longitudinal study of 274 children tested at 3 years of age using diagnostic measures including the *Autism Diagnostic Observation Schedule (ADOS)*, the *Social Communication Questionnaire (SCQ)*, and the *Mullen Scales of Early Learning*. These same children had been administered *PEDS*® at 6-, 12- and 18-months. The results of *PEDS*® at 12 months correctly predicted a subsequent autism diagnosis 83% of the time with specificity of 60% (indicating that children with other types of problems were also identified; and
- 2) a longitudinal study of 268 five- to six-year-olds administered *PEDS*® and then tested two years later with the *Comprehensive Inventory of Basic Skills (CIBS-R)* and the *Renfrew Action Picture Test*. At follow-up, concerns at Time 1 predicted problematic academic performance in 65% of children and 78% of those who repeated a grade during the two years, had parents with at least one predictive concern.

Predictive Validity Pilot Study. In a small study using the 2018-2021 standardization and validation sample, 44 children (mean age = 32 months, range 2 - 83 months) administered *PEDS:Developmental Milestones–Assessment Level*® (*PEDS:DM–AL*®), had been administered *PEDS-R*® one or more times in prior months (for a total of 64 encounters). The average age at prior testing was 22 months, (range = 1- 78 months), producing a mean age difference of 11 months (range = 1 - 42 months). Of the 64 encounters, 41% of children were at risk on *PEDS-R*® while 59% were not at risk. Non-parametric

correlation was used to view the relationship between prior *PEDS-R*® results and subsequent *PEDS:DM-AL*® factors. A robust relationship, given the time interval and potential for risk to emerge with age, is not expected. Nevertheless, Spearman's rho showed a modest but significant association between *PEDS-R*® results and the *PEDS:DM-AL*®'s expressive/receptive language/academic factor ($r_s = .34, p < .05$).

Current Data: Predictive Validity/Predictive Sensitivity Study. From the sample of 3,427 children who had received a diagnosis, 538 cases were randomly selected in order to view prior performance on *PEDS-R*®. On average, children had been screened 3 times prior to referral and diagnoses (range 1 – 11 prior screens). Mean age at initial screening was 23 months (SD = 16.36) while mean age at diagnosis was 44 months (SD = 20.65): Prediction of a diagnosis based on previous *PEDS-R*® results, spanned an average of 21 months. Of the 583 with a diagnosis, 444 were at any risk on one or more prior administrations of *PEDS-R*®. Thus 82% of children with disabilities were identified much earlier by *PEDS-R*®.

SUMMARY OF VALIDITY STUDIES

- **Content Validity.** *PEDS-R*®'s content validity derives from questions eliciting parents' comments in each of well-established developmental-behavioral/mental health domains.
- **Concurrent Validity.** *PEDS-R*® has close associations with comparable sub-domains on an assessment level measure.
- **Construct Validity.** *PEDS-R*® factors were closely associated with similar factors on mid-level assessment and diagnostic measures. Social-emotional and behavioral concerns on *PEDS-R*® were correlated with a range of deficits on in-depth tools – suggesting that when referrals are made, professionals should measure children's skills across multiple domains.
- **Discriminant Validity.** Findings from several different studies illustrate that: a) parents' concerns reflect problems in the same domain on in-depth, milestones-focused measures, b) Risk on *PEDS-R*® also served as an indicator of other DD/MEBDD risks; and c) there are unique performance patterns on *PEDS-R*® for various categories of disabilities (e.g., ASD, motor impairment, learning disabilities). Nevertheless, speech language impairment and mental health diagnoses shared the same pattern, confirming prior research: Children with ongoing language disorders are at greater risk of mental health problems.
- **Predictive Validity/Predictive Sensitivity.** Among children who eventually received a diagnosis and thus enrolled in IDEA/special education, prior screening with *PEDS-R*® revealed risk in 82%. *PEDS-R*® detected problems on average 21 months earlier than age at diagnosis.

PEDS-R® ACCURACY STUDIES

Accuracy Study #1: At-Risk Sample.

Impact of Varying Eligibility Criteria in a Referred Sample. In this study, a sample with elevated risk was identified – reflecting a population that IDEA/special education is likely to encounter at intake. Because eligibility standards differ across US States, considered in this study are how differing US State requirements effect referral decisions based on *PEDS-R®* performance.

Characteristics of the original sample of 515 children and their families are described in Concurrent Validity Study #1 along with the psychometrics of the *PEDS:DM-AL®*. Of the 515, 407 had moderate to high risk results on *PEDS-R®*: Of the 407, 137 (34%) had Paths B results (Moderate DD or Moderate MEBDD risk) and averaged 32 months of age (range 4 – 94 months; SD = 20.25). The remaining 270/407 (66%) had Paths A results (High DD or High MEBDD risk) and averaged 43 months of age (range = 9 – 96 months; SD = 21.80).

Applied to children’s performance on *PEDS:Developmental Milestones–Assessment Level® (PEDS:DM-AL®)* were three different US State IDEA eligibility criteria, of which the most common are: A) two or more 25% delays across domains ; B) one or more 40% delay; and, C) one or more 50% delay. Each of these cutoffs were rendered for each sub-test on the *PEDS:DM-AL®*: Fine Motor, Gross Motor, Receptive Language, Expressive Language, Self-Help, Social-Emotional, Reading, Math and Cognitive, and then a total score was produced. Next, the three different criteria were compared to combinations of *PEDS-R®*s Paths as shown in **Table 5-1**.

Table 5-1. Number/Percent of Children Detected Per Various IDEA Eligibility Criteria by Combinations of *PEDS-R®* Paths.

	CRITERION PERFORMANCE ON THE <i>PEDS:DM-AL®</i>					
	Two 25%+ Delays		One 40% Delay		One 50% Delay	
	Two 25% Delays N %	Ineligible N %	One 40% Delay N %	Ineligible N %	One 50% Delay N %	Ineligible N %
<i>PEDS-R®</i> PATHS	299/515 58%	216/515 42%	324/515 63%	191/515 37%	278/515 54%	237/515 46%
Paths B: Moderate DD/MEBDD + Paths A: High DD/MEBDD Risk	272/299	81/216	287/324	71/191	272/278	85/237
Sensitivity	91%		89%		92%	
Specificity		37%		37%		36%
Under-detection Rate	9%		11%		8%	
Total Over-referred		26%		23%		30%
Path B: Moderate DD Risk + Path A: High DD Risk	34/299	173/216	41/324	155/191	33/278	193/237
Sensitivity	11%		13%		12%	
Specificity		80%		81%		81%
Under-detection Rate	89%		87%		88%	
Total Over-referred		8%		7%		8%
Paths A: High DD/MEBDD Risk	211/299	157/216	213/324	134/191	194/278	161/237
Sensitivity	71%		66%		70%	
Specificity		73%		70%		68%
Under-detection Rate	29%		34%		30%	
Total Over-referred		12%		11%		15%

Table 5-1. continues on next page

Table 5-1. cont'd

	CRITERION PERFORMANCE ON THE <i>PEDS:DM-AL</i> ®					
	Two 25%+ Delays		One 40% Delay		One 50% Delay	
	Two 25% Delays N %	Ineligible N %	One 40% Delay N %	Ineligible N %	One 50% Delay N %	Ineligible N %
	299/515 58%	216/515 42%	324/515 63%	191/515 37%	278/515 54%	237/515 46%
<i>PEDS-R</i> ® PATHS						
Path B: Moderate MEBDD risk + Path A: High MEBDD Risk	238/299	124/216	246/324	107/191	222/278	129/237
Sensitivity	80%	57%	76%	56%	80%	54%
Specificity						
<i>Under-detection Rate</i>	20%	18%	24%	16%	20%	21%
<i>Total Over-referred</i>						
Path B: Moderate MEBDD + both Paths A: High DD/MEBDD Risk	253/299	117/216	261/324	100/191	234/278	119/237
Sensitivity	85%	54%	81%	52%	84%	50%
Specificity						
<i>Under-detection Rate</i>	15%	19%	19%	18%	16%	22%
<i>Total Over-referred</i>						

Table 5-1 shows in the second row, the percent of the total sample eligible for IDEA/special education services based on the three different criteria. The subsequent rows show various combinations of *PEDS-R*® Paths. Shaded rows show combinations that did not work well – either high sensitivity but low specificity or low sensitivity but high specificity.

The optimal combination of *PEDS-R*® Paths include: 1) Referring those with moderate or high MEBDD risk (Path B: Moderate MEBDD risk + Path A: High MEBDD Risk); but better still, 2) Referring those at high DD and MEBDD risk plus moderate MEBDD risk (Path B: Moderate MEBDD + both Paths A: High DD/MEBDD Risk).

Although sensitivity is reasonably high for the above referral decisions, specificity is lower than desired, which is often the case with samples in which risk is elevated. Why? When viewing the characteristics of false-positive performance: 1) 29% were below average on the *PEDS:DM-AL*® (e.g., had a single 25% delay but not two, had one 37% delay but not one 40% delay, etc.); 2) 24% had conditions associated with slowly emerging developmental-behavioral problems that had not yet manifested (e.g., neurodegenerative disorders); 3) 18% of parents worried (wisely) about the impact of pandemic restrictions (e.g., dearth of both educational opportunities and interactions with other children); and 4) 29% had miscellaneous concerns (e.g., whether their child was gifted and needed special services; whether a diagnosed anxiety disorder was interfering with progress). Thus most of the false-positive group deserved the detailed scrutiny afforded by IDEA/special education intake evaluations as well as careful monitoring and referral to non-IDEA services when found ineligible.

Using the *PEDS-R*® Path combinations shown in the final row of Table 5-1, true negatives [meaning those who performed well on both *PEDS-R*® and *PEDS:DM-AL*®) N = 117] were compared to false positives [meaning elevated risk on *PEDS-R*® but ineligible for IDEA/special education based on *PEDS:DM-AL*®) N = 100]. False-positives were 2 ½ times as likely to score below average on *PEDS:DM-AL*® as compared to true-negatives [OR = 2.7; (95%CI = 1.48 – 4.84); p < .001]. As with past and current studies, children

who do not qualify for services are best considered as two distinct groups: Those who did well on screens and those who did not. The latter, false positives, differ significantly from the true negatives. False positives tend to have mild delays that worsen with time. When this occurs, referrals are needed.

Comment on Accuracy Study #1. Compared to a single 50% delay, a single 40% delay enabled 16% more children to meet enrollment criteria, while two 25% delays increased eligibility by 8%. Even so, *PEDS-R*® sensitivity and specificity was not significantly different across varying eligibility criteria (ORs range = 1.0 -1.0 ; $p = 0.41 - 0.72$, NS), meaning the same referral criteria, i.e., Path B: Moderate MEBDD risk, Path A: High DD Risk and Path A: High MEBDD risk can be applied to referral decisions across all 50 US States.

Many children, especially in the birth to 3 year age-range are eligible for IDEA/special education based on qualifying conditions (e.g., epilepsy, sickle cell disease) even when delays are not present. Older children with such conditions usually require evaluation to determine the presence of developmental and/or mental health deficits. Thus it is critical for health care professionals to add their own concerns and medical diagnoses before scoring *PEDS-R*®. Such information greatly aids the IDEA/special education intake process and eligibility determination. In this study, an additional 5% of children (N = 26) might have been eligible for IDEA/special education given inclusion of potentially qualifying conditions.

Families seen in settings with elevated risk (e.g., subspecialty clinics, private speech-language services) have, understandably, many worries about their children. Parents' concerns should always be addressed with guidance. Apart from noting on *PEDS-R*® potentially qualifying conditions and troubling observations, professionals are encouraged to carefully scrutinize children with Path B: Moderate DD risk results. Some will need prompt referring while others will not. *Accuracy Study #3* explores how to prioritize referrals for this group.

Professionals conducting intake evaluations for IDEA/special education services, are encouraged to respond to *PEDS-R*® findings, especially Path B: Moderate DD risk, with mid-level assessment measures such as the *PEDS:DM-AL*®. Mid-level assessment tools are time-efficient and economical, can determine eligibility, and help decide whether expensive multi-disciplinary diagnostic testing is needed. An even more cost-effective approach is to invite parents to complete the *PEDS:DM-AL*® on their own via the *PEDS*® *Online* parent portal. Parents do not see results. Instead these are sent to professionals to interpret and follow up.

Accuracy Study #2: Typical Population.

Performance in a General Sample. This study used data from children seen only in primary care clinics or in regular education services. The goal is to illustrate the accuracy of *PEDS-R*® in a general population, i.e., what to expect when screening at well-visits or in general education programs (e.g., preschool, day care, public school).

Incidence. Children with one or more diagnoses/receiving IDEA/special education services (N = 3427) were identified from parents' comments on *PEDS-R*® (as described in Discriminant Validity Study #2 along with diagnostic measures used, as shown in **Table 4-4**). This group was then combined with a random sample of children without diagnoses/unenrollment (N = 21430) to create a total study group of 24,857. Children diagnosed/receiving special services represented 14% of the total (N = 3427/24857).

Demographics. The average age for both served and unserved groups was 32 months (SD = 20.05, range = 0 – 96 months) with the diagnosed/receiving special services group averaging 48 months and the undiagnosed/unserved group averaging 29 months of age. As with the full standardization sample of 262,310 families, this study group of 24,867 was typical of mixed Medicaid practices and therefore differed slightly from national prevalence: Fewer whites (54% versus 59% nationally); more Latino/Hispanics (27% versus 19%); fewer parents with high school diplomas (75% versus 88%) or college degrees (23% versus 33%); greater poverty (14% versus 11%), and more parents who did not speak English at home (30% versus 20%).

Procedures. *PEDS-R*® Paths were grouped into two clusters: 1) *Lower risk* included Path E: Low DD or MEB risk, together with Path C: Mild DD risk plus Path C: Mild to Moderate MEB risk; versus, 2) *Higher risk* included Both Path Bs (Moderate DD risk and Moderate MEBDD risk) and both Path As (high DD and high MEBDD risk). *Lower risk* versus *Higher risk* clusters were intersected with the presence or absence of diagnoses/Special Education Services, as shown in **Table 5-2**. Computations for the various dimensions of

screening test accuracy are also reported.

Table 5-2. Indicators of Accuracy on PEDS-R® by Presence or Absence of Diagnoses/Special Services

<i>PEDS-R®</i>			
	Lower Risk	Higher Risk	Total
No Diagnoses or Special Services	17852	3578	21430
Diagnosed/Receiving Special Services	332	3095	3427
Total	18184	6673	24857

Sensitivity = 90% (3095/3427)

Specificity = 83% (17852/21430)

Negative Predictive Value = 98% (17852/18184)

Under-detection Rate = 10% (332/3427)

Positive Predictive Value = 46% (3095/6673)

False-Positives Rate = 54% (3578/6673)

Total Over-referral Rate = 14% (3578/24857)

Comment on Accuracy Study #2. *PEDS-R®* has excellent sensitivity, 90%, in detecting diagnoses, with only 10% of diagnosed children undetected. Specificity in detecting children without diagnoses was reasonably high at 83%, i.e., meeting essential psychometric standards for screening tests.

In viewing other options among *PEDS-R®* results in relation to diagnoses, any risk on *PEDS-R®* (meaning all on Paths A, B, and C), sensitivity climbed to 98% but with a cost to specificity, 78%. If referring only those at high risk on *PEDS-R®* (meaning Path A's only), sensitivity plunged to 44% while specificity increased to 98%. Thus, the most parsimonious solution (shown above) is to refer all children on Paths A, and for Paths B: Address concerns, refer to non-IDEA services, and rescreen before deciding on IDEA referrals. Providers tended to follow such recommendations: Children on Paths B were 1½ times more likely than those on Paths A to have had multiple screens prior to diagnosis [OR = 1.6; 95%CI (1.34 – 1.79); *p* < .001].

Specificity is related to false-positive/over referral rates, which were somewhat elevated, as seen in **Table 5-2**. In large part, high false-positive rates are to be expected because *PEDS-R®* is designed to detect children at varying risk levels, not just those at high risk. Meanwhile, professionals are sometimes confused about false-positive rates and in this case, may believe that 54% of all children in their programs will be over-referred, while in fact, only 14% of the total sample (3578/24857) are potential candidates for over-referral.

Prior studies showed that potentially over-referred/false-positive children performed differently than true negative children (meaning those without diagnoses and also not at risk on *PEDS-R®*) [see *Collaborating with Parents, 2013, www.PEDStest.com*]. Children who were false-positive, had substantially lower scores on measures of intelligence, academic achievement, speech-language and adaptive behavior – but not low enough to qualify for special education. This group also had high levels of psychosocial risk, suggesting that referrals should be made to non-IDEA services such as Head Start, parent-training, after school tutoring programs, social services, etc.

In considering **Table 5-2**, most over-referrals occurred among children who had Path B: Moderate DD risk results. *Accuracy Study #3* analyzes this group, offers additional guidance on when to prioritize referrals, and provides a reevaluation of accuracy indicators.

Accuracy Study #3: Reducing Potential Over-Referrals/Improving Sensitivity and Specificity.

Children on *PEDS-R®*'s Path B: Moderate Risk for Developmental Delays/Disorders are a source of over-referrals to IDEA/special education services. Although more about 1/3rd appear eligible, 2/3rds do not. The goal of this study is to determine whether there are unique characteristics of children scoring on Path B: Moderate DD Risk that can help professionals discern which children need referral to IDEA/special education and which children need other kinds of assistance (e.g., Head Start, parent-training, etc.).

The sample used in this study (a subset of those in Accuracy Study #2) included children with Path B: Moderate DD risk (N = 2857). Those diagnosed/enrolled (32%, N = 919) were compared to those undiag-

nosed/unenrolled (68%, N = 1938). Similarities between the two groups should help professionals look for specific characteristics associated with referral needs. **Table 5-3** shows the two groups. In the left hand column is a list of potentially discriminating variables with rows showing frequencies and statistical significance. Below the table is further description of findings for each variable shown.

Table 5-3. Predictors of Need for Referral to IDEA/Special Education with Children on Path B Moderate Risk for Developmental Delays/Disorders

POTENTIAL PREDICTORS OF REFERRAL NEEDS	Path B DD Total N = 2857		
	No IDEA/Special Education Services N % 1938 68%	Receiving IDEA/Special Education Services N % 919 32%	Statistic <i>p</i>
Age (mean) Age Group: 0 to 3 years 3+ years	31 months 1282/1938 66% 656/1938 34%	46 months 339/919 37% 580/919 63%	$t_{(2855)} = 19.31$; $p < .001$ OR = 3.3; 95%CI (2.84 – 3.94); $p < .001$
Gender Male: 62% (N=1430) Female: 32% (N= 891)	926/1430 65% 608/891 68%	504/1430 35% 283/891 32%	NS
PEDS-R® N Concerns (mean) Concern about Expressive Language	1.02 1426/1938 74%	1.01 821/919 89%	NS OR =3.0; 95%CI(2.38 – 3.80); $p < .001$
Enrollment in Non-IDEA services	94/1938 5%	57/919 6%	NS
Repeat PEDS-R® (Mean = 2.2 screens) Non-Presenting/Resolving Reoccurring/Escalating	376/961 39% 585/961 61%	29/588 5% 559/588 95%	OR = 2.4; 95%CI (2.06 – 2.90); $p < .0001$
Psychosocial Risk In poverty + non-English-speaking	283/1938 14%	48/919 5%	OR = 2.4; 95%CI (1.82 – 3.11); $p < .001$
Ethnicity White Minority	1236/1938 64% 702/1938 36%	439/919 48% 480/919 52%	OR = 1.9; 95%CI (1.64 – 2.26); $p < .001$
Using Results from Other Screens			
M-CHAT-R Failed	43/590 7%	20/241 8%	NS
PEDS: DM® (screen) 2 or More Unmet Milestones)	343/961 36%	263/559 47%	OR =1.6; 95%CI(1.30 – 1.98); $p < .001$

Comment on Predictors for Accuracy Study #3:

Children’s Age. Children 3 years and older were significantly more likely to be eligible for IDEA/special education.

Children’s Gender. Gender was reported for 81% of the full study sample (N = 20234/24857) with girls comprising 49% and boys 51%. Of the 20234 parents reporting gender, boys were far more likely to be diagnosed/enrolled (66%; N = 1925/2934) than were girls (34%, N = 1009/2954). Nevertheless, when viewing only Path B: Moderate DD Risk results, boys and girls were equally likely to be diagnosed/enrolled – meaning that gender is not a useful predictor for Path B: Moderate DD Risk.

Types of Concerns on PEDS-R®. Expressive language concerns were a strong predictor of enrollment/diagnosis and present in 89% of this group. Even so, the majority of parents (74%) whose children were undiagnosed/unenrolled also had expressive language concerns – meaning that expressive language concerns are a somewhat murky predictor.

Participation in Non-IDEA Programs. Included in this analysis were participation in either Head Start, daycare, preschool or grade school. Answers to such questions were optional and only 151 parents of children on Path B Moderate DD Risk responded. There were no differences in diagnosis/enrollment rates based on participation in regular education services. Nevertheless, cross-validation on a larger sample would be helpful.

Repeat PEDS-R®. More than half of the unreferral/undiagnosed sample had two or more subsequent administrations of PEDS-R®. Of this group, 34% had fewer or no problems on rescreens - deemed a **Non-Presenting/Resolving** performance pattern. For example, children administered subsequent PEDS-R®s moved from Path B: Moderate DD Risk to Path C: Mild DD Risk to Path E: Low DD and Low MEB Risk. This trajectory toward improved outcomes suggests that developmental-behavioral guidance and/or participation in regular education programs had a positive effect for many families.

Meanwhile, 66% of children without diagnoses/enrollment had a pattern of concerns deemed **Re-occurring/Escalating** – clearly a group for whom primary care guidance and/or non-IDEA services were not fully effective. These children often remained on or returned to Path B: Moderate DD Risk, with many escalating to either of the High Risk Path A's. Of the group with a *Re-occurring/Escalating* trajectory, 47 were eventually diagnosed/referred, whereas none of those with a *Non-Presenting/Resolving* pattern were diagnosed/referred.

Meanwhile, all children diagnosed/enrolled had at least 2 prior screens. Almost all prior results, 95%, reflected the *Re-occurring/Escalating* pattern. The remaining 5% had a *Non-Presenting/Resolving* pattern, had been diagnosed/enrolled prior to their first administration of PEDS-R®, and so clearly benefited from professional advice plus IDEA/special education. Thus children's likelihood of receiving a diagnosis/referral was significantly higher for those whose trajectory followed the *Re-occurring/Escalating* pattern.

Psychosocial Risk. Children who are poor and whose parents do not speak English at home typically have more developmental-behavioral problems than do children with zero to one of these psychosocial risk factors. Unfortunately, children with both risk factors are less likely to be diagnosed/enrolled. This may be due to professionals relying on parents to make referrals on their own to IDEA/special education services. Non-English-speaking parents are understandably wary of making a phone call if unsure of interception by someone who speaks their language. Such families make lack phones, computers or stable addresses. Ideally, professionals should make referrals on behalf of families with high psychosocial risk.

Ethnicity. Minority children (mostly Latino/Hispanic or Black/African American) were more likely to be those diagnosed/enrolled as compared to white children.

M-CHAT-R Performance. Providers tend to administer the *M-CHAT-R* per American Academy of Pediatrics' recommendations – at 18- months and again at 24- or 30 months. Because 50% of the sample was older than 30 months, the *M-CHAT-R* was infrequently administered. Even so, the diagnosed/enrolled group on Path B: Moderate DD risk were as likely as those undiagnosed/unenrolled to have a failed *M-CHAT-R*. Per the PEDS-R® Interpretation Form, all children with problematic results on the *M-CHAT-R* should be referred for either the *M-CHAT-R* Follow-up Interview (if 3-8 items are missed) or full evaluations of autism spectrum disorder (if more than 8 items are missed).

PEDS:DM® (Screener) Performance. Children with two or more unmet milestones on the PEDS:DM® were more likely to receive diagnoses/referrals than were those with fewer unmet milestones. Note that if the PEDS:DM® is also administered, the PEDS-R® Interpretation Form prompts for referral is provided if 3 or more milestones are unmet.

Accuracy Analyses With Various Predictor Sets Applied to Children with Path B: Moderate DD Risk Who were Undiagnosed/Unenrolled

In an effort to identify those in the undiagnosed/unenrolled group whose characteristics were similar to the diagnosed/enrolled group, a subsample of the 24857 (N = 12758) was created by selecting for

children who had repeated PEDS-R® or were administered either the PEDS:DM® (screener) and/or the M-CHAT-R. The strongest and clearest predictors from **Table 5-3** (above) were combined into two different ways. **Table 5-4** shows accuracy indicators for the original subsample as well as accuracy indicators given application of presence/absence of predictors from Predictor Set #1:

Predictor Set #1.

1. Trajectory of repeat administrations of PEDS-R® grouped by the *Non-Presenting/Resolving* pattern versus the *Re-occurring/Escalating* pattern.
2. Ethnicity/race grouped by white versus minority
3. Age of child grouped by less than 3 years versus 3 years and older.

Table 5-4. PEDS-R® Accuracy Before and After Applying Predictor Set #1 to Path B: Moderate DD Risk.

OUTCOMES	PEDS-R® ACCURACY WITHOUT PREDICTORS FOR PATH B: MODERATE DD RISK			PEDS-R® ACCURACY WITH PRESENCE/ABSENCE OF PREDICTORS FROM SET #1 APPLIED TO PATH B: MODERATE DD RISK		
	Not At Risk	At Risk	Totals	Not At Risk	At Risk	Totals
No Diagnosis or Special Services AND Without Other Predictors of Risk	9091	1787	10878	9467	1202	10669
Diagnosed/Receiving Special Services AND/OR Additional Predictors of Risk	179	1701	1880	179	1910	2089
Totals	9270	3488	12758	9646	3112	12758
	ACCURACY INDICATORS			ACCURACY INDICATORS		
Sensitivity	90% (N = 1701/1880)			91% (N = 1910/2089)		
Specificity	84% (N = 9091/10878)			89% (N = 9467/10669)		
Negative Predictive Value	98% (N = 9091/9270)			98% (N = 9467/9646)		
Under-detection Rate	10% (N = 179/1880)			9% (N = 179/2089)		
Positive Predictive Value	49% (N = 1701/3488)			61% (N = 1910/3112)		
False Positive Rate	51% (N = 1787/3488)			39% (N = 1202/3112)		
Total Over-referral Rate	14% (N = 1787/12758)			9% (N = 1202/12758)		

Comment on Predictor Set #1. As shown in the columns on the right, combining presence or absence of predictors from Set #1 to those with Path B: Moderate DD risk results but without diagnoses/enrollment, improved sensitivity and specificity, under-detection, positive predictive value, and provided modest reductions in false positive and overall over-referral rates.

Despite these improvements to accuracy, one problem with this solution is that repeated administrations of PEDS-R® are needed in order to discern whether performance trajectories are Non-Presenting/Resolving versus Re-occurring/Escalating. Repeated screenings can require much time (e.g., if a 2-year-old is only rescreened at the next annual visit, a full year later), although a rescreen 6-8 weeks later is reasonable and recommended. Nevertheless, for professionals who have already administered PEDS-R® repeatedly, reviewing records to identify whether performance has a Re-occurring/Escalating pattern is advised, because it

clearly identifies children in need of referral.

Accuracy with Predictor Set #2. Predictor Set #2 includes the following:

Predictor Set #2.

1. Ethnicity/race grouped by white versus minority.
2. Age of child grouped by less than 3 years versus 3 years and older.
3. *M-CHAT-R* performance grouped by pass versus fail.
4. *PEDS:DM*® performance grouped by fewer than two unmet milestones versus two or more.

Accuracy improvements deploying this predictor set are shown in **Table 5-5**.

Table 5-5. Improvements to *PEDS-R*® Accuracy After Applying Predictor Set #2 to Undiagnosed/Unenrolled Children with Path B: Moderate DD Risk Results.

OUTCOMES	<i>PEDS-R</i> ® ACCURACY WITH PREDICTOR SET #2		
	Not At Risk	At Risk	Totals
No Diagnosis or Special Services AND Without Other Predictors of Risk	9467	826	10293
Diagnosed/Receiving Special Services AND/OR Additional Predictors of Risk	179	2286	2465
Totals	9646	3112	12758

Sensitivity = 93% (N = 2286/2465)
Specificity = 92% (N = 9467/10293)
Negative Predictive Value = 98% (N = 9467/9646)
Under-detection Rate = 7% (N = 179/2465)
Positive Predictive Value = 74% (N = 2286/3112)
False Positive Rate = 26% (N = 826/3112)
Total Over-referral Rate = 6% (N = 826/12758)

Comment on Predictor Set #2. Applying the presence/absence of predictors from Predictor Set #2 to the undiagnosed/unenrolled with Path B: Moderate DD Risk results involved administering a separate screen (in this case the *M-CHAT-R* and/or *PEDS:DM*®) and considering children’s age and ethnicity. In looking at the total sample, this solution was applied to only 7% (N = 961/12758) illustrating that time/effort demands on professionals are minimal. Use of Predictor Set #2 maintained high sensitivity and greatly improved specificity, positive predictive value, with large reductions in false positive and over-referral rates.

An enormous advantage to this approach is that it offers a same day solution: In every encounter, providers make a decision to refer or not. Simultaneous administration of both *PEDS-R*® and the *PEDS:DM*® (along with the *M-CHAT-R* if children are within its targeted ages) offers both immediate and evidence-based decision-making. Such an approach complies with American Academy of Pediatrics’ recommendations for early detection at every encounter: 1) elicit and address parents’ concerns; 2) measure milestones; and 3) deploy the *M-CHAT-R* when concerns are present or at targeted ages. In addition, consideration of demographic factors (e.g., age and minority status) is helpful in deciding which children with Path B: Moderate DD risk need prompt referrals.

ACCURACY SUMMARY AND RECOMMENDATIONS

- Many young children with pre-existing conditions (e.g., Very Low Birthweight, Zika, Neonatal Abstinence or Fetal Alcohol syndromes) are eligible for IDEA/special education based solely on qualifying diagnoses. Professionals are advised to add their concerns and children's known conditions before scoring *PEDS-R*®. The [IDEA website](#) has information on eligibility criteria for each US State.
- All children have elevated risk levels when cared for in subspecialty clinics or if selected for referral to IDEA/special Education. Without a qualifying condition, those referred due to Path B: DD risk results on *PEDS-R*® should be administered a mid-level assessment test like *PEDS:DM-AL*® to determine eligibility or need for more detailed evaluations. In addition, mid-level assessment is an economical and time-efficient approach to intake for all IDEA/special education services and a helpful measure of progress for children seen in subspecialty clinics or enrolled in research studies.
- Children in poverty whose parents do not speak English have lower rates of diagnosis/enrollment than do children with only one or none of these psychosocial risks. To overcome such disparity in care, referral coordination is advised. Professionals who are able to bill Medicaid or private insurance should find payment rendered by adding procedure code 99452.
- *PEDS-R*®'s sensitivity is high, 93%, as is specificity, 92%, especially when applying to Path B: Moderate DD risk results, additional predictors such as *M-CHAT-R* or *PEDS:DM*® (screener) results, minority status and child's age.

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CLINICAL GUIDANCE AND FAQ'S FOR RESEARCHERS

Clinical guidance is found in the *PEDS-R*® Handbook along with FAQ's for researchers. You can download the Handbook at www.pedstest.com/Handbook.