

## The Construction and Norm-Finding of a Rating Scale for Diagnosing Attention Deficit Hyperactivity Disorder in Children

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**Objective:** Evaluation and diagnosis are determinants of treatment outcome; therefore, diagnostic tools should be accurate. The purpose of the present research is construction and norm-finding of a rating scale for the diagnosis of attention deficit hyperactivity disorder (ADHD).

**Method:** A checklist based on behavioral symptoms of ADHD from clinical sources was constructed, based on interview with patients and the medical records. After being studied by specialists, this checklist was reduced to items and arranged in a rating scale format. The study population included Tehran's elementary school students (boys and girls) from which a sample of 800 children was chosen in a random-cluster manner. Then teachers were asked to rate the students according to the scale characteristics. After two weeks, the subjects were tested and interviewed using a corrected form of the scale, the rating scale of Swanson, Nolan and Pelham (SNAP-IV) and Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). After data analysis the scale was reduced to 23 items.

**Results:** According to the results of the analysis, the scale had two factors: The first factor was hyperactivity that explained 37.41%, and the second factor was attention deficit that explained 33.78% of the total variance. Cronbach's alpha was 0.96 and the alpha of the two subscales, hyperactivity and attention deficit, was 0.94 and 0.96, respectively. Spearman-Brown Coefficient was 0.78 and scale coefficient correlation with a similar form (SNAP-IV) was 0.82. Criterion validity coefficient of the scale was 0.76 and the content validity of the scale was confirmed by the experts. According to sensitivity analysis of the trait, the cutoff point of the scale was 35. Considering the above findings, we can safely use the above scale in clinical studies.

**Conclusion:** Considering the obtained values in the psychometric indexes and the consensus among specialists on the basis of test content validity and also considering the calculation methods of the cutoff point, we can safely use this scale in different clinical situations, epidemiological studies, and other researches and also for studying ADHD children especially when teachers deal with evaluation of children's behavior.

### Key Words:

*Attention deficit disorder with hyperactivity, Rating scale, Validation studies*

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**A**DHD is a disorder with biological basis which is recognized by a combination of attention deficit and hyperactivity symptoms (1). Children and adolescents with often face some difficulties in their educational performance and in controlling their behavior; for instance, they have difficulty to establish good relations with the family members and peers (2). ADHD manifests itself mainly in childhood and the prevalence decrease from 3 to 20 percent in childhood to 4 percent in adulthood. This decrease does not necessarily mean improvement; in some cases only the disorderliness changes (3).

Some authorities have reported the prevalence of this disorder in school-age children between 10 to 20 percent and some others have reported the prevalence

rates between 7 to 8 percent (4, 5). Other studies have reported 3 to 5 percent of children as ADHDs (6).

Oppositional-defiant disorder, conduct disorder and disruptive behavior, anxiety disorders, antisocial behaviors and drug abuse are may be consequences of ADHD in adolescence (7-10). Comorbid disorders include depression, recklessness, conduct and reading disability (11) and in other researches Tourette's disorder (12, 13).

ADHD children report negative experiences in relation with their friends, also their relation with their family and teachers is turbulent and disjointed (3, 14).

Teachers spend a lot of time with children; therefore, they should be aware of the educational-social problems of the children with ADHD, and through some special training they should also be aware of

these children's inner feelings and therefore, treat these children differently (15). Teachers should recognize morbid behaviors from non-morbid ones. Usually the first point of evaluation is the time when the teacher feels that the child is abnormal and he/she should do something for him/her. Tools such as interviews, reports by teachers and school authorities and questionnaires filled by parents are helpful (16, 17). Psychometric tools such as checklists, questionnaires and scales which are available for experts and researchers could also be useful (6, 9). These kinds of tools are designed in a way that should be filled by parents or teachers; some examples are as follows: SNAP-IV scale made by Swanson, Nolan and Pelham based on DSM-IV criteria (6); Conner's scale Teachers and parents version (18). Wender Uta Scale measures chronic depression disorder, ODD and ADHD (4); Do-paul scale: The items of this scale have been collected according to DSM-IV criteria and they measure the two factors of attention deficit and hyperactivity (2). Wanderbuilt a questionnaire which has been made by Wolraich, Feurer & Hannah and is composed of 35 questions of which 18 are related to attention deficit hyperactivity disorder (19). Child Symptom Inventory-four (CSI-4) questionnaire: a tool for screening children's psychiatric disorder collected according to DSM criteria and it has two forms of teachers and parents.

Some of the above-mentioned tools such as the rating scale of SNAP-IV, CSI-4 scale and Conner's scale have been normalized in Iran, but the more accurate diagnosis is made when cultural criteria are used in the questionnaire. Therefore, considering the importance of ADHD diagnosis by teachers, the purpose of the present research is to make a diagnosis test in the field of attention deficit hyperactivity disorder especially for teachers that are suited to the cultural context of Iran. Some questions are posed in the making of the test which provided the abstract theoretical variable of a quantitative measurement (20). A good test has two aspects of validity and reliability. Validity refers to the precision of the construct measurement and reliability refers to the consistency of the test results (21). In a new examination based on culture, some symptoms have more prominence and previous symptoms may assign to itself different operative scales.

## Materials and Method

### *Population, Sample and Sampling procedure*

The population of the present research included 7-12 year old children in the educational years of 1385-1386 (2006-2007) at elementary schools in the city of Tehran. The present sample with the size of 800 children was selected for norm finding of the instrument and was evaluated by their teachers. The research sample was selected in a random-cluster manner. Therefore, the samples were selected from the first 5 zones from the north, south, east, west and center of Tehran; then two schools from each zone, 2

classes from each school in each grade and 10 students from each classroom were tested.

### *Measuring tools*

The main test which is the aim of the present research, is a list of ADHD symptoms provided by some authorities and it includes: 1) clinical and diagnostic sources of ADHD including DSM, checklists, rating scales and other resources like textbooks of psychiatry and clinical psychology; 2) The medical records of children, consulting with psychiatric centers and receiving ADHD label which included those attributes that are not mentioned in clinical sources; 3) Psychiatrists and specialists view. Including attributes the specialists observed during their experiences, which helped to have a better diagnosis.

Other tools included: SNAP-IV test: This test has been used in different studies, especially the screening ones. The scale includes criteria similar to DSM-IV which were scored in the spectrum from 0 to 3 and were used as a similar form for calculating reliability coefficient by parallel forms DSM-IV criteria: These criteria include 18 items of which 9 were used to diagnose attention deficit and 9 were used to diagnose hyperactivity disorder.

Method of data analysis: Pearson correlation coefficient was used to determine criterion validity and reliability coefficient by parallel forms method, Cronbach's Alpha and Spearman-Brown coefficient were used to determine reliability by internal consistency; factor analysis method and Varimax rotation method were used to determine the number of test items, construct validity of scale and subscales; Kolmogorov-Smirnov test was used to compare data distribution with normal distribution; mean , standard deviation , median , quartile deviation , sensitivity and trait test indexes were used to determine the cutoff point of the scale .

## Results

Determining scale items: the primary checklist was prepared with 56 items, but based on the specialists view, it was reduced to 36 items by the elimination of the overlapping cases and in appropriate items .

The results of the factor analysis and statistical analysis include symptoms which are in other ADHD scales, namely the kind that with clustering symptoms and performing a factor analysis reaches at a double elements structure.

With regards to the scale, factor analysis has difference toward other scales that behavioral evidences for recognizing hyperactivity disorder specify graver scale to itself.

Similar contain to other scales from one side strengthens this hypothesis that ADHD is a disorder with a genetic basis; some symptoms may have more importance in some cultural contexts; for example hyperactivity may be more important to teachers in our settings .

## The Construction and Norm-Finding of a Rating Scale for ADHD

The 36 item scale was given to specialists (4 child psychiatrists and one child psychologist) and they were asked to identify those items which had to be eliminated, corrected or remain in the scale. After that, the form was reduced to 30 items for the final administration.

### *Elimination based on frequency of responses and distributions*

According to the determined criteria and on the assumption of normal distribution and in cases where item variance is low, an item should be eliminated when more than 80 percent of the subjects respond to it. But with regards to the shape of the present research did a distribution and independency of scales measuring clinical traits from normal curve, this rule is not true and none of the items was eliminated in this stages.

As seen in the above table, the frequency of all the positive responses is less than 20 and that of all the negative responses is more than 80.

Alpha is an index of test reliability. Correlation of each item with the whole test influences the test reliability. Therefore, if one item has a negative or lower correlation with the whole test score, it must be eliminated from the total scale.

The results showed that none of the items had a negative or even lower than %6 correlations with the total test and the size of alpha didn't change with the elimination of each of the items; therefore, in this stage no item is dominated.

Elimination of items with regards to the number of factors: in the item analysis, it is expected that each item has a load only less than one factor. The results of the factor analysis with the elimination of items having a load in common factors, progress to the extent that no item has considerable load factor under two factors, and in each stage an item having higher factor loading in two factors is eliminated from the set of scale items based on the factor analysis results, first the item number 26 which has no load under any factor is eliminated. Then items of 16, 11, 14, 15, 18 and 12 are eliminated for having high factor loading in two factors, and a 23 item scale remains at last.

Determining test psychometric characteristics: considering the specialists view, the shape of distribution, calculation of construct reliability and validity (factor analysis), and the present scale is provided with 23 items which has psychometric characteristics as follows:

### *Scale validity*

**Content validity:** The prepared scale was given to 5 specialists (child psychiatrists and psychologists). After reviewing the scale items, all the specialists agreed on the appropriateness of the items for the measurement of ADHD.

**Criterion validity:** criterion test in the present research

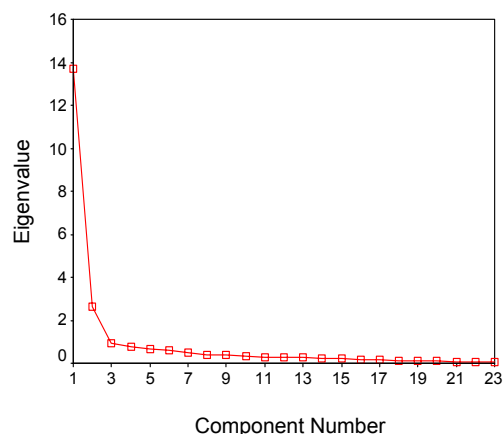
**Table1. Frequency and percent of negative and positive response to items**

Responses Statistics Item number	Negative responses		Positive response	
	Frequency	Percent	Frequency	Percent
1	519	81.6	117	18.4
2	574	90.3	92	6.7
3	556	74.4	80	12.6
4	565	88.8	71	11.2
5	568	89.3	68	10.7
6	545	85.7	91	14.3
7	561	88.2	75	11.8
8	547	86	89	14
9	563	88.5	73	11.5
10	492	77.4	144	22.6
11	518	81.4	118	18.6
12	532	83.6	104	16.4
13	533	83.8	103	16.2
14	546	85.8	90	14.2
15	547	86	89	14
16	530	83.3	106	16.7
17	576	90.6	60	9.4
18	545	85.7	91	14.3
19	558	87.7	78	12.3
20	557	87.6	79	12.4
21	559	87.9	77	12.1
22	556	87.4	80	12.6
23	554	87.1	82	12.9
24	542	85.2	94	14.8
25	536	84.3	100	15.7
26	529	83.2	107	16.8
27	559	87.9	77	12.1
28	514	80.8	122	9.2
29	571	89.8	65	10.2
30	594	93.4	42	6.6

was DSM-IV diagnostic standards, 30 participants were again tested by final scale and were interviewed clinically with DSM-IV diagnostic standards. The results indicated that the correlation between the obtained scores in the present scale and the DSM-IV diagnostic standard equals 0.76.

**Construct validity:** factor analysis was used to examine construct validity; its results can be observed in the Figure 1. The number of the factor is determined.

According to special value, Eigen value is the size of item variance on the basis of one factor. Those factors having the special value equal to or more than 1 are chosen as the main factor. According to Kaiser and based on Scree kattle diagram, there are two factors.



**Figure1. Scree plot**

Table2. Total variance explained

Component	Initial Eigen value			Extraction <sup>†</sup> sums of Squared Loadings			Rotation sums of squared lodgings		
	Total	Variance of %	Cumulative %	Total	Variance of %	Cumulative %	Total	Variance of %	Cumulative %
1	13.721	59.655	59.655	13.721	59.655	59.655	8.605	37.414	37.414
2	2.656	11.548	71.203	2.656	11.548	71.203	7.771	33.788	71.203
3	0.927	4.030	75.233						
4	0.792	3.445	78.678						
5	0.669	2.907	81.584						
6	0.577	2.511	84.095						
7	0.483	2.099	86.194						
8	0.397	1.725	87.919						
9	0.368	1.602	89.521						
10	0.326	1.419	90.939						
11	0.297	1.290	92.229						
12	0.285	1.239	93.468						
13	0.259	1.127	94.595						
14	0.220	0.957	95.552						
15	0.193	0.837	96.389						
16	0.187	0.814	97.203						
17	0.161	0.700	97.903						
18	0.125	0.543	98.445						
19	9.849E-20	0.428	98.874						
20	8.903E-20	0.387	99.261						
21	6.950E-20	0.302	99.563						
22	6.157E-20	0.268	99.831						
23	3.896E-20	0.169	100.000						

† Extraction Method: Principal Component Analysis

The two factors have dedicated higher than one Eigen value to themselves. Therefore, the prepared questionnaire was bi-factorial.

Based on the results of the Table 2, the special value of the first factor is 13.22 and that of the second factor is 2.56. The first factor or hyperactivity shows greater part of test variance and then the second factor or attention deficit exists. On the whole, 71.2 percent of the total variance is explained by the test; of which 37.41 percent relates to the first factor and 33.78 percent relates to the second factor.

The Table 2 indicates factors priority and factorial loading of each item in the related factors. According to the content of the items, the first factor was named "hyperactivity factor" and the second one "attention deficit".

Administration of parallel forms: Together with the prepared scale, the scale of SNAP-IV was administered on sample group. Correlation of each scale with the form which measures the same construct is an index of test validity.

#### Scale reliability

Internal consistency estimate of scale items: It was done using Cronbach's alpha method; the size of alpha for the total test was 0.96, for the subscale of hyperactivity was 0.49 and for the subscale of attention deficit was 0.96.

Reliability by Split-Half method : Coefficient of the two halves equals 0.72, but it was 0.83 after correction and using Spearman – Brown method. The values of

Alpha for each of these subscales were 0.95 and 0.95, respectively.

Test-retest reliability: In order to determine the reliability of the retest method, two weeks after the first

Table3. Component matrix for extraction factors after rotation

Items	Components
	<b>1</b>
22	0.865
21	0.856
25	0.848
27	0.844
19	0.829
23	0.811
28	0.764
24	0.762
20	0.739
30	0.730
29	0.623
10	0.565
17	0.544
	<b>2</b>
5	0.908
6	0.858
3	0.846
4	0.840
8	0.828
1	0.820
2	0.814
7	0.796
9	0.672
13	0.645

## The Construction and Norm-Finding of a Rating Scale for ADHD

**Table 4. Calculation of cut off point whit means and standard deviation**

Scales	Disorder	Determined
	Severity	Cut off point
ADHD	Severe	$10.14+(14.54*1.64) \approx 35$
	Moderate	$10.14+14.54 \approx 25$
ADD	Severe	$4.59+(7.19*1.64) \approx 17$
	Moderate	$4.59+7.19 \approx 12$
HD	Severe	$5.55+(8.6*1.64) \approx 20$
	Moderate	$5.55+8.6 \approx 15$

**Table 5. kolmogorov-smirnov test**

ADHD		
	N	636
Normal Parameters <sup>a, b</sup>	Mean	10.14
	Std. Deviation	14.54
Most Extreme Differences	Absolute positive	0.280
	Negative	-
		0.243
Kolmogorov-smirnov Z		7.071
Asymp.sig(2-tailed)		0.000

a. test distribution is normal

b. Calculated from data

administration of the scale on 30 children of the sample group, the test was administered again.

Based on the results of the retest, the correlation coefficient between the first and second administration equals 0.78

### Calculation of the cut off

Most of the tests so far prepared to diagnose ADHD have used mean, standard deviation or percentiles to determine the cut off point. The present scale's cut off point was calculated using mean, standard deviation,

and 20% responses because even the prevalence of the disorder in most cases is also less than 20% ;and the possibility of 20% and 80% responses to a clinical test is natural. In these cases, the use of items factor loading in each subscale is the best method since it helps selecting the items which have high factor loading only in one factor and this increases the diagnostic power of the test and as a result increases its validity.

Test psychometric characteristics were reviewed by common methods. Assessors agreement on confirming the test content validity certifies the reliance on the test content especially that this agreement is complete. With regard to criterion validity, the obtained coefficient is also 0.79 which is a strong association.

The appropriate coefficient of criterion validity is usually 0.40. The result of factor analysis shows that this scale like the other prepared scales with this subject is bi factorial, but it differs in that the first The

quartile and attribute sensitivity test. In the attribute sensitivity test, the minimum possible cut off point was begun using quartiles and its M maximum was determined based on the result of the test sensitivity of the attribute.

To determine the participants with severe ADHD, the mean and unit of 1.64 standard deviation were used; and to determine the subjects with mild ADHD, the mean and standard deviation of 1 were used. Which the results are seen demonstrated in the following table:

As it is seen in the above table, standard deviation of the cut off for the total test is 34; in subscale of attention deficit it is 17; and in subscale of hyperactivity it equals 20. The calculated cut off using the third quartile is 11 .To determine the cut off by the sensitive test of attribute, a sample of 36 children was chosen and they were clinically interviewed by the diagnostic criteria of DSM-IV. According to the observed results, in the score of the35, the highest value of sensitivity is 0.89 with attribute of 0.76 in the score of 35. In the obtained score of 35, the most agreement between this scale and DSM-IV criteria was observed. According to the obtained cut off, the prevalence of ADHD children in the population of 7-12 years old children in Tehran was equal to 13.8 percent of the school children.

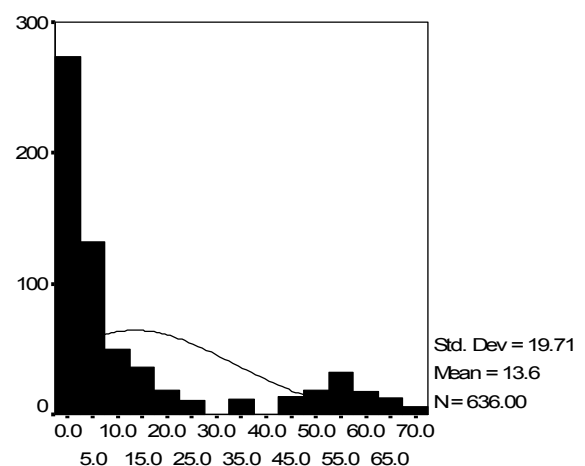
The distribution obtained from the administration of clinical questionnaires in normal population is not normal.

## Discussion

Selection of test items was made using specialists view and precise statistical methods; the clinical aspects of the questionnaire and data distribution format affected the selection of items.

The shape of curve is an inverse "J". The observation of form scores also shows that the shape of distribution is asymmetric.

The observed skewness in the distribution format didn't permit us to use the elimination method of 80%



**Figure 2. Distribution of the scores of the questionnaire**

appropriate coefficient of criterion validity is usually 0.40. The result of factor analysis shows that this scale like the other prepared scales with this subject is bi factorial, but it differs in that the first factor in this scale is hyperactivity and the second factor is attention deficit. In norm finding scale of SNAP-IV in Iran, the hyperactivity factor also has more factorial loading. This problem causes no damage to scale validity because the factors are descriptive categories and these factors are not fixed and are the result of the individual cumulative experience.

The indexes related to reliability all have acceptable values. The result of retest with the coefficient of 0.78 describes confident use of the scale in different situations. Cronbach's alpha with the coefficient of 0.96 shows that scale items measure the same objective in accord with each other and this value is an index of appropriate internal consistency. The split-half coefficient of the test with 0.83 values is also a acceptable index of test reliability.

The abovementioned indices are the commonest and the most reliable method in the estimation of test reliability.

Data distribution is also like an inverse "J" showing that the greater part of data has been accumulated in one side of the curve, and this case is natural for those questionnaires which measure one clinical characteristic in a normal population as a great number of people has no signs of the disorder and only a limited number have these signs. Therefore, this causes the great part of data to be accumulated in one side.

The cut off point of the test was estimated by three methods; the best point for diagnosis is to obtain the score of 35 in the test. The method of trait sensitivity in cases that data don't follow normal distribution is the best estimation method of the test's cut off point given that the extent of diagnostic agreement by scale diagnosis is another diagnosis with the necessary and sufficient stability.

## Conclusion

Based on the obtained values in the psychometric indices and consensus among the specialists on the basis of test content validity and also based on the calculation methods of the cut off point, we can safely use this scale in different clinical situations, researches and for ADHD children and epidemiology studies, especially when teachers deal with evaluation of children's behavior.

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## The Construction and Norm-Finding of a Rating Scale for ADHD

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