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ORIGINAL PAPER

The Importance of Language Delays as an Early Indicator of Subsequent ASD Diagnosis in Public Healthcare Settings

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Abstract
Previous studies have reported that ASD children with more severe symptoms are diagnosed earlier. However, previous studies in community settings have mostly relied on retrospective parental reports without the use of quantitative standardized test scores. Here, we evaluated the association of language, cognitive, and ASD severity standardized scores with the age of diagnosis in 1-6-year-old children diagnosed in a public healthcare setting. The results revealed that language scores were the strongest variable associated with the age of diagnosis, explaining ~ 30% of the variability across children. Indeed, all children diagnosed before 30-months of age exhibited moderate-to-severe language delays. These results further substantiate the prominence of language delay as a highly visible symptom associated with earlier ASD diagnosis in community clinical settings.

Keywords Autism · Autism spectrum disorders · Early diagnosis, delayed diagnosis · Symptom severity · Language delay · Speech delay

Participants

In this retrospective study, we analyzed data from a sample of 104 children diagnosed with ASD at Soroka University Medical Center (SUMC) between June 2017 and November 2020. SUMC is the only clinical center where children insured by the Clalit HMO (who cover healthcare for 70% of the population in southern Israel) can receive an ASD diagnosis (Dinstein et al., 2020; Meiri et al., 2017). Only Hebrew speaking children who were younger than 78 months old at diagnosis and completed a Preschool Language Scale, 4th edition (PLS-4; Zimmerman et al., 2002; Zimmerman & Steiner, V. G., & Pond, 2010) assessment within ± 3 months of their Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2; Lord et al., 2012) assessment were included in the current study. All participating children were diagnosed with ASD according to DSM-5 criteria by a developmental psychologist, and either a child psychiatrist or pediatric neurologist. The participating children were, on average, 32 months old at diagnosis (Table 1). The study was approved by the SUMC Helsinki Committee. Since this was a retrospective analysis of anonymized data, there was no need to obtain signed consent from the participating families.

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Introduction

Early diagnosis of ASD is essential for enabling earlier access to services and ASD-specific interventions that improve clinical outcomes (Hyman et al., 2020; Zwaigenbaum, Bauman, Choueiri, et al., 2015; Zwaigenbaum, Bauman, Stone, Zwaigenbaum et al., 2015a, b). For example, it has been shown that children diagnosed before 2.5 years of age and treated in community settings are three times more likely to make considerable improvements in social symptoms in comparison to children diagnosed at later ages (Gabbay-Dizdar et al., 2021). This motivates research regarding easily detectable early signs that can help reduce the age of ASD diagnosis, particularly in community settings where the current mean diagnosis age is > 3.5 years old (van 't Hof et al., 2021) and standardized ASD screening tools are used by < 50% of physicians (Gillis, 2009; Gura et al., 2011; Self et al., 2014). We briefly describe previously reported factors that are associated with ASD diagnosis at earlier ages while highlighting the potential importance of language delays.

The age of ASD diagnosis is associated with a variety of child, parent, and societal characteristics. For example, some studies have reported that children with more severe ASD symptoms (Harrop et al., 2021; Mazurek et al., 2014; Mishaal et al., 2014), poorer cognitive abilities (Bickel et al., 2015; Constantino et al., 2020; Mazurek et al., 2014), and larger language delays (Brett et al., 2016; Goodwin et al., 2017; Mandell et al., 2005; Salomone et al., 2016; Vanegas, 2021) tend to be diagnosed at earlier ages. Furthermore, minorities (Constantino et al., 2020; Kerub et al., 2021) and children of poorer families (Emerson et al., 2016; Mandell et al., 2005) and immigrant families (Vanegas, 2021) tend to be diagnosed at older ages than their counterparts, likely due to difficulties in accessing and utilizing healthcare resources. However, it is not clear whether some of these variables are more strongly associated with the age of ASD diagnosis than others.

Of the child related variables listed above, language delays are of particular interest given that they are easily discernible at an early age and prevalent in most children with ASD (Tager-Flusberg, 2016). The majority of children with ASD (> 85%) exhibit language delays that include delays in word learning and the use of phrases (Adamson et al., 2019; Pickles et al., 2014), with 25–30% of children with ASD remaining minimally verbal (i.e., use less than 50 words) throughout childhood (Rose et al., 2016; Tager-flusberg & Kasari, 2013). Numerous studies have reported that parent-reported language delays are associated with earlier ASD diagnosis (Brett et al., 2016; Goodwin et al., 2017; Herlihy et al., 2015; Mandell et al., 2005; Salomone et al., 2016; Zablotsky et al., 2017) and ~75% of parents of children who eventually receive an ASD diagnosis, initiate clinical assessments with a concern of language delay (Kozlowski et al., 2011; Richards et al., 2016). However, these studies were based on gross, retrospective parent reports that were acquired years after the diagnosis. Hence, these studies could not perform an accurate, quantitative assessment of the relationship between language delays and the age of diagnosis. Such an assessment would require quantification of the child's language delays using a standardized language test at the time of diagnosis.

The most common language delay identified in young children with and without ASD is late talking (sometimes referred to as late language emergence), typically defined as production of fewer than 50 words and/or no word combinations by 2 years of age (Desmarais et al., 2008). The prevalence of late talking in the general population ranges between 8 and 20% depending on its precise definition (Collisson et al., 2016; Dale et al., 2014; Zubrick et al., 2007). Most children who are late talkers will not develop ASD. However, given that the prevalence of ASD in the general population is ~2% (Dietz et al., 2020), and given that ~85% of children with ASD are late talkers (Adamson et al., 2019; Pickles et al., 2014), a reasonable conjecture is that approximately 1 in 5–12 children who are late talkers will develop ASD. This emphasizes the potential utility of language delays as a highly visible sign of ASD risk.

Another line of relevant research includes prospective studies with siblings of ASD children, where 1 in 5 participating children usually receive a final diagnosis of ASD (Ozonoff et al., 2011;i.e., ten times higher risk than the general population). These studies have reported that language delays are prominent in baby siblings, whether they eventually receive an ASD diagnosis (Mitchell et al., 2006) or not (Garrido et al., 2017; Marrus et al., 2018). Hence, while not all children with language delays will develop autism, these reports further support the claim that children at high risk for ASD (including baby siblings) exhibit early language delays.

While there is considerable literature substantiating the association between language delays and early ASD diagnosis, previous studies have not examined whether this symptom is more strongly associated with the age of ASD diagnosis than core ASD symptoms or cognitive delays. Such a comparison requires measuring each of these symptom domains with standardized tests. The objective of the current study was, therefore, to quantify the strength of association between the age of diagnosis and standardized language, cognitive, and ASD severity assessment scores using correlation and regression analyses. We performed this study with data acquired at a public healthcare setting that serves the entire population of southern Israel and mostly performs ASD diagnoses in 1-6-year-old children.

Table 1 Participant characteristics at time of ASD diagnosis

Variable	n	Range	Mean	SD
Age at Diagnosis (months)	104	16–78	32	13
Male, Females	88, 16			
PLS-4 Total Scores	104	50–112	61.7	13.1
PLS-4 AC Scores	104	50–115	65.1	13.7
PLS-4 EC Scores	104	50–105	67.1	12.6
ADOS-2 Total CSS	104	1–10	7.19	2.2
ADOS-2 SA CSS	104	1–10	7.49	2.2
ADOS-2 RRB CSS	104	1–10	6.96	1.8
Cognitive Scores	84	49–128	81.6	16.5

This study, therefore, examined how relative child symptom severities were associated with earlier ASD diagnoses in a secondary community clinical setting. We hope that the results will be useful for improving diagnostic procedures in similar clinical settings.

Methods

Participants

In this retrospective study, we analyzed data from a sample of 104 children diagnosed with ASD at Soroka University Medical Center (SUMC) between June 2017 and November 2020. SUMC is the only clinical center in the south of Israel where children insured by one of the largest HMOs (which provides healthcare for 70% of the population in southern Israel) can receive an ASD diagnosis (Dinstein et al., 2020; Meiri et al., 2017). Only Hebrew speaking children who were younger than 78 months old at diagnosis and completed a Preschool Language Scale, 4th edition (PLS-4; Zimmerman et al., 2002; Zimmerman & Steiner, V. G., & Pond, 2010) assessment within ± 3 months of their Autism Diagnostic Observation Schedule, 2nd edition (ADOS-2; Lord et al., 2012) assessment were included in the current study. All participating children were diagnosed with ASD according to DSM-5 criteria by a developmental psychologist, and either a child psychiatrist or pediatric neurologist. The participating children were, on average, 32 months old at diagnosis (Table 1). The study was approved by the Helsinki Committee. Since this was a retrospective analysis of anonymized data, there was no need to obtain signed consent from the participating families.

Procedure and Measures

Language ability was measured using the Hebrew version of the PLS-4, which was performed by a licensed speech and language pathologist. The PLS-4 can be used from birth to 6 years and 11 months of age and provides scores of Auditory Comprehension (AC), Expressive Communication (EC), and a total language score that are standardized relative to the abilities expected of children at specific ages (Zimmerman & Steiner, V. G., & Pond, 2002). The Hebrew version of the PLS-4 was validated for use with the Israeli population (Zimmerman & Steiner, V. G., & Pond, 2010). Standardized scores have a population mean of 100 and a standard deviation of 15 (equivalent to IQ scores). Scores above 85 are defined as "Normal language ability", scores between 70 and 85 are defined as "Moderate language impairment" and scores below 70 are defined as "Severe language impairment".

ASD symptoms were evaluated using the ADOS-2 (Lord et al., 2012), a validated diagnostic test, administered by a clinician with over 5 years of experience and research reliability. We used the ADOS calibrated severity scores (CSS) to estimate ASD symptom severity and computed separate CSS for the Social Affect (SA) and the Restricted and Repetitive Behavior (RRB) domains. The CSS were specifically developed to enable comparison of ASD severity independently of the child's age and language abilities (Hus et al., 2014).

Cognitive abilities were estimated by an expert pediatric psychologist in 84 (~ 81%) children using one of three standardized tests. The Bayley Scales of Infant and Toddler Development, Third Edition (Viezel et al., 2014) was used with 58 (~ 69%) of the 84 children, the Mullen Scales of Early Learning (MSEL; Mullen 1995) was used with 13 (~ 15%) children, and the Wechsler Preschool and Primary Scale of Intelligence, Third Edition (Luiselli et al., 2013) was used with 13 (~ 15%) children. The appropriate test was selected according to the child's age and language ability as determined by the pediatric psychologist. The three tests yield equivalent standardized scores with a mean of 100 and a standard deviation of 15. Since strong correlations exist between the Bayley and Wechsler tests, as well as between the Mullen and Bayley tests, (Bayley, 2006; Lense et al., 2014), we combined scores from these tests in our analysis. Cognitive assessments in the remaining 20 children were not completed due to lack of cooperation. The age of diagnosis of children who did not complete cognitive assessments did not differ significantly from those who did ($t(102)= -1.011$, $p = 0.314$).

Data Analysis & Statistics

We calculated Pearson's correlation coefficients in R-studio (R-studio Inc., Boston, MA) to assess associations between pairs of continuous variables (e.g., PLS scores, ADOS scores, and age of diagnosis). We performed a chi-square test of independence to compare the percentage of children with specific language delays (e.g., percentage of children who did not achieve the one-word phase) across children

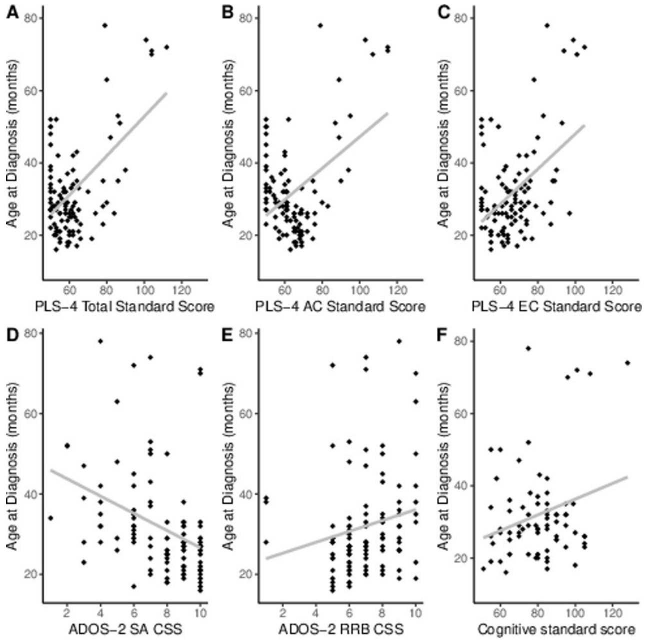

Fig. 1 Relationships between age of diagnosis and behavioral assessment scores. *Note.* Scatter plots demonstrating the relationship between the age of diagnosis and behavioral assessments standard scores. **A**. PLS-4 Total standard scores (r = 0.55, p < 0.001). **B**. PLS-4 AC standard scores (r = 0.46, p < 0.001). **C.** PLS-4 EC standard scores (r = 0.47, p < 0.001). **D.** ADOS-2 SA CSS (r=-0.37, p < 0.001). **E**. ADOS-2 RRB CSS (r = 0.19, p = 0.0515). **F**. Cognitive scores (r = 0.28, p = 0.009). Each point represents a single child. Gray line: least squares fit

diagnosed < 2.5 years of age and those diagnosed at older ages. We performed a stepwise regression analysis using SPSS (IBM, USA) to determine the relative contribution of the PLS-4 scores, cognitive scores, ADOS SA CSS, and ADOS RRB CSS (i.e., independent variables) for predicting the age of ASD diagnosis (i.e., dependent variable). SPSS starts with a multiple regression using all variables/predictors and then iteratively excludes each of the variables according to their impact on the model's R^2. Predictors that do not contribute to the R^2 of the model (i.e., removing them does not significantly reduce the R^2 of the model) are excluded from the final model. We report the weights and significance of the predictors included in the final model along with their relative explanatory power (i.e., change in variance explained – R^2).

Results

Age of ASD diagnosis was significantly positively correlated with PLS-4 scores (r(102) = 0.55, p < 0.001) and cognitive scores (r(82) = 0.28, p = 0.009). Significant positive correlations were also apparent when examining the PLS-4 AC (r(102) = 0.46, p < 0.001) and EC (r(102) = 0.47, p < 0.001) scores separately. Note that PLS-4 AC and EC scores were strongly correlated with each other (r(102) = 0.76, p < 0.001), indicating a strong correspondence between expressive and receptive language difficulties in the children. Age of diagnosis was significantly negatively correlated with total ADOS CSS (r(102)=-0.26, p = 0.008). Separate examination of social and RRB scores revealed a significant negative correlation with ADOS-SA CSS (r(102)=-0.37, p < 0.001) and a marginally significant positive correlation with ADOS-RRB CSS (r(102) = 0.19, p = 0.05), demonstrating that the severity of the two core ASD symptoms are associated with the age of diagnosis in opposite directions. Taken together, these correlations demonstrate that children with lower language and cognitive abilities, lower RRB symptom severity, and higher SA symptom severity were diagnosed earlier (Fig. 1).

Explaining Differences in the Age of ASD Diagnosis

We performed a stepwise regression analysis using the PLS-4 scores, cognitive scores, ADOS SA CSS, and ADOS RRB CSS as predictors in explaining individual differences in the age of ASD diagnosis. Since PLS-4 AC and EC scores were strongly positively correlated with each other (r(102) = 0.76, p < 0.001) and similarly correlated with the age of diagnosis (Fig. 1), we performed this regression with the total PLS-4 scores. In contrast, ADOS SA CSS and RRB CSS exhibited opposing correlations with the age of diagnosis (Fig. 1) thereby justifying their separate inclusion in the regression model.

The final model selected by this analysis was highly significant (F(103) = 28.54, p < 0.001), explaining over 46% of the variability in the age of diagnosis. The model included the total PLS-4 scores (β = 0.49, P < 0.001), ADOS-2 SA (β=-2.18, P < 0.001) and RRB (β = 1.92, P < 0.001) predictors. Note that cognitive scores did not add significantly to the explanatory power of the model and were, therefore, left out. The total PLS-4 scores were the most dominant predictor in the model, explaining 30% of the variance in age of diagnosis, followed by ADOS-2 SA CSS that explained an additional 9.3% of the variance and ADOS-2 RRB CSS that explained an additional 6.8% of the variance (Table 2). This analysis highlights the strong and unique association between the severity of language delays and the age of diagnosis.

Gross Language and Social Symptom Differences Across Age Groups

Given that language and social ASD symptoms seemed to explain most of the variance in the age of diagnosis, we compared gross language delays and social impairments across children who were diagnosed < 30 months old (n = 60)

Table 2 Stepwise linear regression model for explaining the variability in age of diagnosis across participants

Variable	*B*	*SE. B*	*β*	R^2	ΔR^2
Step 1				0.299	**0.299***
PLS-4 Total Standard Scores	0.54	0.08	**0.56***		
Step 2				0.393	**0.093***
PLS-4 Total Standard Scores	0.51	0.08	**0.51***		
ADOS-2 SA CSS	-1.77	0.45	**-0.31***		
Step 3				0.461	**0.068***
PLS-4 Total Standard Scores	0.49	0.07	**0.49***		
ADOS-2 SA CSS	-2.18	0.44	**-0.38***		
ADOS-2 RRB CSS	1.92	0.54	**0.27***		
***p < 0.001	104				
Observations	0.461 / 0.445				
R^2 / R^2 adjusted					

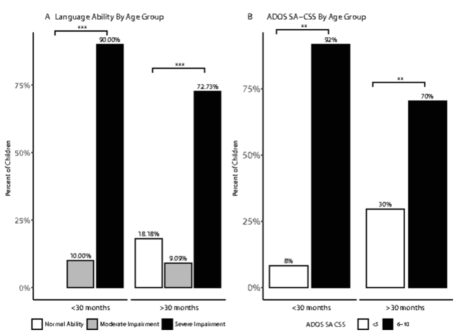

Fig. 2 Gross language abilities and ADOS SA CSS of children diagnosed before and after 30 months of age. *Note.* Bar graphs demonstrate gross language abilities and ADOS SA CSS of children diagnosed with ASD before and after 30 months of age. **(A)** Percentage of children with different language abilities as determined by PLS-4. Normal language ability: Total PLS-4 score of 100 ± 15. Moderate language impairment: 70 < Total PLS-4 score < 85. Severe language impairment: Total PLS-4 score < 70. **(B)** Percentage of children with low and high ADOS SA CSS. Low SA CSS: <5. High SA CSS: 6–10

and those diagnosed later (n = 44) (Fig. 2). This cutoff was selected because it corresponds to the upper age limit of early screening recommendations by the American Academy of Pediatrics (Hyman, Levy, Myers, et al., 2020) and because children diagnosed and treated before 30 month of age are three times more likely to exhibit improvements in social symptoms than children diagnosed at later ages (Gabbay-Dizdar et al., 2021). In this analysis we intentionally compared gross language and ASD severity across the two age groups, because gross differences are more likely to be identified in public healthcare settings where standardized tests are not always used.

The percentage of children with moderate or severe language impairments was significantly higher amongst children diagnosed with ASD before 30 months of age as compared with children diagnosed later (X^2 (1, N = 104) = 12.794, $p < 0.0001$). In fact, all children diagnosed before 30 months of age exhibited moderate (i.e., PLS scores of 70–85) or severe (i.e., PLS scores < 70) language impairments in contrast to 82% of the children diagnosed at later ages. Similarly, the percentage of children with relatively severe social symptoms (i.e., ADOS-2 SA CSS of 6–10) was significantly higher in children diagnosed with ASD before 30 months of age as compared with children diagnosed later (X^2 (1, N = 104) = 9.165, p = 0.002) (Fig. 2).

While children diagnosed early had more severe social ASD symptoms and poorer language abilities, we noted that a considerable group of children diagnosed > 30 months of age also had relatively severe ASD symptoms and poor language abilities. This was apparent in 25 of the 44 children (i.e., 57%) diagnosed > 30 months of age. Hence, more than half of the children diagnosed late exhibited easily noticeable language delays and relatively severe social ASD symptoms that should have been visible at earlier ages and enabled a timely diagnosis before 30 months of age.

Expressive Language Delays

Since gross expressive language deficits are particularly easy to identify at early ages, we also specifically examined two items from the expressive communication section of the PLS-4 that may be considered as critical milestones of language acquisition:

1. One-word phase – the clinician assesses the ability of the child to spontaneously produce 5–10 words.
2. Combining words together – the clinician assesses the ability of the child to produce word combinations involving a noun, verb, place, adjective, preposition, or possession.

The percentage of children who did not pass the "one-word" phase was significantly higher amongst children diagnosed with ASD before 30 months of age as compared with children diagnosed later (X^2 (1, N = 104) = 42.672, p < 0.0001). Approximately 85% of the children diagnosed < 30 months old (51 of 60) versus 25% of the children diagnosed later (11 of 44) did not pass the one-word phase, which is typically achieved by 12–18 months of age (Tager-Flusberg et al., 2009). Similarly, the percentage of children who did not pass the "combining words together" phase was significantly higher amongst children diagnosed with ASD before 30 months of age as compared with children diagnosed later (X^2 (1, N = 104) = 20.025, p < 0.0001). Indeed, all children diagnosed < 30 months old versus 73% of children diagnosed ≥30 months old (32 of 44) were unable to combine words (Fig. 3). This milestone is typically achieved by 24 months of age (Hagan et al., 2007). This comparison

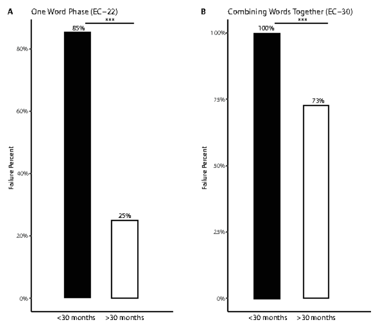

Fig. 3 Comparison of expressive language milestones across children diagnosed before and after 30 months of age. *Note.* Bar graphs demonstrate comparison of expressive language milestones across children diagnosed before and after 30 months of age. **(A)** Failure to achieve the one-word phase (item EC-22 on the PLS-4). **(B)** Failure to achieve the ability to combine words together (item EC-30 on the PLS-4).

further demonstrates that despite the higher percentage of clear language impairments in those diagnosed < 30 months of age, there is a considerable group of children diagnosed ≥30 months old with clear expressive language delays that should have raised concerns and justified referral to further ASD screening by a child development specialist. It is likely that at least some of these children, who also exhibited severe social ASD symptoms (see section above), could have been diagnosed before 30 months of age.

Discussion

Our results demonstrate that PLS-4 scores were more strongly associated with the age of diagnosis than ADOS-2 or cognitive scores, single handedly explaining 30% of the variability in age of diagnosis across children (Table 2). Despite the clear relationship described above, we found that 57% of the children who were diagnosed after 30 months of age also exhibited moderate to severe language delays (PLS-4 scores < 85) and relatively severe social ASD symptoms (ADOS SA CSS ≥ 6). These cases seem to represent a missed opportunity to identify children with noticeable language delays and core ASD symptoms at earlier ages. We believe that emphasizing the value of language delay as an early sign of ASD within public healthcare settings, such as the one examined in this study, will motivate streamlined referral of children with language delays to ASD screening, which can lead to earlier diagnosis of relevant cases and prevent at least some of these missed opportunities for early intervention.

Child Characteristics Associated with the Age of ASD Diagnosis

The most important contribution of the current study is in demonstrating the unique relationship between language delays and the age of ASD diagnosis as it appears in a large secondary clinical center that serves a large community. An important novelty of the current study was the utilization of standardized tests, performed by trained clinicians during the diagnosis, which enabled us to accurately quantify the severity of language, core ASD, and cognitive symptom domains, and assess their relative value in predicting the age of diagnosis (Table 2). While many previous studies have also reported that language delays are associated with an earlier age of ASD diagnosis (Brett et al., 2016; Goodwin et al., 2017; Herlihy et al., 2015; Mandell et al., 2005; Salomone et al., 2016; Zablotsky et al., 2017), these studies were based on retrospective parent reports, where gross information regarding early language delays was acquired years after the diagnosis itself. Hence, these studies could not perform an accurate, quantitative assessment of the relative value of different symptom domains in predicting the age of diagnosis.

In line with these findings, longitudinal studies with baby siblings of ASD children who are at high-risk for developing ASD (1 in 5 are commonly diagnosed with ASD (Ozonoff et al., 2011)), have also reported that language delays are apparent in the majority of children who are later diagnosed with ASD (Garrido et al., 2017; Mitchell et al., 2006). Note, however, that these prospective studies focus on a very special subgroup of high-risk children who do not represent the general population seeking services in large community health centers.

Another important contribution of our study is in demonstrating that the age of ASD diagnosis is associated differently with the two core ASD symptom domains. While the age of diagnosis was negatively correlated with social symptom severity, it was positively correlated with RRB symptom severity (Fig. 1). Previous studies examining this relationship did not separate the two symptom domains, and have reported that 2–11% of the variance in the age of ASD diagnosis can be explained by total ADOS CSS (Harrop et al., 2021; Mazurek et al., 2014; Mishaal et al., 2014). Our results are in line with their findings, showing that ~ 7% of the variance in diagnosis age is explained by the total ADOS-2 CSS. However, examining the two symptom domains separately reveals that ADOS SA CSS explain ~ 14% of the variance and ADOS RRB CSS explain ~ 4% of the variance. Adding the two score domains separately to a multiple regression analysis yields an explained variance of ~ 16% (Table 2). Hence, the severity of SA and RRB symptoms have distinct, opposing, relationships with the age of ASD diagnosis, with SA symptom severity explaining a considerably larger amount of variability, perhaps because SA symptoms are more easily identified at earlier ages in contrast to RRB symptoms (Lobban-Shymko et al., 2017).

The final behavioral measure examined in our study was cognitive scores. Previous studies have reported mixed results regarding the potential association between cognitive abilities and age of ASD diagnosis. While some have reported that children with lower cognitive abilities are diagnosed earlier (Bickel et al., 2015; Constantino et al., 2020; Mazurek et al., 2014), others have reported the opposite (Rosenberg et al., 2011), and several have reported that cognitive deficits do not contribute to predictive models of diagnosis age (Brett et al., 2016; Frenette et al., 2013; Mandell et al., 2005). Our findings are in line with these reports in demonstrating that there is a significant correlation between cognitive scores and age of diagnosis (Fig. 1), yet this association does not add to the predictive ability of a regression model that included ADOS-2 and PLS-4 scores (Table 2). Taken together, cognitive scores seem to be of limited independent utility for aiding early identification of ASD.

To place our findings in a broader context, it is useful to consider that most previous studies regarding the age of ASD diagnosis have reported that child, family, and sociodemographic factors explain ~ 50% of the variance in the age of ASD diagnosis (Daniels & Mandell, 2014). Demonstrating that PLS-4 scores alone explain 30% of the variance in the age of diagnosis highlight the utility of this specific variable as an early indicator of ASD risk.

Prevalence of Language Delays in Children with ASD Diagnosed Before the Age of 6.5

The results of the current study are in line with previous reports regarding the large prevalence of language delays in children with ASD. Previous studies have reported that > 85% of children with ASD exhibit delays in word learning and use of phrases (Adamson et al., 2019; Pickles et al., 2014). In our sample, all children diagnosed < 30 months of age and > 80% of the children diagnosed ≥30 months of age exhibited moderate to severe language delays according to the PLS-4 (Fig. 3). Approximately 85% of the children diagnosed < 30 months of age and 25% of the children diagnosed ≥30 months of age did not use 5 words spontaneously, a milestone that is typically achieved by 12–18 months of age (Tager-Flusberg et al., 2009). In addition, all of the children diagnosed < 30 months of age and 73% of the children diagnosed ≥30 months of age were unable to combine words into short phrases, a milestone that is typically achieved by 24 months of age (Hagan et al., 2007) (Fig. 3). An important contribution of the current study is in quantifying the specific language delays that are apparent in children diagnosed with ASD in public health community settings by the age of 6.5 (upper age limit in our study) using standardized language assessments at diagnosis, which offer a detailed and accurate picture of specific delays.

ASD Screening and Language Development

The prevalence of language delays in young children who develop ASD has motivated all ASD screening tools to include items that assess language use or comprehension, but there is variability across screening tools in the weight assigned to this issue. For example, the Quantitative Checklist for Autism in Toddlers (Q-CHAT; Allison et al., 2021) devotes five of its 25 items to questions about speech and language comprehension. Similarly, the Young Autism and other developmental disorders Check-up Tool (YACHT-18; Honda et al., 2009) devotes 2 of 14 questionnaire items and more than half of the parent interview items to speech and language comprehension. In contrast, only one of the 23 items on the Modified Checklist for Autism in Toddlers (M-CHAT; Robins et al., 2001) is devoted to language comprehension, without any items assessing speech.

As ongoing research efforts reveal the sensitivity and specificity of the different early screening tools (Petrocchi et al., 2020), it may be important to consider the extent to which they quantify language delays. We suggest that inclusion of multiple items that quantify expressive language delays may be important for increasing sensitivity that is critical for reducing the age of ASD diagnosis. Further studies assessing the utility of specific questionnaire items for increasing the sensitivity of ASD screening, with a minimal reduction in specificity, are highly warranted.

Limitations

The current study has several limitations. First, it would have been useful to add parent report measures regarding the timing and type of early parental concerns (e.g., using the Autism Diagnostic Interview; Rutter et al., 2003) for comparison with scores from the standardized clinical assessments. This would have added important context for comparison with previous studies that mostly utilized parent reports. Second, we did not include other behavioral measures such as assessments of adaptive behaviors, aberrant behaviors, and sensory sensitivities, which may also influence the age of ASD diagnosis (Daniels & Mandell, 2014). Third, we did not have access to information regarding the latency between the onset of clinical concerns and the date of final ASD diagnosis. Some children participating in the current study may have had prolonged diagnostic procedures due to long waiting lists or intermittent clinical services. Such information would be important for determining the reason for late ASD diagnoses in cases with clear language delays. Finally, this study examined a limited sample of 104 Hebrew speaking children. Larger studies comparing multiple ethnic groups are highly warranted for determining potential differences across distinct populations.

Conclusion

While ASD is not a language disorder, the presence of language delays is a clear early sign of ASD risk. Our findings suggest that language delays are by far the most predictive symptom in achieving early ASD diagnosis in large healthcare centers serving the broad community. We suggest that specific attention should be given to “late talkers” who are communicating with less than 50 words at 2 years of age. Completing standardized ASD screening, specifically with these children, has the potential to further reduce the age of ASD diagnosis in the community.

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Conflict of Interest The authors declare no conflict of interest.

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