A R T I C L E

AN ABBREVIATED SCREENING INSTRUMENT FOR AUTISM SPECTRUM DISORDERS

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ABSTRACT: The reliability and validity of the Parent's Observations of Social Interactions (POSI), a new, seven-item screening instrument for autism spectrum disorders (ASD), is examined in two substudies. In Study 1, parents of 217 children (18–48 months) evaluated at a developmental clinic completed intake questionnaires that included the POSI and the Modified Checklist for Autism in Toddlers (M-CHAT) checklist. POSI and M-CHAT scores were compared to clinical evaluation results to assess reliability and validity. In Study 2, parents of 232 children (16–36 months) from both primary care and subspecialty settings completed the POSI, the M-CHAT, and a report of their child's diagnoses. POSI and M-CHAT scores were compared to reported diagnoses to assess reliability and validity. In both studies, the POSI demonstrated adequate internal reliability (Cronbach $\alpha =$ 0.83 and 0.86, respectively). In Study 1, POSI sensitivity (89%) was higher than that for the M-CHAT (71%; $p < .05$); specificities were not significantly different (POSI: 54%, M-CHAT: 62%). In Study 2, sensitivity (83%) compared favorably to that for the M-CHAT (50%), although specificity was lower (75 vs. 84%). Despite its brevity, the POSI demonstrated good internal reliability and comparable sensitivity/specificity to the M-CHAT checklist in two independent populations. If results are reproduced in larger, more diverse samples, the POSI may provide an efficient method for ASD screening in young children.

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The prevalence of diagnosed autism spectrum disorders (ASD) has risen drastically over the past 2 to 3 decades: Current estimates are that in the United States, 1 child in every 88 to 110 is affected (Centers for Disease Control and Prevention, 2009, 2012). This increased prevalence, combined with evidence that early detection leads to earlier interventions and improved outcomes (Harris & Handleman, 2000; Lord & McGee, 2001; Matson & Smith, 2008), has instigated national organizations such as the American Academy of Pediatrics (AAP; 2006; Johnson & Myers, 2007) and the Centers for Disease Control and Prevention (2010) to establish policy statements and initiatives advocating early detection via the routine administration of validated screening instruments in primary care. The AAP policy statement recommends general developmental screening in all children at 9, 18, and either 24 or 30 months plus autism-specific screening at 18 and 24 or 30 months (Johnson & Myers, 2007). While many parents have reported concerns that their child may have an ASD as young as 15 to 18 months (Howlin & Asgharian, 1999), the average age at diagnosis is variable across regions and remains at 4.5 to 5 years of age nationally, with no significant change in recent years (Filipek et al., 1999; Centers for Disease Control and Prevention, 2007). This discrepancy between age at manifestation and age at diagnosis represents a critical period of missed opportunity. While it is apparent that many solutions are needed to reduce this discrepancy, an important one is providing better methods and measures for ASD identification in primary care.

The proportion of pediatricians who use developmental screening instruments in the United States has increased from 23% (Sand et al., 2005) to 48% (Radecki, Sand-Loud, O'Connor, Sharp, & Olson, 2011) over the past decade while as few as 8% of primary care pediatricians report screening for ASD (Dosreis, Weiner, Johnson, & Newschaffer, 2006). Among the barriers often cited to routine screening are the limited time that providers have available for patient encounters and the cost of screening (Dobrez et al., 2001), which includes both the instruments themselves and the professional and staff time needed to stock, distribute, score, and discuss them. The process of making effective referrals for further evaluation also is challenging and time-consuming. In addition, parents may not complete screening checklists, as demonstrated by a survey return rate of 54% in "real-world" conditions (Hix-Small, Marks, Squires, & Nickel, 2007). For these reasons, short and quick-to-score screening instruments are essential to practical implementation, as they decrease both parental burden and administrative cost. To increase the likelihood of parent completion and to address the barriers of the cost/time involved in scoring and interpreting results, the POSI was specifically designed to be shorter than the M-CHAT and quicker to administer and score.

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Our primary goal in these studies was to investigate the internal reliability and concurrent validity of a new, abbreviated screening instrument for ASD: the Parent's Observations of Social Interactions (POSI). To achieve these goals, we (a) performed an initial study of the use of the POSI in a referred population and (b) analyzed data from an independent sample in which parents had been enrolled from both subspecialty and primary care settings.

STUDY 1

Overview

This study was based on a retrospective chart review of a clinical population. Participants were parents of children 18 to 48 months who presented for clinical evaluation at a tertiary developmental clinic. Before a child was scheduled for an evaluation, parents completed an intake questionnaire. Embedded within this questionnaire for children under 5 years were the POSI and the M-CHAT checklist. Once initial paperwork was received, each child was scheduled for a comprehensive diagnostic evaluation by a board-certified subspecialist, which is the typical clinical procedure for ASD diagnosis (Klin, Lang, Cicchetti, & Volkmar, 2000). Subspecialists were either developmental-behavioral or neurodevelopmental pediatricians, and evaluations included a detailed history, physical examination, observation of play and parental interactions, and direct testing. Choice of test depended on clinical presentation and physician discretion, and included any combination of the following: Autism Diagnostic Observation Scale, Childhood Autism Rating Scale, Social Responsiveness Scale, Bayley Scales of Infant Development (2nd ed.), Brigance Developmental Screen and/or Inventory, Mullen Scales of Early Learning, and Preschool Language Scale (4th ed.). Clinicians had full access to the intake questionnaire, although they did not score either the POSI or the M-CHAT checklist, so information from the measures was used qualitatively. This study received approval from the medical center's Institutional Review Board. Results of the clinical evaluation were compared to results of the POSI and M-CHAT to derive scoring thresholds and concurrent validity data. Internal reliability also was analyzed.

Sample

Chart review over a 15-month period from August 2009 to November 2010 yielded parent reports on the POSI and the M-CHAT and the results of the clinical evaluation. Inclusion criteria were (a) age 18 to 48 months at the time of evaluation; (b) completed questionnaire with demographic information, the POSI, and the M-CHAT; and (c) completed diagnostic evaluation. The intake questionnaire and measures were available only in English, but English fluency was not required.

Although the original study of the M-CHAT only included children as old as 30 months, we extended the age range to 48 months because (a) the average age at diagnosis is still high nationally (Centers for Disease Control and Prevention, 2007), (b) the AAP (2006) recommends the use of the M-CHAT in children 16–48 months, and (c) the 18- to 48-month population is typical of validation studies of similar screening measures (Wong et al., 2004), including four of the six follow-up studies of the M-CHAT (Dumont-Mathieu & Fein, 2005; Eaves, Wingert, Ho, & Mickelson, 2006; Kleinman et al., 2008; Snow & Lecavalier, 2008). Exclusion criteria were significant blindness, deafness, or severe physical disability, as these may significantly impact how a parent answers the questions on either measure.

Measures

The POSI was drafted by a multi-institutional panel of clinicians and psychologists who are experts in autism for the purpose of creating a short, Level-1 screening test for autism with appeal to primary care pediatricians. Like researchers before them, they were frustrated by the limitations of currently available tools and wanted to improve upon them by providing more than binary response options and decreasing parental burden. The POSI is a seven-item, parent-report, paper questionnaire with Flesch-Kincaid readability of Grade 5. It takes 5 min or less to complete. The items largely reflect the *Diagnostic and Statistical Manual of Mental Disorders, fourth edition, text revision* (*DSM-IV-TR*; American Psychiatric Association, 2000) criteria for diagnosis of autistic disorder, with questions about social interactions, communication, and repetitive behaviors. Although the POSI questions were not field-tested, they were modeled on the same constructs as five of the six critical items of the M-CHAT, with two additional questions about quality of behavior, reflective of *DSM-IV-TR* criteria. The POSI items also reflect the proposed *Diagnostic and Statistical Manual of Mental Disorders, fifth edition* (*DSM-V*, American Psychiatric Association, 2011) diagnostic criteria for the diagnosis of ASD. Instead of dichotomous responses as in the M-CHAT, the POSI has five potential answers for each question, as offering more response options per item has the potential to improve the accuracy of parental report (Wong et al., 2004). For 5 of its 7 items the response options describe the frequency of the specified behavior, while for two questions they describe the type or quality of behavior. Of the 5 response options, 2 are atypical/concerning responses, 1 is neutral, and 2 are typical/unconcerning responses (see Table 1 for examples of questions and response options; the complete instrument is available at www.TheSwyc.org). The layout of the POSI was designed to allow for a visual, direct scoring system to decrease the time needed to score and interpret results: Three or more answers in the last three columns indicate that a child is "at risk" and needs further evaluation.

The M-CHAT is a 23-item parent-report checklist of a child's behavior that was based upon the Checklist for Autism in Toddlers (CHAT; Robins, Fein, Barton, & Green, 2001). Response options are *yes*/*no*. Six of the 23 items were found to be most predictive of ASD diagnosis and were termed "critical items." Published guidelines instruct that a child is identified as "at-risk" and in need of further evaluation if she or he fails two or more of the six critical items or 3 or more of the 23 total items; to improve specificity, a failed checklist is to be followed by a telephone interview.

TABLE 1. *Questions From the Parent's Observations of Social Interactions (POSI)*

Is your child interested in playing with other children?				
Very Often	Often	Sometimes	Rarely	Never
Does your child look at you when you call his or her name?				
Very Often	Often	Sometimes	Rarely	Never
How does your child usually show you something he or she wants?				
Says a word for it	Points to it with one finger	Reaches for it	Pulls me over or puts my hand on it	Grunts, cries or screams

Note. The POSI is available in its entirety at www.TheSWYC.org

Various studies of the M-CHAT have been published using the same published scoring guidelines, but different overall study methodologies, resulting in widely varying estimates of sensitivity and specificity. Some have estimated its sensitivity to be as high as 0.92 and its specificity to be as high as 0.43 without telephone follow-up, or 0.93 with telephone follow-up (Dumont-Mathieu & Fein, 2005; Eaves et al., 2006; Snow & Lecavalier, 2008). The positive predictive validity has been reported between 0.28 and 0.83 (Pandey et al., 2008; Robins, 2008; Snow & Lecavalier, 2008).

As both the POSI and the M-CHAT checklists were scored retrospectively, answers could not be clarified when parents selected no response or multiple responses for a single question. When multiple answers are circled on the POSI, the answer indicating highest risk is counted to maximize sensitivity. On both the POSI and the M-CHAT, a question with no answer was considered "missing." Missing data on either checklist were not scored. No follow-up interview was performed for either the POSI or the M-CHAT.

Analyses

Descriptive statistics of demographic variables were calculated. Standard psychometric techniques were used to assess reliability and validity of the POSI and the M-CHAT, including Cronbach's α to establish internal reliability and sensitivity and specificity for validity. McNemar tests conducted among children with and without ASD were used to establish statistical differences between sensitivity and specificity data for the POSI versus the M-CHAT.

Results

Complete data from 217 children between the ages of 18 months and 48 months (inclusive) at the time of diagnostic evaluation were obtained during the study period. Four children were excluded because of incomplete data; none of the participants met exclusion criteria. Characteristics of the sample are reported in Table 2. Children were 26% female, and 33% were either Hispanic or of minority race. Approximately one third of participants had Medicaid insurance, which was used as a proxy for lower socioeconomic status (SES), and half had mothers who had completed an associate degree or higher.

TABLE 2. *Sample Demographics*

Population Characteristic	Study 1 % (n)	Study 2 % (n)
Population Type		
Primary Care (Low-Risk)		57 (132)
Subspecialty (Referred)	100 (217)	11 (26)
NICU Follow-up (High-Risk)		32 (74)
Male Gender	74 (160)	54 (124)
Race/Ethnicity		
Caucasian, non-Hispanic	66 (144)	63 (146)
Hispanic	15 (33)	13 (29)
African American	7 (15)	16 (37)
Asian	9 (20)	9 (20)
Other	2 (5)	0 (0)
Age		
16–36 months		100 (232)
18–30 months	37 (81)	
31–48 months	63 (136)	
Primary Language		(30%
English	82 (179)	exposed to
Spanish	7 (15)	>1 language
Portuguese	3 (6)	at home) (70)
Other	8 (17)	
Highest Maternal Education Level Completed		
High School or less	48 (105)	27 (63)
College (2- or 4-year program)	28 (61)	49 (113)
Graduate School	20 (43)	22 (51)
Unknown	4 (8)	2 (5)
Gestational Age		
Term (≥37 weeks' gestation)	75 (162)	65 (151)
Premature (<37 weeks' gestation)	20 (44)	34 (79)
Unknown	5 (11)	1 (2)
Medicaid Insurance	35 (77)	24 (55)
Diagnosis		
ASD	63.2 (137)	2.5 (6)
Autistic Disorder	28.1 (61)	
PDD-NOS	34.6 (75)	
Asperger Disorder	0.5 (1)	
Non-ASD	36.8 (80)	97.5 (226)
Any Type of Developmental Delay	32.2 (70)	25 (59)
No Delays	4.6 (10)	

ASD = Autism spectrum disorders; PDD-NOS = Pervasive developmental disorder not otherwise specified.

In this sample, 63% ($n = 137$) of children had an ASD diagnosis. When compared to the results of the diagnostic evaluation, the sensitivity was 89% for the POSI and 71% for the M-CHAT, $p < .05$. There was no significant difference between the specificities (POSI: 54%, M-CHAT: 62%; see Table 3). In the 18- to 30-month population—the population specifically targeted for ASD screening by the AAP (Johnson & Myers, 2007)—the POSI had sensitivity of 96% and the M-CHAT had 80%, $p < .05$. Once again, there was no significant difference between the specificities (POSI: 53%, M-CHAT: 42%). Cronbach's α was 0.83 for the POSI and 0.83 for the M-CHAT.

TABLE 3. *Psychometrics of the POSI vs. the M-CHAT*

	Sensitivity [95% CI] (*n*)		Specificity [95% CI] (*n*)	
Study Type	POSI	M-CHAT	POSI	M-CHAT
Study 1	89%* [82–93%] (121/136)	71%* [63–79%] (97/136)	54% [43–65%] (44/81)	62% [50–72%] (50/81)
Study 2	83% [36–99%] (5/6)	50% [12–88%] (3/6)	74%* [68–80%] (168/226)	84%* [78–88%] (190/226)

* $p < .05$.

STUDY 2

Overview

To replicate the POSI results in an independent population, we analyzed a subset of data from a cross-sectional study validating the Survey of Well-being of Young Children (SWYC; Sheldrick, Neger, & Perrin, 2012; Sheldrick, Henson, Merchant, Murphy, Neger, & Perrin, in press). The SWYC is a new, comprehensive, pediatric primary care surveillance instrument that is currently under development for monitoring child development and behavior in children 0 to 5 years. The SWYC incorporates family risk factors, emotional and behavioral functioning, and developmental achievement (i.e., communication, cognition, motor and social skills, and self-regulation) into an integrated instrument for use at each well-child visit in the first 5 years.

Field testing of the SWYC involved enrolling a sample of parents of young children who completed SWYC questions and a matched set of validated screening instruments. The POSI and the M-CHAT checklists were included in the questions administered to parents of children 16 to 30 months. Parents were identified from three types of pediatric practice settings representing different levels of risk for developmental and behavioral morbidity: primary care practices (low-risk); subspecialty programs (referred) including developmental-behavioral pediatrics, speech/language therapy, occupational therapy, and international adoption clinic; and NICU follow-up programs (high-risk). A research assistant either approached parents in the waiting room and briefly described the study or telephoned parents of the clinic to gauge their interest in having further materials mailed to them. Parents who (a) had a child 5 years or younger, (b) spoke English, and (c) were interested in learning more were asked to sign a brief consent-to-contact form including their preferred contact information. A meeting was then arranged at the parent's convenience to complete informed consent documents, demographic and medical information including history of the child's medical diagnoses, and the packet of research instruments. Questions were read aloud to participants who had difficulty reading. This study was approved by the medical center's Institutional Review Board. To derive validity and internal reliability data, results of the POSI and the M-CHAT were compared to parental report of diagnoses.

Sample

Participants were enrolled over a 12-month period from June 2009 to June 2010. Data were analyzed for all children who had complete demographic information as well as complete POSI and M-CHAT data. To ensure that there was no duplication of participants between Study 1 and Study 2, we excluded children enrolled from the developmental-behavioral clinic that had been used for Study 1.

Measures

The POSI was scored according to guidelines developed in Study 1. Where there were multiple responses, the most concerning answer was scored. To score positive, at least three questions with responses in one of the three most concerning columns were required. The M-CHAT was scored according to published guidelines. On both the POSI and the M-CHAT, a question with no answer was considered missing. Missing data on either checklist were not scored. No follow-up interview for either the POSI or the M-CHAT was performed.

Analyses

Demographic variables were analyzed descriptively. Standard psychometric techniques were used to calculate sensitivity and specificity for the POSI and the M-CHAT when compared to parents' reports of diagnoses. McNemar tests conducted among children with and without ASD were used to establish statistical difference between sensitivity and specificity data for the POSI versus the M-CHAT.

Results

Two hundred thirty-two participants between the ages of 16 to 30 months were recruited from primary care practices ($n = 132$), developmental-behavioral pediatrics ($n = 11$), speech and language ($n = 3$), occupational therapy ($n = 8$), international adoption clinics ($n = 4$), and NICU follow-up clinics ($n = 74$). All had complete data. Characteristics of the sample are reported in Table 2. Participants were 54% male, and 38% were of Hispanic ethnicity and/or minority race. Approximately 24% of

participants had Medicaid insurance, which was used as a proxy for lower SES, and 73% had mothers who had completed an associate degree or higher. Prevalence of ASD diagnosis was 2.5% ($n = 6$), all originating from the specialty clinic sample.

Cronbach's α was 0.86 for the POSI and 0.89 for the M-CHAT. Among these participants, 12% of children scored positive on the POSI, which yields a sensitivity of 83% and a specificity of 74% (Table 3). Of the children who scored positive on the POSI, but did not have ASD, 49% had developmental delay ($n = 28$). In comparison, 7.4% of children scored positive on the M-CHAT, which yields a sensitivity of 50% and a specificity of 84% (Table 3). Of the children who scored positive on the M-CHAT, but did not have ASD, 59% had developmental delay ($n = 22$). The M-CHAT was more specific than was the POSI, $p < .05$, but the difference in sensitivities was not statistically significant.

To examine the difference in sensitivity, post hoc analyses were conducted by comparing POSI questions with corresponding M-CHAT critical items among the 6 children with ASD. Every child who scored positive on an M-CHAT item also scored positive on the corresponding POSI item. Of the 22 negative responses on the M-CHAT, 9 were positive on the POSI; of these, 6 (66%) responses were in the middle or "Sometimes" column.

DISCUSSION

The goals of this study were to provide initial data supporting the internal reliability and concurrent validity of the POSI. With a Cronbach's α of 0.83 to 0.86, the POSI displayed adequate reliability, comparable to that of the M-CHAT. This is significant because usually Cronbach's α increases with the number of items in a measure; in this initial study, the POSI had comparable reliability with fewer than one third the number of items.

We compared the new instrument, the POSI, to an established screening instrument (M-CHAT) in terms of sensitivity and specificity, in two independent samples. In both studies, the POSI was more sensitive to ASD diagnoses than was the M-CHAT checklist, although the difference was statistically significant only in the first study. Conversely, the POSI was less specific to ASD diagnoses than was the M-CHAT checklist in both studies, although the difference was statistically significant only in the second study.

We note both strengths and limitations of these studies. One strength is that the number of children tested in Study 1 ($n = 217$) is larger than many of the studies used to establish the validity of other screening instruments (Kleinman et al., 2008; Robins, 2008; Robins et al., 2001). A second strength is that all children in Study 1 received diagnostic testing regardless of their screening results. Many validation studies of instruments intended to screen for low-prevalence conditions are unable to perform clinical follow-ups for children who score negative (i.e., within the normal range). Without diagnostic testing of children who score negative, it is impossible to know the true prevalence of ASD in the study sample; therefore, sensitivity and specificity can only be estimated based on prior prevalence rates. Because in Study 1 we had full clinical-evaluation results for all children, we were able to calculate true sensitivity and specificity data.

Our sampling strategy shares a limitation common among investigations of screening instruments. Because the prevalence of ASD is approximately 1 in 88 to 110 in primary care, it was artificially increased in these studies by including families from subspecialty care clinics. Parents of children who already have been identified by their primary care provider as having a developmental problem may be more aware of ASD symptoms and therefore may be more likely to report them on screening instruments. Thus, sensitivity for either instrument may be spuriously inflated. In contrast, since the majority of children in Study 1 had some type of developmental delay, specificity for both instruments may be spuriously depressed because children with potential ASD are being compared to a background population of children with developmental delays rather than a background population of typically developing children. When the discrepancy between the target symptom(s) and the background population is wider (as in primary care), specificity is increased. Thus, the relatively low specificities found in Study 1 (POSI: 55%, M-CHAT: 62%) are not surprising and are likely to be higher in a primary care context.

The number of children with ASD in Study 1 versus Study 2 differed significantly due to the different populations from which they were derived. Study 2 was drawn mostly from primary care, where the prevalence is approximately 1 in 88 to 110, while Study 1 was derived entirely from a specialty clinic, where the prevalence of ASD is expected to be much higher.

Incorporation bias is another potential limitation and results when the reference standard against which a new instrument is being tested is influenced by the instrument itself. In Study 1, it is possible that clinical diagnoses may have been influenced by answers on the POSI and/or the M-CHAT. Such a bias would have increased the agreement between the instrument and the result of the evaluation. There is no reason to believe that this bias would be different for the POSI versus the M-CHAT.

A limitation of Study 2 is that diagnostic status was assessed with a survey question of parents, which is very much like the procedure used in the National Survey of Children's Health and other national studies of condition prevalence (Centers for Disease Control, 2009). This method is likely to be less reliable than is direct clinical evaluation. We reiterate that both the POSI and the M-CHAT checklists were used without follow-up interviews or tasks. In this regard, our studies reflect routine clinical care, where the recommended M-CHAT telephone interview is rarely used. This procedure also is similar to that used in previously published studies of the M-CHAT that did not use the telephone follow-up (Eaves et al., 2006; Snow & Lecavalier, 2008). Follow-up interviews or tasks serve to increase the specificity of paper checklists. In general, sensitivity is reciprocal to specificity (i.e., as the sensitivity of a test rises, its specificity generally falls). Striking the best balance requires a judgment about the clinical use of the instrument. For a Level-1 screening instrument, high sensitivity is critical so that fewer true cases of ASD are missed at a time when earlier

intervention leads to improved outcomes. The trade-off for high sensitivity is that the specificity may go down, resulting in more false-positive results. In detecting a relatively low-prevalence condition such as autism, clinical assessment and/or a second-level screening is necessary to identify false-positives, thereby compensating for the lack of specificity of the Level-1 screening instrument. Increasing specificity is important so that service systems are not burdened with needless referrals and parents are not made unnecessarily anxious. While the M-CHAT protocol recommends a follow-up telephone interview for this purpose, other types of follow-up procedures (e.g., guided observation by the pediatrician) also could be effective.

These findings represent an initial study of a new instrument and provide guidance for further research into efficient and effective screening for autism in primary care. Despite its brevity, the POSI's psychometric characteristics appear to be comparable to those of the much longer M-CHAT in both referred and mixed primary care/subspecialty populations. In the future, these results should be replicated in a larger and more diverse sample. Full validation of this new, brief, first-level screening test for ASD will require extensive funding to enroll an extremely large sample from primary care settings.

REFERENCES

American Academy of Pediatrics. (2006). Identifying infants and young children with developmental disorders in the medical home: An algorithm for developmental surveillance and screening. Pediatrics, 118(1), 405–420.

American Psychiatric Association. (2000). Diagnostic and statistical manual of mental disorders (4th ed., Text rev.). Washington, DC: Author.

American Psychiatric Association. (2011, January 26). A 05 autism spectrum disorder: Proposed revision. Retrieved from http://www.dsm5.org/ProposedRevisions/Pages/proposedrevision.aspx?rid=94

Centers for Disease Control and Prevention. (2007). Prevalence of autism spectrum disorders—Autism and Developmental Disabilities Monitoring Network, six sites, United States, 2000. Morbidity and Mortality Weekly Report, 56(SS01), 1–11.

Centers for Disease Control and Prevention. (2009). Prevalence of autism spectrum disorders—Autism and Developmental Disabilities Monitoring Network, United States, 2006. Morbidity and Mortality Weekly Report, 58(SS10), 1–20.

Centers for Disease Control and Prevention. (2010). Autism spectrum disorders, screening and diagnosis. Retrieved May 13, 2010, from http://www.cdc.gov/ncbddd/autism/screening.html

Centers for Disease Control and Prevention. (2012). Prevalence of autism spectrum disorders—Autism and Developmental Disabilities Monitoring Network, 14 sites, United States, 2008. Morbidity and Mortality Weekly Report, 61(SS03), 1–19.

Dobrez, D., Lo Sasso, A., Holl, J., Shalowitz, M., Leon, S., & Budetti, P. (2001). Estimating the cost of developmental and behavioral screening of preschool children in general pediatric practice. Pediatrics, 108(4), 913–922.

Dosreis, S., Weiner, C.L., Johnson, L., & Newschaffer, C.J. (2006). Autism spectrum disorder screening and management practices among general pediatric providers. Journal of Developmental & Behavioral Pediatrics, 27, 88–94.

Dumont-Mathieu, T., & Fein, D. (2005). Screening for autism in young children: The Modified Checklist for Autism in Toddlers (M-CHAT) and other measures. Mental Retardation and Developmental Disabilities Research Reviews, 11, 253–262.

Eaves, L.C., Wingert, H.D., Ho, H.H., & Mickelson, E.C.R. (2006). Screening for autism. Autism, 10(3), 229–242.

Filipek, P.A., Accardo, P.J., Baranek, G.T., Cook, E.H., Dawson, G., Gordon, B. et al. (1999). The screening and diagnosis of autistic spectrum disorders. Journal of Autism and Developmental Disorders, 29, 439–484.

Harris, S.L., & Handleman, J.S. (2000). Age and IQ at intake as predictors of placement for young children with autism: A four to six year follow-up. Journal of Autism and Developmental Disorders, 30(2), 137–142.

Hix-Small, H., Marks, K., Squires, J., & Nickel, R. (2007). Impact of implementing developmental screening at 12 and 24 months in pediatric practice. Pediatrics, 120(2), 381–389.

Howlin, P., & Asgharian, A. (1999). The diagnosis of autism and Asperger syndrome: Findings from a survey of 770 families. Developmental Medicine and Child Neurology, 41, 834–839.

Johnson, C.P., & Myers, S.M. (2007). Identification and evaluation of children with autism spectrum disorders. Pediatrics, 120(5), 1183–1215.

Kleinman, J.M., Robins, D.L., Ventola, P.E., Pandey, J., Boorstein, H.C., Esser, E.L. et al. (2008). The Modified Checklist of Autism in Toddlers: A follow-up study investigating the early detection of autism spectrum disorders. Journal of Autism and Developmental Disorders, 38, 827–839.

Klin, A., Lang, J., Cicchetti, D.V., & Volkmar, F.R. (2000). Interrater reliability of clinical diagnosis and DSM-IV criteria for autistic disorder: Results of the DSM-IV Autism Field Trial [Brief Report]. Journal of Autism and Developmental Disorders, 30(2), 163–167.

Lord, C., & McGee, J.P. (Eds.). (2001). Educating children with autism. Washington, DC: National Academy Press.

Matson, J.L., & Smith, K.R.M. (2008). Current status of intensive behavioral interventions of young children with autism and PDD-NOS. Research in Autism Spectrum Disorders, 2, 60–74.

Pandey, J., Verbalis, A., Robins, D.L., Boorstein, H., Klin, A., Babitz, T. et al. (2008). Screening for autism in older and younger toddlers with the Modified Checklist for Autism in Toddlers. Autism, 12(5), 513–535.

Radecki, L., Sand-Loud, N., O'Connor, K.G., Sharp, S., & Olson, L.M. (2011). Trends in the use of standardized tools for developmental screening in early childhood: 2002–2009. Pediatrics, 128(1), 14–19.

Robins, D.L. (2008). Screening for autism spectrum disorders in primary care settings. Autism, 12(5), 537–556.

Robins, D.L., Fein, D., Barton, M.L., & Green, J.A. (2001). The Modified Checklist for Autism in Toddlers: An initial study investigating the early detection of autism and pervasive developmental disorders. Journal of Autism and Developmental Disorders, 31(2), 131–144.

Sand, N., Silverstein, M., Glascoe, F.P., Gupta, V.B., Tonniges, T.P., & O'Connor, K.G. (2005). Pediatricians' reported practices regarding developmental screening: Do guidelines work? Do they help? Pediatrics, 116(1), 174–179.

Sheldrick, R.C., Henson, B.S., Merchant, S., Murphy, J.M., Neger, E.N., & Perrin, E.C. (in press). The Preschool Pediatric Symptom Checklist (PPSC): Development and validation of a new social/emotional screening instrument. Academic Pediatrics.

Sheldrick, R.C., Neger, E.N., & Perrin, E.C. (2012). Concerns about development, behavior & learning among parents seeking pediatric care. Journal of Developmental and Behavioral Pediatrics, 33(2), 156–160.

Snow, A., & Lecavalier, L. (2008). Sensitivity and specificity of the Modified Checklist for Autism in Toddlers and the Social Communication Questionnaire in preschoolers suspected of having pervasive developmental disorders. Autism, 12(6), 627–644.

Wong, V., Hui, L.H.S., Lee, W.C., Leung, L.S.J., Ho, P.K.P., Lau, W.L.C. et al. (2004). A modified screening tool for autism (Checklist for Autism in Toddlers [CHAT-23]) for Chinese children. Pediatrics, 114(2), e166–e175.