Review of Autism Screening Tests

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Abstract:

Introduction: Autism is a neurodevelopmental disorder that onset in the first 3 years of life and led to lifelong disability. Despite the early onset of symptoms, diagnosis of this syndrome does not happen until several years later, some any children lose the opportunity for early intervention. There are various tools for screening and diagnosis, but their design, strengths and weaknesses are different. The aim of this study is assess these tools from various aspects to provide a comprehensive view.

Materials and Methods: This study is a narrative literature review on screening tools of autism. Comprehensive searches of the scientific literature were conducted in textbooks and 8 electronic databases (Proquest, Wiley, Google scholar, SID, Scopus, Web of Science, Science Direct, and Medline) and Pediatric book. Language restriction (Persian and English) was applied. The search strategy consisted of keywords and medical subject headings for autism and various screening tests.

Results: In this study, 28 screening tests were identified from 1992 to 2014. CHAT is oldest test and the most recent test is Childhood autism screening test (CAST) the minimum age that can perform the screening is six months that related to Infant toddler checklist (ITC). Minimum time of testing was 5 minutes for Checklist for autism in toddlers (CHAT) and the maximum time was 90-120 minutes for Autism screening instrument for educational planning - Third edition (ASIEP-3). Ritvo autism asperger diagnostic scale-revised (RAADS-R) test was the highest specificity and specificity (100%) and the lowest specificity was 14% in Early screening of autistic traits (ESAT) test.

Conclusion: The results of this study indicate that any of the autism screening tools consider specific skill and various aspects of the disease, careful evaluation is need to choose proper test.

Keywords: Autism, Child, Pervasive developmental disorder, Screening test.

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The causes of this increase includes: increase number of true diagnose, changing diagnostic criteria, different methods of ascertainment, and use of screening tests (3).

Studies have shown that autism is three to four times more common among boys than girls (Fombonne, 2005). Autism has various symptoms raised from neurobiological malfunction of brain, but three symptom. The Diagnostic and statistical manual of mental disorders 4th Ed. (DSM-IV-TR) category of pervasive developmental disorders included autistic disorder, Rett’s disorder, Asperger’s disorder, childhood disintegrative disorder, and pervasive Developmental disorder not otherwise specified (PDD-NOS) (2). There is variability in the age at which children may present the features essential for this diagnosis. Its onset is before three years old. Despite the early onset of symptoms, often diagnose of this syndrome does not happen until several years later. Often Parents of autistic children mention the child's symptoms at 12-18 months of age but the diagnosis is usually delayed until 4 years old or later (13). So, many children lose the opportunity for early intervention. Standardized observations, parent inter views, and thee valuation by professionals, are reliable diagnostic tools on the autism spectrum. A big factor that led to delay in diagnosis is professional who performs a preliminary investigation without enough training and criteria for diagnose of autistic children. There are different tools for screening and diagnosis, but the design, strengths and weaknesses are different. Autism diagnostic observation schedule-generic (ADOS-G) is the gold standard in the diagnosis of autism. But it is expensive test and need long time and specialists. Behavioral checklist that completed with parent are often the only standard tools for screening (14). Standardized screening test for general developmental problems recommended at the 9, 18 and 24 or 30 months old. Use of standard tools for screening in primary care surveillance is a
effectiveness way to decline in complications caused by delayed diagnosis (13-15). Today, there is considerable attention to screening tools and various tools made for screening that each of them has its own advantage sand problems (16). Nevertheless, 22% of pediatricians use of these tools (17). The screening tools must contain 4 characteristics: Sensitivity, Specificity, Positive predictive value (PPV), and Negative predictive value (NPV). But most of researchers focused on sensitivity and specificity. Sensitivity and specificity of tools should be high. According to increased prevalence of autism, health care providers have to focus on symptoms of autism and need ability to detect early diagnose to reduce the effects of delay in treatment (3). To our knowledge any study is available about comparing between advantages and weaknesses of different screening tools, so aim of this study is investigated these tools from various aspects to provide a comprehensive.

Materials and Methods

Over the past 15 years, there has been increasing documentation of the early signs of autism spectrum disorders through both individual retrospective parental reports and screening studies. This study is a narrative literature review. Comprehensive searches of the scientific literature were conducted in 8 electronic databases (Proquest, Wiley, Google scholar, SID, Scopus, Web of Science, Science Direct, Medline and Pediatric books). Language restriction was applied. The search strategy consisted of keywords and medical subject headings for autism and various screening tests. In addition, manual searches of the reference lists and searches of personal collections were conducted to identify additional citations.

Study selection

The authors defined a search strategy to identify studies for inclusion. In addition, the inclusion criteria of the reviews must have addressed Screening tests which uses for identification the following ASD conditions: autistic disorder, Asperger syndrome, atypical autism, high-functioning autism, and suspected but not yet diagnosed autism.

The studies identified in the search were initially screened for relevance by one reviewer on the basis of their titles and abstracts, using broad criteria that were intended to be overly inclusive. Subsequently, two reviewers independently assessed the full text of potentially relevant studies and selected the studies using a standard form that outlined the eligibility criteria. Disagreements were resolved by consensus.

Results

In this study, 28 screening tests were identified from 1992 to 2014. Checklist for autism in toddlers (CHAT) is the Oldest test and the most recent test is Childhood autism screening test (CAST), which were built 1992 and 2014. The maximum number of items were (113 items) in Child behavior checklist (CBCL) screening test and the minimum number of test items were in contrast and the rest of the interview and observation. According to these tests, the minimum age that can perform the screening is six months that related to Infant toddler checklist (ITC). The highest age are The Ritvo autism asperger diagnostic scale-revised (RAADS-R) and Autism-spectrum quotient (AQ), that the are used for more than 18 years.

Test duration was varied. Minimum time of 5 minutes for Checklist for autism in toddlers (CHAT) and the maximum time 90-120 minutes for Autism screening instrument for educational planning - Third edition (ASIEP-3).

In terms of sensitivity and specificity of the tests the highest sensitive is Childhood autism screening test (CAST) test with a sensitivity of 100% and the lowest sensitive is Movement assessment battery for children (M-ABC) test with a sensitivity of 41% . The highest specificity is the Ritvo autism asperger diagnostic scale-revised (RAADS-R) test with a specificity 100% and the lowest specificity is Early screening of autistic traits (ESAT) test with a14%. The findings are summarized in (Table1, at pp.322-325). Table 1: Sensitivity and specificity of Autism screening tests.
<table>
<thead>
<tr>
<th>Item</th>
<th>Reliability</th>
<th>Specificity</th>
<th>Validity</th>
<th>Sensitivit y</th>
<th>Time required</th>
<th>Method of Administration</th>
<th>Age</th>
<th>Author and year</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>0/8</td>
<td>0.98−1</td>
<td>0/81</td>
<td>0.18–0.38</td>
<td>5 Unclear</td>
<td>Parent questionnaire</td>
<td>18-24 months</td>
<td>United Kingdom (Baron-Cohen et al. 1992)</td>
<td>(CHAT) Checklist for autism in toddlers(18)</td>
</tr>
<tr>
<td>23</td>
<td>r = 0.990</td>
<td>0.99</td>
<td>*</td>
<td>0/95-0/97</td>
<td>5–10</td>
<td>Parent questionnaire</td>
<td>16-30 months</td>
<td>Robbins, Fein, Barton, &amp; Green, 2001</td>
<td>(M-HAT) Modified checklist for autism in toddlers (14,18,19)</td>
</tr>
<tr>
<td>25</td>
<td>0/85%</td>
<td>0.91</td>
<td>*</td>
<td>0.88</td>
<td>5-10</td>
<td>Parent report questionnaire</td>
<td>18-24 months</td>
<td>Allison C, Baron-Cohen S, Wheelwright S, Charman T, Richler J, Pasco G, Bryne C. 2008 (1)</td>
<td>(Q-CHAT) Quantitative checklist for autism in toddlers (14,18,20)</td>
</tr>
<tr>
<td>28</td>
<td>Pearson's $r = 0.933$</td>
<td>0.85</td>
<td>*</td>
<td>0.84</td>
<td>5–10</td>
<td>Parent questionnaire; Professional observation</td>
<td>16-30 months</td>
<td>Wong, 2004</td>
<td>(CHAT-23) Checklist for autism in toddlers-23 (14,18,21)</td>
</tr>
<tr>
<td>57</td>
<td>r = 0/89</td>
<td>92.6%</td>
<td>8/80</td>
<td>92.1%</td>
<td>10-20</td>
<td>Parent Or teacher questionnaire</td>
<td>3 to 14 YEAR</td>
<td>(Krug, Arick, &amp; Almond, 1993)</td>
<td>(AABC) Autism Behavior Checklist (14,22,23)</td>
</tr>
<tr>
<td>12</td>
<td>*</td>
<td>0.73</td>
<td>0/95</td>
<td>0.95</td>
<td>20</td>
<td>Interactive play-based Yields scores on four domains</td>
<td>24 - 36 months</td>
<td>Stone, Coonrod, &amp; Ousley, 2000</td>
<td>(STAT) Screening tool for autism in children aged 2 years (14,24)</td>
</tr>
<tr>
<td>*</td>
<td>0/86%</td>
<td>88%</td>
<td>*</td>
<td>41%</td>
<td>20-40</td>
<td>Checklist: Group or individual, 10 minutes</td>
<td>In three age 3–6, 7–10, &amp; 11–16 years</td>
<td>Henderson, Sugden, &amp; Barnett, 1992</td>
<td>(M_ABC) Movement Assessment Battery for Children(25)</td>
</tr>
<tr>
<td>14</td>
<td>*</td>
<td>0.14</td>
<td>*</td>
<td>0.88</td>
<td>10-15</td>
<td>parents/caregivers</td>
<td>16-30 months</td>
<td>Swinkels, Dietz, van Daalen, Kerkhof, vanEngeland, &amp; Buitelaar, 2006(3)</td>
<td>(ESAT) Early screening of autistic traits(26,27)</td>
</tr>
<tr>
<td>24</td>
<td>*</td>
<td>85%</td>
<td>*</td>
<td>89%</td>
<td>5–10</td>
<td>Parent questionnaire</td>
<td>6-24 months</td>
<td>Wetherby, A. Prizant, B 2001</td>
<td>(ITC) Infant toddler checklist(27)</td>
</tr>
<tr>
<td>63</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>15+min</td>
<td>Parent questionnaire</td>
<td>12 months</td>
<td>Baranek, Watson, Crais &amp; Reznick, 2003</td>
<td>(FYI) The First Year Inventory(28)</td>
</tr>
<tr>
<td>Test</td>
<td>Author(s)</td>
<td>Age</td>
<td>Validity</td>
<td>Reliability</td>
<td>Scoring</td>
<td>Description</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>-----------</td>
<td>-----</td>
<td>----------</td>
<td>-------------</td>
<td>---------</td>
<td>-------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCQ</td>
<td>Rutter et al.</td>
<td>4-18 years</td>
<td>95%</td>
<td>0.97</td>
<td></td>
<td>Social communication questionnaire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRS</td>
<td>Constantino &amp; Gruber</td>
<td>4-18 years</td>
<td>0.78</td>
<td>0.91</td>
<td></td>
<td>Social Responsiveness Scale</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SRS-2</td>
<td>Constantino</td>
<td>2.5 years through adulthood</td>
<td>0.85</td>
<td>0.97</td>
<td></td>
<td>Social Responsiveness Scale, Second Edition</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CAST</td>
<td>Sun et al.</td>
<td>4-11 years</td>
<td>97%</td>
<td>0.75</td>
<td></td>
<td>Childhood autism screening test</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASSQ</td>
<td>Ehlers et al.</td>
<td>6-17 years</td>
<td>0.91</td>
<td>0.77</td>
<td></td>
<td>Autism spectrum screening questionnaire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>AQ-Child</td>
<td>Auyeung et al.</td>
<td>4-9 years</td>
<td>95%</td>
<td>0.85</td>
<td></td>
<td>Autism Spectrum Quotient-Child Version</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PEDS</td>
<td>Ellsworth &amp; Vandermee</td>
<td>Birth to 9 years</td>
<td>81.3%</td>
<td>0.88</td>
<td></td>
<td>Parents Evaluation of Developmental Status</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The table includes various tests used for assessing social communication and related behaviors, with details on age ranges, validity, and reliability coefficients.
### Autism Screening Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Retest</th>
<th>Construct validity</th>
<th>Face validity</th>
<th>Questionnaire for parents</th>
<th>Age Range</th>
<th>Author(s)</th>
<th>Validity</th>
<th>Intraclass Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>test-retest</td>
<td>r=0.92</td>
<td>0.952</td>
<td>convergent validity</td>
<td>0.933</td>
<td>20</td>
<td>Questionnaire for parents</td>
<td>Over 18 yrs</td>
</tr>
<tr>
<td>50</td>
<td>test-retest</td>
<td>r=0.7</td>
<td>0.92</td>
<td>convergent validity</td>
<td>0.933</td>
<td>20</td>
<td>Questionnaire for parents</td>
<td>Over 18 yrs</td>
</tr>
<tr>
<td>50</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Parent/teacher caregiver questionnaire</td>
<td>5-18 yrs</td>
<td>Myles, et al., 2001</td>
<td>Asperger Syndrome Diagnostic Scale (ASDS)(37)</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>Parent Questionnaire</td>
<td>3-19 yrs</td>
<td>Garnett &amp; Attwood, 1995; Attwood &amp; Barnett, 1998</td>
<td>Australian Scale for Asperger Syndrome (ASAS) (37)</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>test-retest</td>
<td>r = .987</td>
<td>%92</td>
<td>Concurrent validity = 95.5</td>
<td>%90</td>
<td>self-report instrument</td>
<td>&gt;18 years</td>
<td>Ritvo, RA, Ritvo, ER, Guthrie, D, Ritvo, MJ, Hufnagel, DH, McMahon, W, Tonge, B, Mataix-Cols, D, Jassi, A, Attwood, T, Eloff, J (2011)</td>
</tr>
<tr>
<td>22</td>
<td>*</td>
<td>91%</td>
<td>92%</td>
<td>parents/caregivers questionnaire or an interview</td>
<td>12–24 months</td>
<td>(Reznick et al. 2007)</td>
<td>(PDDST-II) The Pervasive Developmental Disorders Screening Test—Second Edition(19)</td>
<td></td>
</tr>
<tr>
<td>47</td>
<td>yes</td>
<td>yes</td>
<td>R=0.8</td>
<td>professional educator or parent questionnaire</td>
<td>2-13 years</td>
<td>Krug, Arick, Almond, 2008</td>
<td>(ASIEP-3 autism screening Instrument for Educational Planning - Third Edition(39)</td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>intraclass correlation .97 - .99</td>
<td>0.69</td>
<td>Discriminative &amp; Concurrent Validity r = 0.53</td>
<td>0.86</td>
<td>5-10 min.</td>
<td>Checklist-Parent/primary caregiver report</td>
<td>4-18 years</td>
<td>Algorithm (Brereton, Tonge, Mackinnon, &amp; Einfeld, 2002)</td>
</tr>
</tbody>
</table>
Discussion

The purpose of this study was the evaluation and availability of the autism screening tests. The results show that none screening tools is not completely and better of hers. In this study, 28 screening tests were identified. In study of Ghorbani et al., 25 tests were reviewed of which 14 tests were related to screening and 11 tests were used for diagnosis (14).

In study of Meng-Chuan Lai, 13 screening tools find out and divided them into 3 sections including:
1-Screening tools for young children: Checklist for autism in toddlers (CHAT), 18 month, Early screening of autistic traits (ESAT), Modified checklist for autism in toddlers (M-CHAT), Infant toddler checklist (ITC), Quantitative checklist for autism in toddlers (Q-CHAT), Screening tool for autism in children aged 2 years (STAT).
2-Screening tool for autism in older children and adolescents: Social communication questionnaire (SCQ), Social responsiveness scale, first or second edition (SRS, SRS-2), Childhood autism screening test (CAST), Autism spectrum screening questionnaire (ASSQ), Autism spectrum quotient (AQ).
3-Screening: adults Autism spectrum quotient (AQ), the Ritvo autism asperger diagnostic scale-revised (RAADS-R) (41).

Handout in his article about screening for autism shows only 6 tools for autism, Checklist for autism in toddlers (CHAT), Modify checklist for autism in toddlers (M-CHAT), Screening tool for autism in children aged 2 years (STAT), Childhood autism screening test (CAST), the Pervasive developmental disorders screening test-second Edition (PDDS_II), Communication and symbolic behavior scales developmental profile (CSBS DP) (42).

In study of Marianne, only 8 screening scale for young children find out which include CHAT, M-CHAT, Checklist for autism in toddlers (CHAT 23), ESAT, Pervasive developmental disorders screening test-II (PDDST-II), First year inventory (FYI), Developmental checklist-early screen (DBC-ES) and ITC (15).
Study findings show that the majority of the questionnaires filled by parents. The reason is that parents have more information from children. This leads to faster and more accurate diagnosis. Early detection and intervention has an important role in reducing the negative effects of disorder. Based on these results, some tools for early and some are used for older ages. For example, the screening tool like CHAT used for ages 18-24 months (15). CHAT was the first to be made (Baron-Cohen S 1992)(21). According to the Bern study, after 7 years follow-up of 16235 children (mean age of 18/7months) reported that, 94 case of ASD were identified. But CHAT reported only 33 children, which is a rate 2/03 per 1000. As a result, CHAT has a specificity of 97.7%, but a sensitivity of 35.1% and a positive predictive value of 8.1%. Low sensitivity and high false-negative rate indicate that the CHAT is not valid screening tool at 18 months (43). Studies showed that combination screening tool such as M-CHAT and interview reduce false positives and avoid parent concern (32).

ITC is designed as a broadband screener for communication delays in 6-12 months old children. It is designed to measure the following 7 language predictors that have been identified: Emotion, use of eye gaze, communication, gestures, sounds, words, understanding of words, and use of objects. Wether and et al (2003) compared validity of the ITC to standardized testing on 232 children between 12–24 months old and half with delay language and half with typical development. Sensitivity was 87.4% and specificity was 75.2% using the bottom 10th percentile or 1.25 standard deviations below average risk (44-45).

In study Of Wether and et al. (2008) that to examine the validity of ITC in 5385 children 9-24 months showed, 56 of 60 children that diagnosed with ASD, had positive test in ITC (45). Results suggest that the ITC has high sensitivity and specificity (both 88.9%) for catching toddlers at risk for ASD and other developmental delays from a general pediatric sample. The ITC is a broadband screener, and therefore, a positive screen indicates that the child is at-risk for a communication delay but does not differentiate a child with ASD from a child with other developmental problems (45).

One of the most comprehensive screening tests is ESAT. It designed for 14-15 month old children, which has been studied in a population sample. The ESAT consists of fourteen parent report items, which include a variety of play skills, verbal and nonverbal communication, interest in others, emotional reaction, joint attention, social interaction, and eye contact (46). Distinction this test compared to other tests is broad domains are considers, as well as, it evaluate non–verbal aspects of autism. The majority of the tests were attention to the main aspects of the communication disorder. Over time, the tests were more specialized than before. In specialized tests are attention to detail, imagination, pretend play and social interaction. For example, CAST is one of the new tools for autism screening. CAST is designed for children 4 to 11 years old. It is a parent questionnaire designed to screen for Asperger syndrome and other social and communication disorders. The test consists of a 37-item yes/no parent questionnaire and cutoff at 15(47).

Screening autism tools for older children are different from younger children. Tools for older children concentrate mainly on social communication. Total area of this test are including social behavior, peer relationships, imaginative play (48-49). AQ test were designed to adult over 18 years, that attention to detail, imagination, communication (49).

Conclusion
The results of this study indicate that any of the autism screening tools consider specific skill and various aspects of the disease, careful evaluation is need to choose proper test. No way is treat these patients via drug therapy. The only treatment is early detection through screening test. Early detection is the goal of the World health organization (WHO). Early diagnosis of autism before age 2 is a global challenge.

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