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Psychometric Properties of the Arabic Vanderbilt Children's ADHD Diagnostic Rating Scale (VADRS-A) in a Saudi Population Sample

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Abstract

Objective: This study aimed to utilize Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA) to investigate the constructive validity of the Arabic translation of the Vanderbilt Attention Deficit/Hyperactive Disorder (ADHD) Diagnostic Scale (VADRS-A) using its two versions, the Arabic Vanderbilt ADHD Diagnostic Parent Rating Scale (VADPRS-A) and the Arabic Vanderbilt ADHD Diagnostic Teacher Rating Scale (VADTRS-A).

Method: A descriptive research design was employed. Children were assessed by their parents and teachers, and a cluster sample of 1812 participants was chosen from many schools in Saudi Arabia, divided into two groups: parents (504) and teachers (1308) of children whose ages ranged between 5 to 12 years old. The VADPRS-A and VADTRS-A were administered to parents and teachers under the supervision of the Saudi ADHD Society.

Results: The results of the PCA of VADPRS-A found that the six factors saturate one general factor that explained (59%) of the total variance of the factor matrix with eigenvalues (3.540). Similarly, the PCA of VADTRS-A demonstrated that the five factors were saturated on a general factor that explained (69.20%) of the total variance of the factor matrix with eigenvalues (3.460). Also, the results indicate the high internal consistency of VADPRS-A and VADTRS-A, all factors correlated together and the total scores positively and significantly statistically ($p>.001$) correlation coefficients ranged between (0.296 to 0.843) for VADPRS-A, and ranges between (0.432 to 0.939) for VADTRS-A. Also, the Cronbach's α coefficient values for the six factors and total score of VADPRS-A were (.906, .925, .900, .896, .853, .872, .959) respectively, and these values are close to the values of the McDonald's ω for the factors and the total score were (.908, .923, .901, .871, .850, .877, .925) respectively. In the same way, Cronbach's α coefficients were (.967, .921, .914, .858, .948, .971) for all factors and the total score of VADTRS-A respectively, and these values are close to the values of the McDonald's ω (.968, .921, .919, .856, .943, .965) for all factors

and the total score of VADTRS-A. In addition CFA for VADPRS-A and VADTRS-A models showed acceptable factor loading and good values of goodness-of-fit indices; CFI, TLI, RMSEA, IFI, and GFI (0.956, 0.942, 0.049, 0.956, 0.952) respectively for VADPRS-A model, and were (0.958, 0.932, 0.051, 0.963, 0.964) for VADTRS-A model, all of these were at an acceptable range. These results suggest a fit with the previous theoretical literature about VADPRS and VADTRS and DSM-5 and ICD-11 criteria of ADHD.

Conclusion: These findings highlighted the good psychometric properties of VADRS-A in both its versions VADPRS-A and VADTRS-A in the Saudi environment. Due to these findings, we suggest utilizing VADPRS-A and VADTRS-A during ADHD diagnosis in children 5-12 years old in Saudi Arabia, to facilitate early diagnosis and intervention, and to help mitigate the risks of ADHD during subsequent developmental phases in children's lives.

Keywords: ADHD, Children, VADPRS, VADTRS, Parent, Teacher, Saudi Arabia

Introduction

ADHD is a prevalent neurobehavioral condition in school-age children, leading to difficulties in school tasks and daily activities. As per the Diagnostic and Statistical Manual of Mental Disorders (1) and the International Classification of Diseases (2), ADHD is classified as a neurodevelopmental disorder that involves a pattern of inattention symptoms and/or a mix of hyperactivity and impulsivity symptoms that exceed the expected range for age and intellectual development, persisting for at least 6 months. Both the DSM-5 and ICD-11 agree that diagnosing ADHD requires meeting a set of criteria related to attention deficit and impulsivity/hyperactivity behaviors, with the child displaying 6 of the 9 criteria in two settings (e.g., home or school) for a minimum of 6 months.

ADHD is described by two diagnostic criteria defined in the DSM-5 and ICD-11: Attention-Deficit/Hyperactivity Disorder refers to a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with performance or development, as manifested by (a) and/or (b):

(a) Inattention: Six or more of the following symptoms that have persisted for at least six months to a degree that is inconsistent with the developmental level and that directly and negatively affects social and occupational/academic activities: often fails to pay careful attention to detail or makes careless mistakes in homework, at work, or in other activities; often difficult for him to maintain attention while performing work or doing activities; often appears not to be listening when spoken to directly; often does not follow instructions and fails to finish homework, daily routines, or practical duties; often has difficulty organizing tasks and activities; often avoids, dislikes, or is reluctant to engage in tasks that require sustained mental effort; often loses items necessary to carry out his tasks and activities; often easily distracted by an external stimulus; is very forgetful in daily activities (1, 2).

(b) Hyperactivity-Impulsivity: Six of the following symptoms persisted for at least six months to a degree that does not correspond to the developmental level and that directly and negatively affects social and occupational/academic activities: Children often show fidgety movements of hands or feet or squirm in their chair; Often leave their seats in situations where they are expected to remain seated; often run or climb in inappropriately; often have difficulties playing or quietly engaging in recreational activities; Often agitated or act as if "driven by a motor"; often talk excessively; often rush to answer before completing the questions; often find it difficult to wait their turn; often interrupt or involve themselves in others' affairs (1, 2). Furthermore, symptoms of hyperactivity-impulsivity or inattention must exist or have existed before the age of 12, and must have been present in two or more environments (at school and home, with friends or relatives, or other activities). There must be clear evidence of symptoms interfering with and/or decreasing the quality of social, academic, or occupational functioning. The symptoms must not occur exclusively in the context of schizophrenia or another psychotic disorder and are not better explained by a mental disorder (e.g., mood disorder, dissociative disorder, personality disorder, substance intoxication, or withdrawal) (1).

ADHD is linked to poor academic performance, emotional instability, behavioral issues, and a lack of self-control. These factors make it challenging for ADHD children to adapt to the school environment and its demands, increasing their susceptibility to developing other psychological disorders. ADHD is recognized as one of the most prevalent disorders in child and adolescent psychiatry. Studies indicate that around 70% of children with ADHD continue to exhibit symptoms of the disorder during adolescence, with 30% of them carrying these symptoms into adulthood.

There is no clear and precise cause of ADHD; however, numerous studies have found a link between ADHD and certain factors (3). Pharmacological treatment is effective in managing symptoms; nevertheless, it does not replace behavioral and educational therapy (4). ADHD is associated with a deficiency in the number of neurotransmitters (dopamine, noradrenaline) in the

frontal cortex (frontal lobe) that enable cells to perform their functions and communicate within the brain's periphery (5).

Internationally, previous research has indicated that the pooled prevalence of ADHD among children worldwide is 5.29% to 7.6% (6, 7).

In the Arabian Gulf region, a systematic review and meta-analysis reported a prevalence rate of 5.9% (8). A systematic review and meta-analysis by Chan et al. (9) reported a regional pooled prevalence rate of around 13% for studies using the Vanderbilt ADHD Rating Scale; while a systematic review conducted by Alhraiwil et al. (10), indicated that prevalence rates in Arab countries varied from 1.3-16% (hyperactive-impulsive ADHD 1.4-7.8%, primarily inattentive ADHD 2.1-2.7%).

In a systematic review of prevalence studies conducted in Saudi Arabia, Aljadani et al. (11) identified the prevalence rates of Inattentive and Hyperactive-Impulsive ADHD as 2.9% and 2.50%, respectively. Wide variation exists between studies conducted in different regions of Saudi Arabia. For example, in a study by Alqahtani (12) on 708 elementary school students the prevalence of ADHD in Saudi Arabia found to be 12.6%; Jenahi et al. (13) studied 1009 primary school students in Al-Khobar, Saudi Arabia, with a prevalence of 3.5%. While Abu Taleb and Farheen (14) examined primary school students in Sabia, Saudi Arabia, finding a prevalence of 13.5%. More recently, Al-Saedi et al. (15) reported that the overall prevalence of ADHD in the Makkah Region of Saudi Arabia was 52.50%.

Such variations in ADHD prevalence rates can be attributed to methodological heterogeneity such as the diverse assessment tools used (7, 16); while changes in diagnosis rates are also associated with administrative and clinical practice changes (17).

ADHD is diagnosed through a psychological evaluation, and it is valuable to support clinical judgment with parent and teacher reports using a standardized and validated rating scale (18); furthermore to exclude other potential causes or comorbidities, additional tests may be indicated (19). In North America, the DSM-5 criteria are the basis for clinical diagnosis and ICD-10-CM for billing and insurance purposes, while European countries typically rely on the international version of ICD-10 with many in the process of transitioning to ICD-11 (20). In Saudi Arabia, as well as New Zealand and Vietnam, the Australian ICD-10-AM is used for clinical coding (21).

One of the most widely used assessment tools for children is the Vanderbilt ADHD Diagnostic Rating Scale (VADRS) developed by the American Academy of Pediatrics (AAP). It is a comprehensive tool used by both parents (VADPRS) and teachers (VADTRS) to screen for symptoms of ADHD in children and adolescents in various settings. The Vanderbilt Scale consists of two main parts, assessing core ADHD symptoms such as inattention, hyperactivity, and impulsivity, as well as other relevant domains related to childhood behavior disorders like oppositional-defiant behavior, conduct disorder, and anxiety/depression. To establish that a child meets diagnostic ADHD criteria, there is an additional functioning subscale consisting of eight items that examine academic performance and relationships (22).

The current study

Significant discrepancies exist between pediatricians' clinical practice and the American Academy of Pediatrics' (AAP) Guidelines regarding the assessment of children with ADHD (23). Therefore, it is crucial to offer a valid and reliable tool to aid medical professionals in diagnosing children and making treatment decisions. This is essential due to the rising prevalence of ADHD, particularly among primary school-aged children. As a result, the AAP (24) has introduced resources to support clinical practitioners in diagnosing and managing ADHD symptoms in children and has developed an evidence-based clinical practice guideline for treating school-aged children with ADHD.

Specialists may encounter challenges when diagnosing ADHD, as applying scales to certain children with this disorder can be difficult. Therefore, they may turn to evaluation scales aimed at caregivers such as parents, teachers, or other stakeholders. The unpredictable behavior of some children can lead to confusion and disrupt the evaluation process (25). Each child should undergo a comprehensive assessment that considers the presence and severity of symptoms in various situations, the onset and duration of symptoms, the nature and extent of dysfunction, the impact of ADHD on the family, and the child's psychological, behavioral, social, and academic well-being (26, 27).

The study conducted by Alqahtani (28) on primary school children in the Kingdom of Saudi Arabia revealed that ADHD children exhibited high rates of poor academic achievement (63%) and social deficits (90%) compared to non-ADHD children. These adverse effects of ADHD on children's academic and social functioning underscore the importance of early diagnosis and treatment to mitigate such impacts. This underscores the need for the creation of assessment tools with strong psychometric properties for diagnostic use.

Sürücü and Maslakçı (29) emphasized that for studies to produce valuable results, the assessment tools utilized must exhibit strong psychometric properties of validity and reliability. These two qualities are essential because a study conducted with

an assessment tool that lacks validity and reliability will not generate meaningful results. Therefore, researchers are required to assess the validity and reliability of the measurement instrument they plan to use, ensuring that it meets these criteria. Failure to do so will hinder researchers from accurately interpreting the outcomes of their research.

Validity pertains to the assessment tool's capability to fulfill its intended purpose and accurately measure the targeted characteristic. Additionally, another crucial psychometric property that an assessment tool should possess is stability. Reliability signifies the consistency of the measured values obtained through repeated assessments conducted under the same conditions using the same evaluation tool (30).

Many studies have been conducted to verify the psychometric properties of the various versions of VADPRS and VADTRS (31–35). However, no national survey has investigated VADRS-A validity and reliability on a general population sample in the Kingdom of Saudi Arabia. Therefore, the current study aimed to test the constructive validity of the newly-translated VADRS-A in Saudi Arabia in order to provide specialists with a validated assessment tool for ADHD in children in Saud Arabia.

Methods and Materials

Methods

From 26 January to 24 June 2023, following the required approvals, the research team visited a random selection of schools, surveyed a random sample of parents and teachers, and applied the VADRS-A. Data was collected through a national survey using a descriptive approach to validate the VADRS. Two versions of VADRS-A were used, one for parents and the other for teachers of children aged 5-12.

Participants of the study

After obtaining institutional approvals to conduct the study, a cluster sample from many schools in Saudi Arabia involving 1812 participants, comprising both Saudis and non-Saudis, from Riyadh, Makkah Al-Mukarramah, and the Eastern Province of Saudi Arabia. Of these participants, 504 parents and 1308 teachers assessed their children's (aged 5 to 12 years old) behaviors who are students from Kindergarten to 6th grade. The participants' ages ranged from 25 to 60 years old (37.548 ±7.630). They were given a test and an ethical approval form to obtain their consent to participate in this study.

The study had a participation rate of 86.80%, with 80.63% being Saudi nationals and 19.37% non-Saudis, while 13.20% declined to participate for reasons such as not having children in the specified age group, lack of time, or unwillingness to share their data (Table 1). Participation in the study sample of parents and teachers was voluntary after providing them with information about the purpose of the study, and they were informed that they could withdraw from participating in this study.

TABLE 1. Sociodemographic characteristics of participants (parents+ teachers).

Sociodemographic Variable	*N (%)*
Gender	
Male	953 (52.59%)
Female	859 (47.41%)
Region	
Riyadh	810 (44.70%)
Makkah Al-Mukarramah	509 (28.09%
Eastern Province	493 (27.21)
Nationality	
Saudi	1461 (80.63%)
Non-Saudi	351 (19.37%)
Age	
Younger than 30 years old	256 (14.13%)
30- 35 years old	505 (27.87%)
36- 40 years old	336 (18.54%)
41- 45 years old	323 (17.83%)
46- 50 years old	214 (11.81%)
51- 55 years old	154 (8.50%)
Older than 56 years old	24 (1.32%)
Children age	
5- 6 years old	236 (13.02%)
7- 8 years old	493 (27.21%)
9- 10 years old	487 (26.88%)
11- 12 years old	596 (32.89%)

Measures

Although VADRS was originally designed for DSM-4 criteria, it remains compatible with the current DSM-5 for diagnosing ADHD, Oppositional defiant behavior, and conduct disorder in children, as the diagnostic criteria have not changed between versions (31). The Saudi ADHD Society translated the VADRS into the Arabic Language VADRS-A. This translated version (VADRS-A) has been used for this study.

VADRS comprises two versions: one for parents, with 56 items across 6 dimensions (Vanderbilt Attention Deficit/Hyperactive Disorder Parent Rating Scale-VADPRS), and the other for teachers, with 43 items across 5 dimensions (Vanderbilt Attention Deficit/Hyperactive Disorder Teacher Rating Scale-VADTRS).

Vanderbilt's Attention Deficit/Hyperactivity Disorder Parent Rating Scale (VADPRS) comprises 56 items, including 18 ADHD symptom items based on DSM-IV criteria (9 for inattention and 9 for hyperactivity/impulsivity). It also includes subscales for screening 8 oppositional-defiant behavior items, 14 conduct disorder behavior items, and 7 anxiety or depression behavior items. Additionally, there is a

functioning subscale with 8 items assessing performance and relationships on a 5-point scale (1 = above average performance, 5= problematic performance). Due to this structure, it is not feasible to incorporate all subscales into a single model.

Vanderbilt's Attention Deficit/Hyperactivity Disorder Teacher Rating Scale (VADTRS) comprises 43 items, including 18 ADHD symptom items (9 for inattention and 9 for hyperactivity/impulsivity) based on DSM-IV criteria. It also includes subscales for screening 10 oppositional-defiant behavior items and 7 anxiety or depression behavior items. Additionally, there is a functioning subscale with 8 items assessing academic performance and relationships on a 5-point scale (1 = above average performance, 5 = problematic performance).

In each VADPRS and VADTRS version items were assessed using a 4-point Likert scale [never (0), occasionally (1), often (2), very often (3)] in Predominantly Inattentive subtype, Predominantly Hyperactive/ Impulsive, Oppositional- Defiant Disorder, Conduct Disorder, Anxiety/ Depression. However, the subscale of Performance was assessed using a 5-point Likert scale [excellent (1), above average (2), average (3), somewhat of a problem (4), and problematic (5)].

Statistical Analysis

A Principal Component Analysis (PCA) and Confirmatory Factor Analysis (CFA) were applied to investigate the constructive validity performed by JASP0.18.3.0 software. According to Byrne & Russon (36), we focused on four fit indices to measure how well both VADPRS-A and VADTRS-A measurement models matched the data collected from the parents and teachers' sample: the X2 test, the comparative Fit Index (CFI), and the root mean square error of approximation (RMSEA). The RMSEA measures how well the model fits a properly fitted model, and values less than 0.05 - 0.08 are acceptable. The goodness of fit index (GFI) measures the fit between the hypothesized model and the observed covariance matrix. We also examined the adjusted goodness of fit (AGFI) indicating the proportion of variance accounted for the estimated population covariance. We also examined the adjusted goodness of fit (AGFI). The GFI should range between 0 and 1, and it is generally accepted that values of 0.90 or greater. Also, the reliability analysis of VADPRS-A and VADTRS-A tested by Cronbach's α coefficients and McDonald's ω coefficient were done by JASP 0.18.3.0 software.

Results

Verifying the factorial structure of VADPRS-A and VADTRS-A

Factorial structure of VADPRS-A

To verify the factorial structure of VADPRS-A, the researchers used the Principal Components Analysis (PCA) method by JASP0.18.3.0. The results of the Kaiser-Muller-Olkin test was (0.812), this value was greater than (0.05), which indicates the adequacy of the analysis sample, while the value of the Bartlett test was (1457.141, df=19, p<.001), thus the conditions for applying PCA are verified. Tables 2, and 3 show the results of the PCA of VADPRS-A.

TABLE 2. Factor characteristics of VADPRS-A.

Factor	*Eigenvalues*	*Cumulative %*
Factor 1	3.540	59.00

TABLE 3. Component Loadings of VADPRS.A.

Components	*VADPRS.A*
Oppositional defiant behavior	0.841
Inattention	0.832
Hyperactivity and impulsivity	0.791
Performance	0.753
Conduct disorder	0.720
Anxiety/ depression	0.655

The results of PCA of VADPRS-A with its six factors shown in Tables 2, and 3 are consistent with the theoretical literature of the VADPRS-A to diagnose the ADHD of children by their parents, and with the DSM and ICD criteria of ADHD. These results are confirmed by the scree plot representation of the factors shown in Figure 1.

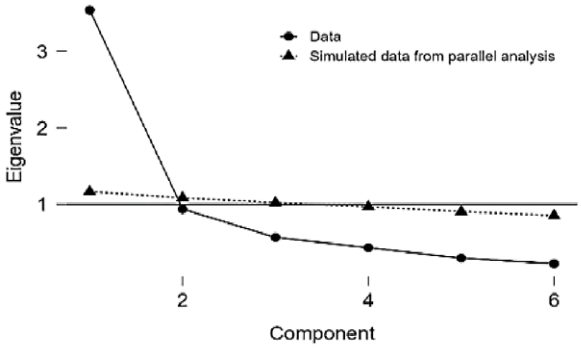

FIGURE 1 Scree plot representation of the latent root of the general factor of VADPRS-A.

Also, the PCA results of six factors of VADPRS-A shown in Table 2 revealed that the six factors saturate one general factor that explained (59%) of the total variance of the factor matrix with eigenvalues (3.540).

Also, the results shown in Table 3 and Figure 2 indicated that the most saturated factor was oppositional defiant behavior (0.841), then inattention (0.832), followed by hyperactivity and impulsivity (0.791), performance (0.753), conduct

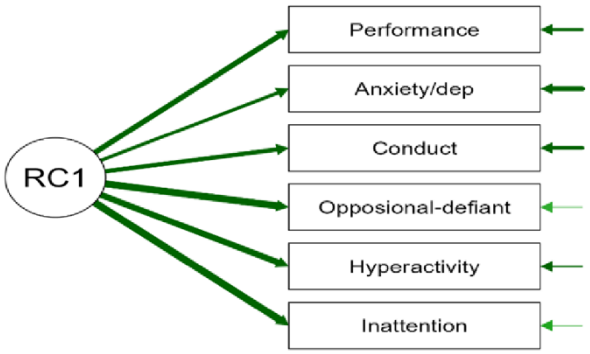

FIGURE 2. Component analysis of VADPRS-A.

disorder (0.720), and anxiety/ depression (0.655) respectively, that represented by the heavy green lines. The PCA results presented in Tables (2, and 3) are consistent with the theoretical aspect of the VADPRS-A, screening ADHD.

Factorial structure of VADTRS-A

To verify the factorial structure of VADTRS-A, the PCA was performed by JASP0.18.3.0. The results of the Kaiser-Muller-Olkin test was (0.80), this value was greater than (0.05), which indicates the adequacy of the analysis sample, while the value of the Bartlett test was (4376.309, df=10, p <.001), thus the conditions for conduct PCA are met. Tables 4, and 5 presented the results of the PCA of VADTRS-A.

TABLE 4. Factor characteristics of VADTRS-A.

Factor	*Eigenvalues*	*Cumulative %*
Factor 1	3.465	69.20

TABLE 5. Component Loadings of VADPRS.A.

Components	*VADTRS-A*
Inattention	0.916
Performance	0.856
Hyperactivity and impulsivity	0.839
Oppositional defiant behavior	0.811
Anxiety/ depression	0.722

The results presented in Tables 4, and 5 of the PCA of VADTRS-A are consistent with the previous theoretical aspect reported of VADTRS-A, that we can diagnose ADHD by five factors assessed by the teachers. The scree plot in Figure 3 of VADTRS-A confirmed these results.

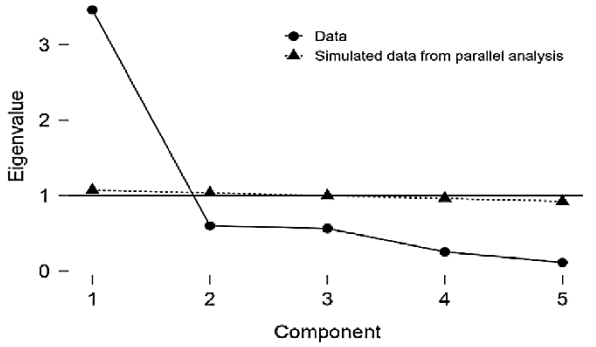

FIGURE 3. Scree plot representation of the latent root of the general factor of VADTRS-A.

Also, the results of the PCA of VADTRS-A shown in Table 4 revealed that the five factors saturated on a general factor that explained (69.20%) of the total variance of the factor matrix with eigenvalues (3.460).

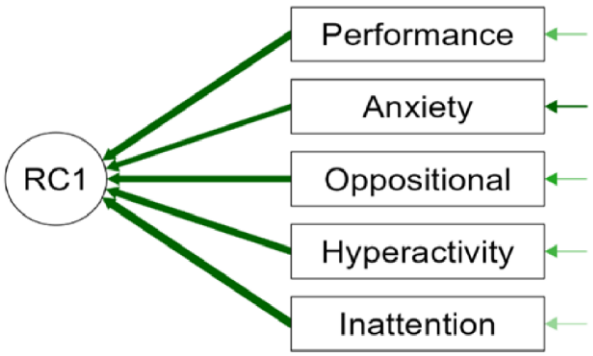

FIGURE 4. Component analysis of VADPRS-A.

Also, the results shown in Table 5 indicated that the most saturated factor was inattention (0.916), then the performance (0.859), followed by hyperactivity and impulsivity (0.839), oppositional-defiant behavior (0.811), and anxiety/depression (0.722) respectively, that represented by the heavy green lines in the component analysis model (Figure 4). The PCA results presented in Tables 5, and 6 are consistent with the theoretical aspect of the VADTRS-A, screening ADHD among children assessed by their teachers.

Confirmatory Factor Analysis (CFA) of VADPRS-A and VADTRS-A

Confirmatory Factor Analysis of VADPRS-A

In light of the theoretical literature on ADHD in childhood and the results of the PCA of VADPRS-A, a model of six factors was tested using CFA by maximum likelihood method using the JASP0.18.3.0. The results of CFA revealed the validity of the proposed model of VADPRS-A through good goodness-of-fit indicators (Table 6), as the chi-square

TABLE 6. Fit indices of VADPRS-A.

Index	*Value*
Comparative Fit Index (CFI)	0.956
Tucker-Lewis Index (TLI)	0.942
Bentler-Bonett Normed Fit Index (NFI)	0.956
Parsimony Normed Fit Index (PNFI)	0.717
Bollen's Relative Fit Index (RFI)	0.925
Bollen's Incremental Fit Index (IFI)	0.956
Root mean square error of approximation (RMSEA)	0.049
Goodness of fit index (GFI)	0.952

value reached (222.082, df=9, p <0.001). This confirms the matching of the six-factor model with the data collected from the study sample of parents (n= 504). The saturation values of six components were presented in Figure 5.

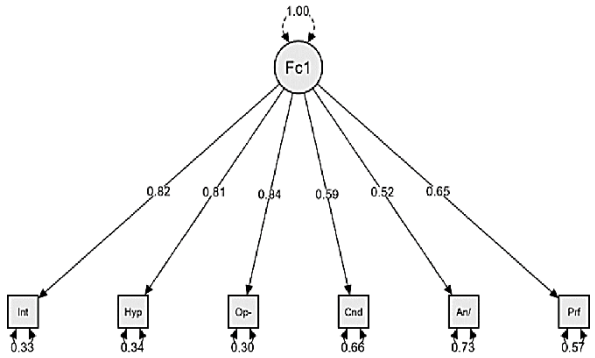

FIGURE 5. Results of confirmatory analysis of VADPRS-A

The findings shown in Table 6 and Figure 5 of CFA of VADPRS-A provided further evidence of the validity of the constructive validity of VADPRS-A. The factor loading coefficients were acceptable (0.82, 0.81, 0.84, 0.59, 0.52, 0.65) for inattention, hyperactivity/impulsivity, oppositional-defiant behavior, conduct disorder, anxiety/depression, and performance respectively.

Confirmatory Factor Analysis of VADTRS-A

In light of the theoretical literature and the results of the component analysis of VADTRS-A, a model of five factors was investigated using CFA by maximum likelihood method using the JASP0.18.3.0. The results of CFA demonstrated the validity of the proposed model of VADTRS-A through good goodness-of-fit indicators (Table 7), as the chi-square value reached (4328.051, df=10, p <0.001), these findings confirmed the matching between the five-factor model and the data collected from the sample of teachers (n= 1308), the saturation values of five components were as in Figure 7.

TABLE 7. Fit indices of VADTRS-A

Index	*Value*
Comparative Fit Index (CFI)	0.958
Tucker-Lewis Index (TLI)	0.932
Bentler-Bonett Normed Fit Index (NFI)	0.951
Parsimony Normed Fit Index (PNFI)	0.720
Bollen's Relative Fit Index (RFI)	0.936
Bollen's Incremental Fit Index (IFI)	0.963
Root mean square error of approximation (RMSEA)	0.051
Goodness of fit index (GFI)	0.964

The findings shown in Table 7 and Figure 6 of CFA of VADTRS-A presented other evidence of the

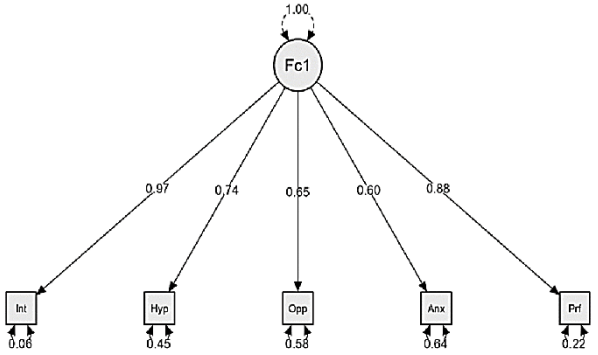

FIGURE 6. Results of confirmatory analysis of VADTRS-A

validity of the factorial structure of VADTRS-A consisting of five components, their loading factor were (0.97, 0.74, 0.65, 0.60, 0.88) for inattention, hyperactivity/impulsivity, oppositional-defiant behavior, anxiety/depression, and performance respectively.

Internal Consistency of VADPRS-A and VADTRS-A

The internal consistency of each version of VADPRS-A and VADTRS-A was verified by calculating Pearson's correlation coefficients between the six factors and the total score of VADPRS-A. Tables 8 and 9 and Figures 7 and 8 show the results.

Internal consistency of VADPRS-A

It is clear from Table 8 and Figure 7 that the correlation coefficients between the VADPRS-A six factors together were positive and statistically significant (p> 0.001), as the values of these correlations ranged between (0.296 and 0.737). Likewise, the factor correlation coefficients with the scale as a whole were positive and statistically significant (p> 0.001) and ranged between (0.615 and 0.843). These results indicate that VADPRS-A has good reliability indicators.

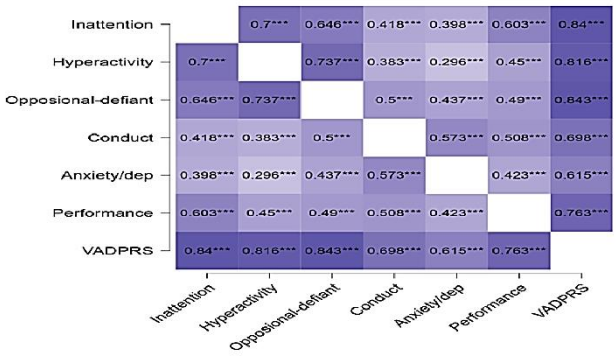

Figure 7. Pearson's r heatmap for VADPRS-A.

TABLE 8. Pearson's Correlation Matrix of VADPRS-A.

Variable	*In*	*Hy*	*Opp*	*Con*	*An*	*Per*	*VADPRS-A*
In	-						
Hy	*0.700****	-					
Opp	*0.646****	*0.737****	-				
Con	*0.418****	*0.383****	*0.500***	-			
An	*0.398****	*0.296****	*0.437****	*0.573****	-		
Per	*0.603****	*0.450****	*0.490****	*0.508****	*0.423****	-	
VADPRS-A	*0.840****	*0.816****	*0.843****	*0.698****	*0.615****	*0.763****	-

****p >0.001*

TABLE 9. Pearson's Correlation Matrix of VADTRS-A.

Variable	*In*	*Hy*	*Opp*	*An*	*Per*	*VADTRS-A*
In	-					
Hy	*0.720****	-				
Opp	*0.608****	*0.710****	-			
An	*0.730****	*0.432****	*0.531***	-		
Per	*0.864****	*0.602****	*0.534****	*0.533****	-	
VADTRS-A	*0.939****	*0.834****	*0.772****	*0.669****	*0.898****	-

****p> 0.001*

TABLE 10. Results of Cronbach's α and McDonald's ω coefficient of VADPRS-A

Variable	*McDonald's ω*	*Cronbach's α*
Inattention	0.908	0.906
Hyperactivity and impulsivity	0.923	0.925
Oppositional defiant behavior	0.901	0.900
Conduct disorder	0.871	0.896
Anxiety	0.850	0.853
Performance	0.877	0.872
VADPRS-A	0.925	0.959

TABLE 11. Results of Cronbach's α and McDonald's ω coefficient of VADTRS-A

Variable	*McDonald's ω*	*Cronbach's α*
Inattention	0.968	0.967
Hyperactivity and impulsivity	0.921	0.921
Oppositional defiant behavior	0.919	0.914
Anxiety	0.856	0.858
Performance	0.943	0.948
VADPTS	0.965	0.971

Internal consistency of VADTRS-A

The internal consistency of VADTRS-A was verified by calculating Pearson's correlation coefficients between the six factors and the total score of VADTRS-A. Table 9 shows the results.

It is clear from Table 9 and Figure 8 that the correlation coefficients between the five factors of VADTRS-A together were positive and statistically significant (p> 0.001), and their values ranged between (0.432 and 0.864). Likewise, the factor correlation coefficients with the VADTRS-A as a whole were positive and statistically significant (p>.001) and ranged between (0.669 and 0.939).

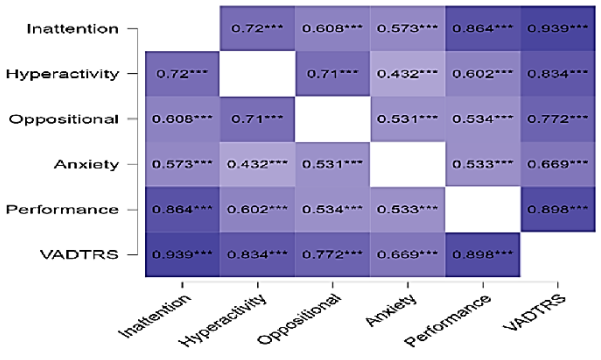

FIGURE 8. Pearson's r heatmap of VADTRS-A

These results indicated that VADTRS-A has good reliability indicators.

Reliability analysis of VADPRS-A and VADTRS-A

Reliability analysis of the VADPRS-A and VADTRS-A was tested using Cronbach's α and McDonald's ω coefficient. The results shown in Tables 10 and 11 indicated that the VADPRS-A and VADTRS-A had acceptable reliability coefficients for all factors and the scale as a whole.

Reliability analysis of VADPRS-A

The results presented in Table 10 about Cronbach's α coefficients and McDonald's ω of the six factors and VADPRS-A as a whole show that they have good coefficients. The Cronbach's α coefficient values for the six factors and VADPRS-A as a whole reached (0.906, 0.925, 0.900, 0.896, 0.853, 0.872, 0.959) respectively, and these values are close to the values of the McDonald's ω for the factors and VADPRS-A as a whole, which reached (0.908, 0.923, 0.901, 0.871, 0.850, 0.877, 0.925) respectively. These results indicate that the VADPRS-A and its factors have good Cronbach's α and McDonald's ω coefficients.

Reliability analysis of VADTRS-A

It is clear from Table (11) that the VADTRS-A and its five factors have good Cronbach's α and McDonald's ω coefficients. The Cronbach's α coefficients were (0.967, 0.921, 0.914, 0.858, 0.948, 0.971) for VADTRS-A and its factors respectively, and these values are close to the values of the McDonald's ω (0.968, 0.921, 0.919, 0.856, 0.943, 0.965) for each VADTRS-A and its factors respectively. These results indicate that the VADTRS-A and its factors have good Cronbach's α and McDonald's ω coefficients.

Discussion

In the current study, the factorial structure of the VADPRS-A model (inattention, hyperactive/ impulsive, oppositional-defiant disorder, conduct disorder, anxiety/ depression, and performance) was investigated in the Saudi general population using the principal components method. The results confirmed the measurement model and detected positive and statistically significant correlations between these factors and VADPRS-A, which indicated that the VADPRS-A had good constructive validity when we applied it to diagnose ADHD in childhood in the Saudi environment. Likewise, the validity of the VADTRS-A factorial structure and all its factors were positively and statistically significantly associated with each other and the whole score. Thus, VADTRS-A had good constructive validity and internal consistency for use in diagnosing ADHD in children in the Kingdom of Saudi Arabia.

Also, we tested the measurement fit model using confirmatory factor analysis to verify the results of the principal components analysis of VADPRS-A. The results of CFA revealed that VADPRS-A is composed of 6 factors extracted from PCA: inattentive, hyperactive/ impulsive, oppositional-defiant, conduct disorder, anxiety/ depression, and performance. The results showed that the VADPRS-A six-factor measurement model had goodness-of-fit indicators: CFI, TLI, RMSEA, IFI, and GFI (0.956, 0.942, 0.049, 0.956, 0.952) respectively. In the same way, the VADTRS-A measurement model consisting of 5 factors as extracted from PCA was tested using CFA. The results showed that VADTRS-A is composed of 5 factors: inattentive, hyperactive/ impulsive, oppositional-defiant disorder, anxiety/ depression, and performance. The findings of the CFA revealed that the VADTRS-A five-factor measurement model had goodness-of-fit indicators: CFI, TLI, RMSEA, IFI, and GFI were (0.958, 0.932, 0.051, 0.963, 0.964) all of these were at an acceptable range.

Then, Cronbach's α and McDonald's ω coefficients were calculated, and the results found that VADPRS-A and VADTRS-A had good reliability coefficients. The results also indicated a convergence in the values of Cronbach's α and McDonald's ω for the form used with parents and teachers, as no differences were observed in the values of each.

The results of the current study are consistent with the previous studies. Bard et al. (32) study in the USA found good internal consistency for VADPRS and acceptable goodness-of-fit indicators, as well as reasonableness and constructive validity measurement correctness of VADPRS. In addition, the current findings are consistent with the study conducted in the USA by Wolraich et al. (22) that found the VADPRS is a reliable and cost-effective measurement for screening ADHD among children in both clinical and research settings. Furthermore, VADPRS was acceptable and consistent with DSM-IV and other validated assessments of ADHD. Similarly, the results consistent with the findings of the Xiao et al. (37) study which found that VADPRS is suitable for a general population screen for ADHD in childhood.

In the same context, in the USA, Anderson et al. (31) found good validity and reliability indicators of both VADPRS and VADTRS to diagnose ADHD among children. Beyond this, the results of the current study are also consistent with the findings of the investigation performed by Kapogiannis et al. (34) that the Greek version of VADPRS is an accurate and valid tool for diagnosing attention-

deficit/hyperactivity disorder. On the other hand, the current study's results agreed with the findings of an investigation conducted in the Czech Republic by Sebalo Vňuková et al. (38) that VADPRS had good psychometric properties as a tool for ADHD diagnosis.

In the same way, the Kharamin et al. study (35) that examined the psychometric properties of the Iranian version of VADTRS and found a good level of reliability and good fitness indicators and recommended its use for screening Iranian primary school children who are at risk of developing ADHD. Also, agreed with Bussing et al.'s study (33) which revealed high internal consistency for the VADTRS and CFA results confirm fit with previously reported VADTRS factorial structure.

From the above, we can conclude that the results of the current study were consistent with previous literature about VADPRS and VADTRS and with the diagnostic criteria of ADHD defined in the DSM-5 and ICD-11. Similarly, the current results agreed with previous studies conducted on the psychometric properties of VADPRS-A and VADTRS-A, all factors loading are acceptable on VADPRS-A and VADTRS-A, and the values of Cronbach's α and McDonald's ω were good. These findings of the current study concluded that parents and teachers are the best estimators of their children's behavior, and this was consistent with what Bard et al. mentioned (32) that parents are the best sources of information about their children's behavior.

Conclusion

The current study contributed important results in the field of children's ADHD assessment in the Kingdom of Saudi Arabia, by investigating the psychometric properties of the Arabic version of the Vanderbilt scale, in both its versions VADPRS-A and VADTRS-A, using the principal components method to test the factorial structure, as well as applying confirmatory factor analysis to investigate these components. Due to the results of this study in terms of high-reliability coefficients and good fit indicators for the measurement models of VADPRS-A and VADTRS-A, we support the application of the Vanderbilt Arabic Scale, in its two versions, for the early diagnosis of children's ADHD in Saudi Arabia, which will maximize the scale's usefulness in enhancing the effect of treatment for children who will be found to be at risk of developing ADHD symptoms, and provides specialists with valid and reliable tools that help them in diagnosis ADHD, consistent with previous theoretical literature for the Vanderbilt scale and the diagnostic criteria according DSM or ICD.

Limitations and Future Directions

The present study examined the validity and reliability of the sex-factor VADPRS-A model and five-factor VADTRSA- model using a descriptive research design on a large sample of parents and teachers of children in Saudi Arabia. One of the strengths of the current study is that it was applied to a large sample of parents and teachers together, and it used the two versions of the Vanderbilt scale for the research sample. Even so, the study also has many limitations. First, the current findings apply to children only. The second limitation is the sample of the current study consisted of parents and teachers of general population children while not including other persons responsible for caring for children such as healthcare providers. With these limitations in mind, we suggest that future studies must be directed toward examining the validity and reliability of VADPRS-A and VADTRS-A in other settings, using different research designs such as qualitative or mixed methods, and applying other tools such as interview and observation to diagnosis the ADHD in children in addition to the VADPRS-A and VADTRS-A.

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Conflicts of Interest

The authors declare that they have no conflict of interest.

Compliance with Ethical Standards

The Research Ethics Committee at the Saudi ADHD Society (Approval no: IRB-06-23) approved this study. All methods were carried out by relevant guidelines and regulations, and informed consent was obtained from all subjects.

Availability of data and materials

All data are fully available without restriction.

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