

Cognitive function and academic achievement in children with type 1 diabetes

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Abstract

Background: Diabetes can affect people in three different aspects; physical, social and psychological. Occurrence of type 1 diabetes is one of the most significant factors affecting the development of a child on many levels, including cognitive development. Several studies have proven that diabetes in children has a significant effect on neurocognitive function of the brain and low academic achievement.

Objectives: This review aimed to apply the concept of developmental and educational theories on school-age children with type 1 diabetes, explore the impact of having school-age children with type 1 diabetes on cognitive function, verbal and academic skills.

Methods: The meta-analysis sample of 1,029 children with type 1 diabetes and 751 control children from 15 studies. Tasks from individual studies were assigned to one of six cognitive functions as follows: intelligence, learning and memory (verbal and visual modalities), psychomotor activity and speed of information processing, attention/ executive function, academic achievement, and visual motor integration. A second meta-analysis is conducted to compare children with early onset diabetes and those with later onset.

Results: Type 1 diabetes was associated with slightly lower overall cognition, with small differences compared with control subjects across a broad range of domains, excluding learning and memory, which were similar for both groups. Learning and

memory skills, both verbal and visual, were more affected for children with early-onset diabetes than late-onset diabetes.

Conclusion: Diabetes influence academic skills and school performance of school age children. Studies have been shown that diabetes has an effect on cognitive function e.g. learning, memory skills, verbal and visual.

Keywords: Type 1 diabetes; cognitive function; learning ability; academic achievements

{**Citation:** Hani Abozaid. Cognitive function and academic achievement in children with type 1 diabetes. American Journal of Research Communication, 2014, 2(12): 22-34} www.usa-journals.com, ISSN: 2325-4076.

Introduction

Diabetes is a chronic disease that affects multi organ from head to toes. The problem of diabetes is old and the prevalence increases dramatically worldwide especially in the gulf area. According to the statistics of international diabetetic federation (IDF) in 2011, 366 million have diabetes and will reach 552 million in 2030. ⁽¹⁾ IDF stats that "there is a global diabetes epidemic". The impact of diabetes on the health is well established.

Diabetes is most frequent severe metabolic disorder in humans and characterized by high blood sugar as a product of reduce of insulin secretion or defect in insulin action or both. We have two types of diabetes, type 1 and type2 diabetes. Type1 diabetes characterize by autoimmune destruction of B cell of islet of Langerhans in pancreas which lead to sever insulin deficiency. Type 2 diabetes characterize by relative insulin deficiency, insulin resistance or both. ⁽²⁾

Diabetes can affect people in three different aspects; physical, social and psychological. For that we should as a health care provider make a strategic plan to prevent and decrease these implications. Duration of the disease and degree of diabetic control play an important role in the disease outcome.

Type 1 diabetes affects 1 in 500 children.⁽³⁾ Occurrence of diabetes is one of the most significant factors affecting the development of a child on many levels, including cognitive development. Several studies have proven that diabetes in children has a significant effect on neurocognitive function of the brain and low academic achievement.⁽³⁾

This review aimed to apply the concept of developmental and educational theories on school-age children with type 1 diabetes, explore the impact of having school-age children with type 1 diabetes on cognitive function, verbal and academic skills and improve academic achievement and cognitive functions in type 1 diabetic primary school children.

Cognitive Function in Children With Type 1 Diabetes.⁽³⁾

The meta-analysis sample of 1,780 children, 1,029 children with type 1 diabetes (mean age 12.96 years) and 751 control children (mean age 12.55 years) from 15 studies. Tasks from individual studies were assigned to one of six cognitive functions as follows: intelligence, learning and memory (verbal and visual modalities), psychomotor activity and speed of information processing, attention/executive function, academic achievement, and visual motor integration. A second meta-analysis is conducted to compare children with early onset diabetes EOD (children younger than 7 years) (n= 232) and those with later onset, LOD (n= 536). EOD may be responsible for recurrent severe hypoglycemia.

Objectives

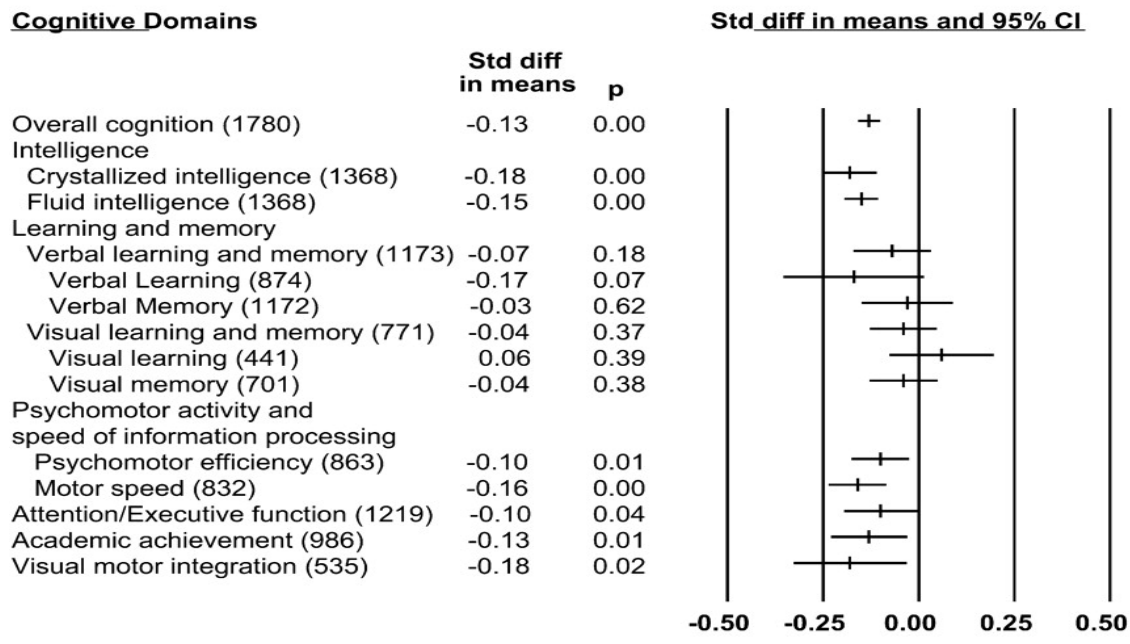
- 1- To find out whether there is evidence of cognitive dysfunction in children with type 1 diabetes compared with children without diabetes.
- 2- To examine the impact of early onset diabetes EOD compared to late onset diabetes LOD on cognitive dysfunction.
- 3- To compare EOD with non-diabetic control subjects.

Results

- 1- Type 1 diabetes was associated with slightly lower overall cognition, with small differences compared with control subjects across a broad range of domains, excluding learning and memory, which were similar for both groups. Figure 1
- 2- Learning and memory skills, both verbal and visual, were more affected for children with early-onset diabetes (EOD) than late-onset diabetes (LOD), along with attention/executive function skills. Figure 2
- 3- Compared with non-diabetic control subjects, EOD effects were larger particularly for learning and memory.

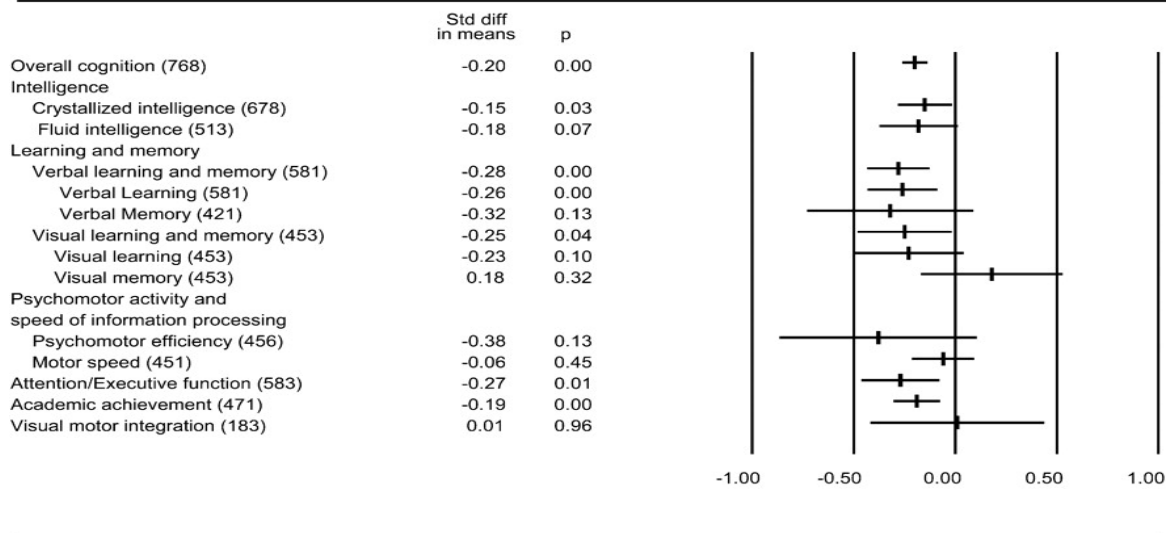
Figure 1: Diabetes versus Control children

A



B

Figure 2: Earlier versus Later Disease



Cognitive function in type 1 diabetes with hypo or hyperglycemia status:⁽⁴⁾

It's a clearly documented that glucose fluctuation can cause damaging to various organs including the brain. A total of 61 children aged 6-11 years with type 1

diabetes found that mental efficiency decrease with glucose fluctuations in children with type 1 diabetes.

According to this study, decline in mental math and reaction time performance was equivalent at glucose levels <3.0 and >22.2 mmol/l with no age or sex differences.

Figure 3

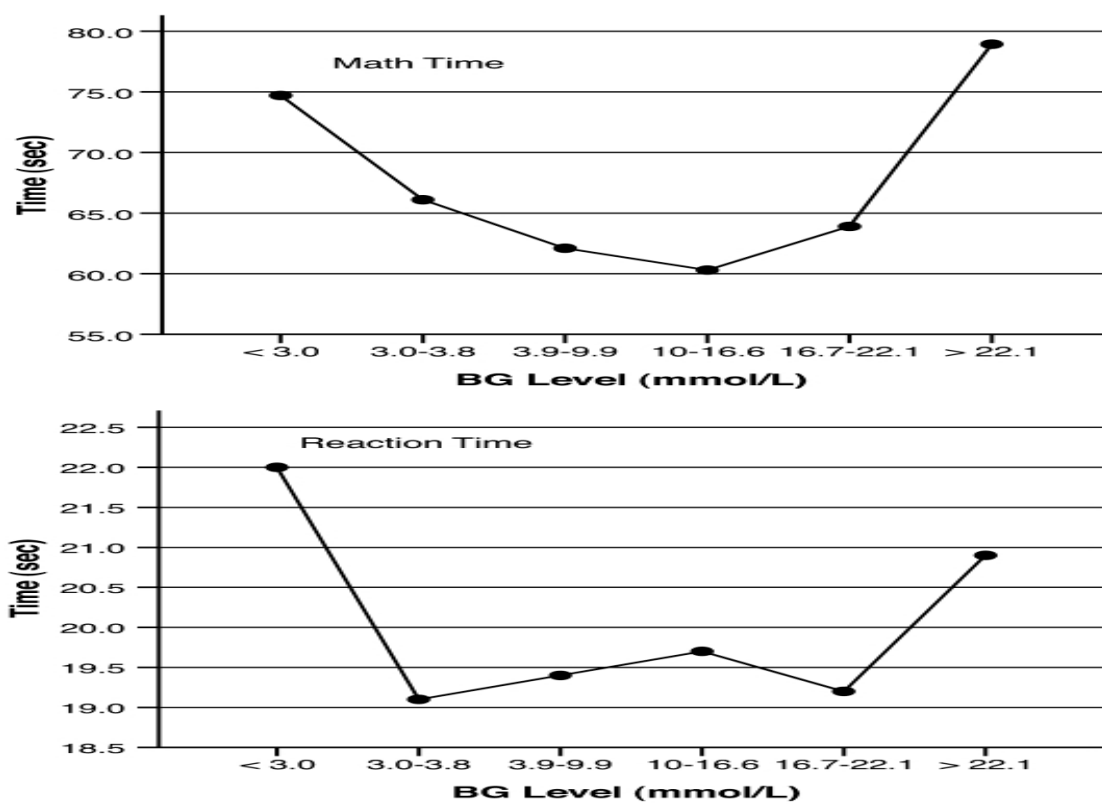


Figure 3: Blood glucose level in relation to mental math and reaction time performance.

Cognitive function in type 1 diabetes with bad control.⁽⁵⁾

A study was done to compare the neuro-cognitive functioning of young children with T1DM diagnosed before 6 yr of age and healthy children. It showed that

among children with diabetes, poor glycemic control [higher hemoglobin A1c (HbA1c)] was related to lower general cognitive abilities, slower fine motor speed and lower receptive language scores. According to this study, young children with T1DM already demonstrate some negative neurocognitive effects in association with chronic hyperglycemia.

Verbal and academic skills in children with early-onset type1 diabetes.⁽⁶⁾

Verbal and academic skills can be negatively affected by early onset diabetes. The performance of 51 children with early-onset diabetes (25 females, 26males; mean age 9 years 11moths) was compared with that of 92 children without diabetes (40 females, 52 males; mean age 9 years 10 months) in the tasks of phonological processing, short-term memory, rapid automatized naming, reading, spelling, and mathematics. According to this study, Children with early-onset diabetes are prone to minor learning difficulties in their early school years as a result of deficits in phonological processing.

Missed primary care visits and attachment style.⁽⁷⁾

In patients with diabetes from nine health maintenance organization primary care clinics. They collected data on attachment style and major depression status and determined the number of missed primary care appointments from automated data. According to this study attachment styles characterized by low levels of collaboration are associated with more missed primary care appointments compared to secure attachment style in patients with diabetes. These associations are moderated by depression status.

Developmental theories

A-Cognitive Developmental theory (Jean Piaget, 1896-1980):⁽⁸⁾

Piaget believed that "the development of cognitive abilities of the child occurs because of maturation of the brain and the interaction with the environment".

There are three basic components to Piaget's Cognitive Theory:⁽⁸⁾

1- Schema: (building blocks of knowledge)

2- Processes that enable the transition from one stage to another (assimilation, equilibrium, accommodation).

when a child can use an existing schema to deal with new situation (Assimilation); he will reach to the equilibrium stage. However, if the child existing schema does not work for the new situation and he used a new schema that's called accommodation stage (Figure 4).



Figure 4: Stages of development

3- Stages of development:⁽⁸⁾

1- sensorimotor stage (0-2 years).

2- Pre-operational (2-7 years):

Learns to use language and to represent objects by images and words. Thinking is still egocentric: has difficulty taking the viewpoint of others. Classifies objects by a single feature

3- Concrete operational (7-11 years):

Can think logically about objects and events Achieves conservation of number (age 6), mass (age 7), and weight (age 9). Classifies objects according to several features and can order them in series along a single dimension such as size.

4-Formal operational (adolescence and adulthood).

-Limitation of Piaget Cognitive Developmental theory:

It is concerned with children, rather than all learners.

It focuses on development, rather than learning.

He failed to consider the effect of social and culture factors on cognitive development.

B- behavioral social Learning, Vygotsky Educational Theory (1896–1934): ⁽⁹⁾

Vygotsky's theories stress on the fundamental role of social interaction in the development of cognition. He believed strongly that community plays a central role in the process of "making meaning". According to Vygotsky "language plays a critical roles in cognitive development".

Zone of Proximal Development (ZPD): ⁽⁹⁾

This is an important concept that relates to the difference between what a child can achieve independently and what a child can achieve with guidance and encouragement from a skilled partner. According to Vygotsky, this type of social

interaction "promotes cognitive development and developing higher mental functions". He agreed that group members should have different levels of capability to facilitate developing skills and strategies. Figure 5

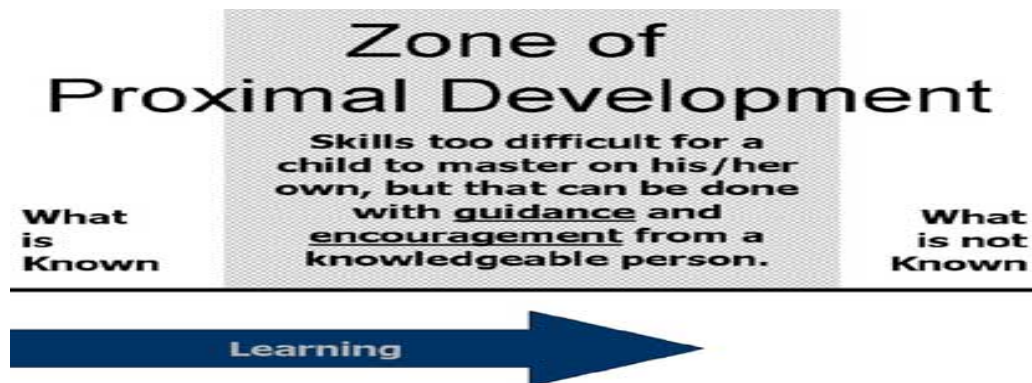


Figure 5: Zone of Proximal Development

C- behavioral social Learning, Bandura's Social Learning Theory (1977):⁽¹⁰⁾

He bridge between behaviorist and cognitive learning theories. Bandura considered personality as an interaction between three components: the environment, behavior, and cognitive.

Most human behavior is learned observationally through "modeling, from observing others one forms an idea of how new behaviors are performed, and on later occasions this coded information serves as a guide for action". Figure 6

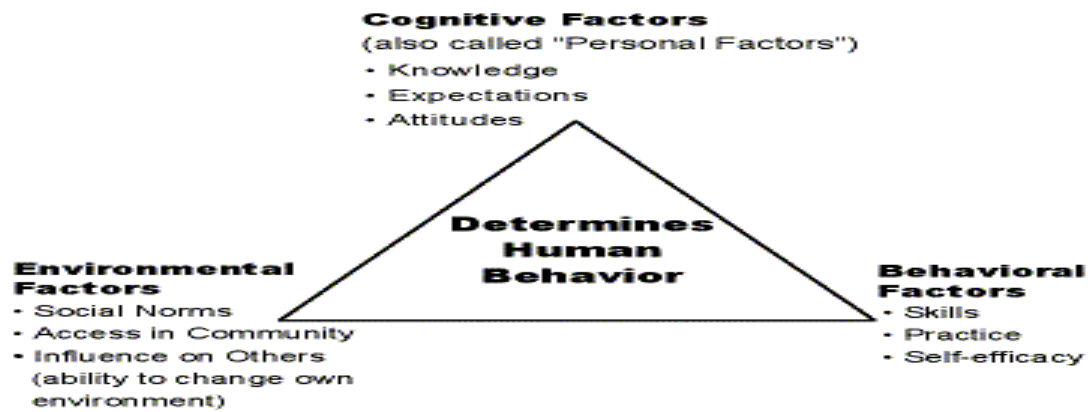


Figure 6: Determinants of human behavior

9-Improving academic achievement and cognitive functions in type 1 diabetic primary school children.

We have to Increase the awareness of primary school teachers about the important of a cooperative group learning exercises in improving cognitive functions and academic achievement of primary school children (according to zone of proximal development of Vygotsky).

The best example for that is divided the class in to deferent groups during answering questions; each group have a high and low competent students. consequently low competent student use his knowledge add to it experience and knowledge that he get it from skillful persons and peers for best learning and academic achievement.

Conclusion

Diabetes influence academic skills and school performance of school age children. Studies have been shown that diabetes have an effect on cognitive function

e.g. learning, memory skills, verbal and visual. Variation of glucose level with or without bad control can adversely affect cognitive function. Piaget, emphasized self initiated discovery and ignored the role of the social and environment in the process of development and learning.

While Vygotsky combined the two thinks together. He emphasized that a group members should have different levels of ability to attain the learning goals. Bandura consider the interaction of; environment, behavior and cognitive in determines human behavior. He emphasize on the role of modeling in learning.

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