Reliability and Concurrent Validity of a Cultural Adaptation and Northern Sotho Translation of the M-CHAT-R/F

Carlien Vorster, PhD[1], Alta Kritzinger, PhD[1], Loina Coetser[1] and Jeannie Van der Linde, PhD[1]

[1]University of Pretoria, South Africa

*Corresponding Author: Carlien Vorster, Department of Speech-Language Pathology and Audiology, University of Pretoria, Lynnwood Road and Roper Street, Hatfield, Pretoria, Gauteng 0002, South Africa. Emails: carlien.vorster@up.ac.za; carlienwerk@gmail.com

Abstract

Currently, no culturally and linguistically adapted autism screening tools are available in South Africa. The aim was to determine the reliability and concurrent validity of the adapted English and Northern Sotho–translated Modified Checklist for Autism in Toddlers–Revised with Follow-up (M-CHAT-R/F). Reliability was confirmed with near-perfect agreement ($p <$ .001) between the checklists in a sample of 158 Northern Sotho/English bilingual mothers of children with a low risk for autism. Concurrent validity between the Northern Sotho M-CHAT-R/F and the communication and socialization sub-domains of the Vineland-3 was established with significant association at the 5% level. A third (33.5%) of the children showed a developmental delay. The checklists are valid and reliable, and may improve early identification that will render better long-term outcomes for children with autism in South Africa. Autism screening should be combined with developmental assessment. The study contributes to an emerging body of research on the development of contextually appropriate screening measures.

Keywords: service delivery, birth to 3 years, age, cultural/linguistic, diversity, autism, and other pervasive developmental disorders, exceptionalities

Advanced Organizer

The following article is the third in a series of studies in which the cultural adaptation, translation, and piloting of the Modified Checklist for Autism in Toddlers–Revised with Follow-up (M-CHAT-R/F) have already been conducted. Due to a shortage of autism-specific screening tools in South Africa, the overall goal is to offer two instruments of which one is a South African English adaptation of the M-CHAT-R/F and the other is a Northern Sotho translation of the adapted version.

The authors now present an investigation into the reliability and concurrent validity of the South African–adapted English version and the Northern Sotho translation of the M-CHAT-R/F in a larger sample.

The main findings of the study indicate that the two versions of the M-CHAT-R/F are culturally and linguistically appropriate, and that these autism-specific screening tools should be used together with a developmental assessment to promote earlier identification of autism in South Africa. The culturally adapted English and Northern Sotho M-CHAT-R/F versions should be considered for use as they present with significant psychometric properties.

Autism screening is limited in South Africa, resulting in delayed identification, diagnosis, and intervention. Limited screening and late identification of autism are caused by several constraints, such as a paucity of resources and service delivery, limited community awareness and knowledge of autism, a lack of culturally and linguistically appropriate instruments, and an overburdened health system (Amaral et al., 2019; Franz et al., 2017, 2018). The increase in prevalence observed globally is estimated to be similar in sub-Saharan Africa (Olusanya et al., 2018). Cultural and linguistic appropriate tools may contribute a more accurate prevalence rate of autism in sub-Saharan Africa and in South Africa. In a review of the past 30 years, Amaral et al. (2019) reported that sub-Saharan Africa and Southeast Asia have shown the largest increase in developmental disabilities, including autism. It is not fully known how children with autism are identified in South Africa, but because diagnoses are increasing, it is important to advocate for a nationwide approach to screening. Although there is no formal autism screening and surveillance program in South Africa, it is clear that investment is required as detection opens the pathway to diagnosis and intervention (Choueiri et al., 2021).

Studies show a reduction in the average age of autism diagnosis in the six government-funded autism-specific schools in South Africa in recent years (Erasmus et al., 2019; Van Biljon et al., 2015). In a retrospective case study of an autism-specific school, the mean age of autism diagnosis of learners (n = 141) was 71.6 months from 1990 to 2014 (Van Biljon et al., 2015). Yet, in a prospective follow-up study, the mean age of diagnosis in the six autism-specific schools was much lower (46.6 months; Erasmus et al., 2019). The positive decline of 25 months in the age of autism diagnosis for school-going children in South Africa is encouraging, but identification and assessment efforts need to increase further to reap the benefits of early intervention as an accurate diagnosis of autism can already be made as early as 14 months of age (Pierce et al., 2019).

Research has consistently shown that autism screening is feasible and necessary to lower the age of diagnosis (Hyman et al., 2020; Marlow et al., 2019; Robins et al., 2014; Zwaigenbaum & Penner, 2018). There are, however, differences in accuracy of screening methods and procedures implemented (Wallis, 2021). When broad-based developmental screening and disorder-specific screening are compared, autism-specific screens show significantly higher agreement with diagnosis of the condition (Wiggins et al., 2014). Universal autism-specific screening in combination with developmental screening is recommended to prioritize referrals to autism specialists and improve reliability (Wiggins et al., 2014). Similarly, a combined approach of developmental monitoring and autism-specific screening was the best solution for early identification across different ethnic communities (Barger et al., 2021). Universal autism screening in low- and middle-income countries (LMICs) has been recommended but is a challenge as reliable and culturally appropriate resources, tools, and supporting policy guiding referrals are limited (Franz et al., 2018; Lee & Meadan, 2021; Marlow et al., 2019).

The latest version of the M-CHAT-R/F (Robins et al., 2018) is globally the most used and translated autism-specific screening instrument (Lord et al., 2018; Robins et al., 2018). Cronbach's alpha (internal consistency) of the updated version of the M-CHAT with the Follow-up section is .8, adequate to support reliability (Robins et al., 2014). The M-CHAT-R/F was identified as an applicable instrument to use in LMICs as it does not require extensive training, is free of charge, and can be used by all health care professionals, parents, and community health workers (Marlow et al., 2019). The screen can be completed electronically on the M-CHAT website or in hard copy format. The electronic format

provides the child's risk score immediately after completion (Robins et al., 2018). For settings where access to the internet and technology is limited, the hard copy is available, making it easily accessible, allowing increased coverage of screening.

To accurately identify children at risk for autism, culturally sensitive instruments should be used as accurate identification is affected by the child's age, culture, socio-economic circumstances, and gender (Guthrie et al., 2019; Wallis, 2021). Children from lower socioeconomic circumstances and minority groups are generally identified later (Guthrie et al., 2019; Zeleke et al., 2019). The use of instruments without cultural adaptation may result in unreliable outcomes, varying prevalence estimates, with unintended over- or under-identification of children at risk (DuBay et al., 2021; Rea et al., 2019; Soto et al., 2015). There is currently no culturally adapted, autism-specific screening instruments available in South Africa (Franz et al., 2017). Given the late identification of autism and the shortage of culturally appropriate and validated screening tests in South African languages, the M-CHAT-R/F was adapted, translated into Northern Sotho, and piloted in two previous studies (Vorster et al., 2021, 2022). Northern Sotho, one of the 11 official South African languages, is widely used in the greater Tshwane region, a densely populated urban and peri-urban area of South Africa, where the study was conducted. Northern Sotho, also known as Sepedi, has the highest percentage of speakers (19.4%) for a single language group in the region (Statistics South Africa [StatsSA], 2019).

A culturally adapted English version and a Northern Sotho translation of the M-CHAT-R/F were developed by two professional translators and an eight-member panel of linguists, speech-language therapists, and researchers, of whom three were first-language Northern Sotho speakers (Vorster et al., 2022). The comprehensive process involved checklist-item scrutiny, forward and back translation, two panel discussions, and written feedback based on the Item translation and adaptation review form (Hambleton & Zenisky, 2011). Four items were culturally adapted (Items 3, 4, 9, and 14) with linguistic gaps posing the greatest challenge with the translation of technical terms. The adapted English M-CHAT-R/F and Northern Sotho M-CHAT-R/F were shown to be equivalent versions of the M-CHAT-R/F in the pilot study that followed the cultural adaptation and

translation process. Preliminary reliability of the two checklists was therefore established in the pilot study, with no difference evident at the 5% interval of the Wilcoxon signed-ranks test. (Vorster et al., 2021). A need for investigating the validity of the two checklists was identified as the pilot sample was too small to determine psychometric properties. Preferably, the concurrent validity of the screening checklists should be as high as possible while acknowledging the limitations of the parent-report format of the M-CHAT (DuBay et al., 2021). This study aimed to determine the reliability and the concurrent validity of both versions of the checklist in a larger sample.

Method

Ethical Clearance

Permission to adapt and translate the M-CHAT-R/F was obtained from the original authors. The study was approved by the institutional research board (HUM041/0919), the provincial health ethics board, and the local clinic where data collection was conducted. Participants were aged older than 18 years and gave written informed consent.

Research Design

A comparative within-subject design involving correlational research was used to assess the reliability and concurrent validity of the adapted English M-CHAT-R/F and the Northern Sotho M-CHAT-R/F. An item-level analysis was performed, allowing comparison between the two checklists. The overall pass/fail rate of the two M-CHAT-R/F versions was compared by investigating the level of agreement among participants' responses of the two checklists, utilizing their own child as referent with each application. The internal consistency of the two checklists was calculated and compared to determine the reliability and equivalence of the two M-CHAT-R/F versions. Concurrent validity was investigated by comparing the outcome of the M-CHAT-R/F versions with the results of the communication and socialization sub-domains of the Vineland-3 Parent/Caregiver Form (Sparrow et al., 2016).

Participants

The study participants comprised 158 mothers of children aged between 18 and 48 months (mean age = 28.3 months, SD = 9.6), identified with purposive sampling at a local government clinic in a peri-urban area of a large city. Typical reasons for child clinic attendance are immunizations, deworming, growth monitoring, and surveillance using the Road to Health Booklet (RTHB) developmental screen. The RTHB, mandated by the National Department of Health, is a record of a child's immunizations, health interventions, and growth, and includes developmental information for caregivers (Slemming & Bamford, 2018). The reference population was typically low risk for autism and generally regarded as typically developing as they were not assigned to high-risk clinics due to established risk and diagnosis. The inclusion of a low-risk population allowed us to truly assess the understanding of the constructs by participants without interference of additional developmental factors in the children, similar to the validation study of the M-CHAT-R/F (Robins et al., 2014). Participants had to identify Northern Sotho or Sepedi as the dominant language spoken in the household. They also had to be proficient in English, with Grade 4 reading ability, as per M-CHAT-R/F guidelines for caregivers who complete the checklist. In South Africa, English is identified as a dominant language in education, public office, and business (Posel & Zeller, 2016). The child's RTHB was perused to exclude a previously diagnosed health condition or developmental disability, but children with low birth weight and preterm birth were included. Additional descriptive information regarding the caregivers and the reference child population is included in Table 1.

The participant mothers all identified Northern Sotho as their home language, with 14% (n = 23) speaking an additional language at home. The home language diversity reflects the multilingual nature of South Africans. The use of purposive sampling may have contributed to a skewed gender sample, with more girls than boys in the reference population. Preterm birth in the referent sample (8.2%) is lower than the national preterm birth rate, but low birth weight (17.1%) is higher than the latest available statistic of 14.6% for Gauteng, the province where the study was conducted (National Perinatal Morbidity and Mortality Committee, 2016).

Table 1. Descriptive Information Regarding the Caregivers and the Reference Child Population.

Caregiver Population Characteristics (n = 158)	
Caregiver characteristic	Frequency (%)
Additional home language (n = 23)	
IsiNdebele	2 (8.7)
IsiXhosa	1 (4.3)
IsiZulu	1 (4.3)
Sesotho	2 (8.7)
Setswana	4 (17.4)
Siswati	1 (4.3)
Xitsonga	8 (34.9)
Other	4 (17.4)
Maternal education	
Primary school only (4–7 years)	4 (2.5)
Grade 9	38 (24.1)
Grade 12	104 (65.8)
Bachelor's degree	12 (7.6)
Age	
≤37 years	151 (95.6)
≥38 years	7 (4.4)
Reference child population characteristics (n = 158)	
Age (child)	
18–23 months	53 (33.5)
24–35 months	53 (33.5)
36–48 months	52 (33.0)
M = 28.3 months	
Mdn = 24.0 months	
SD = 9.6 months	
Gender	
Male	57 (36.1)
Female	101 (63.9)
Pregnancy duration	
≤36 weeks	13 (8.2)
≥37 weeks	145 (91.8)
Birth weight	
≤2,499 g	27 (17.1)
≥2,500 g	131 (82.9)
Apgar score (10 min)	
0–6	15 (9.5)
7–10	143 (90.5)

Materials

Four instruments were used in the research study. A sociodemographic questionnaire with questions relating to the child's developmental and medical history, developmental risk factors, and current living conditions were used for comprehensive participant description.

Both the adapted English M-CHAT-R/F and the Northern Sotho M-CHAT-R/F were used. The Vineland-3 Comprehensive Parent/Caregiver Form (Sparrow et al., 2016) was used to obtain information relating to the child's current level of functioning based on parental report and to further exclude children with diagnosed genetic and neurological conditions or sensory disorders. The Vineland-3 communication and socialization sub-domains were used to investigate the concurrent validity of the two M-CHAT-R/F versions.

The English M-CHAT-R/F adaptation was conducted prior to the pilot study. Based on the expert panel's recommendations, four adaptations were made to checklist items (Vorster et al., 2022). Items 3, 4, and 9 were adapted due to unfamiliar constructs in the Northern Sotho culture which appear in the original checklist. "Soft toys," "playground equipment," and "make-believe" were replaced with more familiar, yet similar concepts, "toys," "trees," and "act." Item 14, relating to the child's eye contact was adapted from "Does your child look you in the eye when you are talking to him or her, playing with him or her, or dressing him or her?" to "look in your direction or in the eye" to compensate for the local customary avoidance of eye contact with an elder. In some Southern African cultures, direct eye contact with an elder or superior is perceived as disrespectful behavior (Mncwango, 2009). No changes were made to the format of the initial 20 items or the Follow-up section. The Northern Sotho M-CHAT-R/F was created by translating the adapted English version to Northern Sotho. The scoring of both checklists remained as described in the M-CHAT-R/F (Robins et al., 2018).

The Vineland-3 Comprehensive Parent/Caregiver Form (Sparrow et al., 2016) is a reliable instrument to formally assess a child's level of functioning and adaptive behaviour based on parental report. The form was found to be reliable for use in South Africa in a recent study by Du Toit et al. (2021). The standardization of the third revision of the Vineland utilized a sample of 2,560 individuals from different contexts and different diagnoses. The test–retest reliability showed an r value ranging from .64 to .94. Corrected correlations were used to measure the reliability (.61 to .87) representing strong correlations (Pepperdine & McCrimmon, 2018). The parent/caregiver form includes four subdomains, Communication, Daily Living Skills, Socialization, and Motor Skills. For this study, the Motor skills subdomain was omitted as it does not contribute to the Adaptive Behavior Composite score (ABC score). The ABC score is determined by calculating the sum of the three subdomain standard scores (Communication, Daily Living Skills, and Socialization) and allows for the description of the current level of functioning of an individual. The descriptors of child functioning are categorized into five groups: High (ABC score = 130–140), Moderately high (ABC score = 115–129), Adequate (ABC Score = 86–114), Moderately low (ABC score = 71–85), and Low (ABC score = 20–70). A score below 86, at the 90% confidence interval, is indicative of a developmental delay. Adaptive behavior scores are fundamental to the diagnosis of intellectual disability and developmental delay. The scores may not be definite of autism, but there are noticeable patterns of results, especially in Communication and Socialization. When combining the Vineland-3 with other diagnostic measures, the Vineland-3 is a valuable component of an autism evaluation as children with autism demonstrate lower levels of adaptive functioning. (Peters & Matson, 2019; Sparrow et al., 2016). The study thus employed a combined method using both an autism-specific screen and a developmental assessment instrument (Vineland-3), as recommended by other researchers (Barger et al., 2021; Wiggins et al., 2014).

Procedures

The two versions of the M-CHAT-R/F were prepared and numbered to ensure random variation in the presentation of the two checklists to participants. Both versions of the M-CHAT-R/F were self-completed by participants in the predetermined randomized order to prevent a learning effect between the two checklists and fatigue influencing the accuracy of a specific checklist's responses. Once both versions of the M-CHAT-R/F were completed, the first author asked the Vineland-3 questions to participants in an area separate from the mothers waiting in line at the clinic. The structured questions were asked in a short interview, instead of self-completed, to ensure accurate understanding, limit fatigue in participants, and shorten the time of the data collection session. The sociodemographic questionnaire was self-completed last as the questions were the least complex. Finally, the author asked whether the participant preferred a specific version of the M-CHAT-R/F as part of a needs assessment. Determining the language preference may provide an indication of the necessity of a Northern Sotho translation as the adapted English version already includes the necessary cultural adaptations. Refreshments were offered to participants following the completion of the set of instruments. After completion by the mothers, the screening checklists were scored immediately so that the Follow-up questions could be asked to the mother in case of a medium risk score, and referrals could be made in case of a high risk for autism score. Parents of the children identified with developmental delay received a referral letter and contact details of the relevant specialists in both public and private health sectors.

Data Processing and Analysis

The raw data from the instruments were scored according to the guidelines described in the test manuals. The M-CHAT-R/F scores were categorized as low risk (0–2) [Pass], medium risk (3–7) [Refer], and high risk for autism (≥8) [Refer]. If a child scored in the medium-risk category, the mandatory follow-up questions were posed to participants. A high-risk score required direct referral to a specialist. The Vineland-3 data were processed by determining the v-scale score, the age equivalent, and the growth scale value. The sum of the v-scale score was used to determine the standard score of each subdomain. The sum of the standard scores was used to determine the ABC score identifying the presence or absence of developmental delay, with an ABC score below 86 indicating a delay. Concurrent validity was investigated by determining the biserial correlations using the M-CHAT-R/F outcome in both English and Northern Sotho as well as the Communication and Socialization subdomains of the Vineland-3. The Communication and Socialization domains were investigated in particular as core symptoms of autism are typically evident in these domains.

The data were populated in a Microsoft Excel spreadsheet to be analyzed using descriptive statistical analyses and SPSS. Cronbach's alpha (internal consistency, .7–.9), Cohen's kappa, initial frequencies, Pearson's chi-square, item-level analysis, and cross-tabulation were used to investigate the reliability and validity of the two checklists. An item analysis was conducted to calculate the percentage of children who failed each item.

Results

Preferred Language Options

After completion of the two checklists, the 158 mothers of children aged between 18 and 48 months were requested to choose their preferred language option. A marginal majority (*n* =

87; 55.1%) chose Northern Sotho as the preferred language in which they wanted to complete the M-CHAT-R/F, whereas the remaining (n = 71; 44.9%) chose English.

Referral Rate and Item Analysis

Despite a few differences, the comparison of the adapted English and the Northern Sotho M-CHAT-R/F showed near-perfect agreement with a significant association ($p < .001$) between the two versions. Figure 1 illustrates the risk categories of the two checklists, before and after the Follow-up questions were posed to the participants.

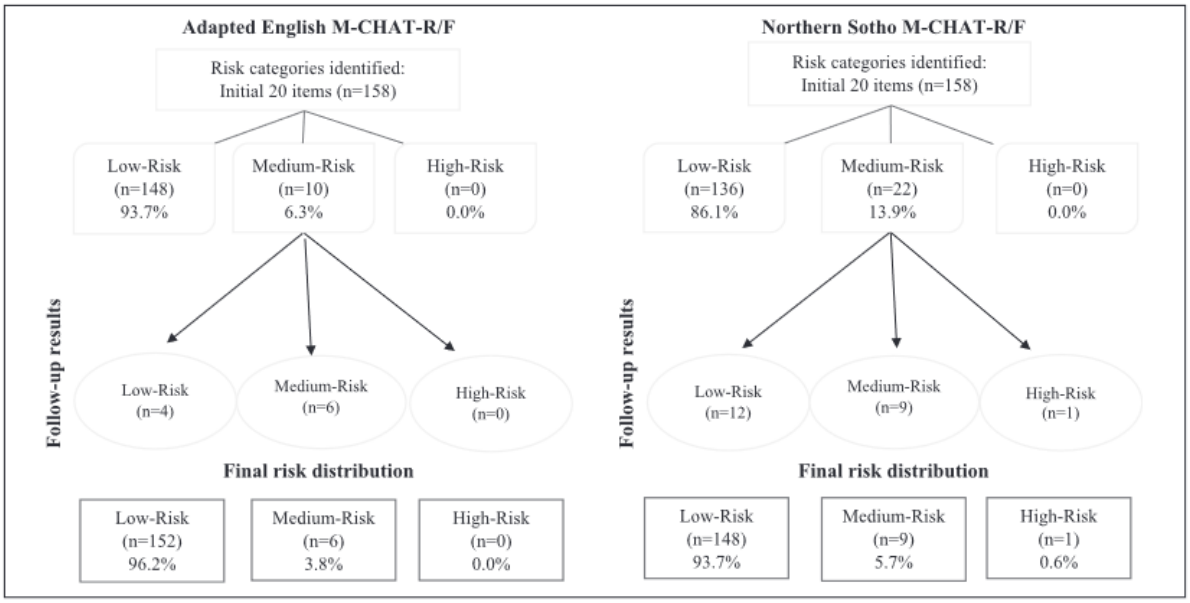

Figure 1. Risk Categories.

Following the M-CHAT stepwise screening procedure, and as expected from a low-risk sample, no child was identified as high risk for autism with the initial 20-item screen. The Follow-up questions were asked to mothers whose children obtained a medium risk for autism score of 10 (6.3%) children with the English screen, and 22 (13.9%) children with the Northern Sotho screen. The final risk distribution showed that more children moved to the low-risk category, with only six (3.8%) on the English screen and nine (5.9%) children on the Northern Sotho screen in the medium-risk category after the prescribed Follow-up questions were asked. The Northern Sotho M-CHAT-R/F had a slightly higher referral rate (n = 10; 6.3%) than the adapted English screen (n = 6; 3.7%). With the English screen, no high-risk cases were identified, whereas a single high-risk toddler was identified with the Northern Sotho checklist. The child was referred to the high-risk clinic of the local tertiary hospital to be assessed by a pediatric neurologist; the outcome was still unknown at the time of submission of the article.

Item-level analysis was conducted to gain insight into the reliability and concurrent validity of both M-CHAT-R/F versions. All 158 data sets were used for the item-level analysis (see Table 2). Seven items, from the total of 20, showed perfect agreement between the adapted English checklist and the Northern Sotho M-CHAT-R/F. Thirteen items showed response differences between the two tests. Ten of the 13 items showed near-perfect agreement with ≥95% agreement between the two checklists. The items with the greatest

number of differences were Item 11, with a 6.3% difference in answer distribution, and Items 12 and 5 that showed a 12.5% and 13.3% variation, respectively.

The item response comparison was further analyzed to show within-group results to determine the equivalence and inter-rater reliability between the adapted English and the Northern Sotho M-CHAT-R/F for each age group. The analysis was also conducted to verify whether specific items were less reliable for certain age groups as the child's age, and therefore the developmental level, could influence how mothers answered the questions. The oldest group, the 36- to 48-month-old sample, presented with greater disagreement between the two language versions of the checklist, with more than two data sets presenting with a difference in seven items compared with the six items for the other two age groups. The two younger groups presented with a higher level of agreement.

Items 5 and 12 were the two items showing the most salient disagreement in responses between the two checklists and across the three age categories. Item 5 "Does your child make unusual finger movements near his or her eyes? (For example, does your child wiggle his or her fingers close to his or her eyes?" showed the highest disagreement (13.3%). Participants frequently mentioned that the child rubs their eyes, possibly indicating an irritation in the eyes or drowsiness, and responded "Yes" to the question in the Northern Sotho version. It appears that the typical autistic behavior of unusual finger movements close to the eyes (finger flicking), was confused with eye rubbing. Item 12

Table 2. Comparison of Item Responses and Percentage Disagreement Between Adapted English M-CHAT-R/F and Northern Sotho M-CHAT-R/F.

	Adapted English		Northern Sotho		
Item	Yes	No	Yes	No	% disagreement
1	157	1	157	1	**0.0**
2	4	154	9	149	3.7
3	154	4	151	7	1.9
4	149	9	144	14	3.7
5	34	124	55	103	13.3[a]
6	156	2	153	5	1.9
7	158	0	156	2	1.3
8	153	5	153	5	**0.0**
9	153	5	152	6	0.6
10	155	3	156	2	0.6
11	158	0	148	10	6.3[a]
12	34	124	54	104	12.7[a]
13	158	0	158	0	**0.0**
14	157	1	157	1	**0.0**
15	157	1	157	1	**0.0**
16	155	3	155	3	**0.0**
17	153	5	153	5	**0.0**
18	154	4	155	3	0.6
19	156	2	152	6	2.5
20	154	4	148	10	3.8

Note. M-CHAT-R/F = Modified Checklist for Autism in Toddlers–Revised with Follow-up. Items in bold had perfect agreement.

[a]Three items with the greatest disagreement

"Does your child get upset by everyday noises? (For example, does your child scream or cry to noise such as a vacuum cleaner or loud music?)" resulted in 12.7% disagreement. With both items, more participants indicated "Yes" in Northern Sotho and "No" in the adapted English checklist version. Interestingly, 24.1% of the data sets that showed variation of Item 5 were due to first-time caregivers. Despite the few instances of disagreement, the majority of items with more agreement supports the preliminary reliability and equivalence between the two versions, indicating the internal consistency of the adapted English checklist and the Northern Sotho M-CHAT-R/F.

Internal Consistency

Similar to the item-level analysis, the internal consistency of the total sample, a measure of reliability, was determined for both checklists. The internal consistency for the total sample (n = 158) of the adapted English screen was Cronbach's $\alpha = .251$ which was lower than the .543 of the Northern Sotho checklist, and the expected .7 to .9. With further investigation of the different age groups, internal consistency improved for some groups compared with the overall value. The adapted English checklist showed a stronger value for the 24- to 35-month-old sample, with a Cronbach's $\alpha = .446$. The internal consistency for the 18- to 23-month-old sample of the English adaptation was low, with .101 and .008 for the oldest group. The Northern Sotho version showed stronger internal consistency for the 18- to 23-month ($.655 \approx .7$), 24- to 35-month (.359) and 36- to 48-month (.526) groups. The greater internal consistency observed with the Northern Sotho checklist aligns with the participants' preference for the Northern Sotho version (55.1%).

Concurrent Validity

The Vineland-3 results were not only used to identify developmental delays and risk for autism in the referent population, but also to investigate the concurrent validity of the two M-CHAT-R/F versions. A significant association between the Northern Sotho M-CHAT-R/F and the Vineland-3 sub domains of communication (0.028) and socialization (0.044) was evident at the 5% level, thereby supporting concurrent validity. The adapted English M-CHAT-R/F did not present with any significant association as shown in Table 3. No association was found between the overall Vineland-3 outcome (ABC-score) and preterm **birth and low birth weight, respectively.**

Table 3. Concurrent Validity of M-CHAT-R/F Checklists and the Vineland-3.

Checklist version	Sub-domain	Biserial Correlation	*p* value
Northern Sotho M-CHAT-R/F	Communication	0.276	.0278*
	Socialization	0.2572	.0436*
Adapted English M-CHAT-R/F	Communication	0.2414	.1211
	Socialization	0.2827	.07

Note. M-CHAT-R/F = Modified Checklist for Autism in Toddlers–Revised with Follow-up.

*Significant association at 5% level.

Age Effect

Using the Pearson's chi-square, a significant age effect ($p < .001$) was evident with the Vineland-3 overall outcome. The youngest age group showed five (9.4%) children with developmental delay followed by 23 (43.4%) children in the 24- to 35-month group. The oldest group showed the greatest number of children with developmental delay ($n = 25$; 48.1%). Overall, 53 (33.5%) of children showed developmental delay. No age effect was evident with the two M-CHAT-R/F versions.

Discussion

A marginal majority of participants preferred the Northern Sotho checklist over the culturally adapted English version. The Northern Sotho language preference may be linked to better comprehension as it was the self-identified home language of the participants (Mophosho et al., 2019). A total of 44.9% participants indicated a preference for the adapted English checklist, showing that both versions of the South African M-CHAT-R/F will be used, with the possibility of greater use of the adapted English checklist by other language groups as English is the predominant language of learning and teaching in South Africa (Posel et al., 2022).

The referral rates of the adapted English checklist and Northern Sotho M-CHAT-R/F showed near-perfect agreement ($p < .001$). The two versions also displayed similarities with the M-CHAT-R/F validation study. With the large-scale validation study of 16,115 participants, 92.6% of children had a negative screening outcome after completion of the initial 20 items (Robins et al., 2014). The results of this study align well with the initial M-CHAT-R/F validation study where 93.7% ($n = 148$) of children passed the adapted English version prior to Follow-up while 86.2% ($n = 136$) of children passed the Northern Sotho M-CHAT-R/F. However, the distribution of the Northern Sotho child risk categories post-Follow-up were more similar to the initial validation study with 93.7% negative screen outcome than the adapted English version (96.2%).

The item-level analysis showed perfect agreement and near-perfect agreement between 17 items of the two M-CHAT-R/F versions. The equivalence between the two versions is similar to the pilot study results (Vorster et al., 2021). Only three of the 20 items (Items 5, 11, and 12) showed slight variations between the Northern Sotho and the adapted English versions, with Item 11 displaying 90% agreement in the pilot study and 93.7% agreement in this study (Removed for blind peer review). The variations in Items 5 and 12 became apparent in the current larger scale study. Consistent with Northern Sotho being the preferred language in which participants wanted to complete the screen (55.1%), the Northern Sotho M-CHAT-R/F also showed higher internal consistency (Cronbach's $\alpha = .543$) than the adapted English checklist. A recent study reported that participants showed improved comprehension in their home language when answering questions that require in depth knowledge of their child's behavior (DuBay, 2020). Therefore, better understanding of questions could have played a role in the higher internal consistency that was observed in the Northern Sotho version when compared with the English adaptation.

The confirmed equivalence in this study between the adapted English M-CHAT-R/F and the Northern Sotho M-CHAT-R/F permitted further investigation by considering internal consistency as a measure of reliability (Field, 2009). The internal consistency for each checklist was lower than the expected .7 to .9. A lower Cronbach's alpha value could be anticipated as the 20 M-CHAT-R/F items are not closely related as a group. The checklist does not investigate a unitary dimension as three items indicate a risk for autism if the answer

is “Yes,” whereas the remaining 17 items indicate a risk score when the answer is “No” (Robins et al., 2014). The higher internal consistency of the Northern Sotho M-CHAT-R/F (.543) may be ascribed to the stronger preference for Northern Sotho. The internal consistency values of the Northern Sotho M-CHAT-R/F results for the 18 to 23 months (0.66) and 36 to 48 months (0.53) age groups were more similar to the initial validation study of the M-CHAT-R/F (.63; Robins et al., 2014). The reverse coding of the responses for Items 2, 5, and 12 may have resulted in higher Cronbach’s alpha values for the adapted English checklist (.45). A possible explanation for the low Cronbach’s alpha (less than the ideal .7 to .9) may thus be the specific binary dimension inherent in the M-CHAT-R/F.

Further evidence of the performance of the Northern Sotho checklist was found in the significant association between the Northern Sotho M-CHAT-R/F and the Vindeland-3 subdomains. This is indicative of the concurrent validity of the Northern Sotho M-CHAT-R/F with the Vineland-3 Communication and Socialization subdomains, which are typically affected in children with autism. The adapted English M-CHAT-R/F was not significantly associated with the outcome of two subdomains. It can be concluded that the Northern Sotho M-CHAT-R/F presented with higher validity although both instruments were shown to be reliable.

Based on the reliability and validity results of the study, final changes were made to both checklists. Clarification was included for Item 5, adding the phrase “not rubbing the eyes” to the explanation in both checklists. Participants appeared to confuse unusual finger movements near their eyes with eye rubbing, possibly being unaware of the association between autism and stimming using one’s fingers and/or hands (Lilley, 2017). The pronouns used in the adapted English version were changed from “he/she” to “they” and “his/her” to “them” to include gender-neutral terminology. This change was not incorporated in the Northern Sotho M-CHAT-R/F as pronouns are gender-inclusive in Northern Sotho (Franko Aixela, 2009). The South African Culturally Adapted English M-CHAT-R/F and the Northern Sotho M-CHAT-R/F are available upon request from the first author.

This study also indicated the feasibility of combining autism-specific screening with developmental assessment, using the Vineland-3 to support identification of autism, intellectual and developmental disabilities, and developmental delay. The results of the parent-reported Vineland-3 assessment showed that a high number (33.5%) of participants’ children, particularly the older age group, had developmental delay. A recent study in the same peri-urban area in South Africa also found a high prevalence of developmental delay among children, with more delays in an older age group. In this study, the mHealth Parents’ Evaluation of Developmental Status (PEDS) tools and the Vineland-3 were used to assess 3- to 7-year-old children (Du Toit et al., 2021). Based on the results of this study and international trends, the use of an autism-specific screening instrument in combination with developmental assessment or screening is recommended (Barger et al., 2021; Wiggins et al., 2014). The combined approach may promote early identification of autism and developmental delay at the same time. Further research is required.

Limitations

The sample size of the study was smaller than expected due to limited access to the data collection site during the different COVID-19 lockdown levels. Due to an overburdened health system, diagnostic confirmation of the referred case was not possible, limiting the investigation of sensitivity and specificity of the two checklists.

Recommendations for Future Research

A large-scale study with confirmation of an autism diagnosis in participants is required to determine the sensitivity and specificity of the adapted English and Northern Sotho M-

CHAT-R/F versions. A comparison with the original M-CHAT-R/F is recommended for further confirmation of the sensitivity and specificity of the two new checklists. Future research may investigate whether the M-CHAT-R/F can discriminate between disability categories when various disability populations with social communication deficits are screened in different cultural groups. Conducting a similar study in a rural setting, including a different population, may also be considered.

Conclusion

The study showed the reliability and concurrent validity of the adapted English M-CHAT-R/F as well as the Northern Sotho M-CHAT-R/F. The Northern Sotho M-CHAT-R/F showed slightly more significant psychometric properties. The South African culturally adapted and translated checklists for autism are now available for use. A combined approach of autism screening and developmental assessment is strongly recommended. It is anticipated that the new screening tools may contribute to improved access to care for more children. The checklists may contribute to decrease the average age of autism identification, opening the pathway to diagnosis, and improved long-term outcome for children with autism in South Africa. The study contributes to an emerging body of research on the development of contextually appropriate screening measures.

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