



## Comparing Executive Functions in Normal and Diabetic Children in the City of Isfahan

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### ABSTRACT

**Background:** The emergence of chronic physiologic diseases such as diabetes damages the children's psychological, cognitive, communicational, social and emotional processes. Therefore, the present study was aimed to compare executive functions in normal and diabetic children.

**Methods:** The research method was cross-sectional. The statistical population included healthy and sick children in 2019 in Isfahan. The statistical population of the study included diabetic children and 150 healthy children who were selected through convenient sampling method. The applied questionnaires focused on their executive functions. The data from the study were analyzed through t method.

**Results:** There was a significant difference between diabetic children and healthy ones in the variable of executive functions ( $p < 0.001$ ), in a way that diabetic children got lower mean scores in executive functions. The mean scores of executive functions of children with diabetes were 233.63 and the mean scores of non-diabetic children were 192.64.

**Conclusion:** According to the findings of the present study it can be concluded that diabetes causes the decrease of executive functions due to being chronic and this process emphasizes the necessity of applying child-oriented psychological interventions for these people.

**Keywords:** Executive Functions, Diabetes, Children



## Introduction

Diabetes was recognized as one of the utmost prevalent chronic diseases observed in children, potentially ending their lives. This was in such a way that diabetes impressed all parts of the body, lifestyle, personality, and emotions of children and families (Foulkner, 2007). Actually, diabetes was seen as the most widespread metabolic disease, which was detected by hyperglycemia, impaired carbohydrates metabolism, fats, and proteins, leading to defects in insulin in reality, diabetes was a specific chronic disease and different clinical symptoms and progression trends, comprising insulin-dependent diabetes or juvenile diabetes (type 1) and non-insulin-dependent diabetes (type 2). Additionally, diabetes was the most common endocrine disorder in childhood and adolescence (Sapra et al., 2018).

Based on the World Health Organization (WHO) report, the prevalence of diabetes in Iran was 9.8% among men and 11.1% among women. Controlling blood sugar at a normal level without hypoglycemia was considered the final objective of treating diabetes (Hordern et al., 2012). Moreover, the prevalence of type 1 diabetes among children was rising in all parts of the world, the main reason of which was unknown and influenced approximately one in every 300 to 500 children under 18 years old. In the United States, one in every 400 children and adolescents was affected by diabetes. In Iran, the outbreak of type 1 diabetes in children was 1 to 35 cases per 100,000 populations (Baquedano et al., 2010).

Complications of diabetes could be referred to as cardiovascular disorders, peripheral vascular and cerebrovascular disorders, neuropathy and retinopathy, diabetic foot, amputation, and psychological damages (Mishalia et al., 2011). The previously conducted research findings illustrated that the prevalence of chronic physiological diseases directed the children towards behavioral disorders (Mohammad Zadeh Farhani et al., 2018; Jaser et al., 2017; Caruso et al., 2014). Appropriately, diabetes was often attributed to

psychological problems and disorders (Khodabakhshi Koolae et al., 2016; Zare et al., 2013). These problems minimized the patient's ability in self-management of the disease. The diminished ability of patients to control diabetes aggravated their psychological disorders and caused the patients to be involved in a vicious cycle. These problems would probably be exacerbated by patients' psychological reactions that negatively affected the experience of diabetes symptoms. There existed a paramount difference between two people who were medically injured with the same conditions in terms of reactions and disabilities as well as social and physical functioning. One of the effectual factors in describing this disparity was psychological components, namely thoughts and underlying beliefs of people with diabetes (Mahmoud Alilou et al., 2014).

Furthermore, recent researches declared that people with diabetes were suffering from damages in executive function-related tasks originating in the frontal lobe (Schuur et al., 2010; Ishizawa et al., 2010). Executive functions contained the ability related to oncoming future strategies, judgment, planning or execution of cognitive tasks, abstract, problem-solving, organization of chain actions based on logical strategies, conceptualization, or change behaviors with flexibility in attitudes and monitoring the performance of the behavior. Indeed, executive functions were noticeable structures, associating with the psychological processes responsible for controlling consciousness and thinking in action. These functions adjusted behavioral outputs and usually involved inhibition and stimuli control, working memory, sustained attention, planning, and organization. It appeared that higher executive performance was able to decrease the less stress due to impulsivity or inhibition of impulses in the child (Anderson et al., 2001). Besides, executive functions were designated as higher and self-regulatory hierarchies of cognitive processes, contributing to managing and direct thoughts

and actions (Carlson, 2005). Managing actions and thoughts via executive processes was required for analyzing external stimuli, formulating mental goals and strategies, recognizing the appropriateness of plans, and actions preparation. Therefore, executive function was an instrumental tool in human cognitive and behavioral functions, emotional control, and social interactions (Anderson, 2002). Also, executive functions were known as the most vital cognitive functions, influencing people's involvement. If the executive functions have not happened thoroughly, executive dysfunctions would have appeared. In this regard, the individual's involvement would diminish. The individual's roles would be limited, and even the social life of independence and the quality of the individual's life might be even under the influence (Cramm et al., 2013). Executive functions were of paramount significance in the overall neurodevelopmental function in childhood and exerted a fundamental effect on children's cognitive, behavioral, and social and emotional development (Isquith et al., 2005).

Considering the necessity of performing the current paper, it was worth mentioning that, in response to the accumulative prevalence of diabetes in children, this disease lately turned as one of the most remarkable challenges confronting health officials of countries (Levesque, 2017). In reality, diabetes was observed as one of the most noticeable metabolic diseases, but on the other side, it was a disease under the control. Furthermore, according to this fact that the patient was the most crucial factor in controlling diabetes and inhibiting the occurrence of complications of the disease, the examination of psychological factors associated with the patient and family could be a conspicuous agent in coping with the disease as well as enhancing their psychological, emotional and communication components. In fact, besides limiting physical health, diabetes was capable of influencing many important psychological issues in childhood, many of which imposed durable consequences in children's next developmental stages. Considering the previously

performed research findings, family performance and strong parent-child relationships were significantly associated with metabolic control and child health (Lewin et al., 2006). Based on the above-addressed materials and the lack of a study on the comparison between executive functions in children and diabetes with normal children, the researchers attempted to examine the research problem and determine the existence of a difference between executive functions in with diabetes and normal children.

### Methods

This descriptive cross-sectional study was conducted among 7-11 year-old children with diabetes and healthy children in Isfahan in 2018. The participants were selected using convenience sampling method. Hence, by referring to the pediatric endocrinologist and metabolism clinics in Isfahan, 150 children aged 7 to 11 years with diabetes and 150 normal children were selected based on age and gender matching with children with diabetes using the conventional method. However, 69 of them were girls, and 81 were boys. It was necessary to state that since the mothers completed the questionnaires, the presence and accompany of them was mandatory in both groups of children. By referring to two primary schools for boys and girls, 69 normal girls and 81 normal boys were selected according to age and gender matching, i.e., they were selected concerning age and gender similar to children presented in the diabetic group. It should be mentioned that using the matching process was aimed at minimizing the effective factors in the two groups' executive functions. Inclusion criteria for children with diabetes included a diagnosis of diabetes in a child by a pediatric endocrinologist, the mother's accompany with the child (as mothers completed the questionnaires) and lack of psychiatric disorders in child and mother (such as depression and anxiety) which was specified through a short interview with the mother by the researcher. Also, exclusion criteria included the child and mother's reluctance to continue the cooperation and

inaccuracy in answering the questionnaires. To comply with the research ethics, the researcher received the parents and children's consent to participate in the research and informed them of all research stages. Moreover, they were assured that their personal information would remain confidential, and their name would not be cited in the research.

The following questionnaire was applied in the present study:

#### *Behavior Rating Inventory of Executive Function*

The executive Function Questionnaire Gioia et al. (2000; Quoted from Nodeei et al., 2016) was developed to investigate different aspects of the functions of the former frontal segment of the brain. The questionnaire is designed in two forms: parent and teacher and are used for children and adolescents aged 5-18 years. The initial version of the executive performance behavioral measurement questionnaire, which examines executive functions in children 6-11 years old, has 85 options, which is never ranked 1, sometimes ranked two, and most of the time with rank 3. The range of the scores of the questionnaire was 85-255. Higher scores are weaker than executive performance. Parents of children will also complete the questionnaire. Salman prepared the questionnaire in 2015 in Persian, and the results of the face validity of this study showed that all the phrases were simple and clear, and the Persian version had good validity (Nodeei et al., 2016). In Shahabi's study, the questionnaire's validity and reliability were measured, in which the test-retest reliability coefficient was 0.89 in the overall score of executive functions. The questionnaire's internal consistency coefficient was 0.87 to 0.94, which indicated high internal consistency of all subscales (Nodeei et al., 2016). Cronbach's alpha was 0.96.

#### *Research Implementation Process*

For data collection, the research process was started by referring to endocrinology and metabolism specialist clinics in Isfahan city and selecting children with diabetes and referring to

two boys and girls' schools for normal children and by syncing two groups of children with diabetes to normal children. Then, the questionnaires were provided to mothers of two to answer. In fact, in this study, questionnaires were responded to by mothers. After mothers' responses, questionnaires were collected and scoring and analysis of the results began. Parents and children's satisfaction to participate in the study was gained and informed of all stages of the study. People were also assured that their information remains confidential and that no need to insert names. This article is registered with the ethics code IR.KHUISF.REC.1397.312. Data analysis was performed using ANOVA and SPSS 23 software.

#### **Results**

The demographic data findings showed that the subjects were 7-11 years old, among which the mean age of diabetic children and normal children group was 10.25 and 9.25 years. The mean duration of diabetes was 3.35 years in diabetic children. On the other hand, these children were studying in primary school. The highest frequency of diabetic children was related to fourth grade (68 children were 45.33%) and in normal children group was related to third grade (57 children were equal to 38%). Also, 46% of the children were female, and 54% were male. It should be noted that by investigating the relationship between demographic variables (age, duration of disease, education level and gender) with research dependent variable (executive functions) using Pearson correlation test (to investigate the relationship between executive functions with age and duration of disease), Spear There was no significant relationship between demographic variables (age, duration of disease, education level and gender) with research dependent variable (executive functions) to investigate the relationship between executive functions and gender. Now descriptive findings of the study are being investigated.

The results of table 1 indicate that the mean of executive functions varies between children with

diabetes and normal children. However, a significant difference is investigated by inferential statistics. Before presenting the results of ANOVA, the defaults of parametric tests were measured. Accordingly, the results of the Kolmogorov - Smirnov test showed that the default normality of sample distribution of data in executive functions variable are established in two groups of children with diabetes and normal

children ( $p > 0.05$ ). Now the results of inferential tables are presented.

As can be observed in Table 2, the difference between the mean of the two groups of children with diabetes and normal children in the variable of executive functions is significant ( $p < 0.05$ ). Hence, the executive function rate in children with diabetes is significantly lower than in normal children.

**Table 1.** Mean and Standard Deviation of Executive Functions in Two Groups of Children with Diabetes and Normal Children

Variables	Group	Mean	SD	Z Kolmogorov-Smirnov Statistics	Sig
Executive functions	Diabetic children	233.63	32.66	0.96	0.09
	Normal children	192.64	31.16	0.90	0.08

**Table 2.** Results of t-test of two independent groups to compare executive functions in two groups of children with diabetes and normal children

Surveying the differences with 95% confidence		SEM	Differences of means	Significance amount	Freedom degree	t value
High level	Low level					
48.24	33.73	3.68	40.98	0.0001	298	11.12

### Discussion

The purpose of this research was to compare executive functions in children with diabetes and normal children. The results showed a significant difference between children with diabetes and normal children in executive function variables. Children with diabetes had lower mean scores in executive functions. This finding was in sync with the results of Mohammad zadeh Farhani et al. (2018) and Jaser et al. (2017). As these researchers have shown, the incidence of chronic and physiological diseases causes psychological, cognitive, and emotional damage to children. This process causes cognitive and emotional mistreatment in them.

In the analysis of this hypothesis that executive function and its dimensions are low in diabetic children, it can be said that executive functions are brain functions, which are applied to willful and purposeful behaviors and integrated goal-

based construction and management help people to consider short and long-term consequences simultaneously and immediately evaluate their behavior and can adjust and adjust them in a desirable way. Executive functions are also called higher hierarchies and cognitive processes self-regulators, which help manage and control thoughts and actions (Carlson, 2005). Therefore, executive functions play an important role in cognitive, behavioral, emotional control, and human social interactions. In fact, the evolution of executive functions is synced with the duration of neurocognitive growth in the brain's forehead region (Anderson, 2002).

Diabetic children are required to observe some limitations due to glycemic management. Also, nowadays, due to the spread of the variety of fatty foods and the types of sweets and children's interest in these colorful foods, observing and restraining the child in the environment outside





the home and among friends and their years is very difficult. In fact, in such a situation, the child is in a fight to control his/her behavior and sometimes succeeds and sometimes follows the principles of the regime. Therefore, this problem between successful and unsuccessful behavioral control in the child may cause stress for the child, increase anxiety and even reduce mood, which causes changes in the path of neurotransmitters, which can damage the child's active memory, focus, and attention and consequently reduce the child's executive function (Sapra et al., 2018). In another analysis, it seems that children with daily life face the important problem of glucose control, which is due to the mental ability of a child. These meta-stress and conflict-related conditions due to glycemic management can also cause anxiety, stress, and behavioral disorders to be imposed on the child. In fact, the child may experience diabetes problems, which occur in the form of anxiety, depression, and isolation or show external symptoms that appear like aggression, anger, and conduct disorders. Behavioral disorders such as aggression or anger affect executive functions and response inhibition in children, which also reduces executive function.

The limit of the range of research to the age range of 7-11 years and also children with diabetes in Isfahan city and the existence of some uncontrolled variables, such as social and mental status of the subjects present in this study, financial status of families, lack of background factors and comparison between the two groups, lack of using random sampling methods and methodological limitations (using causal-comparative research method and This study was recommended to increase the generalized power of results at the proposed level of research, this study should be conducted in other age periods, children with diabetes in other cities, regions and communities with different cultures, other diseases, controlling the mentioned factors, random sampling method and experimental method (using appropriate psychological interventions).

## Conclusion

The results of this study showed that there is a significant difference between children with diabetes and normal children in executive functions variable, and it is recommended to use the results of this study to use child-centered psychological treatments such as mindfulness therapy, acceptance-based therapy, commitment and executive functions training for these children to improve their performance.

## Conflict of interest

Authors declare no conflict of interest during the study period.

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## Authors' Contribution

Conceptualization, N.S.Sh.; Methodology, Z.Y.; Formal Analysis, Z.Y.; Investigation, N.S.Sh.; Writing -Review & Editing, Z.Y.; Supervision, N.S.Sh.; Writing -Original Draft, N.S.Sh.

All authors read and approved the final manuscript and are responsible about any question related to article.

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