

Statistical Analysis of the Relationship between Diabetes and Psychological Disorders in Children

Mohamed E. M. Abdelhafez *

College of Business Administration, Kuwait University

*Corresponding author: elwym@hotmail.com

Abstract The main objective of this paper is to investigate the impact of diabetes on the psychological characteristics in children. The study investigated 302 children aged 7 to 13 years old who had diabetes type I in Kuwait. A questionnaire was administered to participants (Parents or Guardians) of diabetic children. The questionnaire has two parts; the first part has sociodemographic and clinical characteristics of the children and participants and the second part is the "strengths and difficulties questionnaire" (SDQ) [1]. The strengths and difficulties questionnaire (SDQ) was widely used for screening emotional and behavioral problems. Internal consistency of the sample and the strengths and difficulties questionnaire (SDQ) (Arabic version) were measured by Cronbach's alpha coefficient. The percentages of children whose scores are in the normal, borderline, and abnormal classes were calculated. The results indicate that regarding the mental health of the children, 69.1% were considered positive overall (55% abnormal and 14.1% borderline). Correlation analysis on the item-subscale level revealed that all items had the highest correlations to their respective subscales of origin. Further, subscale-subscale and subscale-total correlations were calculated. The results show significant correlations between the five subscales of the SDQ. Each subscale correlated significantly ($p < 0.01$) with every other subscale. A principal component analysis with varimax rotation was conducted to investigate the factorial structure of scales. A discriminant analysis was performed to classify the diabetic children into one of the three groups (Normal, borderline, and abnormal). The results show that 93.3% of the original grouped cases were correctly classified.

Keywords: diabetes, children, psychology, disorder, Kuwait

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1. Introduction

Several studies have shown that children with diabetes are more likely to have emotional or behavioral problems than children who do not have diabetes. Diabetes affects the life style and overall psychological and physical characteristics of the children.

Relationship of diabetes to emotional or behavioral problems in adolescents has been investigated by many authors [2,3,4,5,6,7]. Roy and Lloyd, 2012 pointed out that people with Type I diabetes have depression rates up to three times higher than those without Type I diabetes.

In the present study, we investigate the relationship between Diabetes and Emotional and Behavioral Problems for children aged 7 to 13 years old who had diabetes in Kuwait.

2. Methods

The present study was conducted at Kuwait University, 2005. The sample comprised 302 children aged 7-13 years. Trained interviewers administered questionnaires to Participants (parents and caretakers) at a governmental hospital.

The questionnaire consists of two parts; the first part has demographic and clinical characteristics of the children and participants and the second part is the "strengths and difficulties questionnaire" (SDQ) [1]. The demographic and clinical characteristics included respondent gender, child gender, child age, respondent nationality, respondent age, respondent education, child education, family income, duration of diabetes (in years), type of diabetes, does any of the parents have diabetes, the number of brothers who have diabetes, the number of times the child entered the hospital because of diabetes, and the Hemoglobin level.

The strengths and difficulties questionnaire (SDQ) is widely used as a useful tool for screening emotional and behavioral problems in children aging 4-16 years [8-18]. The SDQ has been translated into more than 60 languages, being available in the internet at www.sdqinfo.com. The structure, reliability, validity, and psychometric properties of the strengths and difficulties questionnaire (SDQ) have been extensively evaluated in different countries [8,19-36].

The SDQ has 25 items, some are positive and some are negative. The 25 items in the SDQ comprise five subscales of 5 items each. The five subscales are emotional symptoms, conduct problems, hyperactivity, peer problems, and prosocial behavior.

Each of the 25 items is marked as "Not true", "Somewhat true" or "Certainly true". Except for five

positive items, written in bold, the scores for each item are 0 for "Not true", 1 for "Somewhat true" and 2 for "Certainly true". The five positive items, written in bold, are scored in the opposite direction, 2 for "Not true", 1 for "Somewhat true" and 0 for "Certainly true". The sum of the scores of each subscale ranges from 0 to 10. The sum of the scores of the first four subscales of the SDQ gives a total difficulties score, ranging from 0 to 40. High scores for each of the first four subscales indicate difficulties, whereas high scores on the prosocial subscale indicate strengths. The author of the SDQ classified scores for each of the subscales and for the total difficulties as normal, borderline and abnormal (clinical). According to the author of the instrument the cut-offs for 'high' scores for each sub-scale were as follows: conduct problems ≥ 4 , hyperactivity ≥ 7 , peer relationships ≥ 4 , emotional symptoms ≥ 5 and prosocial behavior ≤ 4 . A 'high total difficulties score was defined as ≥ 17 . In the present study, abnormal and borderline cases were considered positive for mental health problems.

Table 1. Endorsement rates (%) of response categories on each item

	Not true	Somewhat true	Certainly true
Prosocial subscale			
Care about	8.9	23.8	67.2
Easy to share	27.5	16.9	55.6
Help other	4.3	17.5	78.1
Friendly with younger	7.6	16.2	76.2
Volunteer to help others	3.7	13.6	82.7
Emotional subscale			
Extremely complains from headache	31.2	28.2	40.5
Worried	34.4	27.5	38.1
Unhappy child	29.8	11.3	58.9
Nervous	21.5	22.8	55.6
Easily scared	34.8	14.9	50.3
Conduct subscale			
Easy to be angry	10.6	21.6	67.8
Obedient	15	29.3	55.7
Fights with others	51.3	16.9	31.8
Lies and cheats	34.4	14.6	51
Steals from home, school	83.1	4.6	12.3
Hyperactivity subscale			
Cannot stability in one place	20.5	21.2	58.3
Move his body	44	20.2	35.8
Little concentrate	50.8	17.9	31.2
Thinks before behave	33.1	28.5	38.4
Good attention	35.1	14.6	50.3
Peer subscale			
Loneliness	78.4	13.3	8.3
Has at least one good friend	5.6	6.6	87.7
Liked by other children	2	7.6	90.4
Ridicule from other children	67.9	10.9	21.2
Best conformity with adults	55	12.3	32.8

Table 1 shows the response rates of the SDQ items. The respondents had a tendency to choose the alternatives "not true" and "certainly true". This tendency was emphasized on the prosocial scale (55.6-82.7% were rated "certainly true) and the positively worded problem items which were rated "certainly true" by (55.7%, 38.4, 50.3, 87.7, 90.4%) of the respondents. on the prosocial scale, the items that

most often rated "certainly true" were " Volunteer to help others" (82.7%), "Help other" (78.1%), and " Friendly with younger" (76.2%). On the emotional scale, the items that are most often rated "certainly true" are "unhappy child" (58.9%), "nervous" (55.6%), and "easily scared" (50.3%). On the conduct scale items, the most common problems are "Easy to be angry" (67.8%), "Lies and cheats" (51%), and "fight with others" (31.8%). Of the hyperactivity problem items, "cannot be stable" was most often rated "certainly true" (58.3%).

The following table shows the percentages of boys and girls and total percentages of children whose scores are in the normal, borderline, and abnormal classes.

Table 2. Percentage of Children in Normal, Borderline, and Abnormal Groups

Scale	Normal (%)	Borderline (%)	Abnormal (%)
Total Difficulties Score			
Boys	24.1	17.5	58.4
Girls	36.6	11.2	52.2
Total	30.9	14.1	55
Emotional Problems			
Boys	20.9	9.4	69.8
Girls	14.9	11.8	73.3
Total	17.7	10.7	71.7
Conduct Problems			
Boys	23.2	12.3	64.5
Girls	27.3	12.4	60.2
Total	25.4	12.4	62.2
Hyperactivity			
Boys	47.9	25	27.1
Girls	64.6	14.3	21.1
Total	56.8	19.3	23.9
Peer Problems			
Boys	69.8	12.2	18
Girls	70.2	9.3	20.5
Total	70	10.7	19.3
Prosocial			
Boys	92.8	4.3	2.9
Girls	90.7	4.3	5
Total	91.7	4.3	4

According to the total difficulties scores, the results showed that 69.1% of the children have overall mental health problems (55% abnormal and 14.1% borderline). The highest percentage (82.4%) was for the emotional problems whereas the lowest percentage (30%) was for peer relationship problems. In the present study, abnormal and borderline cases were considered positive for psychological problems.

The study comprised 302 respondents, (75.8%) citizen and (24.2%) non-citizen; (32.1%) males and (67.9%) females. The age of the respondents ranges from 17 to 75 year-old and the respondent education ranges from elementary school (7%), intermediate (21%), high school (20.3%), Diploma (19.7%), university level (31.7%) to master level (0.3%). Family income ranges from less than 500 KD (15.6%), 500-700 KD (17.3), 701-900 KD (14.6%), 901-1100 KD (9%) to more than 1101 KD (43.5%).

The total sample of children was 302: (53.5%) girls and (46.5%) boys. The child age ranges from 7 to 13 years old with mean 10.2 years and SD (2.1). The child education

ranges from elementary (49%), intermediate (50%), and high school (0.7%); the duration of diabetes (in years) ranges from 0 to 11 years with a mean of 3.52 years and a standard deviation of 2.343 years. Of the total sample of children (19.9%) with diabetic parents and (80.1%) their parents were not diabetic. The number of times the child entered the hospital because of high or low diabetes ranges from none (12.3%), (53.8%), 2-3 times (16.6%), 4-5 times (7.6%), to 6 or more times (9.6%). The hemoglobin readings range from 3 to 32 with a mean of 12.97 and a standard deviation of 5.88. Except two children (0.7%) having type 2 diabetes, all the children (99.3%) had type I diabetes.

The following table presents the means and standard deviation of subscale scores by gender.

Table 3. Means and Standard Deviations of Subscale Scores

		Mean	Std. Dev.
Strengths and Difficulties			
Emotional	Males	5.68	2.55
	Females	6.11	2.54
Conduct	Males	4.54	2.36
	Females	4.30	2.52
Hyperactivity	Males	5.24	2.44
	Females	4.57	2.51
Peer	Males	1.84	1.59
	Females	1.94	1.81
Prosocial	Males	8.20	1.69
	Females	7.96	2.02
Total	Males	17.29	5.99
	Females	16.91	6.72

3. Statistical Analysis

3.1. The Demographic Variables:

1. Child Gender:

There is a significant difference between males and females with respect to the child age ($p = .021$) whereas the other demographic variables show no difference with respect to the child gender. The mean score of the child age is significantly higher for females (10.431).

2. Nationality

There is a significant difference between Kuwaiti and Non-Kuwaiti with respect to child age ($p = .02$), the number of brothers who have diabetes ($p = .001$), and the family income ($p = 0.00$) where is the mean is significantly higher for the Kuwaiti group in the three cases. The other demographic variables show no difference with respect to the nationality.

3. Does Any of Parents have diabetes? (Yes\No):

There is a significant difference between the two groups with respect to the child age ($p = .039$). The mean child age of the first group (Yes) is significantly higher than the second group (No). The other demographic variables show no difference with respect to this variable.

3.2. The SDQ Subscales

1. Child Gender:

There is a significant difference between males and females with respect to the hyperactivity subscale

($p = .016$) whereas the other subscales show no difference. For the hyperactivity subscale, the mean score is significantly higher for males.

2. Nationality:

There is a significant difference between Kuwaiti and Non-Kuwaiti with respect to the hyperactivity subscale ($p = .007$) whereas the other subscales show no difference. For the hyperactivity subscale, the mean score is significantly higher for Non-Kuwaiti.

3. Does Any of Parents have diabetes? (Yes\No):

There is a significant difference between the two groups with respect to the peer subscale ($p = .004$). However, there is some weaker indication of significant difference with respect to the hyperactivity subscale ($p = .058$) and the total score ($p = .058$). The mean score for the first group (Yes) is significantly higher than the second group (No).

4. Respondent Gender

There is a significant difference between the two groups with respect to the emotional ($p = .006$) and peer (.043) subscales. The female respondents have mean scores significantly higher than the mean scores of the male respondents with respect to the emotional and peer subscales.

3.3. The Internal Consistency

The internal consistency of the SDQ for this sample, using Cronbach's alpha coefficient, was 0.59. For the SDQ subscales, the Cronbach's alpha coefficient for the total difficulty scores was 0.72, whereas for the five subscales were prosocial subscale 0.51; hyperactivity subscale 0.49; emotional subscale 0.53; conduct subscale 0.61; and the peer subscale 0.27. The internal consistency of the SDQ has also been investigated in many countries (e.g. UK [5], German [14], Holland [19], Sweden [26], Bangladeshi [18], and Finnish [15]). The results across different countries supported the internal consistency of the SDQ.

3.4. Item-total and Item-subscale Correlations

Correlations of items to subscales and items to total difficulties scale are shown in Table 4.

The item-total correlations coefficients (last column) were negative on all prosocial items and positive on all other items. The highest correlations between single items and total scale were found "Nervous" (.594), "Easy to be angry" (.545), "Fights with others" (.515), and "Lies and cheats" (.513). The lowest item-total correlation was found on the item "Has at least one good friend" (.068).

Correlation analysis on the item-subscale level revealed that all items had the highest correlations to their respective subscales of origin. The item correlations on the prosocial behavior ($r = .471-.648$). For the emotional problem items, the item correlations were ($r = .561-.615$), and on the hyperactivity problems scales (.545-.685). Finally, on the peer problems scale, the item correlations were ($r = .340-.636$).

Further, it was noticed that "Nervous" (emotional) with a correlation coefficient of 0.456 to the conduct problems subscale. "Easy to be angry" with a correlation of 0.416 to

the emotional problems subscale. "Obedient" (Conduct) with a correlation to hyperactivity problems subscale of 0.366 and of -0.393 to the prosocial subscale. "good attention" (Hyperactivity) with a correlation of 0.358 to the conduct problems subscale, and "ridicule from other children" (Peer) with a correlation of 0.382 with the conduct problems subscale.

3.5. The Subscales Correlations

Subscale-subscale and subscale-total correlation coefficient according to Pearson were calculated. Table 5 presents correlations between the five subscales of the SDQ. Each subscale correlated significantly ($p < 0.01$) with every other subscale.

Table 4. Correlations of items to subscales and items to total difficulties scale (Pearson's correlations coefficients). Note that the prosocial subscale does not contribute to the total sum

	Subscales					Total scale
	Prosocial	Emotional	Conduct	Hyperactivity	Peer	
Prosocial subscale						
Considerate of other people's feeling	.648*	-.083	-.272*	-.257*	-.194*	-.291*
Shares readily with other children	.608*	-.189*	-.221*	-.159*	-.153*	-.270*
Helpful if someone is hurt, upset of feeling ill	.584*	-.088	-.192*	-.186*	-.204*	-.236*
Kind to younger children	.629*	-.127*	-.213*	-.166*	-.214*	-.258*
Often Volunteers to help others	.471*	.047	.02	-.113	-.191*	-.074
Emotional subscale						
Often complains of headaches, ...etc	-.057	.561*	.218*	.135*	.184*	.407*
Worried	-.150*	.606*	.149*	.216*	.238*	.442*
Often unhappy	-.015	.615*	.153*	.192*	-.013	.376*
Nervous	-.282*	.593*	.456*	.286*	.229*	.594*
Many fears, easily scared	-.038	.574*	-.013	.018	.123*	.263*
Conduct subscale						
Often has temper tantrums or hot tempers	-.236*	.416*	.574*	.241*	.233*	.545*
Generally obedient	-.393	.102	.610*	.366*	.194*	.465*
Often fights with others	-.201*	.202*	.685*	.309*	.183*	.515*
Often lies and cheats	-.130	.252*	.693*	.264*	.164*	.513*
Steals from home, school	-.057	.013	.545*	.254*	.099	.338*
Hyperactivity subscale						
Restless, overactive, cannot stay still for long	.024	.035	.207*	.434*	-.033	.250*
Constantly fidgeting or squirming	-.248*	.262*	.287*	.621*	.135	.488*
Easily distracted, concentration wanders	-.235*	.254*	.221*	.606*	.100	.448*
Thinks things out before acting	-.208*	.105	.246*	.563*	.183*	.406*
Good attention	-.181*	.150*	.358*	.635*	.149*	.483*
Peer subscale						
Loneliness	-.183*	.245*	.035	.023	.440*	.242*
Has at least one good friend	-.111	-.090	.014	.042	.340*	.068
Liked by other children	-.252*	.116*	.205*	.102	.491*	.299*
Picked on or bullied by other children	-.201*	.259*	.382*	.174*	.605*	.479*
Gets on better with adults than with other children	-.123*	.072	.057	.104	.636*	.261*

Table 5. Subscale-subscale and subscale-total correlation coefficients

	Emotional	Conduct	Hyperactivity	Peer	Prosocial	Total
Emotional Pearson - Correlation Sig (2-tailed)	1	.317** .000	.284** .000	.251** .000	-.177** .002	.679** .000
Conduct Pearson - Correlation Sig (2-tailed)	.317** .000	1	.461** .000	.277** .000	-.322** .000	.762** .000
Hyperactivity Pearson - Correlation Sig (2-tailed)	.284** .000	.461** .000	1	.186** .001	-.301** .000	.730** .000
Peer Pearson - Correlation Sig (2-tailed)	.251** .000	.277** .000	.186** .001	1	-.316** .000	.545** .000
Prosocial Pearson - Correlation Sig (2-tailed)	-.177** .002	-.322** .000	-.301** .000	-.316** .000	1	-.402** .000
Total Pearson - Correlation Sig (2-tailed)	.679** .000	.762** .000	.730** .000	.545** .000	-.402** .000	1

** P < 0.01.

The prosocial subscale correlated inversely to the other subscales especially to the conduct problems (-0.322), peer (-0.316), and hyperactivity subscales (-0.301), but also to total difficulties score (-0.402). All subscales are highly correlated to the total score. The emotional, conduct, hyperactivity, and peer subscales correlations to the total score were, respectively, 0.679, 0.762, 0.730, and 0.545. The hyperactivity subscale correlated strongly to the conduct problems subscale (0.461); the emotional problems subscale correlated fairly strong to the conduct problems subscale (0.317) but weaker to the hyperactivity problems subscale (0.284) and peer problems subscale (0.251). The conduct problems subscale correlated also fairly strong to the peer problems subscale (0.277).

It should be noticed that the most strongly correlation (0.461) is between the conduct and hyperactivity subscales. In addition, the prosocial subscale correlated most strongly with the conduct subscale (-0.322).

3.6. Factorial Analysis

To investigate the factor structure of the SDQ, exploratory factor analysis has been conducted using the SPSS principal components with varimax rotation. The principal component analysis results in 8 factors with

eigenvalues over than one, explaining 54.3% of the variance. However, a varimax rotated solution with a specified number of 5 factors explaining 41.3% of the variance was easier to interpret. The results are given in **Table 6**.

The first three factors were the conduct subscale, prosocial subscale, and emotional subscale. The hyperactivity items are loaded on the fourth and fifth factors. The items: "Easily distracted, concentration wanders", "Thinks things out before acting", and "Good attention" were loaded heavily on the fourth factor. The two items "Restless, overactive, cannot stay still for long" and "Constantly fidgeting or squirming" were loaded on the fifth factor. The strongest factor was the conduct explaining 10.2%. The second and third factors explained, respectively, 8.8% and 8.5% of the total variance. The fourth and fifth factors explained 7.9% and 6%, respectively, of the total variance.

The problem was with peer subscale. The two peer items: "Liked by other children and Picked on or bullied by other children" are loaded highly on the Conduct factor. In addition, the two peer items "Loneliness" and Gets on better with adults than with other children are loaded on the prosocial factor. The fifth peer item "Has at least one good friend" was loaded on the fifth factor.

Table 6. Principal Component's analysis with varimax rotation

Subscales	factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Conduct subscale					
Often has temper tantrums or hot tempers	.509				
Generally obedient	.391				
Often fights with others	.580				
Often lies and cheats	.598				
Steals from home, school	.489				
Prosocial subscale					
Considerate of other people's feeling		.467			
Shares readily with other children		.125			
Helpful if someone is hurt, upset or feeling ill		.598			
Kind to younger children		.501			
Often Volunteers to help others		.609			
Emotional subscale					
Often complains of headaches, ...etc			.322		
Worried			.556		
Often unhappy			.443		
Nervous			.548		
Many fears, easily scared			.500		
Hyperactivity subscale					
Restless, overactive, cannot stay still for long					.676
Constantly fidgeting or squirming					.365
Easily distracted, concentration wanders				.641	
Thinks things out before acting				.545	
Good attention				.668	
Peer subscale					
Loneliness		.294			
Has at least one good friend					.123
Liked by other children	.414				
Picked on or bullied by other children	.626				
Gets on better with adults than with other children		.237			

3.7. Discriminant Analysis

Discriminant analysis is aimed at finding weighted linear functions of the predictor variables. These discriminant linear functions are used to classify objects into distinct groups according to their observed characteristics. This is usually done by calculating the scores of the linear functions. In addition, it is of interest to determine the predictor variables that contributes significantly to the linear discriminating functions.

3.8. Empirical Results

The analysis was conducted using a stepwise selection procedure. Since we have three groups (Normal, borderline, and abnormal), two discriminant functions were extracted. These two functions (shown down) were used to classify the diabetic children into one of the three groups.

The first function is

$$Z_1 = -4.623 - 0.352 \text{child gender} + 0.312 \text{emotional} + 0.356 \text{conduct} + 0.253 \text{Hyperactivity} + 0.267 \text{peer}$$

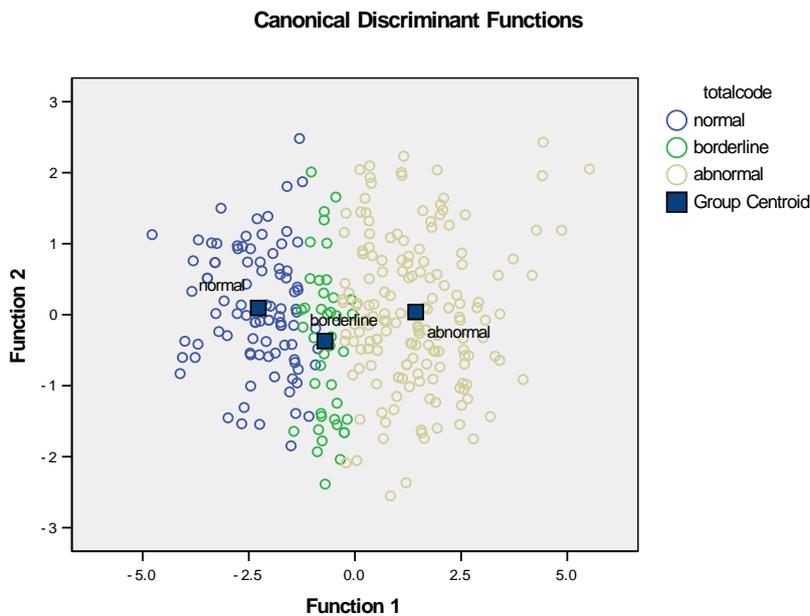
The second function is

$$Z_2 = -1.791 + 1.255 \text{child gender} - 0.043 \text{emotional} + 0.219 \text{conduct} - 0.264 \text{Hyperactivity} + 0.217 \text{peer}$$

To determine whether the two discriminant functions are significant in separating patients in the three groups we found that the first function explains 99.2% of the total variance and the chi-square test of the Wilks' lambda is significant (P = 000). In contrast, the second function explains only 0.8% of the total variance and the chi-square test of the Wilks' lambda is not significant (P = .171).

To know which variables have the greater impact we examine the standardized canonical discriminant functions. Recall that the second function was not significant. For the first function, the emotional factor has the greatest impact (.644) followed by the conduct factor (.639), hyperactivity (.505), peer (.410), and child gender (-.174).

Since the three centroids are significantly different the first function will do a good job discriminating between the three groups. This result has been illustrated by the following scatterplot.



The classification results are shown in the following table. This table is called a confusion matrix.

Table 7. Confusion Matrix

Total code		Predicted Group Membership			Total	
		Normal	Borderline	abnormal		
Original	Count	Normal	88	4	0	92
		Borderline	11	28	3	42
		Abnormal	0	2	162	164
Original	%	Normal	95.7	4.3	0.0	100.0
		Borderline	26.2	66.7	7.1	100.0
		Abnormal	0.0	1.2	98.8	100.0
Cross Validation	Count	Normal	87	5	0	92
		Borderline	12	26	4	42
		Abnormal	0	3	161	164
Cross Validation	%	Normal	94.6	5.4	0.0	100.0
		Borderline	28.6	61.9	9.5	100.0
		Abnormal	0.0	1.8	98.2	100.0

Hits (correct classifications) Ratio = (278/298) (100) = 93.29%.

Errors = (20/298) (100) = 6.71%.

4. Conclusions

Diabetes has a great impact on the emotional and behavioral characteristics of the diabetic children in Kuwait. According to the total difficulties scores, the results showed that 69.1% of the children have overall mental health problems (55% abnormal and 14.1% borderline). The highest two percentages (82.4% and 74.6%) were, respectively, for the emotional and conduct problems. Subscale-subscale and subscale-total correlation coefficient according to Pearson were all significant. All subscales are highly correlated to the total score. The discriminant analysis indicates that 93.3% of the original grouped cases were correctly classified into the three groups (Normal, borderline, and abnormal).

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