Can Screening with the Ages and Stages Questionnaire Detect Autism?

Sarah Hardy, MA,* Lauren Haisley, MA,† Courtney Manning, BS,† Deborah Fein, PhD†

ABSTRACT: ***Objective:*** **Parents rely on pediatricians to monitor their child's development. The American Academy of Pediatrics recommends routine developmental screening with both broadband and autism-specific instruments at specified ages. If broadband screeners can detect autism risk, this might minimize the burden of administering autism-specific screens to all children. The current study examines the ability of the Ages and Stages Questionnaire—Third Edition (ASQ-3) to identify children at risk for autism. We looked at ASQ-3 scores of children who screen positive on the Modified Checklist for Autism in Toddlers—Revised (M-CHAT-R), children who continue to screen positive on the M-CHAT-R Follow-up Interview, and children diagnosed with autism spectrum disorder (ASD).** ***Methods:*** **A total of 2848 toddlers, aged 16 to 30 months, were screened with the ASQ-3 and M-CHAT-R across 20 pediatric sites. Children who screened positive on the M-CHAT-R and its follow-up interview were offered a diagnostic evaluation.** ***Results:*** **Using the "monitor and/or fail" cutoff on any domain, the ASQ-3 identified 87% of the children who screened positive on the M-CHAT-R with follow-up and 95% (20/21) of those diagnosed with an ASD. Monitor and/or fail on the Communication domain alone also identified 95% of the diagnosed children.** ***Conclusions:*** **Scores below the "monitor" cutoff on the Communication domain of the ASQ-3 can indicate initial concern requiring autism-specific follow-up. If these results are confirmed with a sample large enough to separately examine toddlers of different ages and different cultural backgrounds, it may be feasible to implement a 2-stage screening strategy, with autism-specific screening reserved for those who are positive on a broadband screen.**

*(J Dev Behav Pediatr 36:*536–543, 2015) **Index terms:** developmental screening, autism spectrum disorder (ASD), pediatrics, Modified Checklist for Autism in Toddlers–Revised (M-CHAT-R/F), Ages and Stages questionnaire–Third Edition (ASQ-3).

Recent studies have highlighted the importance of early intervention for children with developmental disorders, such as autism spectrum disorder (ASD[1,2]). By providing early intervention services to children with ASD, there is a greater chance for improved social, communicative, adaptive, and cognitive outcomes.[3,4] The prevalence of ASD has risen to 1 in 68 children,[5] and the timely identification of these children has never been more important. On average, children in the United States are diagnosed with ASD between 3 and 6 years of age.[6–8] However, parents frequently report their first developmental concerns around 18 months.[9] Systematic developmental screening helps to close this gap, leading to reliable diagnoses closer to age 2 years.[10–12]

Parents rely mainly on their primary care provider to monitor their child's development and to detect the need for further assessment or intervention; thus, it is critical that pediatricians have the most effective tools to screen for possible delays. Glascoe[13] suggests that early detection rates for developmental disorders have been low overall due to an over reliance on clinical surveillance alone. She suggests the need for more sensitive means of detection within primary care, including standardized screening, which has been shown to facilitate timely referral to specialists.[14]

Routine developmental screening with a validated instrument leads to improved outcomes for those children who are identified and referred for evaluation.[15] Child development is dynamic and any single source of information may be incomplete; therefore, regular and repeated screening combined with developmental surveillance will optimize the detection of delays.[13,16] Since 2006, the American Academy of Pediatrics (AAP) has recommended developmental screening, using a validated screening tool, at specific well-child visits (9, 18, and 24, or 30 mo), as well as ASD-specific screening at 18-month and 24-month well-child visits.[16]

There are many reported barriers to effective screening by primary care professionals including time, practitioner knowledge, costs, and practice implementation constraints,[17] with the predominant concern being time.

From the *Department of Psychology, University of Rhode Island, Kingston, RI; †Department of Psychology, University of Connecticut, Storrs, CT.

Received October 2014; accepted June 2015.

This study is funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

Disclosure: D. Fein is part owner of the M-CHAT-R LLC. The M-CHAT-R is provided free of charge for physician's use but provides royalties from companies that charge for its use. The other authors declare no conflict of interest.

Address for reprints: Sarah Hardy, BA, Early Detection Study, University of Connecticut, Department of Psychology, 406 Babbidge Road, Unit 1020, Storrs, CT; e-mail: hardy.sarah.e@gmail.com.

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

Primary care practitioners most often use broadband developmental screening tools, as opposed to autism-specific screening measures, because they are general, quick, easy to use, readily interpretable, and detect a range of disorders.[18] Therefore, if the broad screeners could be shown to be sensitive to autism, primary care providers might be able to save time by administering general, broadband developmental screening measures before narrowband screens, such as instruments for detecting autism.[13,19] With this procedure, broadband screening could be used as a first-level screen and autism-specific screening as a second-level screen for those with autism risk indicated on the broadband screening.

One autism-specific measure commonly used in the United States is the Modified Checklist for Autism in Toddlers (M-CHAT). The CHAT, developed in the United Kingdom, was the first autism-specific screening measure.[20] Robins et al[21] adapted it for use in the United States in 2001, producing the M-CHAT,[22] and its revision, the M-CHAT-R. The M-CHAT-R was recently validated as a 2-stage, level 1 ASD screening tool for use at 18- and 24-month well-child visits. In the first stage, parents complete the M-CHAT-R at a well-child visit. A score of 0 to 2 items failed indicates low risk for autism. The M-CHAT-R Follow-up Interview (M-CHAT-R/F) is used when the parent's responses indicate medium risk, with a score of 3 to 7. If the parent's responses indicate high risk, with a score of 8 or higher, it is acceptable to bypass the follow-up interview and refer immediately for diagnostic evaluation and eligibility evaluation for early intervention. The M-CHAT-R/F effectively identifies toddlers who should receive a more thorough assessment for possible ASD; physicians using the screener plus follow-up interview can be confident that most screen-positive cases warrant evaluation and referral for further screening and assessment; screen-positive children not found to have ASD are usually found to have another developmental issue warranting attention. Widespread implementation of universal screening can lower the average age of ASD diagnosis by 2 years, increasing time available for early intervention.[23]

The question remains, then, whether using an autism-specific instrument such as the M-CHAT-R as a second-level screen, following a positive screen on a broad instrument, would have sufficient sensitivity for detecting autism. There are very little data on this question. Two widely used, validated broad developmental screeners are the Parents Evaluation of Developmental Status (PEDS[24]), and the Ages and Stages Questionnaire.[13] One study[4] examined children identified by the PEDS compared with those identified by the M-CHAT. This revealed little overlap between the 2 screeners, with less than one-third of children identified by the M-CHAT also screening positive with predictive concerns on the PEDS. Glascoe et al[24] also compared children screening positive on PEDS with those screening positive on M-CHAT: 34% of children who screened positive on the PEDS screened negative on the M-CHAT, but these potential over referrals could be reduced by 70% by requiring multiple specific concerns on the PEDS. However, neither of these studies on the PEDS conducted formal ASD evaluations. A recent study by Wiggins et al[25] compared the agreement of the PEDS and M-CHAT screeners with the results of a comprehensive clinical autism evaluation. Although the M-CHAT demonstrated higher agreement with the clinical diagnosis, all children diagnosed with an ASD demonstrated at least 1 domain of concern on the PEDS, indicating good sensitivity for ASD if a fairly low threshold is used. Using this threshold, the PEDS identified over twice as many children as the M-CHAT, and would need to be followed by an autism-specific screen to reduce autism over-referrals. The authors concluded that both broad developmental and autism-specific screeners should be regularly administered at well-child visits.

Another such general developmental screening instrument is the Ages and Stages Questionnaire (ASQ). The ASQ is currently in its third version[26] and is nationally recognized as an effective broad developmental screening measure.[13] The ASQ-3 has strong psychometric properties when it is used to detect developmental delays, with .85 specificity and .86 sensitivity across age groups.[26] However, there are little or no data on the ASQ-3's sensitivity as a screening instrument for specific disorders, such as ASD.

The current study examines the sensitivity of the ASQ-3 domain scores in identifying children detected by the M-CHAT-R screening and follow-up and then receiving an ASD diagnosis. The study also examines each of the 5 domains of the ASQ-3 to see which domain(s) is most useful in detecting the autism cases. Based on the core symptoms of autism and the nature of early parent concerns, we hypothesized that the Personal-Social and Communication domains would be most sensitive.

METHODS

Research Design

Children at risk for autism were detected with the use of the Modified Checklist for Autism in Toddlers—Revised (M-CHAT-R). This sample was then followed up with the M-CHAT-R interview, and children continuing to screen positive were evaluated. The Ages and Stages Questionnaire—Third Edition (ASQ-3) was filled out at the same time as the M-CHAT-R. ASQ-3 scores (pass, monitor, fail) on each domain were examined for: children screening positive on the M-CHAT-R, children continuing to screen positive on the M-CHAT-R Follow-up Interview (M-CHAT-R/F), and children evaluated and receiving a diagnosis of autism spectrum disorder (ASD), to estimate sensitivity of the ASQ-3 for children at each stage of autism screening/evaluation.

Participants

Screening data were collected from 20 pediatricians across Connecticut over the course of 4 years (2009–2013) as part of the institutional review board approved study on

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

early detection of ASD at the University of Connecticut. A sample of 2848 children was screened during their 18-month or 24-month well-child checkups (1458 male and 1390 female children). Children ranged in age from 16 months 1 day to 30 months 25 days (mean = 20.44 mo, SD = 2.9 mo). A group of 207 Spanish speakers were included, using the Spanish language M-CHAT-R and ASQ-3.

Physicians were recruited to participate in the study by means of widespread mailings across Connecticut, which explained the benefits of using the M-CHAT-R as an autism-specific screening tool and the current recommendation by the American Academy of Pediatrics for using such a tool for screening. The ASQ-3 was an optional addition to the M-CHAT-R screening; therefore, only pediatricians who used both the M-CHAT-R and the ASQ-3 were included in the current study (20 offices of the total 47 offices in the larger study). Furthermore, only children whose parents completed both screening instruments were included in this study (n = 2848).

Children were excluded from the study if the M-CHAT-R was not completed within the appropriate age range (16 to 30 mo and 29 d), if the incorrect age-specific form of the ASQ-3 was used, or if the ASQ-3 was incomplete. Children were also excluded from the study if the child's legal guardian did not complete the M-CHAT-R or ASQ-3, or if the family did not speak either English or Spanish. Children who had severe motor problems or sensory impairments that would prevent the child from participating in further diagnostic assessments were excluded, as well as children who had been given an ASD diagnosis before the screener's completion.

Measures

Ages and Stages Questionnaire—Third Edition

The ASQ-3 has 21 age-specific developmental questionnaires starting at 1 month and ending at 5 years 6 months of age. For this study, we used the 16, 20, 22, 24, 27, and 30-month ASQ-3 forms. There are 5 domains: Fine Motor, Gross Motor, Communication, Problem-Solving, and Personal-Social; each domain contains 6 questions that can be answered with a yes (10 points), sometimes (5 points), or not yet (0 points), as well as 9 open-ended questions. The ASQ-3 is written at a fourth-to-sixth grade level and overall, it takes 10 to 15 minutes to complete. Based on the total score, each domain is coded as "Fail," "Monitor," or "Pass." If the score is below a specified cutoff, then the child has *failed* that domain (i.e., screened positive), and further assessment is indicated. If the score is within a specified range of the cutoff, then there are concerns and it is advised that learning activities are provided and the child's development is *monitored*. If the child's score is well above the cutoff, then the child *passes*; the child's development appears to be on schedule.[26]

In the current study, the 5 ASQ-3 domain scores (Gross Motor, Fine Motor, Communication, Personal-Social, and Problem Solving) were each coded as: 0 = pass, 1 = monitor, or 2 = failed.[23] This coding system is standard across all versions of the ASQ-3 (the 16-mo questionnaire through 30 mo); therefore, the levels of risk could be compared between the M-CHAT-R (see below) and the ASQ-3 results.

Modified Checklist for Autism in Toddlers—Revised

The M-CHAT-R[21] is an autism-specific screener composed of 20 yes or no items that have been reworded from the original M-CHAT; examples have also been added to clarify items. Furthermore, 3 of the lowest performing M-CHAT items were dropped in the revision. The parent-completed questionnaire is designed for children aged 16 to 30 months, ideal for use at their 18-month and 24-month well-child visit. Scores on the M-CHAT-R determine follow-up: 0 to 2 failed items are considered a negative screen and no further follow-up is necessary, 3 to 7 failed items require the M-CHAT-R/F and potentially a referral for an evaluation, 8 or more failed items can use the telephone follow-up to verify results or can bypass the follow-up and be referred directly for evaluation.[21] The M-CHAT-R/F is a structured interview based on the items each child failed; it contains additional examples and clarifying questions.

The M-CHAT-R has an option for a pediatrician to "red flag" a child for evaluation if the pediatrician has ASD-specific concerns regardless of the parent's answers. The pediatrician checks a box at the top of the questionnaire and is later contacted by the research team for follow-up; if the concerns relate to ASD, the child is offered an evaluation.

Procedures

Pediatric office staff gave parents an information sheet describing the study, including all potential follow-up procedures. If they chose to participate, parents were given the M-CHAT-R and the appropriate ASQ-3 form, which they completed at their pediatrician's office. Participation was voluntary, and parents could withdraw their child from participation at any time. The information sheet explained that with parental consent, the data would be de-identified and included in the study.

The pediatrician's staff sent the completed questionnaires back to the University of Connecticut, where all measures were evaluated for validity and scored. If a child screened positive on the M-CHAT-R by failing any 3 items,[21] the parents were called to complete the M-CHAT-R/F. Graduate students trained on the structured interview asked parents to elaborate their answers, including specific examples of the behavior in question and how frequently it occurs. The child was considered to have failed the M-CHAT-R/F if he/she failed any 2 items.

If the child passed the M-CHAT-R or passed the M-CHAT-R/F and the ASQ-3, no further follow-up was conducted. If the child passed the M-CHAT-R and/or the M-CHAT-R/F but failed 1 or more domains on the ASQ-3, a letter was sent to the pediatrician with a copy of the ASQ-3, suggesting that the child be referred to an early

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

intervention provider. Irrespective of the ASQ-3 result, if the child was "red flagged" on the M-CHAT-R by their pediatrician, failed 8 or more M-CHAT-R items, or failed 2 or more on the M-CHAT-R/F items, the child was offered a free diagnostic and developmental evaluation. This evaluation was completed at the University of Connecticut with a licensed clinical psychologist or a developmental/behavioral pediatrician and a graduate student in clinical psychology.

The developmental and diagnostic evaluation consisted of parent measures (Vineland II,[27] Toddler ASD Symptom Interview [unpublished], and a developmental history form), as well as measures completed with the child: the Autism Diagnostic Observation Scale[28] and the Mullen[29] Scales of Early Learning. All clinicians and graduate students were research reliable on the diagnostic measures administered. Once the testing was complete, the family was given verbal feedback, which included the screening results, information about the child's developmental functioning, any appropriate diagnoses, and recommendations. Due to the nature of the evaluation and feedback, researchers could not be blind to the screening data as parents often wanted to discuss the results of screening during the evaluation feedback session. Families were later provided with a full written report.

Data Analysis

Descriptive statistics, including simple counts and percentages, were conducted in order to initially analyze the number of children who screened positive on the ASQ-3 and M-CHAT-R/F. Next, we describe the ASQ-3 scores (and resulting sensitivity) of the children who screened positive on the MCHAT-R, children who continued to screen positive on the follow-up interview, and children who went on to receive an ASD diagnosis.

Table 1. Demographic Information for all Children Who Were Screened

Factor	n	%
Total	2848	
Age, mo		
Mean	20.44	
SD	2.9	
Range	16–30.83	
Gender		
Male	1458	51.2
Female	1390	48.8
Race/ethnicity		
White, not Hispanic	1489	52.3
White, Hispanic	196	6.9
Black, not Hispanic	235	8.3
Black, Hispanic	48	1.7
Hispanic (race unknown)	455	16.0
Asian/Pacific Islander	169	5.9
Biracial	186	6.5
Other	17	0.5
Not reported	53	1.9
Maternal education		
Did not complete HS/GED	220	7.7
HS diploma or GED	462	16.2
Vocational/technical degree	110	3.9
Some college	657	23.1
Bachelor's degree	672	23.6
Advanced degree	608	21.3
Not reported	119	4.2
Language		
English	2641	92.7
Spanish	207	7.3

GED, general education development; HS, high school.

RESULTS

A total of 2848 children were screened with both the Ages and Stages Questionnaire (ASQ) and the Modified Checklist for Autism in Toddlers—Revised (M-CHAT-R) (Table 1, demographic information; Table 2, full ASQ-3 screening results by domain). Of this sample, 1038 children (36% overall) scored in the "monitor" range on 1 or more domains of the ASQ; of those children, 424 (15% of the whole sample) failed 1 or more domains. Of the children who failed 1 or more domains, 218 (51% of those who failed any domain; 7.7% overall) scored in the monitor or failed range on the Communication domain specifically.

On the M-CHAT-R, 276 children screened positive (10%; Fig. 1) and 2572 children (90.3% of total sample) passed on the initial M-CHAT-R screen. Of the 276 screen-positive children, 132 (48%) failed at least 1 domain on the ASQ, and 193 (70%) scored in the monitor and/or fail range on at least 1 domain, suggesting a sensitivity of 70% for the ASQ-3 to detect children screening positive on the M-CHAT. Study personnel were unable to conduct a phone interview for 32 children (1.1% of total sample) due to refusal, inability to contact, or lack of proficiency in either English or Spanish; these children were excluded from the current study. Parents of 244 children completed the follow-up interview; 166 children (5.8% of total sample) demonstrated initial concerns, but went on to screen negative on the M-CHAT-R Follow-up Interview (M-CHAT-R/F). Seventy-eight children (30%; 2.7% of total sample) continued to screen positive. Of these 78 children, 59 (76% of the screen-positive children) failed at least 1 domain on the ASQ, and 68 (87%) scored in the monitor and/or failed range on at least 1 domain, suggesting a sensitivity of .87 for the ASQ-3 to detect children who screened positive on the M-CHAT-R/F. Additionally, 61 (78%) of the 78 children who screened positive on the M-CHAT-R/F scored in the monitor and/or fail range of the ASQ-3 Communication domain specifically. For a summary of the M-CHAT-R screening, see Figure 2.

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

Table 2. Ages and Stages Questionnaire—Third Edition Results by Domain for all 2848 Children Who Were Screened

Domain	Monitor, n (%)	Fail, n (%)	Monitor or Fail, n (%)	Pass, n (%)
Communication	257 (9)	155 (5.4)	412 (14.5)	2436 (85.5)
Gross Motor	185 (6.5)	89 (3)	274 (9.6)	2574 (90.4)
Fine Motor	241 (8.5)	143 (5)	384 (13.5)	2464 (86.5)
Problem Solving	295 (10.4)	153 (5.4)	448 (15.7)	2400 (84.3)
Personal-Social	252 (8.8)	111 (3.8)	363 (12.7)	2485 (87.3)
One or more domains	869 (30.5)	424 (14.9)	1038 (36.4)	1810 (63.6)

Fifty-six children received an evaluation (this includes 4 children who were "red-flagged" by their pediatrician) and 21 were determined to have an autism spectrum disorder (ASD). Of the children diagnosed with an ASD, 17 (81%) failed 1 or more ASQ-3 domain and 20 (95%) scored as monitor or fail on at least 1 domain on the ASQ, suggesting a sensitivity of .95 for the ASQ-3 to detect the children with ASD in the current sample. Examination of Tables 3 and 4 shows that using fail or monitor on Personal-Social OR Communication (the 2 domains with the highest percent failing) was no more sensitive than using fail or monitor on Communication alone (95%).

The ASQ's sensitivity for identifying individuals with ASD detected by the M-CHAT-R is, therefore, calculated to be 81%, using failing any 1 domain as the cutoff point. However, if the cutoff criteria are expanded to include *either failing or having a score in the monitor range*, the sensitivity rises to 95% based solely on the Communication domain. Specificity is unable to be calculated due to a lack of information regarding individuals who failed the ASQ-3 but were not evaluated.

DISCUSSION

The initial results of the Ages and Stages Questionnaire—Third Edition (ASQ-3) screening suggest that approximately 1 in every 3 children will initially require monitoring for their development based on scoring in the fail or monitor range on any domain, whereas 14% will require further screening for autism based on scoring fail or monitor on the Communication domain. Although alone, the ASQ-3 identifies a greater number of children than the Modified Checklist for Autism in Toddlers—Revised (M-CHAT-R), if it were used as a part of a 2-stage screening procedure, the ASQ-3 could greatly reduce the number of children requiring further screening. Thus, the current study suggests a 2-stage screening process may be effective for identifying children with autism spectrum disorder (ASD). Specifically, the ASQ-3 may be useful as a general level 1 screening instrument for the identification of ASD in toddlers. Using fail or monitor on any domain, sensitivity was 70% (unacceptably low) for children screening positive on the M-CHAT-R; this rose to 87% for children screening positive on the M-CHAT-R Follow-up Interview (M-CHAT-R/F) (and 78% using monitor and/or fail cutoff on the Communication domain only). Sensitivity rose to 95% (20 of 21 children) of those going on to receive a diagnosis of ASD, using the monitor or fail cutoff in the Communication domain.

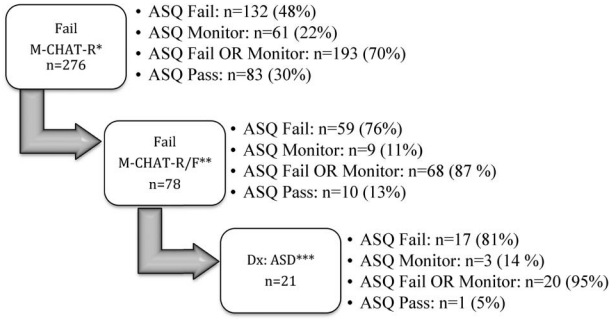

Figure 1. Ages and Stages Questionnaire—Third Edition overall screening results on combined domains for those who failed the Modified Checklist for Autism in Toddlers—Revised. *ASQ screening results are classified by any one or multiple domains that are noted as "fail" or "monitor." These results do not refer to a specific domain. Please note, the asterisk sections of Figure 1 outline the expanded ASQ-3 results at each corresponding point in Figure 2. ASD, autism spectrum disorder; ASQ, Ages and Stages Questionnaire; M-CHAT-R, Modified Checklist for Autism in Toddlers—Revised.

This study demonstrates the importance of using the *monitor* cutoff point on the ASQ-3. This broadened criterion (monitor cutoff point) correctly identified 95% of children with ASD using the Communication domain, as opposed to the *fail* cutoff, which identified only 81%. However, it is important to note that, using the monitor cutoff, the ASQ-3 identified 1038 children (36% of the total sample) and therefore is highly nonspecific for ASD concerns. When using only the Communication domain to identify concerns, the ASQ-3 identified 412 children, or approximately 14% of the entire screened sample. These results highlight the possibility of reducing ASD screening in toddlers through these methods, and it is worth considering and exploring on a larger scale in the future.

These results are similar to those found by Wiggins et al,[25] who compared the agreement between the Parents Evaluation of Developmental Status (PEDS) and the M-CHAT. Wiggins and colleagues demonstrated that using the PEDS (combined Path A and B) effectively identified children with ASD; however, it lacked specificity and would overidentify children to be evaluated for an ASD. Based on the results of the current study as well as the study by Wiggins et al, we expect that using a 2-stage screening model, with PEDS or ASQ-3 as a level

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

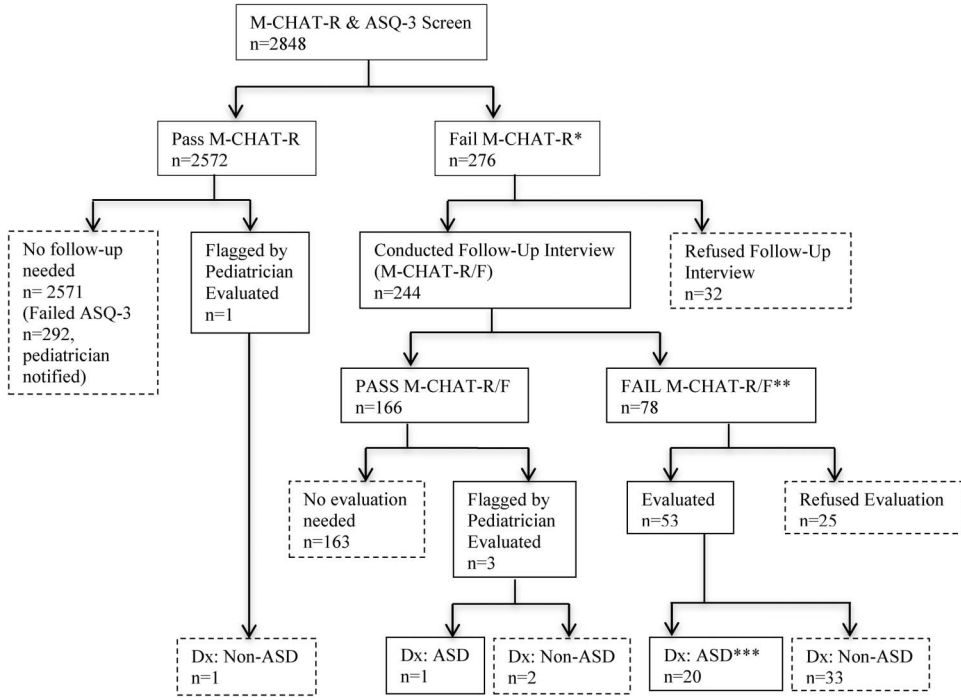

Figure 2. Modified Checklist for Autism in Toddlers–Revised (M-CHAT-R) screening results. ASD, autism spectrum disorder; ASQ-3, Ages and Stages Questionnaire–Third Edition.

1 screen, would reduce the number of children needing ASD-specific screening.

There were several limitations to the current study. Primarily, the current study did not follow children who scored in the monitor or fail ranges on any ASQ domain but screened negative on the M-CHAT-R. Therefore, we are unable to assess the specificity of the ASQ-3 or its ability to pick up children with ASD who were missed by the M-CHAT-R/F.

The current study also used the general ASQ-3; however, there is a related measure that specifically targets the child's social and emotional development: the ASQ: Social-Emotional (ASQ: SE) and a second edition due out in 2015. Whereas the ASQ-3 focuses on broad development, the ASQ: SE was designed to pick up children with social-emotional delays, including autism.[30] The ASQ: SE examines self-regulation, compliance, communication, adaptive behavior, autonomy, affect, and interpersonal interactions to address symptoms of depression, anxiety, and other antisocial behaviors.[31] Although these behaviors may also be associated with characteristics of ASD and might be more specific, this screener adds another 10 to 15 minutes to the screening process; the current study intended to assess the utility of the more generally used ASQ-3 measure.

Consistent with other publications on the M-CHAT-R/F, the current study lost approximately one-quarter of the initial screen positives to follow-up.[32,33] Anecdotal evidence suggests that some parents are confused about the systems serving them and indicate that their child has already received an assessment or is already receiving services. These parents may not realize the difference between types of assessments and services. Windham et al[34] also noted that parents may not be ready to accept a potential diagnosis and therefore do not pursue an evaluation. Additionally, parents may not feel that their child's developmental delays are significant enough to warrant follow-up. The attrition of 32 children in our

Table 3. Ages and Stages Questionnaire–Third Edition Results by Domain for the 21 Children Who Received an Autism Spectrum Disorder Diagnosis

Domain	Monitor, n (%)	Fail, n (%)	Monitor or Fail, n (%)	Pass, n (%)
Communication	5 (23)	15 (71)	20 (95)	1 (4)
Gross Motor	7 (33)	3 (14)	10 (47)	11 (52)
Fine Motor	7 (33)	7 (33)	14 (66)	7 (33)
Problem Solving	6 (28)	8 (38)	14 (66)	7 (33)
Personal-Social	4 (19)	11 (52)	15 (71)	6 (28)
One or more domains	16 (76)	17 (81)	20 (95)	15 (71)

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

Table 4. Examination of the Ages and Stages Questionnaire—Third Edition Communication and Personal-Social Domains Only for the 21 Children Who Received an Autism Spectrum Disorder Diagnosis

21 Dx: ASD Communication and Personal-Social Domain Only	n	%
Failed either domain	17	81
Failed both domains	9	43
Failed or monitor on either domain	20	95
Failed or monitor on both domains	15	71

ASD, autism spectrum disorder.

study represents an unfortunate source of potential bias, as data from these cases were not available for inclusion in the analyses.

It is important to note that universal ASD screening across pediatric care sites continues to be a challenge. Similar to findings from Windham et al,[34] in the current study screening was not conducted during sick child visits, so the sample may not represent families who did not attend regular well-child examinations, potentially reducing the sample's heterogeneity. Additionally, research personnel were responsible for scoring the screeners, contacting families, and conducting follow-up interviews.[23,32,33,35] Therefore, the current study may lack generalizability and ecological validity within unsupported pediatric practices.

Due to our reliance on office staff, and our efforts to make the study design as simple for pediatric practices as possible, we were unable to counterbalance which measure was completed first. The 2 screeners were given to the parents together, and they could fill them out in any order they chose; therefore, it is unlikely that either screener was systematically done first. When comparing the Communication domain on the 18-month version of ASQ-3 with the M-CHAT-R, there is minimal overlap between items. Two items, 1 item about indicating wanted or interesting objects, and the other regarding understanding instructions were the only similarities. The 24-month ASQ-3 version has no overlap with items on the M-CHAT-R. Thus, with very little overlap in items, the potential impact of completing 1 measure before the other is minimal.

It is possible that the ASQ may be more sensitive to autism at older or younger ages, but since we only have 21 children with ASD and 7 possible forms of the ASQ, our sample size is too small to examine this effect. However, future research could examine whether the ASQ is more sensitive to ASD at different ages. While most children diagnosed with ASD completed the 18-month form, 4 were screened with the 24-month version and the remaining 3 used forms for different ages. The 1 child who did not have a monitor/fail result on the ASQ was screened using the 27-month version. Thus, it is possible the ASQ best identifies concerns for ASD in children at younger ages. The only form of the ASQ having enough children in the sample to examine is the 18-month version and all those children with an ASD diagnosis screened positive on the ASQ-3.

The current study did not follow children who screened negative on the M-CHAT-R; therefore, we cannot say whether the M-CHAT-R missed any children who were later diagnosed with an ASD. It is highly likely that there are missed cases and we cannot know how they would have done on the ASQ. Therefore, it is important to note that our sensitivity on the ASQ is an estimate.

Additionally, as previously mentioned, researchers could not be blind to the screening data because all children who qualified for an evaluation were known to have screened positive on the screening measures. This limitation is inherent to the design of the study and is accounted for using a variety of assessment measures and current DSM diagnostic criteria.

Future Considerations

The results from the current study suggest the utility of using a general screener to identify risk for ASD. However, further research should be conducted with a larger sample size, and across varied settings and demographic characteristics before adopting a 2-stage screening procedure for detection of ASD. While our study suggests that the ASQ-3 may be able to detect ASD using a low threshold "monitor" score in the Communication domain, these findings must be verified with a larger sample before they be incorporated into clinical recommendations. Findings by Windham et al[34] suggest that the ASQ is less affected by demographic characteristics than the M-CHAT and support the continued implementation of both general and autism-specific screening measures.

In addition, studies could examine whether the ASQ more effectively identifies ASD at different ages and whether adding the ASQ: SE to the general ASQ-3 makes it more specific for autism. Finally, future studies should examine ASD and developmental screening in pediatric practices without research support, and across broader cultural backgrounds, including translation, validation, and refinement of screening instruments so that children from all the diverse populations in this country can have access to the most timely diagnosis and intervention.

REFERENCES

1. Dawson G, Sterling L, Faja S. Autism: risk factors, risk processes, and outcome. In: de Haan M, Gunnar M, eds. *Handbook of Developmental Social Neuroscience (435-458)*. New York, NY: Guilford Press; 2009.
2. Reichow B. Translating research to practice. *J Autism Developmental Disord.* 2012;42:1153–1155.
3. Myers S, Johnson C. American academy of pediatrics council on children with disabilities. Management of children with autism spectrum disorders. *Pediatrics.* 2007;120:1162–1182.
4. Lord C, McGee J. *Educating Children with Autism*. Washington, DC: National Academies Press; 2001.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

5. Baio J. Prevalence of autism spectrum disorders—Autism and developmental disabilities monitoring network, 14 sites, United States, 2008. *Surveill Summ.* 2012;61:1–19.
6. Pinto-Martin JA, Young LM, Mandell DS, et al. Screening strategies for Autism spectrum disorders in pediatric primary care. *J Dev Behav Pediatr.* 2008;29:345–350.
7. Filipek PA, Accardo PJ, Ashwal S, et al. Practice parameter: screening and diagnosis of autism: report of the Quality Standards Subcommittee of the American Academy of Neurology and the Child Neurology Society. *Neurology*. 2000;55:468–479.
8. Howlin P, Asgharian A. The diagnosis of autism and Asperger syndrome: findings from a survey of 770 families. *Dev Med Child Neurol.* 1999;41:834–839.
9. Gray K, Tonge B, Brereton A. Screening for autism in infants, children, and adolescents. *Int Rev Res Ment Retard.* 2006;32: 197–227.
10. Kleinman JM, Robins DL, Ventola PE, et al. The Modified Checklist for Autism in Toddlers: a follow-up study investigating the early detection of Autism Spectrum Disorders. *J Autism Dev Disord.* 2008;38:8270839.
11. Earls MF, Hay SS. Setting the stage for success: implementation of developmental and behavioral screening and surveillance in primary care practice—the North Carolina Assuring Better Child Health and Development (ABCD) Project. *Pediatrics*. 2006;118: 183–188.
12. Pinto-Martin JA, Dunkle M, Earls M, et al. Developmental stages of developmental screening: steps to implementation of a successful program. *Am J Public Health.* 2005;95:1928–1932.
13. Glascoe F. Screening for developmental and behavioral problems. *Ment Retard Dev Disabil Res Rev.* 2005;11:173–179.
14. Hix-Small H, Marks K, Squires J, et al. Impact of implementing developmental screening at 12 and 24 months in a pediatric practice. *Pediatrics*. 2007;120:381–389.
15. Bailey D, Hebbeler K, Spiker D, et al. Thirty-six-month outcomes for families of children who have disabilities and participated in early intervention. *Pediatrics*. 2005;116:1346–1352.
16. Johnson CP, Myers SM. Identification and evaluation of children with autism spectrum disorders. *Pediatrics*. 2007;120:1183–1215.
17. Anderson L, Shinn C, Fullilove M, et al. The effectiveness of early childhood development programs: a systematic review. *Am J Preventative Med.* 2003;24:32–46.
18. Barton M, Dumont-Mathieu T, Fein D. Screening young children for autism spectrum disorders in primary practice. *J Autism Dev Disord.* 2012;42:1165–1174.
19. Committee on Children and Disabilities, American Academy of Pediatrics. Developmental surveillance and screening for infants and young children. *Pediatrics*. 2001;108:192–195.
20. Baron-Cohen S, Wheelwright S, Cox A. The early identification of autism: the checklist for autism in toddlers (CHAT). *J R Soc Med.* 2000;93:521–525.
21. Robins D, Casagrande K, Barton M, et al. Validation of the modified checklist for autism in toddlers, revised with follow-up (M-CHAT-R/F). *Pediatrics*. 2014;133:37–45.
22. Robins DL, Fein D, Barton ML, et al. The modified checklist for autism in toddlers: an initial study investigating the early detection of autism and pervasive developmental disorders. *J Autism Dev Disord.* 2001;31:131–144.
23. Robins DL. Screening for autism spectrum disorders in primary care settings. *Autism*. 2008;12:537–556.
24. Glascoe FP, Macias MM, Wegner LM, et al. Can a broadband developmental-behavioral screening test identify children likely to have autism spectrum disorder? *Clin Pediatrics.* 2007;46:801–805.
25. Wiggins L, Piazza V, Robins D. Comparison of a broad-based screen versus disorder-specific screen in detecting young children with an autism spectrum disorder. *Autism*. 2014;18:76–84.
26. Squires J, Bricker D, Potter L. *Ages & Stages Questionnaires, Third Edition (ASQ-3) User's Guide*. Baltimore, MD: Paul H. Brookes Publishing; 2009.
27. Sparrow SS, Cicchetti DV, Balla DA. *Vineland-II: Vineland Adaptive Behavior Scales, Second Edition, Survey Forms Manual*. Circle Pines, MN: AGS Publishing; 2005.
28. Lord C, Rutter M, DiLavore P, et al. *ADOS-2: Autism Diagnostic Observation Schedule*. Los Angeles, CA: Western Psychological Services; 2012.
29. Mullen EM. *Mullen Scales of Early Learning: AGS Edition*. Circle Pines, MN: American Guidance Service; 1995.
30. Briggs RD, Stettler EM, Silver EJ, et al. Social-emotional screening for infants and toddlers in primary care. *Pediatrics*. 2012;129:1–8.
31. Squires J, Bricker D, Twombly E. *The ASQ: SE User's Guide: For the Ages & Stages Questionnaires: Social-emotional*. Baltimore, MD: Paul H Brookes Publishing; 2002.
32. Chlebowski C, Robins DL, Barton M, et al. Large-scale use of the modified checklist for autism in low-risk toddlers. *Pediatrics*. 2013; 131:1121–1127.
33. Miller JS, Gabrielsen T, Villalobos M, et al. The each child study: systematic screening for autism spectrum disorders in a pediatric setting. *Pediatrics*. 2011;127:866–871.
34. Windham GC, Smith KS, Rosen N, et al. Autism and developmental screening in a public, primary care setting primarily serving hispanics: Challenges and results. *J Autism Dev Disord.* 2014;44: 1621–1632.
35. Canal-Bedia R, Garcia-Primo P, Martin-Cilleros MV, et al. Modified checklist for autism in toddlers: cross-cultural adaptation and validation in Spain. *J Autism Dev Disord.* 2011;41:1342–1351.

Copyright © 2015 Wolters Kluwer Health, Inc. All rights reserved.

Copyright © 2015 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.