Cognitive Performance and Psychosocial Behavior in Type 1 Diabetic Children

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Abstract

Background: Type 1 diabetes mellitus is one of the most common chronic autoimmune diseaseswith several million people already affected around the globe. It can occur at any age, but is most commonly diagnosed from infancy to the late thirties. It is characterized by destruction of insulin producing beta cells in the pancreatic islets. A constant supply of glucose is critical for normal cerebral metabolism. Therefore, it is not surprising that functional and structural changes within the central nervous system have been documented in patients with type 1 diabetes. Each patient with diabetes is exposed to several factors related either to the disease itself or its treatment, these factors can affect the brain during the course of the disease but their effect on cognition varies. Psychosocial factors in chronic illness in the pediatric population may impede optimal outcome.

Aim: assessment of cognitive functions and psychosocial behavior in patients with type 1 diabetes.

Methods: This case control study was executed in the Diabetes Clinic and the outpatient clinic, Children's Hospital, Ain Shams University. This study was carried out on 40 children, with type 1 diabetes mellitus ages ranged from 6 to 10 years compared with 40 apparently healthy children of the same social background. Cognitive function was assessed by WISC- R, the auditory vigilance testandthe figural memory test. Psychosocial Assessment through the Pediatric Symptom Checklist- 17.

Results: Our results indicated that type 1 diabetes mellitus had negative effect on cognitive performance as type 1 diabetic patients had lower scores in IQ, auditory vigilance test and memory figural test than in controlsand also a negative effect on psychosocial behavior.

Conclusion: type 1 diabetic children are at high risk of cognitive impairment and developing depression, anxiety and low self- esteem.

الأداء الإدراكى والسلوك النفسى والإجتماعى لدى الأطفال المصابين بداء السكرى النوع الأول

مقدمة: إن داء السكرى النوع الأول هو واحد من أكثر أمراض المناعة الذاتية المزمنة انتشاراً. ويمكن أن يحدث فى أى سن ولكن الأكثر شيوعا هو تشخيصه من الطفولة إلى أواخر الثلاثينات و ينتج هذا المرض من التدمير التدريجى لإنتاج الأنسولين من خلايا بيتا فى البنكرياس .إن الإمداد الدائم من الجلوكوز حيوي للإيض الطبيعى للمخ. يتعرض كل مريض بداء السكري لعامل واحد أو أكثر أثناء المرض ولكن تأثيره على الأداء الإدراكى قد يختلف. قد تعرقل العوامل النفسية والإجتماعيه فى مرض مزمن لدى الأطفال أفضل نتيجة للمرض.

الهدف: تقييم الأداء الإدراكى والسلوك النفسى والإجتماعى لدى الأطفال المصابين بداء السكرى النوع الأول.

طرق إجراء البحث: قد أجريت هذه الدراسة المقارنة بعيادة السكر والعيادة الخارجية بمستشفى الأطفال جامعة عين شمس واشتملت على اربعين طفلا يعانوا من داء السكرى النوع الأول تتراوح أعمارهم من ٦ إلى ١٠ سنوات واربعين طفلا من الأطفال الأصحاء من ذات الخلفية الاجتماعية. تقييم الأداء الإدراكى باستخدام النسخة العربية من مقياس الذكاء المعدل ويكسلر للأطفال، اختبار الانتباه السمعى، اختبار الذاكرة الشكلى. التقييم النفسى والاجتماعى باستخدام قائمة فحص الأعراض لدى الأطفال.

النتائج: أوضحت نتائجنا أن داء السكرى النوع الأول له تأثير سلبى على الأداء الإدراكى حيث وجد أن جميع المرضى كانوا أقل من الاصحاء فى الذكاء اللفظى والذكاء فى الأداء والذكاء الكلى وهذا حدث فى صورة التأثير على الذاكرة ومهارات التعلم، التفكير المجرد، الذاكرة قصيرة المدى، التركيز البصري، والقدرة على التركيز المتواصل وفى اختبار الانتباه السمعى وجد أن المرضى قاموا باخطاء أكثر من الاصحاء أما اختبار الذاكرة الشكلى فكان أقل فى المرضى عنه فى الاصحاء وقد أوضحت نتائجنا أيضا أن داء السكرى النوع الأول له تأثير سلبى على السلوك النفسى والإجتماعي.

الخلاصة: إن الأطفال المصابون بداء السكرى النوع الأول هم الأكثر تعرضاً لقصور فى الأداء الإدراكى وحدوث اكتئاب، قلق، تقليل من الذات.

Introduction:

Type 1 diabetes mellitus is one of the most common chronic autoimmune diseases with several million people already affected around the globe. It can occur at any age, but is most commonly diagnosed from infancy to the late thirties.[1] It is characterized by destruction of insulin producing beta cells in the pancreatic islets. Although it is not yet known what initiates the autoimmune process, it is likely that both genetic background and environmental factors contribute to the disease process.[2]

Cognitive function can be defined as the person's capacity to acquire and use information to adapt to environmental demands and the process involves many skills including attention, creativity, memory, perception, problem solving, thinking, and the use of language.[3] A constant supply of glucose is critical for normal cerebral metabolism. Therefore, it is not surprising that functional and structural changes within the central nervous system have been documented in patients with type 1 diabetes.[4] Each patient with diabetes is exposed to several factors related either to the disease itself or its treatment, these factors can affect the brain during the course of the disease but their effect on cognition varies.[5]

Psychosocial factors in chronic illness in the pediatric population may impede optimal outcome. Overt and covert adjustment problems and psychiatric illness may present as unexplained medical symptoms, non-compliance with medical treatment, school refusal and high- risk behaviors. These signs may alert the physician to the presence of underlying issues in the child and/or the family.[6]

The aim of the present study was to assess cognitive function andpsychosocial behavior in patients with type 1 diabetes.

Subject And Methods:

This case control study included 40 children, withtype 1 diabetes mellitus recruited from the regular attendants of the Diabetes Clinic, Children's Hospital, Ain Shams University from June 2011 to June 2012, they were 18 males and 22 females, their ages ranged from (6- 10) years.

- Inclusion Criteria:
  1. Cases diagnosed with Type 1 diabetes mellitus.
  2. Prepubescent (Not more than Tanner stage 1).
- Exclusion Criteria:
  1. Cases diagnosed with Type 1 diabetes mellitus and associated with another chronic disease that may affect cognitive performance as chronic renal failure, cardiac diseases and genetic disorders.
  2. Cases proved to be mentally retarded.
  3. Cases With Auditory Impairment.
  4. Cases With Visual Impairment.

Controls were 40 apparently healthy children of the same social background recruited from the outpatient clinic, Children's Hospital, Ain Shams University. They were 21 males and 19 females, their ages ranged from (6- 10) years.

An oral consent was obtained from each subject in the study and written informed consent from their parents after explanation for t he aim of the study.

- Each child (patients& controls) was subjected to:
  1. Full Medical History: Including age of onset, duration of the disease, regimen of treatment, frequency of hypoglycemia or ketoacidosis. Laying stress on the sociodemographic data.
  2. Thorough Clinical Examination: With particular emphasis on full neurological examination, puberty assessment according to Tanner stages7 and fundus examination.
  3. Auxological Assessment: Growth was assessed through auxological measurements of weight and height. Weight for age, height for age and body mass index for age was recorded according to World Health Organization (WHO) standards using AnthroPlus software for personal computers.[8]
  4. Assessment Of Cognitive Performance: Cognitive function was assessed by a battery of psychological tests that covered verbal& non verbal intelligence, memory, learning, problem solving, and attention. All psychological evaluations were administered in one session (45-60) min. duration in a separate isolated room at the clinic. The tests were: The Arabic version of the Revised Wechsler Intelligence Scale for Children (WISC- R): This is the most widely used test for intellectual assessment and covers age range of (6- 15) years.[9,10] The test is scored according to manual from which verbal,performance score and intelligent quotient were obtained. This test comprises two scales verbal and performance.

     The auditory vigilance test: It measures the attention ability;[11] it is a measure of the efficiency of identifying signal stimuli in the context of non- signal stimuli. [12,13]

     The scores of the test were calculated as total right and total wrong.

     The figural memory test: It's a measure of free recall of visual objects; it also taps some aspects of classification ability.[11,12,13]
  5. Psychosocial Assessment: The Pediatric Symptom Checklist- 17 (PSC-17) was filled out by the child's caregiver. It is a highly reliable and valid tool for the screening of cognitive, emotional and behavioral problems of children so, appropriate interventions can be initiated as soon as possible.[14]

Results:

The study was conducted on 40 patients and 40 age and sex matched controls. Table (1, 2).

Table (1) Age of patients and Controls:

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Age (Yrs.)	Mean ± SD	8.70±1.4	8.08±1.69	Z= 1.58	0.11*
	Range	6- 10	6- 10		

*P >0.05 (Non- significant)

Table (2) Sex of patients and Controls:

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Sex	Males	18 (45%)	21 (52.5%)	X^2=0.45	0.53*
	Females	22 (55%)	19 (47.5%)		

*P >0.05 (Non- significant)

There was no significant difference between patients and controls in height (Ht.) and height for age Z score (HAZ) whereas there's significant difference in weight (Wt.) and in weight for age Z score (WAZ) and highly significant difference in body mass index (BMI) and Z score of body mass index (ZBMI) as shown in table (3).

Table (3) Anthropometric parameters of Patients and controls:

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Wt. (Kgs)	Mean ± SD	34.54 ± 10.55	30.88 ± 6.70	Z= 2.12	0.03*
	Range	21- 39.5	21- 40		
WAZ	Mean ± SD	0.99 ±0.35	0.85±0.34	Z= 2.40	0.04*
	Range	0.14- 1.64	0.06- 1.55		
Ht. (Cms)	Mean ± SD	135.14 ± 8.52	131.59 ± 10.82	Z= 1.17	0.24**
	Range	116- 146	117- 146		
HAZ	Mean ± SD	0.60 ±0.30	0.68 ±0.37	T= 1.00	0.36**
	Range	0.01- 1.27	- 0.12- 1.32		
BMI	Mean ± SD	18.0 ± 1.22	17.17 ± 1.17	Z= 3.42	0.001***
	Range	15.4- 19.9	15.3- 19.1		
ZBMI	Mean ± SD	0.95 ±0.38	0.66 ±0.35	T= 3.60	0.001***
	Range	0.1- 1.60	0.01- 1.24		

*P value <0.05 (significant) , **P value >0.05 (non significant) ,
*** P value <0.001 (Highly significant).

As regards WISC- R, there was highly significant difference between patients and controls as regards verbal, performance and total IQ with lower scores recorded in patients than in controls. Table (4).

Table (4) Results of IQ in patients and controls:

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Verbal IQ	Mean ± SD	85.85 ± 8.29	97.48 ± 6.20	Z= 5.75	0.000*
	Range	71- 106	85- 114		
Performance IQ	Mean ± SD	92.55 ± 7.68	99.50 ± 6.72	Z= 3.99	0.000*
	Range	79- 111	86- 114		
Total IQ	Mean ± SD	87.78 ± 6.77	98.28 ± 6.54	T= 7.04	0.000*
	Range	72- 101	85- 116		

*P value <0.001 (Highly significant).

The Auditory vigilance test including the simple test by its two possibilities right and wrong identification of signal stimulation (Right 1 and Wrong 1), the more difficult test by its two possibilities right and wrong (right 2 and wrong 2), total right and total wrong showed that there was significant difference between patients and controls as regards right 2 and wrong 2 and highly significant difference between patients and controls as regards all other parameters. Patients did more wrong answers than controls Table (5).

Table (5) Results of auditory vigilance test in patients and controls

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Right 1	Mean ± SD	16.28 ± 4.78	21.53 ± 3.54	Z= 4.68	0.000**
	Range	9- 26	12- 27		
Wrong 1	Mean ± SD	10.73 ±4.78	5.48± 3.54	Z= 4.68	0.000**
	Range	1- 18	0- 15		
Right 2	Mean ± SD	10.98 ± 2.73	12.68± 1.56	Z= 2.92	0.003*
	Range	5- 15	8- 15		
Wrong 2	Mean ± SD	4.03 ± 2.73	2.33 ± 1.56	Z= 2.92	0.003*
	Range	0- 10	0- 7		
Total Right	Mean ± SD	27.35 ± 6.94	34.20 ± 4.68	Z= 4.39	0.000**
	Range	15- 41	21- 42		
Total Wrong	Mean ± SD	14.75 ± 6.83	8.00 ± 4.81	Z= 4.41	0.000**
	Range	1- 27	0- 21		

*P value <0.05 (significant), **P value <0.001 (Highly significant).

As regards different parameters of figural memory test including grade of recall and grade of classification. There was significant difference between patients and controls as regards both parameters as shown in table (6). Patients' scores were lower than controls.

Table (6) Figural memory test scores in patients and controls:

Variable		Patients N= 40	Controls N= 40	Statistical Test	
				Test	P
Grade Of Recall	Mean ± SD	8.05± 2.92	9.78±1.99	Z= 3.00	0.003*
	Range	3- 15	7- 15		
Grade Of Classification	Mean ± SD	5.00± 1.94	5.93± 1.32	Z= 2.45	0.014*
	Range	2- 10	4- 9		

*P value <0.05 (significant)

There was a significant difference between patients and controls as regards internalizing score with higher scores among patients than controls but no significant difference could be detected between them in externalizing score, attention and total score table (7).

Table (7) Results of Pediatric Symptom Checklist in patients and controls:

Variable		PatientsN= 40	ControlsN= 40	Statistical Test	
				Test	P
Internalizing Score	Mean ± SD	1.60 ±1.13	0.83 ± 1.05	Z= 2.79	0.005*
	Range	0- 4	0- 4		
Externalizing Score	Mean ± SD	0.98 ±0.97	1.13 ± 1.01	Z= 0.68	0.49**
	Range	0- 4	0- 4		
Attention	Mean ± SD	1.48 ± 1.35	1.18 ± 1.03	Z= 0.83	0.40**
	Range	0- 6	0- 4		
Total Score	Mean ± SD	4.03 ±2.82	3.10 ±2.35	Z= 1.24	0.24**
	Range	0- 10	0- 10		

*P value <0.05 (significant) , **P value >0.05 (non significant)

Discussion:

There was no statistical significance difference between patients and controls as regards age and sex.

There was no statistically significant difference between patients and controls in height and height for age Z score. This in agreement with Demiret al.[15] who also reported that most children with type 1 diabetes were of normal height which signifies that type 1 diabetes mellitus had no significant deteriorative effect on height.

Our patients showed significant increase in weight and in weight for age Z score and highly significant increase in body mass index and Z score of body mass index than controls. These findings was in agreement with Blouin et al.[16] who found that the prevalence of increased weight was higher in youth with type 1 diabetes compared to youth without diabetes, excess energy intake and insufficient physical activity could be a major contributing factor to overweight in children with type 1 diabetes.

Also, recent studies have found a rise in BMI in children at diagnosis of type1 diabetes[17] these findings agreed with Gimenez et al.[18]which observed the presence of an increased trend toward higher rates of BMI. It appears that over substitution by insulin and increased food intake stimulate fat synthesis and subsequently BMI.[19]

In this study we revealed that there was highly significant statistical difference between patients and controls as regards verbal IQ, performance IQ and total IQ. All Scores of our patients were lower than controls which indicates that type 1 diabetes mellitus affects cognitive function in the form of affection of memoryand learning skills (information subtest), abstract thinking (similarities subtest), short term memory (digit span subtest), visual attention (picture completion subtest), abstract thinking and visual organization (Block design subtest), sustained attention (coding subtest) and it affects verbal IQ, performance IQ and total IQ.

Our results were in agreement withTolu- Kendiret al.[20] who found that neurocognitive functions including visual motor development, visual spatial

memory, visual organization, visual perception, short term memory, concentration, selective attention and speed of information processing were found to be negatively affected in children diagnosed with type 1 diabetes mellitus. Verbal IQ, performance IQ and total IQ were also found to be significantly impaired in children diagnosed with type 1 diabetes mellitus.

Northam et al.[4] also reported that type 1 diabetic patients performed more poorly than control subjects on measures of intelligence, attention, processing speed, long term memory, executive functions and selfmonitoring.

Brismar et al.[21] suggested that long diabetes duration, young age at diabetes onset and poor glycemic control were the disease variables that had the strongest correlation to cognitive impairment. Psychomotor speed and visual perceptionorganization were those functions, which showed the strongest dependency on any of the disease variables and the least affected was verbal ability but Asvold et al.[22] had a follow up study among type 1 diabetic patients found that subjects with early hypoglycemia, before 6 years of age, already had reduced cognitive function in childhood, they also tended to have a less favorable development in cognitive function during follow- up compared with control subjects as the developing brain is particularly vulnerable to the effects of hypoglycemia this explains why there is persistent cognitive decline even with good glycemic control, this study could explain the results of our study.

Our study revealed that the auditory vigilance test, (which reflects attention), when measured in patients and controls was statistically highly significant. Type 1 diabetic patients did more mistakes than controls.

This was in agreement with Donga et al.[23] who reported thatpatients with type 1 diabetes have deficits in sustained attention.

In this study we found statistically significant difference between patients and controls as regards figural memory test, which reflects short term memory, being lower in patients.

Hershey et al.[24] found the same results which indicate impairment in memory of type 1 diabetic patients; their results suggested that the cause of that may be medial temporal damage or dysfunction. Brands et al.[25] found the opposite which was, memory spared in patients with type 1 diabetes. This heterogeneity was probably caused by differences in patient characteristics and the psychometric tests used.

In this study Pediatric Symptom Checklist- 17 including internalizing score, externalizing score, attention and total score in patients and controls was statistically significant as regards internalizing score. Patients had higher values than controls. Which signifies that type 1 diabetic patients are prone to have depression and/ or anxiety symptoms than normal population.

While there was no significant difference between them in externalizing score, attention and total score.

Stoppelbein et al.[26] had found the same results which were, patients with chronic illness like type 1 diabetes mellitus are more likely to exhibit higher scores in internalizing symptoms compared to healthy controls. This supports that patients with chronic illnesses scored lower on the conduct problems and higher on the affective problems scales.

The diagnosis of type 1 diabetes represents a crisis for childrenand parents. It is common for children and adolescents to feel sad, lonely, anxious and irritable, pessimism about the future and refusal to take insulin or go to school. Generally, these patients had been found to be at increased risk for depression, anxiety and low self- esteem.[27] In conclusion, type 1 diabetic children could be at high risk of cognitive impairment and development of psychosocial problems.

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