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TABLES Screening for Autism Spectrum Disorders: State of the Art in Europe

Patricia García-Primo, Annika Hellendoorn, Tony Charman, Herbert Roeyers, Mieke Dereu, Bernadette Roge, Sophie Baduel, Filippo Muratori, Antonio Narzisi, Emma Van Daalen, Irma Moilanen, Manuel Posada de la Paz, Ricardo Canal-Bedia

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**Table 1: ASD Screening Tools**

Screening Tool (Long name)	Short name	Admin. Time (min)	Admin. age (months)	Admin method**	Items	Sensitivity	Specificity
<b>Level 1*</b>							
Checklist for Autism in Toddlers [16, 17]	CHAT	5-10	18	Parent + clinician rated	9+5	0,18-0,38	0,98-1,0
Social Communication Questionnaire [18]	SCQ	15-20	36-82	Parent rated	40	0,74	0,54
Modified-Checklist for Autism in Toddlers [19]	M-CHAT	5-10	18-30	Parent rated	23	0,87	0,99
Quantitative- Checklist for Autism in Toddlers [20]	Q-CHAT	5	16-30	Parent rated	25	--	--
Communication and Social Behavior Scale-Infant and Toddlers Checklist [21]	CSBS-DP	5-10	16-30	Parent rated	24	--	--
Early Screening Autistic Traits Questionnaire[22]	ESAT	10	14-15	Parent + Childworker	14	--	--
First Year Inventory[23]	FYI	10	12	Parent rated	59	--	--
Checklist for Early Signs of Developmental Disorders [24]	CESDD			Childworker rated	12		
Autism Observation Scale for Infants [1]	AOSI	10	6-1	Clinician rated	18	0,84	0,98
Young Autism and other developmental disorders Checkup Tool [25]	YACHT-18	10	18	Clinician rated	18	0,82	0,86
The Social Attention and Communication Study [26]	SACS	5	8,12,18,24	Clinician rated	15	0,83	0,99
Joint Attention- Observation Schedule [27]	JA-OBS	5-10	20-48	Child Nurse Rated	5	0,86	--
<b>Level 2*</b>							
Developmental Behaviour Checklist-Primary care version [28]	DBC-ES	5-10	18- 48	Parent rated	96	0,83	0,48
Screening Tool for Autism in Two Year Old [29]	STAT	20	24-35	Childworker rated	12	0,83	0,86
Screening for Infants with Developmental Deficits and/or Autism [30]	SEEK	30-40	8	Parent + clinician rated	9+28	--	--
Pervasive Developmental Disorders Rating Scale [31]	PDDRS	60	> 12	Parent rated	51	--	--
Autistic Behavioral Indicators Instrument [32]	ABII	30	24-72	Clinician rated	18	--	--
Autism Behavior Checklist [33]	ABC	15	> 36	Parent rated	57	0,58	0,76
Childhood Rating Scale [34]	CARS	15-20	>24	Clinician rated	15	0,92-0,98	0,85
Autism detection in early childhood [35]	ADEC	12	12	Parent or nurse rated	16	0,79 - 0,94*	0,88 - 1,00*
Baby and Infant Screen for Children with autism Traits [36-39]	BISCUIT	15	17-37	Parent rated	42	0,84	0,86
Three-Item Direct Observation Screen test [40]	TIDOS	5	18-60	Clinician rated	3	0,95	0,85

\* Level 1= population based screening; Level 2= ASD specific screening tool after developmental delay risk confirmation at a routine developmental surveillance; \*\*Clinician= Usually paediatrician or primary care physician

**Table 2. Overview of European screening studies**

Setting and users	Screening procedure	Study sample and results <sup>a</sup>	Comments
<b>United Kingdom –South East Thames region</b>   Primary health care practitioner to parents	CHAT ( high + medium risk) + CHAT (high + medium risk)	$N = 16.235$ , $Mage = 18.7$ (1.1)  $PPV = .59$ ; $NPV = 1.00$ ; $Se. = .21$ ; $Sp. = 1.00$	<ul style="list-style-type: none"> <li>- Extremely low false-positive rate</li> <li>- High false-negative rate</li> </ul> Specifically, combination of joint attention items + pretend play indicates ASD risk Discriminating protodeclarative acts may be difficult for parents  (Baron-Cohen et al., 1996; Baird et al., 2000) <sup>[17, 62]</sup>
<b>The Netherlands – Province of Utrecht</b> Well-baby clinics + home   Physicians to parents + psychologist to parents	4-item + 14-item ESAT	$N = 31.724$ , $Mage = 14.91$ (1.37) $PPV = .25$ ; $NPV = *$ ; $Se. = *$ ; $Sp. = *$	<ul style="list-style-type: none"> <li>- High false-positive rate but no TD children</li> <li>- At young age, hard to discriminate between ASD and TD/DD</li> <li>- At young age, failure to detect higher functioning children/milder ASD variants/children who regress or develop autism later</li> <li>- Drop-out because parents not yet willing to co-operate</li> <li>- Physicians cautious in referring for ASD</li> <li>- Screen-negative cases not followed up</li> </ul> (Dietz et al., 2006) <sup>[43]</sup>
<b>The Netherlands – Nijmegen</b> Primary care setting + child psychiatry   Primary care worker   Primary care worker + parents' self-administered test   Primary care worker +	<i>Procedure 1:</i> Clinical concern + 14-item ESAT  <i>Procedure 2/3:</i> 14-item ESAT + SCQ 11  14-item ESAT + SCQ 15  <i>Procedure 4:</i>	$N = *$ , $Mage =$  $PPV = .68$ ; $NPV = .37$ ; $Se. = .88$ ; $Sp. = .14$  $PPV = .71$ ; $NPV = .47$ ; $Se. = .84$ ; $Sp. = .28$  $PPV = .79$ ; $NPV = .48$ ; $Se. = .66$ ; $Sp. = .64$  $PPV = .78$ ; $NPV = .50$ ; $Se. = .71$ , $Sp.$	<ul style="list-style-type: none"> <li>- No screening instrument clearly better than any other in differentiating ASD from non-ASD</li> <li>- Trade-off between sensitivity and specificity (F.1)</li> <li>- High false-positive rate</li> <li>- Explore different cut-offs/ item-selection within screening instruments. CHAT not administered in original form, constructed from SCQ and CSBS-DP items</li> <li>- Screen-negative cases not followed up: where true sensitivity and specificity could not be calculated, they were calculated with the percentage of</li> </ul>

	parents' self-administered test	14-item ESAT + CSBS-DP	= .59	children about whom there was already some concern
♀	Primary care worker + parents' self-administered test	<i>Procedure 5/6:</i> 14-item ESAT + CHAT high risk	PPV = .97; NPV = .37; Se. = .18; Sp. = .99	(Oosterling et al., 2009) <sup>[63]</sup>
		14-item ESAT + CHAT high + medium risk	PPV = .88; NPV = .45; Se. = .48; Sp. = .87	
<b>Belgium - Flanders</b>				
	Child day-care setting + home		$N = 7.092$ , $Mage = 16.70$ (8.19)	- First screening to include report by child-care workers
♀	Child care worker + parents' self-administered test	<i>Procedure 1:</i> CESDD + 14-item ESAT	PPV = .55; NPV = .95; Se. = .40; Sp. = .97	- High false-positive rate but many developmental disorders/delays among false positives
		<i>Procedure 2/3:</i> CESDD + SCQ 11	PPV = .44; NPV = .94; Se. = .70; Sp. = .84	- Low parent compliance rate
♀	Child care worker + parents' self-administered test	CESDD + SCQ 15	PPV = .83; NPV = .91; Se. = .43; Sp. = .98	<i>Adaptation of original screening protocol: no telephone interview included in M-CHAT, ESAT completed by parents alone.</i>
♀	Child care worker + parents' self-administered test	<i>Procedure 4:</i> CESDD + M-CHAT	PPV = .29; NPV = .98; Se. = .71; Sp. = .87	(Dereu et al., 2010) <sup>[24]</sup>
♀	Child care worker + parents' self-administered test	<i>Procedure 5:</i> CESDD + FYI	PPV = 1.00; NPV = .93; Se. = .33; Sp. = 1.00	
<b>Spain – Salamanca &amp; Zamora; Madrid</b>				
	Well-baby clinic + home		<i>Salamanca &amp; Zamora</i>	- Translated and adapted; M-CHAT results similar to original M-CHAT study
♀	Parents' self-administered test + researcher to parents	<i>Procedure 1:</i> M-CHAT + M-CHAT telephone interview( by researchers at Univ. when needed)	$N = 8122$ , $Mage = 20.58$ (3.2) PPV = .38; NPV = .99; Se. = .83; Sp. = .99	- Explore adaptation with screening instrument, such as web-based interview instead of telephone interview
♀	+ paediatrician		<i>Madrid</i>	- Need for co-ordination of health services and ASD intervention units in Spain
			$N = 2910$ , $Mage = 23.14$ (4.0) PPV = .26; NPV = .99 ; Se. = .90; Sp. = .99	- Screen-positive children followed up for two years
♀	Parents' self-administered test + paediatrician /nurse to parents through web interface.	<i>Procedure 2:</i> M-CHAT + M-CHAT web-based interview	$N = 1402$ , $Mage = 20.21$ (3.0) PPV = .50; NPV = .99; Se. = .67; Sp. = .99	- Locating and contacting families for telephone interview proved very time-consuming
<b>Sweden – Stockholm</b>				
	(Home +) child health centre		$N = 3.999$ , $Mage = 36.00$ (no SD reported)	- Interview M-CHAT was necessary; many parents had difficulties understanding questions

👤	Nurse	<i>Procedure 1:</i> JA-OBS	PPV =.92.5; NPV =.*; Se. =.86; Sp. = *	- JA-OBS raised nurse awareness about ASD
👤	Parents' self-administered test	<i>Procedure 2:</i> M-CHAT (including interview)	PPV =.92; NPV =.*; Se. =.76; Sp. = *	- Combining different instruments for professionals and parents is effective. Screen-negative cases not followed up
👤	Parents' self-administered test + nurse	<i>Procedure 3:</i> M-CHAT (including interview) + JA-OBS	PPV =.89.6; NPV =.*; Se. =.95.6; Sp. = *	- Screening procedure implemented in developmental programme
(Nygren et al., 2012) <sup>[27]</sup>				
<b>France - Toulouse</b>				
Well-baby clinic			$N = 1227$ , $ Mage = 24$	- Difficulty in obtaining participation of professionals
👤	Parents' self-administered test + professional	M-CHAT + CHAT	Preliminary data: TP = 17; TN= 1192; FN= 1; FP= 17	- Follow up at 30 and 36 months in order to check the diagnosis status
<b>Italy</b>				
👤	Paediatrician to parents	M-CHAT + M-CHAT interview by paediatrician directly	$N = 1000$ , $ Mage = 24.4 (3.2)$ Preliminary data: TP = 4; TN= *; FN= *; FP= 8 <i>PPV 0.28</i>	- Difficulties in re-screening children with "pass result" in order to find false-negative cases.
<b>Finland</b>				
👤	Nurse + Nurse to parents	<i>Procedure 1(first study attempt):</i> At 18m.o.:CHAT + ICQ & CBCL +BITSEA	$N = 200$	-CBCL(Children's Behavioural Checklist-Achenbach & Edelbrock, 1981 ) -No longer ongoing
		<i>Procedure 2(started later):</i> At 12m.o.:Nurse checklist+ BITSEA+ ICQ +ESAT	$N = 677$	-Small sample, no cases with ASD yet. -Planning modifications in short future

*Note.* \*number is unknown and could neither be extracted from the literature nor calculated from the data. PPV = positive predictive value, NPV = negative predictive value, Se. = sensitivity, Sp. = specificity. ASD = autism spectrum disorder, DD =developmental disorder/delay, TD = typical development.  *Mage* in months. <sup>a</sup> Note that the results presented here need to be taken with caution since some of the tools have been used in unusual or adapted conditions and for that reason cannot be considered as the unique psychometric properties of the too

**Table 3. Factors to be considered when evaluating screening studies\***

<b>Factor</b>	<b>Key description</b>
<b>I. Broad-based analysis of qualitative indices</b>	Need for comprehensive approach & consideration of intervention benefits of FP cases besides possible side-effects
<b>II. Prevalence rates and PPV interpretation</b>	"Population-based" sample vs. "High-risk" sample.
<b>III. Age of screening</b>	Younger age => higher FP rate; difficulties in differentiating "ASD" from "other DDs".
<b>IV. Level of functioning and autism severity</b>	Higher IQ and/or milder variants of ASD => higher FP rate.
<b>V. Selection and formulation of items</b>	Specificity: play +sensory + motor skills (young age); social interaction and communication (older age); importance of formulation: ever vs. rarely.
<b>VI. Cut-off criteria</b>	Importance of exploring different cut-off scores for different purposes and populations.
<b>VII. Protocol adherence</b>	Lack of consistency of screening procedures across studies. Need for balance between protocol adherence and deviations, depending on study purpose/resources.
<b>VIII. Informants &amp; training</b>	Parents, paediatricians, primary care physician, child-care workers and child nurses. Good training programmes together with the tool.
<b>IX. Parental non-compliance rate</b>	Socio-economic, ethno-cultural and age-related factors. Importance of re-test.
<b>X. Setting characteristics: organisation of services</b>	Challenges of each screening context. Importance of availability and co-ordination between related services (i.e., screening, diagnostic and intervention services).

\*= Justification for/discussion of these 10 factors also considers literature from non-European studies