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 inter vention. 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) also 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. Checklist for autism in toddlers (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 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.

Introduction

Autism or Autism spectrum disorder (ASD) is a neurodevelopmental disorder that begin in the first 3 years of life and led to lifelong disability, specially to communications with people and world around these patients (1). Autism was first described in 1943 by Kanner (2). Patients with autism have special medical , educational and social needs, and correct estimate of its prevalence in planning is important. Until the 1990s, autism estimate in prevalence was 4 to 5 persons per 10 000 people, but recently prevalence of all autism spectrum disorders increased (30-90 cases per 10 000). 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.are more common in autistic persons and so used for diagnose autism. These symptoms are including: (1) Difficulties in social interaction (nonverbal communication such as: lack of eye contact, facial expression and age-appropriate peer relationships); (2) Restricted, repetitive or stereotyped behaviors and activities (inflexible adherence to specific routines, pronounced preoccupation with one or more unusual and restricted interests); (3) Defects in language development and other communication skills (delays or lack of language acquisition, inability to initiate or maintain a conversation and lack of age appropriate play). Nevertheless, non- specific symptoms such as; abnormal sensory perception skills and experiences, motor awkwardness and insomnia the complex it y and diversity of autism symptoms, make difficult to identify the causes it (6). The etiology of autism is not well-known but studies revealed may be genetic susceptibility and environmental factors are involved. Genetic disorders include fragile X syndrome and tuberous sclerosis (1, 7). Environmental

causes divided into pre-natal (e.g. congenital rubella syndrome, teratogen exposure and pesticide exposure), peri-natal (e.g. associated with obstetric situations like low birth weight, abnormal gestation length and birth asphyxia) and post-natal factors (e.g. autoimmune disease, gut syndrome, viral infection, amygdala developmental failure, oxidative stress, vitamin D deficiency, mercury toxicity and the controversial Measles, mumps, and rubella (MMR) vaccine) (1,8-12). 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 characterizes: 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

Items	Relibility	Specificity	Validity	Sensitivity	Time required	Method of Administration	Age	Author and year	Name	
14	0/8	0.98–1	0/81	0.18–0.38	5 Unclear	Parent questionnaire Professional observation	18-24 months	United Kingdom (Baron-Cohen et al. 1992	(CHAT) Checklist for autism in toddlers(18)	1
23	r= 0.990	0.99	*	0/95-0/97	5–10	Parent questionnaire	16-30 months	Robbins, Fein, Barton, & Green, 2001	(M-HAT) Modified checklist for autism in toddlers (14,18,19)	2
25	0/85%	0.91	*	0.88	5-10	parent report questionnaire	18-24 months	Allison C, Baron-Cohen S, Wheelwright S, Charman T, Richler J, Pasco G, Brayne C. 2008 (1)	(Q-CHAT) Quantitative checklist for autism in toddlers (14,18,20)	3
28	Pearson's r = 0/933	.85	*	.84	5–10 5	Parent questionnaire; Professional observation	16-30 months	Wong,2004	(CHAT-23) Checklist for autism in toddlers-23(14,18,21)	4
57	r-.0/89	92.6%	8/80	92.1%	10-20	Parent Or teacher questionnaire	3 to 14 YEAR	(Krug, Arick, & Almond, 1993)	(Abc) Autism Behavior Checklist (14,22,23)	5
12	*	0.73	0/95	0.95	20	Interactive play-based Yields scores on four domains	24 - 36 months	Stone, Coonrod, & Ousley, 2000	(STAT) Screening tool for autism in children aged 2 years (14,24)	6
*	0/86%	88%	*	41%	20-40 Checklist: Group or individual, 10 minutes	therapists, teachers and nurses	In three age 3–6,7–10,& 11–16 years	Henderson,Sugden,& Barnett,1992	(M_ABC) MovementAssessment Batteryn for Children(25)	7
14	*	0.14	*	0.88	10-15	parents/caregivers	16-30 months	Swinkels, Dietz, van Daalen, Kerkhof, vanEngeland,& Buitelaar, 2006)(3)	(ESAT) Early screening of autistic traits(26,27)	8
24	*	85%	*	89%	5–10	Parent questionnaire	6-24 months	Wetherby,A. Prizant, B 2001	(ITC) Infant toddler checklist(27)	9
63	*	*	*	*	15+min	Parent questionnaire	12 months	Baranek, Watson, Crais & Reznick, 2003	(FYI) The First Year Inventory(28)	10

40	test–retest r = 0/9	58%, for 2-3 years 62%, for 3-5 years	%31-%71	93% for 2-3 years 100% for 3-5 years	10	parent or other caregiver	>4 years (and mental age >2 years)	Rutter, Bailey, Lord, & Berument, 2003	(SCQ) Social communication questionnaire (14,27,29,30)	11
65	Cronbach's α coefficients= 0.91 - 0.97	0.57-0/67	Construct &convergent & Concurrent validity	0.78-0.85	15–20	parents/caregivers or teachers who are familiar	4-18 years	Constantino & Gruber , 2005	(SRS) Social Responsiveness Scale(14,27,31)	12
65	Teacher and father = 0.75; Mother = 0.91	*	Pearson's coefficient correlation: SRS and ADI-R or DSM criteria = 0.7	It is a valid	15–20	2.5to18(completed by parent or teacher 19 and up(completed by a relative or friend Adult Self)	2.5 years through adulthood	Constantino, J. M. 2012	(SRS-2) Social Responsiveness Scale, Second Edition(31)	13
37	Spearman's rho =0.67	97%	predictive criterion validity = 50%	100 %	*	Parent Questionnaire	4-11 years	Sun XA, C. Auyeung, B 2014	(CAST) Childhood autism screening test(27)	14
27	For Parent=0/96 teachers :0/94	0/86	for parent Ruter :0.75 Ruter :0.77	0.91	10	parents or teachers	6 -17 years	Ehlers, Gillberg, & Wing 1999 (8)	(ASSQ) Autism spectrum screening questionnaire (32)	15
50	Test-retest r=0. 85 Cronbach's alpha coefficient = 0.97	95%	Discriminative validity	95%	20	parent report questionnaire	4-9 years	Auyeung, Baron-Cohen, Wheelwright, & Allison (2008)	(AQ-Child) Autism Spectrum Quotient-Child Version(33,34)	16
10	T-retest = .88	81.3%	.60 - .86	83.9%	5 minutes for parents, 2 minutes for providers	Questionnaire And interview	Birth to 9 years	Ellsworth, Vandermee 1996	(PEDS) Parents Evaluation of Developmental Status(35)	17

50	test-retest r=0.92		Construct validity Face validity		20	Questionnaire for parents	15-4-8-9 years	Baron-Cohen, Hoekstra, Knickmeyer, & Wheelwright, 2006	(AQ- Adolescent version) Autism-Spectrum Quotient - adolescent version(14,36)	18
50	r=0.7 α = /74	0/52	convergent validity	0/93	20	Questionnaire for parents	Over 18 yrs	Baron-Cohen, 2001(12)	(AQ) Autism-Spectrum Quotient(14,36)	19
50	*	*	*	*	10-15	Parent/teacher caregiver Questionnaire	5-18 yrs	Myles, et al., 2001	Asperger Syndrome Diagnostic Scale (ASDS)(37)	20
24	*	*	*	*	15-20	Parent Questionnaire	3-19 yrs	Garnett & Attwood, 1995; Attwood & Barnett, 1998)	Australian Scale for Asperger Syndrome (ASAS) (37)	21
80	test–retest r = .987	% 0/92	Concurrent validity = 95.5	% 0/90	----------------	self-report instrument	>18 years	Ritvo, RA. Ritvo, ER. Guthrie, D. Ritvo, MJ. Hufnagel, DH. McMahon, W. Tonge, B. Mataix-Cols, D. Jassi, A. Attwood, T. Eloff, J (2011	(RAADS-R) The Ritvo autism Asperger diagnostic scale-revised(27,38)	22
22	*	91 %	*	92%	10–20	parents/caregivers questionnaire or an interview	12–24 months	(Reznick et al. 2007	(PDDST-II) The Pervasive Developmental Disorders Screening Test-Second Edition(19)	23
47	yes	yes	R=0/8	Content validity= 0/81	variable	professional educator or parent questionnaire	2-13 years	Krug, Arick, Almond, 2008)	(ASIEP-3 autism screening Instrument for Educational Planning - Third Edition(39)	24
29	intraclass correlation .97 - .99	0.69	Discriminative & Concurrent Validity r = 0.53	0.86	5-10 min.	Checklist-Parent/primary caregiver report	4-18 years	Algorithm (Brereton, Tonge, Mackinnon, & Einfeld, 2002	(DBC-ASA) Devalopmental Behavior Checklist-DBC Autism creening Algorithm (40)	25

24	α coefficients = 0/92	0.84	*	0.78	5 to 10	Checklist For caregiver	9 - 24 months	Wetherby and Prizant (2001)	(CSBS DP) Communication and Symbolic Behavior Scales Developmental Profile (14,19)	26
17	interclass Correlation = 0.77	0.48	Social (r= 0/47 Verbal Communication (r = 0.36) NonVerbal Communication (r = 0.37) Restricted &Repetitive (r = 0.53	0.83	5–10 min	Parent/Primary caregiver report	18-48 months	Gray & Tonge, 2005	(DBC-ES) DEVELOPMENTAL CHECKLIST-EARLY SCREEN(40)	27
118	*	82.2 % - 92.5 %	*	75.3 % to 92%	15	Checklist should be completed by a caregiver	6-18 years	Achenbach 1991	(CBCL) Child Behavior Checklist(41)	28

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 out 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), adult version, 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 0f 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 We ther 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- 48). 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 (49). 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(50).

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 (51-52). AQ test were designed to adult over 18 years, that attention to detail, imagination, communication (51).

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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