

Evaluation of toddlers aged between 18 and 30 months for autism spectrum disorders using the Turkish version of the modified checklist for autism in toddlers test: A cross-sectional study

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ABSTRACT

Objective: American Academy of Pediatrics recommends autism-specific screening at 18 and 24 months of age. This study is a cross-sectional study involving a period of 4 months and investigating the validation and reliability of the Modified Checklist for Autism in Toddlers Test (M-CHAT) and the incidence of autism spectrum disorders (ASD) in our study population. **Methods:** Four hundred and seventy-one healthy toddlers aged 18-30 months were screened in well-child clinic between June 2017 and September 2017. It was administered to the caregivers by a nurse by face-to-face interview. Screen positive children were referred to child and adolescent psychiatry clinic for psychiatric evaluation. **Results:** Of all participants, 264 were boys (56.1%) and 207 girls (43.9%). The mean age was found as 24.5 and 24 months in boys and girls, respectively. The risk of ASD was found as 8/1.000 with the M-CHAT and the incidence was found as 6/1.000 after the psychiatric assessment. We found a sensitivity of 100%; a specificity of 0.95; a positive predictive value of 0.75; and a negative predictive value of 100% and accurate discrimination rate of 0.96. Cronbach's α reliability coefficient, which was calculated for internal consistency to determine the reliability in the group which underwent the test was found to be 0.96 for the 23 items and 0.98 for the six critical items. **Conclusion:** M-CHAT is a useful tool in Turkey for screening children for ASD in primary care when adapted to populations with different cultures. (*Anatolian Journal of Psychiatry* 2019; 20(2):196-203)

Keywords: ASD, M-CHAT, developmental screening, early detection

18-30 ay aralığındaki çocukların otizm spectrum bozukluğu açısından Değiştirilmiş Erken Çocukluk Dönemi Otizm Tarama Ölçeği Türkçe Sürümü ile değerlendirilmesi: Kesitsel çalışma

ÖZ

Amaç: Amerikan Pediatri Akademisi, 18 ve 24. aylarda otizme özgü tarama yapılmasını önermiştir. Bu çalışma değiştirilmiş Erken Çocukluk Dönemi Otizm Tarama Ölçeğinin (M-CHAT) geçerliliğini ve güvenilirliğini ve otizm spektrum bozukluklarının (OSB) görülme sıklığını çalışma popülasyonumuzda dört aylık bir dönemi kapsayan bir sürede araştıran kesitsel bir çalışmadır. **Yöntem:** Kliniğimizde Haziran 2017-Eylül 2017 tarihleri arasında 18-30 aylık toplam 471 sağlıklı çocuk tarandı. Bu değerlendirmeler bakımverenlerle yüz yüze görüşerek bir hemşire tarafından uygulanmıştır. Ölçek değerlendirmeleri pozitif olan çocuklar psikiyatrik değerlendirme için çocuk ve ergen psikiyatri kliniğine yönlendirildi. **Bulgular:** Katılımcıların 264'ü erkek (%56.1) ve 207'si kızdı (%43.9). Erkek ve kızlarda ortalama yaş 24.5 ve 24 ay olarak bulundu. OSB riski M-CHAT ile 8/1.000 ve psikiyatrik değerlendirmeden sonra ise sıklık 6/1.000 olarak saptandı. Biz %100 duyarlılık, 0.95 özgüllük, 0.75'lik bir pozitif öngörü değeri, %100 negatif tahmin değeri ve 0.96 kesin ayırıcılık oranı bulduk. Test edilen grupta güvenilirlik için Cronbach- α iç tutarlılık

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katsayısı 23 madde için 0.96 ve altı kritik madde için 0.98 olarak bulunmuştur. **Sonuç:** M-CHAT, Türkiye'de farklı kültürlerle sahip popülasyonlara uyarlandığında ilk basamakta OSB'li çocukları saptamak için kullanılan yararlı bir araçtır. (*Anadolu Psikiyatri Derg* 2019; 20(2):196-203)

Anahtar sözcükler: OSB, M-CHAT, gelişimsel tarama, erken tanı

INTRODUCTION

Autism spectrum disorder (ASD) describes a heterogeneous group of neurodevelopmental disorders that have diverse etiologies but are characterized by impairments in reciprocal social interaction, social communication, and behavior.¹ The current prevalence of these disorders is estimated to be 1 in 68.² American Academy of Pediatrics endorsed formal screening for ASD at 18 and 24 months.³

The Modified Checklist for Autism in Toddlers (M-CHAT) has emerged as the screening instrument that has shown the most promise as ASD-specific screeners in community samples to date. M-CHAT is a 23-item parent-report instrument for children aged 16-30 months.⁴ Validation and reliability study of the test has been previously conducted with different sample groups in Turkey.⁵⁻⁷ This study is a cross-sectional study involving a period of four months and investigating the validation and reliability of the M-CHAT and the incidence of ASD in our study population.⁸

METHODS

Participants

In this study, the goal-directed sample method was used. For this reason, researches on this subject are examined^{4,6} and individuals with similar characteristics as universe parameters are included in the sample.⁹ Four hundred and seventy-one healthy toddlers aged 18-30 months were screened at University of Health Sciences, Ankara Child Health and Diseases Hematology Oncology Training and Research Hospital Well-Child Clinic between June 2017 and September 2017. Children who have been diagnosed with any neurodevelopmental disease or ASD before, or those who had a severe sensory or motor disability and whose parents did not want to participate in the study were excluded. Screen positive children were referred to child and adolescent psychiatry clinic for psychiatric evaluation. Twenty randomly selected screen negative children were also invited to child and adolescent psychiatry clinic for psychiatric evaluation. Written consent was obtained from the families of the children partici-

pating in the study.

Of the 471 children included in the study, 264 (56.1%) were boys and 207 (43.9%) were girls. The mean age of the sample was 24.4 months with mean ages of 24.5 and 24 months in boys and girls, respectively. In families of the children who underwent the test, the mean ages of mothers and fathers were 29.5 and 33.0, respectively. Descriptive statistics of the ages of children and their parents and skewness-kurtosis coefficients within ± 1 limits reveal that the age distribution of the sample was normal in the population.¹⁰ 53% of the families were from middle socioeconomic level, 42% from low, 5% from high levels.

Screening instrument and procedure

An experienced nurse has applied the M-CHAT. In our clinic, nurse who is working in well child clinic since five years has been trained in child growth and development, baby care, nutrition, vaccination, screening and she apply M-CHAT. Before the study, she has been read the latest publication on ASD and M-CHAT. The nurse received education on the application of the test from a social pediatrician and child and adolescent psychiatrist who participated in the study. Prior to study, we conducted a pilot study with 20 children in our well-child clinic. The M-CHAT was originally designed to be filled out by the children's caregivers.⁴ But, people in our culture are rarely familiar with checklists and in daily life, many people avoid following written instructions and usually prefer verbal ones. Therefore, in our study, a nurse administered the M-CHAT to the caregivers by face-to-face interview. The nurse was trained to give some examples or to show the behavior to the parents for failed items. The interview was completed in 5-10 minutes.

Version of the M-CHAT test, which has been adapted to Turkish culture by Kondolot et al., was used in the study. The M-CHAT was administered and scored by using previously published cutoffs.^{4,6} The M-CHAT includes 23 'yes' or 'no' items. The 'yes' response is normal for 19 items, but is abnormal for item numbers 11, 18, 20, and 22. A positive screen was accepted if ≥ 2 of six critical items (2, 7, 9, 13, 14, 15) or ≥ 3 of 23 items were positive.⁴

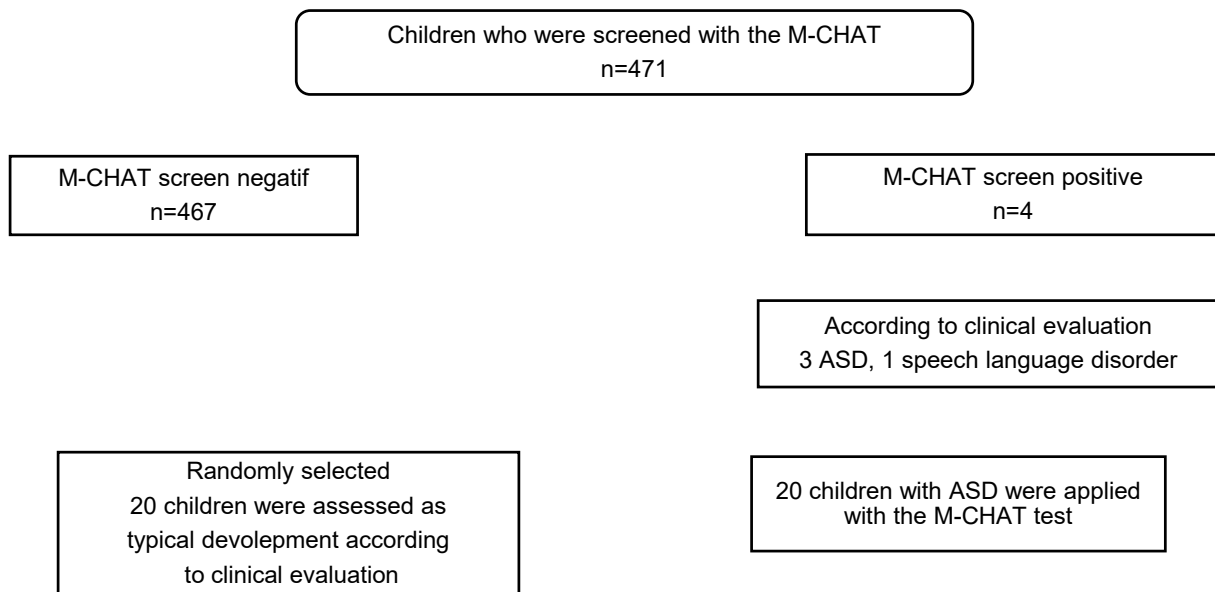


Figure 1. Flow chart of the screening

In general, measurement tools are valid and reliable in some groups, but may be unreliable in the other groups.¹¹ Within this context, although the studies in which M-CHAT test was developed and adopted to Turkish culture demonstrated validity and reliability of the test, it should also be tested in the sampling applied in the study. The use of more than one validity evidence together is important for validity and reliability of the results.^{9,12} Therefore, constructional validity of M-CHAT was investigated using different methods in this study.

Early educational intervention programs were initiated for children who screened positive with the M-CHAT before confirmation of the diagnosis. The child and adolescent psychiatrist was blind to the M-CHAT screening results. Screen positive and randomly selected screen negative children were applied Autism Behavior Checklist (ABC), Childhood Autism Rating Scale (CARS) and developmentally appropriate screening tests by the same child and adolescent psychiatrist. Participants with ASD were diagnosed according to the DSM-5 and based on a detailed clinical examination.^{1,13,14} A family history and information about the child's symptoms were obtained from the primary caregiver using standardised clinical forms. Primary caregivers of children with ASD administered ABC and an experienced child and adolescent psychiatrist administered CARS. A senior specialist child and adolescent psychiatrist made ASD diagnoses. Flowchart of

the screening is shown below.

Statistical analyses

One dimensional confirmatory factor analysis was performed in order to determine constructional validity of the M-CHAT test.¹⁵ Among the non-parametric techniques; chi-square, Mann-Whitney U, Cramer's V and logistic regression analyses were used when the variables did not meet normality, sample size and similar assumptions of categorical or parametric methods.^{16,17} Logistic regression model was construction to determine accuracy of classification of the children in groups with or without risk, and groups with or without risk consisted the dependent variable, while parent's education levels and ages constituted the independent variables. The statistical significance was set at 0.05. Data analysis was carried out using SPSS 21.00 and LISREL 8.80 package software.

Ethical approval was obtained for this study from local ethical committee.

RESULTS

Validation studies

First, confirmatory factor analysis was performed in order to present an evidence to the constructional validity in the group in which the theoretical construct was applied. The results obtained after testing the sample size, multivariate normality,

Table 1. Parents' answers and the correlation coefficients of the answers

M-CHAT items	Response	Risk group (n=24)		Non-risk group (n=467)		Cramer's V	Items total correlation
		n	%	n	%		
1. Does your child enjoy being wung, bounced on your knee, etc?	Yes	7	1.5	466	98.5	0.81*	0.83
	No	17	94.4	1	5.6		
2. Does your child take an interest in other children?	Yes	5	1.1	466	98.9	0.86*	0.81
	No	19	95.0	1	5.0		
3. Does your child like climbing on things, such as upstairs?	Yes	20	4.1	467	95.9	0.40*	0.39
	No	4	100.0	0	0		
4. Does your child enjoy playing peek-a-boo/hide-and-seek?	Yes	3	0.6	467	99.4	0.93*	0.93
	No	21	100.0	0	0		
5. Does your child ever pretend, for example, to talk on the phone or take care of dolls, or pretend other things?	Yes	1	0.2	467	99.8	0.98*	0.94
	No	23	100.0	0	0		
6. Does your child ever use his/her index finger to point or to ask for something?	Yes	5	1.1	467	98.9	0.89*	0.90
	No	19	100.0	0	0		
7. Does your child ever use his/her index finger to point, to indicate interest in something?	Yes	0	0	467	100.0	1.00*	0.97
	No	24	100.0	0	0		
8. Can your child play properly with small toys (e.g. cars or bricks) without just mouthing, fiddling, or dropping them?	Yes	5	1.4	358	98.6	0.27*	0.26
	No	19	14.8	109	85.2		
9. Does your child ever bring objects over to you (parent) to show you something?	Yes	1	0.2	467	99.8	0.98*	0.94
	No	23	100.0	0	0		
10. Does your child look you in the eye for more than a second or two?	Yes	4	0.8	467	99.2	0.91*	0.92
	No	20	100.0	0	0		
11. Does your child ever seem sensitive to noise? (e.g. plugging ears)	Yes	19	11.5	146	88.5	0.22*	0.22
	No	5	1.5	321	98.5		
12. Does your child smile in response to your face or your smile?	Yes	3	0.6	465	99.4	0.89*	0.90
	No	21	91.3	2	8.7		
13. Does your child imitate you? (e.g. you make a face-will your child imitate it?)	Yes	3	0.6	467	99.4	0.93*	0.92
	No	21	100.0	0	0		
14. Does your child respond to his/her name when you call?	Yes	2	0.4	467	99.6	0.96*	0.96
	No	22	100.0	0	0		
15. If you point at a toy across the room, does your child look at it?	Yes	1	0.2	467	99.8	0.98*	0.97
	No	23	100.0	0	0		
16. Does your child walk?	Yes	24	5.0	458	95.0	0.03	-0.03
	No	0	0	9	100.0		
17. Does your child look at things you are looking at?	Yes	1	0.2	466	99.8	0.96*	0.95
	No	23	95.8	1	4.2		
18. Does your child make unusual finger movements near his/her face?	Yes	18	48.6	19	51.4	0.58*	0.61
	No	6	1.3	448	98.7		
19. Does your child try to attract our attention to his/her own activity?	Yes	0	0	464	100.0	0.94*	0.91
	No	24	88.9	3	11.1		
20. Have you ever wondered if your child is deaf?	Yes	20	52.6	18	47.4	0.64*	0.63
	No	4	0.9	449	99.1		
21. Does your child understand what people say?	Yes	2	0.4	465	99.6	0.91*	0.88
	No	22	91.7	2	8.3		
22. Does your child sometimes stare at nothing or wander with no purpose?	Yes	19	61.3	12	38.7	0.68*	0.68
	No	5	1.1	455	98.6		
23. Does your child look at your face to check your reaction when faced with something unfamiliar?	Yes	2	0.4	459	99.6	0.81*	0.79
	No	22	73.3	8	26.7		

*: $p < 0.01$

multivariate extreme values, linearity and multicollinearity assumptions were the following:

χ^2/sd value was found as 1.46, showing that the model has an excellent fit index. GFI (0.94) and AGFI fit indices value (0.93) correspond a good model fit. RMSEA (0.031), SRMR (0.035), NFI (0.98), NNFI (0.99) and CFI (0.99) values also indicated an excellent model-data fit. In addition, we found that t values that give information for explanation of the theoretical items of the M-CHAT were significant by varying between 10.69 and 15.01, and error variances varied between 0.49 and 0.87. Therefore, it can be said that one dimensional structure of the scale was confirmed in the relevant group.^{18,19}

The percents of the answers given by the families to the items and the correlations between the items themselves and the total scores are evalu-

ated as evidence for validity of the measurement tool.^{9,12} Percents of the answers and information about these correlations are shown in Table 1.

Four children who were determined to be at the group with risk for ASD and children selected randomly from the group without risk were assessed with psychiatric examination in order to evaluate validity of the M-CHAT according to ASD criteria. Among the children without risk, children who were similar to the children with risk in terms of age and gender were randomly identified using the random layered sampling method.⁹ The size of sample was calculated at 95% confidence interval level, and the number of individuals in the sample was determined, and 20 children were randomly selected among the children without risk.²⁰ Results of the psychiatric examination are given in Table 2.

Table 2. Psychiatric examination result

	Autism		Total
	Positive	Negative	
M-CHAT positive	3	1	4
M-CHAT negative	0	20	20
Total	3	21	24

Table 3. Cross-tabulation of Psychiatric outcome with M-CHAT test

		Psychiatric examination result		Total
		Autism negative	Autism positive	
M-CHAT test result	Non-risk group	n	20	0
		%	100.0	0.0
	Risk group	n	0	20
		%	0.0	100.0
	Total	n	20	20
		%	50.0	50.0

When Table 2 was examined, it is seen that one of the four children who were found to have risk with the M-CHAT was not diagnosed with ASD in the psychiatric examination. On the other hand, 20 children who passed the test was found as normal in the psychiatric examination. Thus, sensitivity of the test was found as 100%, specificity as 95%, positive predictive value (PPV) as 75%, negative predictive value (NPV) as 100%, and accurate discrimination rate as 96%.

When data are collected from different persons in studies, these data must be proven to mea-

sure the same structure.⁹ Regarding convergent and divergent validity, the correlation between M-CHAT test results and psychiatric examination outcomes of the children in different groups was investigated. Therefore, 20 children with a previous diagnosis of ASD underwent M-CHAT tests. Thus, the correlation between the psychiatric examination results of 20 children who were randomly selected with the group without risk, and the test outcomes of 20 children who had previous diagnosis of ASD because of the psychiatric examination was investigated. The

results of χ^2 are given in Table 3.

The diagnoses of children in the groups with and without risk as the result of psychiatric examination are given in Table 3 in the crosstab. The correlation between the risk group of children and the diagnoses they received based on the child and adolescent psychiatrist examination was statistically significant $\chi^2_{(1,40)}=40.0$, $p<0.05$. This result shows a high and significant correlation between the test results of the children and

the decision made by the child and adolescent psychiatrist (Cramer's $V=1.00$, $p<0.01$).

It is thought that, since the test was applied on the parents with face-to-face interview technique, parents' educational status and age might affect the test results. Therefore, a logistic regression analysis was performed for the model created with parents' educational status and age parameters. The results of logistic regression analysis are given in Table 4.

Table 4. Regression analysis of the demographical variables for autism risk

Variable	B	Wald	SD	p	OR	%95 CI	
						lower	upper
Mother's education (university)	2.58	4.62	1	0.032	13.15	1.26	137.70
Fatherage	-0.69	6.74	1	0.009	0.50	0.30	0.85
Motherage	0.49	5.21	1	0.023	1.63	1.07	2.47
Constant	5.90	1.72	1	0.189	363.73		

Table 4 shows the variables significantly predicting the group which include the children in the model constructed with parents' educational status and age. The full model involving parents' educational status and age is statistically significant $\chi^2_{(8,44)}=18.76$, $p<0.05$. In addition, χ^2 is not significant according to the Hosmer and Lemeshow goodness of fit test $\chi^2_{(8,44)}=6.95$, $p>0.05$. This result indicates that the model including parents' educational status and age variables was supported. We concluded that, only mothers to have a postgraduate educational level significantly predicted the group which included the children based on ASD according to Wald criteria $\chi^2_{(1,44)}=4.62$, $p<0.05$. In this respect, a child who had a postgraduate mother was more likely to be in the risky group. On the other hand, probability of a child for being in the risky group increased as the mother's age increases ($\chi^2_{(1,44)}=5.21$, $p<0.05$) and the father's age decreases ($\chi^2_{(1,44)}=6.74$, $p<0.05$).

Reliability study

Cronbach's α reliability coefficient, which was calculated for internal consistency to determine the reliability in the group which underwent the test was found to be 0.96 for the 23 items and 0.98 for the six critical items. The calculated values show that the test was highly reliable in the group in which the test was applied.⁹

DISCUSSION

The prevalence of ASDs shows changes depending on race/ethnic differences, geographic area, and methodological differences of the studies.²¹ In two United States regions, a total of 18,989 children aged 18-24 months were screened and nearly 5/1000 children were diagnosed with ASD.²² In one Turkey region, a total of 2021 children aged 18-30 months were screened and nearly 1/1000 children were diagnosed with ASD.⁶ In this study, the risk of ASD was found as 8/1.000 with the M-CHAT and the incidence was found as 6/1.000 after the psychiatric assessment during a period of four months. Clinical evaluation was performed within two months of the initial M-CHAT screening by the same child and adolescent psychiatrist. Three children were diagnosed with ASD (one of them are 18 month-old girl and the others are 26 month-old males). The M-CHAT scores of three children with ASD were 10, 13 and 13, respectively. The boy who was diagnosed with speech language disorder was 30-month-old. The M-CHAT score was found 5.

In various countries, The M-CHAT's validity and reliability has been evaluated. M-CHAT may require modifications to be more internally consistent and accurate across different ethnic, socio-cultural, and educational groups of toddlers' caregivers.^{22,23} Robins et al. found a sensitivity of 0.87; a specificity of 0.99; a PPV of 0.80; and

a NPV of 0.99. In Turkey, Kondolat et al. found a sensitivity of 100%; a specificity of 0.76; a PPV of 0.12; and a NPV of 100%. The low PPV has been suggested to be related to the low prevalence of ASD in this Turkey region. In our study was found a sensitivity of 100%; a specificity of 0.95; a PPV of 0.75; and a NPV of 100% and accurate discrimination rate of 0.96.^{4,6} In our study Cronbach's α was found to be 0.96 for the 23 items and 0.98 for the six critical items. The result can be considered reliable. Robins et al. found internal consistency 0.85, 0.83 and Kondolat et al. found 0.84, 0.79, respectively.^{4,6}

As seen in the Table 2, 16th item in our study does not seem as a discriminant item in definition of ASD in children. Again, a significant low correlation was found between the answers given to the 3rd, 8th and 11th questions and children's groups, a significant moderate correlation in the 18th, 20th and 22nd questions, and a significant high correlation in the other items. This finding related to the 3rd, 8th and 11th questions may be due to that the parents might not understand the questions enough. It may also be related to the fact that these questions are not sufficiently effective in distinguishing children with ASD from non-ASD children.^{23,24} These questions should be clearer and should be revised with examples and explanations.

Many previous studies have shown that the sociodemographic characteristics of caregivers may affect test results, since the screening tests are applied to families.^{25,26} In our study, probabi-

lity of the children for being in the high risk group increased as mothers' age and educational status increase and fathers' age decreases. In our study, M-CHAT was administered to the mothers and fathers together, but the questions were mostly answered by mothers who spent more time with their children. Therefore, the test results would possibly be different if the test was applied on mothers and fathers separately. This is an issue which should be focused on and should be supported by further studies.

M-CHAT's negativity may not exclude the possibility of ASD and other developmental problems.^{22,27} Although the patient passed the screening test, if there was any suspicion about child's development, further evaluation can be needed.

This study suffers from some limitations. In this study, none of M-CHAT negative children could not be followed, so we may have missed the opportunity to catch an autistic child. Unavailability of Autism Diagnostic Interview-Revised (ADI-R) and Autism Diagnostic Observation Schedule (ADOS) in Turkish, we were not able to make the diagnosis of autism based on internationally accepted interview form.

In conclusion, M-CHAT is a useful tool in Turkey for screening children for ASD in primary care when adapted to populations with different cultures. Further studies are needed concerning this subject which include larger sample and longer follow-up.

Yazarların katkıları: A.K.U.: Çalışmanın tasarlanması, literatür araştırması, istatistiksel analiz ve yorumlama, makalenin yazılması; B.Ç.Ç.: Çalışmanın danışmanlığı ve planlanması, verilerin yorumlanması, makalenin yazılması; Ç.U.: Çalışma materyalinin toplanması, literatür araştırması, verilerin yorumlanması, makalenin yazılması; Z.P.: Çalışma verilerin toplanması.

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