



Psychometric properties of Autism Spectrum Disorders Screening Assessment Tools: Systematic Review

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Abstract

Background: Due to the prevalence of autism spectrum disorder (ASD), these children must be screened as soon as possible and receive the necessary and appropriate treatment. The purpose of this study was to examine all the ASD screening tools and examine their psychometric properties in available languages.

Methods: This was a systematic review using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines to review the articles published between 2000 and 2023 and were published in PubMed, EMBASE, ProQuest, and Scopus databases. English keywords were as follows: autism spectrum disorders (ASD), screening/screen, tools, psychometric properties, validity, reliability, translations, pervasive developmental disorders (PDD), and children. The Consensus-based Standards for the selection of health Measurement Instruments (COSMIN) checklist were used to investigate the psychometric properties of the studies.

Results: Among the 476 primary studies, 35 ASD screening tools (132 articles related to the psychometric properties of 35 ASD screening tools in different languages) were identified based on our criteria, and their psychometric properties were examined. Various tools, including performance-based, direct observation, interactive play, and parent and teacher reports tools, were included in the list of tools.

Conclusion: Considering that each of these tools has advantages and limitations, they need to be selected and used according to the goals of the researchers and the therapists. Another important point is that many of these tools still need more extensive studies in relation to their psychometric properties.

Keywords: Autism Spectrum Disorder, Validity, Reliability, Review; Screening

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Introduction

Autism Spectrum Disorder (ASD) is one of the developmental disorders in which the presence of challenges in social skills, language, and speech development is one of their

prominent features. The etiology of ASD is unknown, genetics, infection, and metabolic factors are effective in the formation of this disorder. These disorders occur in all

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↑What is “already known” in this topic:

Assessment tools for screening autism spectrum disorder (ASD) are very important. These assessment tools are developed in special contexts and communities. Given the increase in the number of the ASD population, it is important that these children be screened as soon as possible and receive the necessary and appropriate treatment.

→What this article adds:

This article introduces 35 tools for screening ASDs. In the present study, each of these 35 tools has different characteristics in the age of the target group, and they have been translated into different languages. There is still a need for more extensive studies in the field of psychometric properties of tools. It is hoped that different tools will be translated into different languages worldwide so that therapists and researchers can use them in research and clinical studies.

ances, ethnic, and socioeconomic groups (1). The prevalence of ASD is still not clear, but the World Health has estimated its prevalence as 1 in every 160 children worldwide. However, this prevalence varies from country to country, 3.13% in Iceland, 1.7% in the United States, 1.14% in Qatar, and 0.06% in Iran (1). The symptoms of this disorder appear early in life and around 30 months of age, and in fact, families report the initial onset of symptoms at 16 to 20 months of age (2).

Diagnosing ASD is a long-term and multistep process that includes examining the child's behaviors. It is possible to diagnose and screen these disorders by using different tools (1). Although ASD can be diagnosed before the age of 3, many children are not diagnosed until the age of 5, and this delay in diagnosis has a wide impact on the health of society (3).

ASD screening tools refer to tools that help in the early diagnosis of the disorder, and this early diagnosis leads to the provision of timely and more appropriate treatment services (4). These tools are different in terms of cost-effectiveness, execution time, execution format (observational, report or executive), and psychometric features (2). The tools used in each country should be checked and adapted in terms of language, translation, and cultural adaptations. Children who receive a positive score in the screening tests, will refer to more specialized centers for further evaluations as well as early and appropriate treatment (1). Sobieski et al (2022) stated that the use of standard tools leads to timely diagnosis and reduces the consequences of delayed diagnosis (1).

There are many factors influencing the formation of ASD screening tools, including the number of items, areas to be investigated, age, method of implementation, duration of implementation, scoring method, fluent translation, cultural and social compatibility, psychometric characteristics, and

the availability of the desired tool (5). Nowadays, much attention is paid to ASD screening tools and their characteristics, each of which with advantages and disadvantages (1, 5). The aim of this study was to investigate the psychometric properties of ASD screening tools in various languages in order for researchers and therapists to choose appropriate tools and use them in accordance with their diagnostic and treatment objectives. This was done in light of the fact that the availability of tools in the country of use, cultural compatibility, and psychometric properties, including validity and reliability, have a significant impact on the use of screening tools.

Methods

Search Strategy

We used the systematic evidence-based review process and followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) reporting guidelines for systematic review studies (6).

To collect information, 2 researchers (2 occupational therapists who have experience in working with children with ASD) searched different articles in PubMed, Scopus, ProQuest, and EMBASE according to keywords.

Search Terms

The English keywords used individually or in combination using Boolean operators such as AND, OR (according to the MeSH) were as follows: autism spectrum disorders (ASD), screening/screen, tools, psychometric properties, validity, reliability, translations, pervasive developmental disorders (PDD), children, and adolescent. The search strategy of databases is seen in Table 1.

Study Selection and Data Extraction

The search was conducted between March 21, 2023, and

Table 1. Search strategy of different databases

Database	Search Strategy
PubMed	(exp Autism Spectrum Disorders (ASD)) AND (exp Children OR exp ASSESSMENT) (exp Autism Spectrum Disorders (ASD)) AND (exp Children, OR ASSESSMENT)1 (exp CHILDREN) AND (exp Autism Spectrum Disorders (ASD)) (1 AND 2) OR (1 AND 3) – limited to human, and English and no limitation in year. (inclusive)
ProQuest	(exp Autism Spectrum Disorders (ASD)) AND (exp Children OR exp Adolescent OR exp Assessment OR exp tools OR exp Child OR exp Autism Spectrum Disorders (ASD)) (exp Children OR exp Autism Spectrum Disorders (ASD)) AND (exp Children OR exp Child) (exp Children OR exp Child) AND (exp "Autism Spectrum Disorders (ASD)") (1 AND 2) OR (1 AND 3) – limited to human, and English and no limitation in year. (inclusive)
Scopus	(exp CHILDREN) AND(exp AUTISM SPECTRUM DISORDERS OR exp ASD OR exp ASSESSMENT) (exp ASD) AND (exp ASSESSMENT, AUTISM SPECTRUM DISORDERS OR exp ASD OR exp ASSESSMENT TOOLS) (exp ADOLESCENCE) AND (exp AUTISM SPECTRUM DISORDERS) (1 AND 2) OR (1 AND 3) – limited to research and no limited in years (Inclusive)
Embase	('CHILDREN/exp OR ADOLESCENCE OR (CHILD AND (ASD/exp OR ADOLESCENCE))) AND (ASD)/exp OR AUTISM SPECTRUM DISORDERS (ASD)) AND (ASSESSMENT) (CHILD/exp OR ADOLESCENCE) AND ('occupational therapy'/exp OR 'occupational therapy' OR (occupational AND ('therapy'/exp OR therapy))) AND (ASSESSMENT) (Autism Spectrum Disorders (ASD)/exp OR 'ELDERS' OR (children AND (ADOLESCENCE /exp OR CHILD))) AND (ASD/exp OR , AUTISM SPECTRUM DISORDERS) AND (ASSESSMENT) ('Autism Spectrum Disorders (ASD)/exp OR ' Autism Spectrum Disorders (ASD)) AND ('children /exp OR 'child OR (pediatric AND (ASD/exp OR children with ASD))) AND (assessment) (1 AND 2) OR (1 AND 3) – limited to research and no limited in years.

May 22, 2023. All selected articles were reviewed independently and separately by 2 researchers based on the inclusion and exclusion criteria. Disagreements between researchers were resolved by consensus. If no consensus was reached, the final decision was made independently by a third researcher.

Inclusion and Exclusion Criteria

Any research study on any subject related to ASD screening instruments that was published in the English language from 2000 to 2023 and was published in a peer-reviewed publication was included in this study. Studies and presentations that focused on people with primary diagnoses other than ASD have been excluded from this study.

Results

Included Articles

The first author and second independent researcher found

476 articles. They screened the articles again, and after removing duplicate articles and grey literature (unpublished theses, conference proceedings, government reports, unpublished data, and more), 161 articles remained. These articles were once again reviewed based on the eligibility criteria. Articles were excluded if their patients had primary diagnoses other than ASD ($n = 3$), the complete text was unavailable ($n = 4$), they were written in a language other than English ($n = 10$), and they were first published before 2000 ($n = 12$). The 35 ASD screening assessment tools (132 articles relating to the psychometric properties of 35 ASD screening tools in different languages) evaluated and screened ASD in accordance with our criteria, and their psychometric characteristics were examined in translated languages and deemed eligible by both authors. (Agreement rate, 93%) (Figure 1).

The Measurement Properties

The COnsensus-based Standards for the selection of

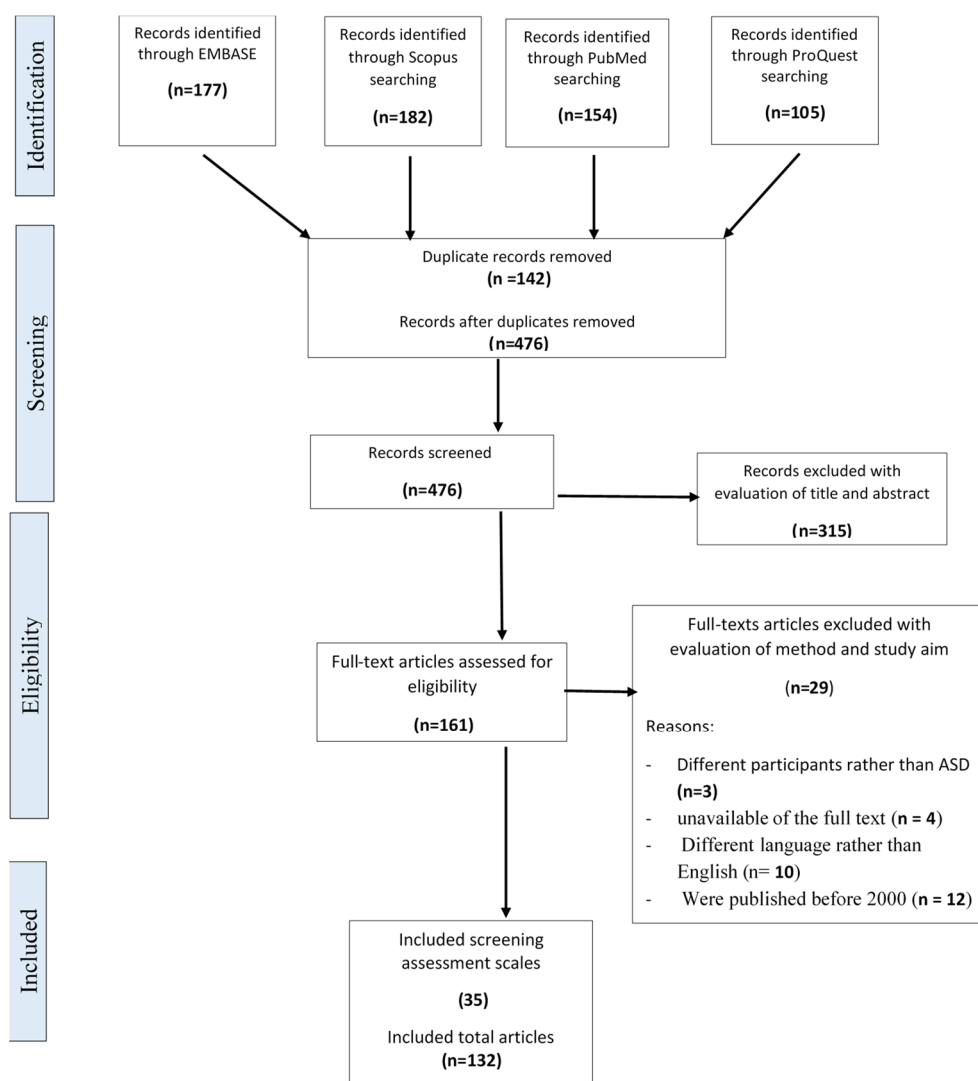


Figure 1. PRISMA flow chart of the study selection process

health Measurement Instruments (COSMIN) checklist is a tool developed to assess the methodological quality of single studies on measurement properties (7). In this study, the measurement properties are divided into 2 domains: reliability and validity. With respect to the psychometric properties proposed by Terwee et al (8), each issue was rated as positive “+” (adequate description), negative “-” (description), indeterminate “?” (Doubtful), or absent “0” (no information).

In this study, we examined the ASD tools in terms of all psychometric qualities, including accessible translations, types of validity, types of reliability, and responsiveness, from an early age through older age.

1. The First Year Inventory (FYI)

This tool was developed by Baranek et al (2003) and screens children under 12 months. It includes 63 items in 2 areas: social communication and sensory-regulatory functions that are completed by parents for 15 minutes. Also, 46 items are scored on a 4-point Likert scale, ranging from 1 (never) to 4 (often); 14 items are multiple choice questions; 1 item inquire regarding early language sounds. Higher scores indicate greater risk for a later diagnosis of ASD. The original language is American English and has been translated into Hebrew, Italian, Chinese, and Spanish (6).

2. Infant Behavioral Summarized Evaluation (IBSE)

This tool was developed by Barthelemy et al (1990) and screens children aged 6 to 48 months. It has 33 items in 6 domains: Socialization, Communication, and Adaptation to environmental situations, Motility, Emotional and instinctual reactions, and Attention-perception. It is completed by direct observation of the child by clinicians and communication with the child and using videotapes. Each videotape lasted for roughly 20 minutes, and each item was scored from 0 to 4—with 0 denoting that the disorder is never noticed, 1 denoting that it occurs occasionally, 2, often, 3, very often, and 4, denoting that it is continuously observed and only available in French (1).

3. The Autism Diagnostic Observation Schedule (ADOS)/ the Autism Diagnostic Observation Schedule—Second Edition (ADOS-2)

This tool was developed by Lord, C et al in 2001 (ADOS) and 2012 (ADOS-2) to screen children aged 12 to 30 months. The ADOS consists of 4 modules based on age and language level. Domains include communication, social interaction, play or imagination, and stereotyped behaviors and restricted interests. Modules are completed by semi-structured observation in 30 to 60 minutes. Ratings are made on an ordinal scale from 0 to 3, with 0 indicating no evidence of abnormality related to autism and 3 indicating definite evidence. This tool is available in Portuguese, Chinese, Swedish, and Dutch languages and the original language is American English. The ADOS-2 consists of 5 modules. It is completed as standardized behavior observation and coding and an interview with the individual in 40 to 60 minutes. Behavioral and language indicators noted during the assessment inform specific coded items for each module. The original language is American English and is

available in Czech, Danish, Dutch, Finnish, French, German, Italian, Norwegian, & Swedish languages (4, 5).

4. Checklist for Autism in Toddlers (CHAT)/ Modified Checklist for Autism in Toddlers (M-CHAT)/ Quantitative Checklist for Autism in Toddlers (Q-CHAT)

The CHAT was developed by Baron Cohen et al (1992), the M-CHAT by Robbins et al (2001), and the Q-CHAT by Allison et al (2008) to screen children aged 18 to 24 months, 16 to 30 months, and 18 to 24 months, respectively. The CHAT has 9 questions in section A filled by the parent and 5 questions in section B filled by direct observation. The chance of developing autism is high if the child fails all 5 of the key items, medium if only 2 of the key items fail, and low if none of the aforementioned conditions apply. The M-CHAT has 23 yes/no questions that evaluates sensory abnormalities, motor abnormalities, social interaction, early joint attention, playing ability, early language, and communication abilities. The Q-CHAT has 25 questions rated on a 5-point Likert scale that evaluate 5 areas: joint attention, pointing, pretend play, language development, repetitive behaviors, and other aspects of social communication and total score ranging from 0 to 100, with higher rates indicating more autistic traits. All completed by parents for 5 to 10 minutes (1, 4, and 5). The CHAT is available in Arabic, French, Deutsch, Estonian, Latvian, Romanian, Spanish, Persian, and Swedish languages. Its reliability in Iran was reported by Ebrahimi et al (2017), with a Cronbach alpha of 0.88 (9). The M-CHAT is available in Arabic, Chinese, Czech, Dutch, French, French Canadian, German, Greek, Gujarati, Icelandic, Italian, Japanese, Kannada, Korean, Kurdish, Malay, Portuguese, Russian, Sinhala, Somalian, Spanish, Swedish, Tamil, Turkish, Vietnamese, Urdu, and Persian languages. In Iran, Samadi et al (2015) reported its sensitivity to be 90.3% (10). The Q-CHAT is also available in Arabic, Chinese, French, Dutch, Spanish, Hebrew, Italian, Polish, Portuguese, Romanian, Serbian, Slovenian, Swedish, Turkish, Korean, and Persian languages, and its reliability in Iran was reported by Mohammadian et al (2015), with a Cronbach alpha of 0.886 (11).

5. Early Screening of Autistic Traits (ESAT)

This tool was developed by Swinkels et al (2006) to screen 16 to 30 months children. It includes 14 yes/no items in 8 areas—pretend play, joint attention, interest in others, eye contact, verbal and nonverbal communication, stereotyped response to sensory stimuli, emotional response, and social interaction that are completed by parents for 10 to 15 minutes. A higher score indicates a higher risk of disorder. The original language is Dutch and has been translated into Persian, Indian, and Polish (4). Its reliability in Iran has been reported by Vakilzadeh et al (2017, with a Cronbach alpha of 0.76 (12).

6. Pervasive Developmental Disorders Screening Test Second Edition (PDDST-II)

This tool was developed by Reznick et al (2007) to screen 18 to 48 months children. It has 3 forms with yes/no responses that are completed by parents in 10 to 20 minutes.

The answers that are marked "yes, usually true" receive 1 point each, whereas the answers that are "no, usually not true" receive 0 points. The accumulated scores are compared to the cutoff score. A screen is positive or negative depending on whether the overall score is less than the cutoff score, equal to the cutoff score, or higher. English and Brazilian versions are available (1) and the Persian version is not available.

7. Developmental Behavior Checklist Early Screen (DBC-ES)

This was developed by Gray et al (2005) to screen children aged 18 to 48 months. It consists 17 items and is completed by parents for 5 to 10 minutes, it has a cutoff score of 11, with a higher score indicating a higher risk of disorder. Australian, American English, and Russian versions are available (1) and the Persian version is not available.

8. Chandigarh Autism Screening Instrument (CASI)

This tool was developed by Arun P et al (2016) to screen children aged 10 months to 1.5 years. It has 37 yes/no items, a cutoff score of ≥ 10 is considered a risk for autism and a higher score indicates a higher risk of disorder. Indian and English versions are available (4) and the Persian version is not available.

9. Screening Tool for Autism in Toddlers & Young Children (STAT)

This tool was developed by Stone et al (2000) to screen 24 to 36 months children. It has 12 items that assess behaviors in 4 social communicative domains, including play, movement imitation, request, and direct attention, which are completed as an active play for 20 minutes. The total score is derived by summing the 4 domain scores, and it can range from 0 to 4, with higher scores representing greater impairment. The original language is American English and is also available in Chinese and Taiwanese (1). The Persian version is not available.

10. Autism Diagnostic Interview-Revised (ADI-R)

This tool was developed by Rutter M et al (2003) for children over 24 months. The tool includes 93 items in social interaction, communication and language, and patterns of behavior that are completed by parents in 90 to 150 minutes, and it is calculated according to the cutoff score. The original language is English and it has also been translated in Danish, Dutch, Finnish, French, German, Hebrew, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian, Romanian, Russian, Spanish, and Swedish languages (5). The Persian version is not available.

11. Autism Screening Instrument for Educational Planning – Third Edition (ASIEP 3)

This tool was developed by Krug et al (2008) to screen children between 2 to 13 years. The instrument has a checklist in 5 different domains: behavior, communication, speech, education, and learning rate, which are completed by parents and in a performance-based manner for 90 to 120

minutes. It is calculated according to standard scores and percentile ranks. The American English and Turkish versions are available (4). The Persian version is not available.

12. Childhood Autism Rating Scale (CARS)/ Childhood Autism Rating Scale-Second Edition (CARS-2)

Chopler et al (1980) developed the CARS, and Chopler et al (2010) also developed the CARS-2 scale to screen children older than 2 years old. The CARS-2 has two 15-item rating scales completed by the clinician in 5 to 10 minutes. Both scales are completed by direct observation and rating is based on using a 4-point response scale. Raw scores are interpreted in terms of cutoff scores, standard scores, and percentiles, and the cutoff score is 28 (4). American English, Bulgarian & Italian, Japanese, Korean, and Danish versions are available. The Persian version is not available.

13. Symptom Checklist for Autism Spectrum Disorders (SCL-ASD)

This tool was developed by Döpfner et al (2008) to screen 2 to 18 years old children. It has 14 items in 3 domains: communication, social interaction, restricted, repetitive interests/behaviors and completed by parents. Items are rated with regard to their severity on a 4-point Likert-type scale, ranging from 0 ("not at all") to 3 ("very much"), with higher scores indicating higher symptom severity. The original language is German and there is no translation of this checklist in another language (4).

14. Autism Behavior Checklist (ABC)

This tool was developed by Krug et al (1993) to screen children aged 3 to 14 years. It has 57 questions in 5 areas: sensory, relating, body concept, language, and social & self-help. It is rated on a 4-point Likert scale and completed by parents in 10 to 20 minutes. Scores >70 indicated moderate to severe autism, 45 to 69 indicated mild autism, 20 to 44 indicated borderline autism, and scores <20 were normal. American English, Swedish, Persian, Indian, Chinese, Spanish, Italian, Arabic, Turkish, and Portuguese languages are available (2). In Iran, the reliability of the ABC has been reported by Yousefi et al (2015) with a Cronbach's alpha of 0.73 (13).

15. Gilliam Asperger's Disorder Scale (GADS)

This tool was developed by Gilliam et al (2001) to screen 3 to 22 year olds. It has 32 items and 4 subscales: Social Interaction, Restricted Patterns of Behavior, Cognitive Patterns, and Pragmatic Skills that are completed by parents in 5 to 10 minutes. American English, Dutch, Spanish, and Arabic languages are available (5). The Persian version is not available.

16. Australian Scale for Asperger Syndrome (ASAS)

This tool was developed by Garnett et al (1995) to screen 3 to 19 years old children. It includes 6 sections and 24 questions. These include social and emotional issues, communication skills, cognitive skills, specific interests, move-

ment skills, and a range of other characteristics such as sensory sensitivities, age of language development, and facial tics or twitches that are completed by parents and teachers in 15 to 20 minutes. Responses are scored on a Likert scale from 0 to 6, with 0 indicating rarely and 6 frequently. Higher scores indicate greater risk. American English, German, and Polish languages are available (5). The Persian version is not available.

17. Indian Scale for Assessment of Autism (ISAA)

This tool was developed by the Government of India (2009) to screen 3 to 9 years old children. It has 40 questions in 6 domains: Social Relationship and Reciprocity, Emotional Responsiveness, Speech-Language and Communication, Behavior Patterns, Sensory Aspects, and Cognitive Component, with a 5-point scoring system that are completed by parents and by observing the child in 1 to 20 minutes. It has a cutoff score of 70. Total ISAA scores range from 40 to 200. A score of <70 indicates no autism, 70 to 106 mild autism, 107 to 153 moderate autism, and >153 severe autism. There is no translation of this tool in another language rather than Indian (4).

18. The Indian Autism Screening Questionnaire (IASQ)

This tool was developed by Smita et al (2021) to screen 3 to 18 years old children with ASD. The IASQ has 10 yes/no items that are completed by observing and interviewing parents in 10 to 15 minutes. Indian and English versions are available (14). The Persian version is not available.

19. Gilliam Autism Rating Scale second edition (GARS-2) / Gilliam Autism Rating Scale third edition (GARS-3)

This tool was developed by Gilliam et al (2006) and the GARS-3 scale was also developed by Gilliam et al (2013) to screen 3 to 22 years and 2 to 22 years old children, respectively. The GARS-2 has 42 items across 3 subscales: Stereotyped Behaviors, Communication, and Social Interaction. The GARS-3 has 56 items grouped into 6 subscales: restrictive and repetitive behaviors, social interaction, social communication, emotional responses, cognitive style, and maladaptive speech. Both are completed by parents in 5 to 10 minutes. The GARS-2 has a mean value of 100 and a standard deviation of 10. A person's likelihood of having autism is indicated by a score of 90 or higher; a score below 70 suggests an individual's likelihood is lower; and a score in the middle shows that the risk status is unclear (2, 5). Administration of the GARS-3 provides standard scores, percentile ranks, severity level, and probability of autism. English, Chinese, Greek, Spanish, Persian, Arabic, and Turkish versions are available. The GARS-3 has also been translated into Arabic and Persian languages, but no information about the validity and reliability of these 2 scale has been reported in Iran.

20. Childhood Autism Screening Test (CAST)

This tool was developed by Sun et al (2014) to screen 4 to 11 years old children. It has 37 (yes/no scores 0/1) items in 3 domains: Social Interaction, Communication, Repeti-

tive and Stereotyped Behavior and Interests that are completed by parents. Also, 31 items can be scored. The total score ranges from 0 to 31. The higher score shows the higher probability of having more autistic features and the cutoff is 15. British, Chinese, Bulgarian, and Spanish languages are available (15). The Persian version is not available.

21. Developmental Behavior Checklist-DBC Autism Screening Algorithm (DBC ASA)

This tool was developed by Brereton et al (2001) to screen 4 to 18 years old children. It consisting 29 of the 96 items of the standard DBC that are completed by parents and caregivers in 5 to 10 minutes and it has a cutoff score of 17. Australian, Switzerland, and American English versions are available (1). The Persian version is not available.

22. Autism Spectrum Quotient-Child Version (AQ-CHILD)/ Autism Spectrum Quotient- adolescent Version (AQ-Adol)/ The Autism-Spectrum Quotient (AQ)

The AQ-CHILD was developed by Auyeung et al (2008), the AQ-Adol was developed by Baron-Cohen et al (2006), and the AQ was developed by Baron-Cohen et al (2001) for screening 4 to 11 years, 12 to 15 years old, and those over 16 years, respectively. All tools have 50 items in 5 areas: social skills, attention switching, and attention to detail, communication and imagination, except for the AQ, which is self-administered in 5 to 10 minutes. The other 2 tools are completed by parents in 20 minutes. In all 3 instruments, a higher score indicates a higher risk of disorders and the original language of these tools is English (1, 4, and 5). The AQ-CHILD tool has been translated into Arabic, Bengali, Chinese, Bulgarian, Spanish, Danish, German, French, Indian, Italian, Dutch, Persian, Polish, Slovenian, Swedish, Portuguese, and Turkish. In Iran, the reliability of this tool was reported by Ameli et al (2019), with a Cronbach alpha of 0.95 (16). The AQ-Adol tool has also been translated into Chinese. The AQ tool has been translated into Chinese, Bulgarian, Spanish, Danish, French, Italian, Dutch, Persian, Polish, Slovenian, Swedish, Portuguese, and Turkish. In Iran, the reliability of this tool has been reported by Ashuri et al (2020) with a Cronbach alpha of 0.62 (17).

23. Social Communication Questionnaire (SCQ)

This tool was developed by Rutter et al (2003) to screen children over 4 years old. The SCQ has 40 yes/no items in 4 domains: Social Interaction, Communication, Abnormal Language, and Stereotyped Behavior that are completed by parents and caregivers in 10 minutes. Scores above the cutoff of 15 suggest the individual is likely to be ASD. American English, Danish, Dutch, Finnish, German, Hebrew, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian, Romanian, Russian, Spanish, & Swedish versions are available (1). The Persian version is not available.

24. Asperger Syndrome Diagnostic Scale (ASDS)

This tool was developed by Myles et al (2001) to screen 5 to 18 years old children. The ASDS has 50 yes/no items in 5 areas, including cognition, incompatibility, language,

social communication, and sensorimotor skills that are completed by parents, caregivers, and teachers in 10 to 15 minutes. Scores are distributed with a mean of 100 and a standard deviation of 15. Scores of 70 to 79 are considered to be unlikely, 80 to 89 are possibly, 90 to 110 are considered to be likely, and 111 are considered to be highly likely. American English, Spanish and Korean versions are available (5). The Persian version was not available.

25. Autism Spectrum Screening Questionnaire (ASSQ)

This tool was developed by Ehlers et al (1999) to screen 6 to 17 years old children. The ASSQ has 27 items in 4 areas: social interaction, communication problems, restricted and repetitive behavior, and motor clumsiness that are completed by parents, caregivers, and teachers for 10 minutes. Items rated on a 3-point scale (0, 1, or 2; 0 indicating normality, 1 some abnormality, and 2 definite abnormality). The range of possible scores is 0 to 54. Swedish, Chinese, Finnish, Norwegian, and Japanese versions are available (4). The Persian version is not available.

26. The Marburg Rating Scale for Asperger's Syndrome (MBAS)

This tool was developed by Kamp-Becker et al (2005) to screen 6 to 24 years olds. This scale consists of 65 questions that address reciprocal social interaction, language and communication, and RRB that are completed by the parents and caregivers of the child or the adult/adolescent person himself. Each item is rated on a 5-point Likert scale, ranging from 0 ("never") to 5 ("always"), with higher scores indicating a higher risk of disorder. German, English, and Dutch versions are available (4). The Persian version is not available.

27. The Ritvo Autism Asperger Diagnostic Scale Revised (RAADS-R)

This tool was developed by Ritvo et al (2011) to screen individuals over 18 years old. It has 80 questions in 4 areas: social relatedness, circumscribed interests, language, and sensory motor that are rated on a 4-point Likert scale and completed as a self-report for 10 to 30 minutes. Its scoring range is from 0 to 240 and the cutoff is 65. Scores higher than 65 indicates you are likely autistic. The Swedish, English, French, and Russian versions are available (5). The Persian version is not available.

28. Diagnostic Interview for Social and Communication Disorders (DISCO)

This tool was developed by Wing L et al (1979) to screen children with ASD. This scale tool has 320 items semi-structured in 7 domains. It is completed by parents or interviews, and a higher score indicates a lower risk of disorder. English, Swedish, Dutch, and Irish versions are available (1). The Persian version is not available.

The results of the psychometric properties of the mentioned screening assessment tools are shown in Table 2.

Discussion

There are different screening tools for ASD, but choosing

the appropriate tool helps to implementing the appropriate treatment and saving time. The purpose of this study was to examine all ASD screening tools and their psychometric properties. Each of these tools has advantages and limitations that will be very helpful for professionals and therapists.

In 2022, Gharamaleki et al presented a narrative study regarding existing ASD screening tools. In this study, 19 ASD screening tools were examined, and their test, validity, reliability, and accuracy features have been briefly mentioned, but in their study, weaknesses related to information such as the developer, the number of items, the method of scoring, the main language of the tool were not presented (4). Another study in a narrative form was conducted by Soleimani et al (2018), which examined 28 ASD screening tools. This study omits information on the subscales, test scoring, availability of and translated languages, full validity and reliability information, and clinical application. (5).

In both mentioned studies, the number of mentioned tools is much less than what is actually available. In the present study, we carefully and completely examined 35 ASD screening tools at different ages from all over the world and comprehensive information on various test fields, including the target population of the tool, the age under investigation, the way of implementation and scoring, the duration of implementation, and the number of items. We reported the subscales and main language. In addition, the clinical use of the tools in different countries, the available and translated languages, and the psychometric properties, including the validity, reliability, and accuracy of the tools in each of these languages, were investigated comprehensively. As far as COSMIN is concerned, this study is a systematic review because it is the first to fully and comprehensively assess every ASD screening instrument. In more specific reviews, the instruments that have been translated in Iran and their psychometric properties have been examined, including (short version) CHAT, M-CHAT, Q-CHAT, ABC, ESAT, AQ-CHILD (short version), and AQ.

In the meantime, in the M-CHAT, only the sensitivity and specificity of the tool were discussed, and no information about its reliability and validity was mentioned. Among these instruments, The AQ-CHILD (short version) has the highest reliability according to Cronbach index (0.95) (16) and the ABC has the highest sensitivity (97%) and specificity (98%) in Iran (13).

Regarding the age of ASD screening tool among children and adolescents, there are tools for ASD screening for all ages. The tool with the lowest screening age is the FYI, which assesses children under 1 year of age and allows early diagnosis of the disorder (6). Tools such as SCQ, AQ, RAADS-R, ADOS, and CARS2, in addition to screening ASD at young ages, also have the ability to screen ASD at adolescent/adult ages. Most of these available tools in Iran are used for children, except for the AQ tool, which is the most used for the screening of adults over 16 years old (17).

Table 2. Psychometric properties of measures

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
CHAT	English	50 ASD and 44 with other PDD	+	0	0	0	0	0	0	0
	Persian	Parents/318	+	0	FA revealed 2-factors	Convergent with, PDDST-II	0	$\alpha = 0.88$	0	0
M-CHAT	American English	Children /480	+	0	0	0	0	$\alpha = 0.85$	0	0
	Arabic	5546 toddlers	+	0	0	Convergent validity=?	0	$\alpha = 0.92$	k= 0.78-0.97 ICC=0.97-0.99	0
	Chinese	Toddlers / 7928	+	0	0	0	ICC = 0.75	$\alpha = 0.57$	ICC = 0.85	0
	Albanian	Toddlers / 2594	+	0	0	0	0	$\alpha = 0.73$	0	0
	French	Children / 1250	+	0	0	0	0	0	0	0
	Iceland	Toddlers/1585	+	0	0	0	0	$\alpha = 0.70 (+)$	0	0
	Japanese	Toddlers and parents/?	+	-	correlated with the CARS-TV	Discriminant validity=?	k = .645-1.000	0	k= .417-1.000	0
	Indonesian	Toddlers and parents/ 110	+	0	0	0	0	0	0	0
	Mexican	Children/456	+	0	K = .17 -.61	Convergent Validity=? Discriminant=? Validity	0	for 23 items k=0 .76 for the 6 items k= 0.70	0	0
	Serbian	Children/148	+	0	0	Convergent validity=?	r= 0.80, p<0.001	$\alpha = 0.91$	0	0
	Korean	Children/2300	+	0	0	0	?	$\alpha = 0.90$	0	0
	South African	Participants/21	+	0	?	0	0	0	0	0
	Spanish	Children/11,710	+	0	0	?	0	$\alpha = 0.72$	0	0
	Taiwanese	Toddlers/317	+	0	0	Convergent with the CBCL	K = 0.47 - 1	$\alpha = 0.84$	0	0
	Turkish	Children/80	+	0	0	Discriminant validity: +	0	for the overall 23 items, $\alpha = .87$ and for the six items $\alpha = .85$	0	0
Persian	Children/16,210	+	0	0	0	0	0	0	0	

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
Q-CHAT	Spanish	Children/140	+	0	0	Discriminant validation=?	0	$\alpha = 0.77$	0	0
	Persian	Children/100	+	0	0	0	ICC=0.99	$\alpha = 0.88$	0	0
	Italian	Toddlers/2400	+	0	FA: ?	Convergent with ADOS 2 and divergent with the Griffiths LDQ	0	$\alpha = 0.68$	0	0
	Korean	Toddlers and preschooler/104	+	0	0	Convergent with CBCL, SCQ, and CARS	ICC= 0.836	$\alpha = 0.65$	0	0
	Polish	Participants/1024	+	0	0	0	0	$\alpha = 0.78$	0	0
	Singaporean	Participants/?	+	0	FA=?	Convergent with CBCL	ICC = .60-.64	$\alpha = 0.76$	0	0
	Serbian	Toddlers/220	+	0	0	Convergent with M-CHAT-R	0	$\alpha \geq .81$	0	0
ABC	English	Children/123	+	0	FA yielded 5 factors	0	0	0	0	0
	Chinese	Children/591	+	0	0	Convergent with CARS	0	$\alpha = 0.426$	0	0
	Indian	Children/?	+	0	0	0	0	0	0	0
	Arabic	Individuals/192	+	0	0	Discriminant validity=?	ICC=0.965	$\alpha = 0.834 - 0.808$	K= 0.96	0
	Persian	Parents/184 Children/184	+	0	item-total correlation ranged from 0.35 to 0.75	convergent with GARS, Discriminant Validity:+	ICC= 0.83	$\alpha = 0.73$	0	0
Portuguese	Mother of autistic children/133	+	0	Concurrent validity=?	0	0	0	0	0	
STAT	English	Children/104	+	0	0	Convergent with ADOS-G	k= 0.90	0	K=1.0	0
	Chinese	Children/154	+	0	0	Concurrent validity=?	0	0	0	0
ESAT	Dutch	Children/478	+	0	0	0	ICC=0.81	0	0	0
	Persian	Toddlers/72	+	CVR= 0.8-1 CVI: 0.91	0	convergent with (M-CHAT) and ESAT-PV Discriminant validity: +	ICC=0.92	$\alpha = 0.76$	0	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
FYI	English	Children/699	+	0	0	0	0	0	0	0
	Spanish	Caregivers/25	+	0	0	0	0	0	0	0
	Italian	Individuals/657	+	0	Convergent with Social-Communication and Sensory-Regulatory Functions	0	0	K= 0.91	0	0
	Hebrew	Parents/471	+	0	Convergent with social-communication and sensory-regulatory domains	Concurrent validity=?	0	$\alpha = 0.69$	0	0
	Chinese	Participants/541	+	0	0	0	0	0	0	0
SCQ	English	Individuals/2134	+	0	FA: (k = 20, $\alpha = .91$)	convergent with ADI-R	0	?	0	0
	Turkish	children and adolescents/100	+	0	FA=?	convergent with CARS	ICC= 0.87 - 0.96	$\alpha = 0.8$	0	0
	Polish	Participants/90	+	0	Convergent with SCQ items	?	0	0	0	0
	Greek	Children/130	+	0	FA confirmed all sub-scale	Discriminant validity: +	0	$\alpha = 0.91$	0	0
	Chinese	Participants/736	+	0	FA: GFI = 0.923	concurrent validity = +	ICC = 0.77-0.78	$\alpha = 0.73-0.91$	0	0
	Australian	Parents/81	+	0	0	0	0	0	0	0
	Arabic	Children/206	+	0	(+)	Discriminant validity: +	0	$\alpha = 0.92$	0	0
CAST	English	Children/1925	+	0	0	predictive validity:+	ICC = 0.67-0.83	0	0	0
	Spanish	Children/ 1496	+	0	FA: factors explained 39%	convergent validity with ADI-R	0	$\alpha = 0.82$	0	0
	Chinese	Children/737	+	0	FA: Confirmed 2 factor	0	0	0	0	0
	Bulgarian	Children/612	+	0	FA=?	0	0	0	0	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
ASSQ	Swedish	Children/110	+	0	0	Divergent validity=? Concurrent validity:+	ICC= 0.94	$\alpha = 0.86$	K= 0.66	0
	Norwegian	Children/9430	+	0	0	Discriminant validity:+	0	0	0	0
	Japanese	Children/1579	+	0	FA: CFA revealed 4-factor	0	0	0	0	0
	Finnish	Children/ 440/8	+	0	0	Discriminant validity:+	0	0	0	0
	Chinese	Children/?	+	0	0	0	0	0	0	0
AQ-CHILD	English (British)	Children/540	+	0	FA=? (+)	0	(+)	$\alpha = 0.97$	0	0
	Spanish	Children/4016	+	0	FA: confirmed five factors	0	0	$\alpha = ?$	0	0
	Swedish	Individuals/2939	+	0	0	Discriminant validity:+	r = 0.76	$\alpha = 0.71$	0	0
	Malay	Children/700	+	0	FA: KMO > 0.6	0	0	$\alpha = 0.82$	0	0
	Italy	Children/545	+	-	FA=?	0	Pearson r = 0.79(+)	$\alpha = 0.76$	0	0
	Persian (short version)	Children/254	+	-	FA: revealed 5 factors, KMO= 0.89	Divergent validity:+ convergent with anxiety and avoidant	0	$\alpha = 0.95$	0	0
	Dutch	Children/961	+	-	FA=?	0	r = 0.78	$\alpha = .81$	0	0
	Chinese	Children/?	+	-	0	0	r = 0.79-0.89	$\alpha = 0.81-0.80$	0	0
	Australian	Children/404	+	-	FA=?	Convergent with AQ-Child Discriminant validity:+		$\alpha = 0.75- 0.85$		
AQ-Adol	English	Adolescent/181	+	-	+	0	r=.92, p<.001	$\alpha = 0.79$	0	0
	Chinese	Participants/809	+	-	FA: KMO= 0.89	0	ICC= 0.93	$\alpha = 0.82$	0	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
AQ	English	Individuals/1005	+	-	FA: three-factor revealed	0	0	$\alpha = 0.67$	0	0
	Spanish	Students/129	+	-	0	Discriminant validity: +	0	?	0	0
	Swedish	Individuals/ 44,722	+	-	FA: yielded three factors	0	0	$\alpha = 0.85$	0	0
	Scottish	Students/ 536	+	-	four-factor revealed	0	0	$\alpha = 0.55-0.69$	0	0
	Polish	Participants/ 2939	+	-	0	+	$r = 0.76$	$\alpha = 0.71$	0	0
	Persian (short form)	Participants/560	+	-	FA: CFA= confirmed two factors	0	0	$\alpha = .62$	0	0
	Italian	Participants/ 545	+	-	0	0	$r = 0.79$	$\alpha = 0.76$	0	0
	French	Participants/123	+	-	0	Discriminant validity: +	0	$\alpha = 0.81$	0	0
	Dutch	Students/302	+	-	FA: +	0	$r = 0.79$	$\alpha = 0.71$	0	0
Chinese	Participants/809	+	-	FA: KMO = 0.89	0	ICC= 0.93	$\alpha = 0.82$	0	0	
ASDS	English	Children/115	+	0	0	Discriminant validity: +	0	$\alpha = 0.83$	k=0.93	0
ASAS	English	Children/60	+	-	FA=?	0	0	0	0	0
	Polish	Children/72	+	-	Convergent with BPRS-C/BPRS and CGI-S	0	0	$\alpha = 0.81$	0	0
RAADS-R	Swedish	Adults/272	+	-	0	Convergent with AQ	$r = 0.80, p = 0.002$	$\alpha = 0.92(+)$	0	0
	English	Children/779	+	-	FA: confirmed 4 factors	Convergent with Social	$r = 0.987$	$\alpha = ?$	0	0
	Russian (short version)	Participant/1724	+	-	inter-item correlation= 0.272	Convergent validity?	0	$\alpha = 0.839$	0	0
	French	Adults/305	+	-	FA=?	0	ICC = 0.97	$\alpha = 0.97$	0	0
(PD DST -II)	English	Individuals/977	+	-	0	0	0		0	0
(ASI EP3)	English	Children/?	+	+	0	0	ICC = 0.81	0	0	0
	Turkey	Students/126	+	-	FA=0	0	$r = .91-.98$	$\alpha = 0.87$	100%	0
GADS	English	Children/?	+	-	0	0	0	$\alpha = 0.58 - 0.71$	0	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
DBC ASA	Australia	Children/180	+	-	FA=0.70	0	0	$\alpha = 0.94$	0	0
	English	Participants/98	+	-	0	convergent with SCQ	0	0	0	0
	Switzerland	Children/84	+	-	0	0	0	0	0	0
DB C-ES	Australian	Children/207	+	-	0	convergent with ADI-R	0	$\alpha = 0.87(+)$	ICC= 0.77 k = 0.51	0
ISA A	Indian	Children/102	+	-	FA=+	convergent with CARS	ICC= 0.93-0.99	0	k = 0.99	0
GARS-2	English	Individuals/1129	+	-	?	0	0	0	0	0
	Turkish	Children/436	+	+	?	discrimination-validity:+	0	$\alpha = 0.91$	0	0
	Spanish	Individuals/77	+	-	?	Discriminative validity:+	r = 0.98	$\alpha = 0.96$	0	0
	Chinese	Participants/?	+	-	?	0	0	$\alpha = 0.89$	0	0
GARS-3	English	Individuals/1859	+	-	EFA=+	0	ICC= 0.90	$\alpha = 0.94$	0	0
	Arabic/	Participants/?	+	-	FA: confirmed six factor	0	r= 0.99	$\alpha = 0.93$	0	0
CARS	American English	Children/37	+	-	FA: PAF identified correlated factors	convergent with ASD-DC	0	0	0	0
	British	Documents/?	+	-	0	0	k = 0.92	$\alpha = 0.89- 0.95$	K=0.79-0.95	0
	Korean	Participants/150	+	-	FA: confirmed four-factor	0	0	$\alpha = 0.92$	K=0.94	0
	Japanese	Children/167	+	-	0	Discriminant validity: +	0	$\alpha = 0.87$	r = 0.62	0
	Indian	Children/-	+	-	FA: confirmed 5-factor	Convergent with Binet-Kamat, Divergent validity:+	ICC=0.81	$\alpha = 0.79$	ICC=0.74	0
	Chinese	Children/474	+	-	?	0	0	$\alpha = 0.77$	0	0
IBSE	Portuguese	Participants/60	+	-	0	Convergent with ATAS discriminant validity:+	k = 0.90	$\alpha = 0.82$	0	0
	French	Children/89	+	+	0	Discriminant validity: +	0	?	?	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
ADOS	Swedish	Children/268	+	-	0	Convergent validity with ADI-R $r = 0.53$	0	0	0	0
	Portuguese	0	+	-	?	0	0	0	k=?	0
	Dutch	Adults/32	+	-	0	Discriminant validity: +	0	$\alpha = 0.84$	ICC= 0.89.2	0
	Chinese	Children/60	+	-	0	0	P<0.01	$\alpha = 0.93$	0	0
ADOS-2	English	Individuals/ (?)	+	+	FA: confirmed two-factor	0	ICC= 0.64 - 0.88	$\alpha=?$	k= 0.60	0
	polish	Participants/401	+	-	FA: confirmed the two-factor	Convergent with-PL and ADI-R	ICC= 0.71-0.95	$\alpha = 0.64$	K=0.92	0
	Korean	Participants/2177	+	-	$r=0.60 - 0.75$	Convergent with ADI-R, SCQ, SRS-2	0	$\alpha= 0.83 - 0.90$	0	0
DISCO	British English	Children/82	+	-	?	0	0	0	ICC => 0.75	0
	Swedish	Patients/91	+	-	0	Convergent with ADI-R	0	0	ICC=0.90	0
	Dutch	Children/115	+	-	FA=?	Convergent with ADOS	0	0	0	0
	Irish	Children/65	+	-	FA: revealed the presence of two factors(+)	0	0	$\alpha= 0.78$	0	0

Table 2. Continued

PROM (ref)	Country/ Language [which the questionnaire was evaluated]	Validity					Reliability			
		Study population/n	Face	Content	Construct	Criterion	Test-retest [ICC]	Internal consistency [Cronbach's alpha (α)]	Inter-rater [Kappa/ICC]	Intra-rater
ADI-R	British English	Children/20	+	-	0	Divergent validity: +	0	α =?	K= 0.62 - 0.89	0
	American English	Children/226	+	-	FA: indicated a three factor	Convergent with ABC/ Vineland/ CYBOCS/ CSI	0	α = 0.54-0.84	0	0
	Swedish	Participants/?	+	-	0	0	ICC= 0.83	α =0.79 - 0.95	ICC=?	0
	Polish	Participants/125	+	-	FA: CFI=0.88	Convergent with SCQ	ICC= 0.88-0.91	α = 0.85-0.95	ICC= 0.96-1.00	0
	Korean	Participants/1271	+	-	0	Convergent with CARS, SCQ, and SRS	0	0	0	0
	Japanese	Individuals/317	+	-	FA: revealed four factors	Discriminant validity:+	0	0	ICC =0.75	0
	Finnish	Children/95	+	-	0	Discriminant validity:+	0	0	0	0
	Dutch	Children/1204	+	-	0	0	0	α =?	0	0
	Chinese	Children/107	+	-	FA: Revealed 3 factors	Discriminant validity:+	P: 0.95- 0.99	α = 0.78-0.98	0	0
	Portuguese	Children/40	+	-	0	Discriminant validity:+	0	α =0.96	0	0
MBAS	Germany	Children/91	+	-	all item-total correlation was good	convergent with ADI-R discriminant validity:+	0	α = 0.91	0	0
IAS Q	Indian	Participants/145	+	+	0	Discriminant validity:+	r = 0.767 (CI = 0.62-0.86)	0	K= 0.87	0
CASI	Indian	Children/405	+	+	0	Convergent with ABC and MCHAT	0	0	0	0
SCL-ASD	Germany	Children/312	+	-	FA: Confirmed two factors	Convergent with MBAS and ADI-R	0	α =0.70	0	0

+, adequate description -; inadequate psychometric property, ?; Doubtful, '0'; no available information. ICC: Intraclass Correlation Coefficient, K: Kappa, GFI: Goodness of Fit Index, CFI: Comparative Fit Index, FA: Factor Analysis.

Meanwhile, in relation to the response time of the tools, tools such as AQ, GADS, DBC-ASA, DBC-ES, GARS2/3, CARS2, CHAT, M-CHAT, Q-CHAT are completed within 5 to 15 minutes because these tools examine few items and are mostly completed by parent. However, tools such as ASIEP3 and ADI-R need 90 to 120 and 90 to 150 minutes to be completed, respectively. It is entirely reasonable that a performance-based tool takes longer to run because it delivers more thorough and reliable data. Among the tools available in Iran, CHAT, M-CHAT, Q-CHAT (9-11), and AQ tools have the shortest (5-10 minutes) and AQ-CHILD the longest (20 minutes) completion time (16, 17). Among the tools available in Iran, the ABC has the largest number of items and examines the child in different areas (13).

While the majority of the tools are filled out by parents, guardians, or instructors, some, like the ASIEP3, are performance-based, the STAT is interactive play (3), the AQ (18, 19), and the RAADS-R (20–22), are filled out as self-reports. Although performance-based, interactive play, and direct observation tools may be more time-consuming and challenging to implement, this possibility is provided to therapists and experts in order to obtain more accurate and comprehensive information from the child directly. Parents are well aware of their child's emotions and behaviors and can report useful information.

Numerous instruments were translated into several languages throughout the research for this study, but information regarding their psychometric qualities in the target language was not available. For example, the SCQ instrument has been translated into Danish, Dutch, Finnish, German, Hebrew, Hungarian, Icelandic, Italian, Japanese, Korean, Norwegian, Romanian, Russian, Spanish, & Swedish, but there is no information about its psychometric properties in Danish, Dutch, Finnish, German, Hebrew, Icelandic, Japanese, Korean, Norwegian, Romanian, Russian, Spanish, and Swedish (23). Other examples include ASDS (24), PDDST-II (25), GADS (26), and DBC-ES (27), which have been translated into different languages, but their psychometric information is only available in the developer's language. Some tools are only available in the developer language and have not yet been translated into another language, including the ISAA, which is in Indian language (28), the SCL-ASD which is in German (4), and the IBSE which is in French (29). It is suggested that the psychometric properties of the mentioned tools can be reported in other languages as well. Among the reviewed tools, the M-CHAT (14) tool has been translated into most languages and seems to be one of the most widely used tools.

Compared to all the tools that are now available, the number of tools that have been translated in Iran and had their psychometric qualities analyzed is very small. It is hoped that more tools will be examined in future research.

It is suggested that researchers and therapists choose tools according to their goals. If they need to directly observe the child's performance, they should use performance-based tools such as the ASIEP3 (30); if they need to assess the attitude of the family and the teacher toward the child's performance, they should use parent and teacher report tools such as the GADS, DBC ASA, ASAS; if a child

with ASD is classified as a high functioning child, self-report tools such as the AQ should be used; and if there is a need for a comprehensive review and evaluation in all areas and dimensions, tools that have the most items and dimensions, including the AQ-CHILD, AQ-Adol, ASDS, RAADS-R, ASIEP 3, and ABC can be used. One can choose wisely and expedite the process of problem diagnosis and treatment by being aware of the available tools, their psychometric qualities, the goal of evaluation and screening, and having access to the desired instrument.

Conclusion

In the present study, each of these 35 tools has different characteristics in the age of the target group, the way of implementation, scoring, the number of items, the investigated areas and the duration of implementation, and they have been translated into different languages. There is still a need for more extensive studies in the field of psychometric properties of tools. It is desired that various tools would be translated into various languages worldwide because the shortage of tools is felt in many places due to the various language and cultural adaptations in different countries. The psychometrics properties should be reviewed so that therapists and researchers can use them in research and clinical studies.

Authors' Contribution

S.E.: design, acquisition of data, and writing the manuscript. M.P.: revising, and final approval of the version to be submitted. N.M.: contributed to writing the and revising the manuscript.

Conflict of Interests

The authors declare that they have no competing interests.

References

- Sobieski M, Sobieska A, Sekulowicz M, Bujnowska-Fedak MM. Tools for early screening of autism spectrum disorders in primary health care—a scoping review. *BMC Prim Care*. 2022 Dec;23(1):1-26.
- Kover ST, Edmunds SR, Ellis Weismer S. Brief report: Ages of language milestones as predictors of developmental trajectories in young children with autism spectrum disorder. *J Autism Dev Disord*. 2016 Jul;46(7):2501-7.
- Stone WL, Coonrod EE, Turner LM, Pozdol SL. Psychometric properties of the STAT for early autism screening. *J Autism Dev Disord*. 2004 Dec;34(6):691-701.
- Fekar Gharamaleki F, Bahrami B, Masumi J. Autism screening tests: A narrative review. *J Public Health Res*. 2022 Jan 31;11(1):jphr-2021.
- Soleimani, F., Khakshour, A., Abbasi, Z., Khayat, S., Ghaemi, S., Hajikhani Golchin, N. Review of Autism Screening Tests. *Int J Pediatr*. 2014; 2(4.1): 319-329. doi: 10.22038/ijp.2014.3151
- Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *Syst Rev*. 2021 Dec;10(1):1-1.
- Mokkink LB, De Vet HC, Prinsen CA, Patrick DL, Alonso J, Bouter LM, Terwee CB. COSMIN risk of bias checklist for systematic reviews of patient-reported outcome measures. *Qual Life Res*. 2018 May;27(5):1171-9.
- Amini M, Hassani Mehraban A, Haghani H, Mollazade E, Zaree M. Factor Structure and Construct Validity of Children Participation Assessment Scale in Activities Outside of School-Parent Version (CPAS-P). *Occup Ther Health Care*. 2017;31(1):44-60.
- Ebrahimi A, Shakibaei F, Mohseni AR, Khayyer Z, Pishghadam E,

- Nasiri-Dehsorkhi H. Psychometric Properties of Persian Version of Checklist for Autism in Toddlers (CHAT). *J Isfahan Med Sch.* 2019 May 22;37(524):419-26.
10. Samadi SA, McConkey R. Screening for autism in Iranian preschoolers: Contrasting M-CHAT and a scale developed in Iran. *J Autism Dev Disord.* 2015 Sep;45(9):2908-16.
 11. Mohammadian M, Zarafshan H, Mohammadi MR, Karimi I. Evaluating reliability and predictive validity of the Persian Translation of Quantitative Checklist for Autism in Toddlers (Q-CHAT). *Iran J Psychiatry.* 2015;10(1):64.
 12. Vakilzadeh N, Abedi A, Mohseni Ezhiyeh A. Investigating validity and reliability of early screening for autistic traits-Persian version (ESAT-PV) in toddlers. *Arch Rehabil.* 2017 Oct 10;18(3):182-93.
 13. Yousefi N, Dadgar H, Mohammadi MR, Jalilevand N, Keyhani MR, Mehri A. The validity and reliability of Autism Behavior Checklist in Iran. *Iran J Psychiatry.* 2015 Jun;10(3):144.
 14. Chakraborty S, Bhatia T, Sharma V, Antony N, Das D, Sahu S, Sharma S, Shriharsh V, Brar JS, Iyengar S, Singh R. Psychometric properties of a screening tool for autism in the community—The Indian Autism Screening Questionnaire (IASQ). *PloS one.* 2021 Apr 22;16(4):e0249970.
 15. Sun X, Allison C, Auyeung B, Matthews FE, Norton S, Baron-Cohen S, Brayne C. Psychometric properties of the Mandarin version of the Childhood Autism Spectrum Test (CAST): an exploratory study. *J Autism Dev Disord.* 2014 Jul;44(7):1565-76.
 16. Ameli S, Ghaderi S, Aslzaker Lighvan M, Davazdah Emami MH, Dadashzadeh H. Psychometric Properties of the Abridged Version of the Autism-Spectrum Quotient Among Iranian Students. *Practice in Clin Psychol.* 2019 Oct 10;7(4):303-18.
 17. Amini M, Hassani Mehraban A, Pashmdarfard M, Cheraghifard M. Reliability and validity of the Children Participation Assessment Scale in Activities Outside of School-Parent version for children with physical disabilities. *Aust Occup Ther J.* 2019;66(4):482-489.
 18. Auyeung B, Baron-Cohen S, Wheelwright S, Allison C. The autism spectrum quotient: Children's version (AQ-Child). *J Autism Dev Disord.* 2008 Aug;38(7):1230-40.
 19. Baron-Cohen S, Hoekstra RA, Knickmeyer R, Wheelwright S. The autism-spectrum quotient (AQ)—adolescent version. *J Autism Dev Disord.* 2006 Apr;36(3):343-50.
 20. Ritvo RA, Ritvo ER, Guthrie D, Ritvo MJ, Hufnagel DH, McMahon W, Tonge B, Mataix-Cols D, Jassi A, Attwood T, Eloff J. The Ritvo Autism Asperger Diagnostic Scale-Revised (RAADS-R): a scale to assist the diagnosis of autism spectrum disorder in adults: an international validation study. *J Autism Dev Disord.* 2011 Aug;41(8):1076-89.
 21. Crucitti M, Muscatello MR, Bruno A, Pandolfo G, Zoccali RA, Mento C. The hidden faces of autism and misdiagnosis in the lifespan: Clinical observations in adults with Autism Spectrum Disorders. *Life Span Disabil.* 2018 Jan 1;21(1):31-45.
 22. Ritvo RA, Ritvo ER, Guthrie D, Ritvo MJ, Hufnagel DH, McMahon W, Tonge B, Mataix-Cols D, Jassi A, Attwood T, Eloff J. Ritvo autism Asperger diagnostic scale--Revised. *J Autism Dev Disord.* 2010.
 23. Rynkiewicz A, Szura M, Bernaciak D, Kozak A, Karwowska M. Polish adaptation of the social communication questionnaire (Scq) and female autism phenotype: an investigation of potentially sex-biased items in the screening assessment and their impact on scores. *Brain Sci.* 2021 May 22;11(6):682.
 24. Boggs KM, Gross AM, Gohm CL. Validity of the Asperger syndrome diagnostic scale. *J Dev Phys Disabil.* 2006 Jun;18(2):163-82.
 25. Siegel B. Pervasive developmental disorders screening test (PDDST). *Encyclopedia of Autism Spectrum Disorders.* 2021:3447-51.
 26. Gilliam JE. *Gilliam Asperger's Disorder Scale: GADS.* Austin, TX: Pro-Ed; 2001.
 27. Einfeld SL, Tonge BJ. The Developmental Behavior Checklist: The development and validation of an instrument to assess behavioral and emotional disturbance in children and adolescents with mental retardation. *J Autism Dev Disord.* 1995 Apr;25(2):81-104.
 28. Mukherjee SB, Malhotra MK, Aneja S, Chakraborty S, Deshpande S. Diagnostic accuracy of Indian Scale for Assessment of Autism (ISAA) in children aged 2–9 years. *Indian Pediatr.* 2015 Mar;52(3):212-6.
 29. Adrien JL, Barthelemy C, Perrot A, Roux S, Lenoir P, Hameury L, Sauvage D. Validity and reliability of the infant behavioral summarized evaluation (IBSE): A rating scale for the assessment of young children with autism and developmental disorders. *J Autism Dev Disord.* 1992 Sep;22(3):375-94.
 30. Cordeiro L, Braden M, Coan E, Welnick N, Tanda T, Tartaglia N. Evaluating Social Interactions Using the Autism Screening Instrument for Education Planning-(ASIEP-3): Interaction Assessment in Children and Adults with Fragile X Syndrome. *Brain Sci.* 2020 Apr 22;10(4):248.