

# Autism spectrum disorder on the basis of executive functioning profile

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## ABSTRACT

**Introduction:** Executive Functioning (EF) has been studied separately in both normal and Autistic children but there are no specific studies on the comparative analysis of strength and weaknesses of executive functioning among children with Autism Spectrum Disorder (ASD) and normal children.

**Objective:** To evaluate and compare the strength and weakness of executive functioning (EF) among children with autism spectrum disorder and normal children.

**Materials & Methods:** A comparative cross-sectional survey was conducted through purposive sampling from July 2018 to February 2019 involving parents of normal school going children and diagnosed Autistic children. Children aged 3 to 8 years old with ASD (n=96) and normally developed children (n=96) were compared on a battery of Executive Functioning (EF) tasks in both groups. Data were analyzed by SPSS version 21 for descriptive statistics; comparisons were done by Independent Samples T Test, keeping  $p \leq 0.05$  as significant.

**Results:** There was a male preponderance among the autistic children (67 versus 45 males in normal children). The most represented ages were 4-4.11 years and 7-8 years. Tests of Executive Function showed significant decline in all the abilities ( $p < 0.05$ ), except in Time Management ( $p = 0.21$ ).

**Conclusion:** Children with Autism Spectrum Disorder show major deficits in Executive Functioning when compared to normal children.

**Keywords:** Autism Spectrum Disorder, Executive Functioning, DSM-5 Diagnostic statistical Manual-5, Applied Behavior Analysis.

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## INTRODUCTION

In Statistical Manual-5 (DSM5) diagnostic criteria of Autism Spectrum Disorder are given as the constant presence of repetitive behavior, and deficit in social communication. Diagnostic criteria are based on individual disease severity.<sup>1</sup>

Autism is a developmental disorder called Autism Spectrum Disorder (ASD), the term Spectrum depicts the wide range of symptoms, disabilities, and levels of impairment.<sup>2</sup>

ASD is characterized by challenged social skills, repetitive behaviors, speech and nonverbal communication, and other sensory difficulties.<sup>3</sup> Deficits of social motivation at the behavioral, biological, and evolutionary levels play a central role in the disorder and more intensely integrate into cognitive impairments such as Executive Dysfunction.<sup>4</sup>

In early childhood, Autism is identified by deficits in social communication and occurrence of repetitive sensory-motor behaviors.<sup>5</sup> In later childhood, various common developmental disorders like Autism Disorder, Attention Deficit and Hyperactive Disorder emerge which are associated with Executive Functioning (EF) Deficit.<sup>6</sup>

Early signs of Autism are evident at age 18 months by repetitive language, no eye contact, delayed speech, poor response to her/his name, failing to point, lack of concentration, motor mannerisms such as hand flapping, lack of interest in other children, failing to imitate caregivers and others, lack of spontaneous play or make believe, and persistent fixation of parts of objects.<sup>7</sup>

Primary symptoms of ASD such as repetitive behavior, poor social interaction, and poor communication vary on individual severity. Mildly autistic children are able to have a normal life but speech is affected. Children with autism might be controlling their emotions, hence slower in communication. Severe Autism at age 2 years affects language, social skills, motor skills, and bowel and bladder control.

Autism is five times more common in boys than girls. Some experts believe that Rett's disorder is similar to ASD at age 6 months with symptoms of communication, coordination, and movements.<sup>8</sup>

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Recently DSM-5 introduced some factors influencing ASD such as language, atypical movements, intelligence, posture, gait, and motor performance particularly the observed atypical movement in children with Autism Spectrum Disorder (ASD) or without delayed speech. Children with ASD and intellectual disabilities often show atypical movements so intellectual functioning may predict visuomotor integrated abilities in autistic children. In autistic children difficulties of verbal and non-verbal abilities are associated with other cognitive aptitudes, essentially speed processing, in both Asperger Syndrome and ASD.<sup>9</sup>

The Executive Functioning (EF) deals with "command and control" thus it can be denoted as the "conductor" of all cognitive abilities. The executive functioning is an umbrella term of neurological based abilities connecting mental control and self-regulation. EF deals with the abilities to achieve goals.<sup>10</sup>

Executive Functioning describes a function of mental processes where past experiences are connected with present actions. EF is used when perform activates like planning, organization, strategizing and paying attention.<sup>11</sup> Deficits of EF occur due to lack of social interaction, behaviors and communication in children with diagnosed ASD; frequent deficits are weaknesses in planning, organization, and cognitive flexibility.<sup>12</sup>

Executive Function enables higher control process of behaviors in a continually change environment affecting working memory, planning, inhibition, flexibility, impulse control, and examined actions. Neuropsychological and behavioral activities are linked to prefrontal cortex and frontal lobe to enable Executive Functioning, in particular the posterior and frontal areas of frontal lobe, and additionally the thalamic and subcortical pathways. Executive dysfunction occurs with the developmental disorders such as ASD; such dysfunction results in repetitive behaviors, lack of impulse control, problem in initiation new tasks, and switching of tasks.<sup>13</sup>

Thus Autism Spectrum Disorder can be diagnosed on the basis of behavioral symptoms and cognitive abilities which is characteristic of individuals with ASD.<sup>14</sup> EF deficit is widely reported in ASD, is engaged with both social and non-social symptoms, and is linked with aspects of communication and social interaction.<sup>15</sup>

Leung et al<sup>15</sup> in 2016 investigated the relationship among EF and social impairments in ASD children. The study used the Social Responsiveness Scale (SRS), Autism Diagnostic Observation Schedule (ADOS), and Behavioral Rating Inventory of Executive Functioning (BRIEF) tools in 70 children and adolescents with, and 71 without diagnosed ASD (TD control group). Results indicated that metacognitive executive developments such as inhibition, working memory, monitoring, planning, and organization estimated social function only in children with ASD and not in Typically Developing (TD) children. Behavioral regulation executive function such as Shifting, Emotional Control Inhibition and Emotional Control predicted social tasks in children.<sup>15</sup>

In 2018 Garon et al<sup>16</sup> investigated the simple and complex abilities of Executive Function in specific domains such as inhibition, working memory and shifting in a research study

taking 34 preschoolers diagnosed with ASD and 255 with Typically Developing (TD) preschoolers, using a novel Preschool EF Battery. The results showed importance of testing for simpler EF abilities in young children with ASD.<sup>16</sup>

Wilson et al<sup>17</sup> in 2018, investigated EF in middle childhood. In the research study 126 typically developing children aged 5 to 12 years participated for evaluating of three cool EF tasks (spatial working memory, stop signal, and intra-extra dimensional shift), two hot EF tasks (delay of gratification and gambling), one advanced theory of mind test (strange stories with high versus low affective tone), and a vocabulary test. Older children performed better than younger ones; multiple regression analysis showed that cool and hot EF correlated with each other, but theory of mind was predicted in different ways.<sup>17</sup>

Executive dysfunction is an endophenotype neurodevelopmental disorder involving Attention Deficit Hyperactivity (ADHD) and Autism Spectrum Disorder (ASD); a review article based on 26 studies<sup>18</sup> showed ASD group had impairments in planning and flexibility while ADHD group had impairments in inhibition. Attention deficit, fluency process, working memory, and concept formation commonly appeared in both ASD and ADHD groups.<sup>18</sup>

In the light of literature search, there exist gaps in relation to the deficiencies and similarities in EF among ASD and normal children. The various domains of EF affecting neurocognitive tasks may help to refine the classification system and enhance the assessment of specific therapeutic intervention strategies. Hence, the present study was conducted to evaluate and compare the strength and weakness of executive functioning (EF) among children with autism spectrum disorder and normal children.

## MATERIALS & METHODS

A comparative cross-sectional design was used for this study conducted in various settings of Lahore in July 2018. Samples were taken from normal school going children, The Children's Hospital Lahore, Autism Resource Center Lahore (ARCL), Mind Professionals - Therapy Center, and Rising Sun Institute for Special Children. The study sample consisted of 192 children comprising 96 Autistic and 96 normal children, inducted through purposive sampling. Sample size was calculated by using online calculator with 95% confidence interval and 10% significance interval.<sup>19</sup>

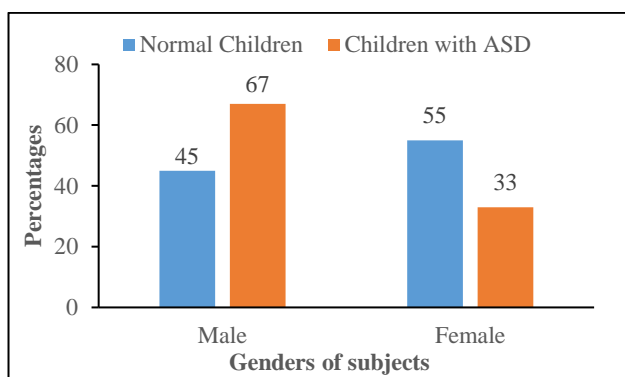
Sample selection was done on the basis of inclusion and exclusion criteria. Inclusion criteria were pre-diagnosed children of Autism Spectrum Disorder, and normal children within the age range of 3 to 8 years. Exclusion criteria were other co-morbid conditions such as hearing loss, ADHD, medical conditions, and structural abnormalities. Data were collected from parents after taking informed consent. The tool used for current study was Executive Functioning Skills Questionnaire by Guare, 2014.<sup>20</sup>

Authority letters explaining the nature of the study were obtained from the included institutes and presented to the parents for informed consent prior to data collection. Questionnaires were filled by mothers for their 3-8 years old children after they were counseled about the Executive Functioning Skills Questionnaire. Data were analyzed by using Statistical Package for the Social Sciences (SPSS) version 21.0 for descriptive statistics;

Independent Sample T Test was applied to compare the mean differences in scores of normal and ASD children, keeping  $p < 0.05$  as significant.

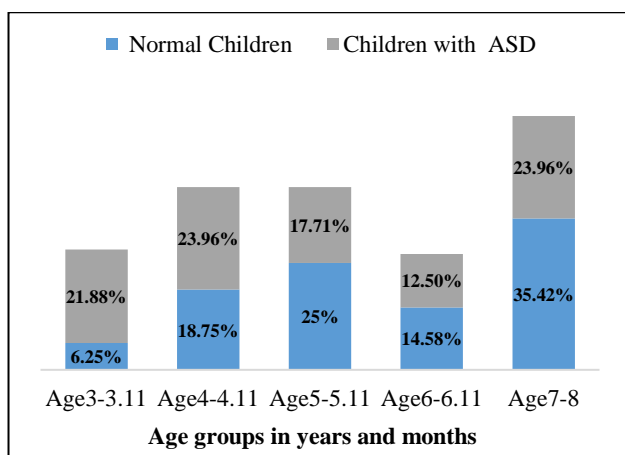
**RESULTS**

The percentage wise distribution of normal children and ASD children by gender is shown in Figure 1. For normal children the male to female ratio was 45:55, while for the autistic children it was 67:33. The female got the maximum response 54 % by following normal children.



**Figure 1: Percentage wise distribution of normal and ASD children by gender (n= 96 each).**

Figure 2 depicts the percentage wise distribution of normal and ASD children by age groups. For normal children the maximum representative age group was 7-8 years (35.42%), followed by age group of 5-5.11 (25%). For ASD children, the maximum representative age groups were ages 4-4.11 and ages 7-8 years (23.96% each), followed by age group of 3-3.11 (21.88%).



**Figure 2: Percentage wise distribution of normal and ASD children by age groups (n=96 each).**

Independent Samples t-test was applied to compare the mean scores of executive functioning profile between normal and ASD children. It determined the significant difference between Normal and Autistic children in the areas of Response Initiation, Working Memory, Emotional Control, Sustained Attention, Planning, Organization, Flexibility, and Goal Directed Persistence.

Table 1 shows that all these sub-domains of Executive Functioning profile were significantly different between the two groups of children ( $p < 0.05$ ) except for Time Management, which did not show a significant difference ( $p = 0.21$ ).

**Table 1: Independent T-Test of Executive Skills Questionnaire-Child comparing normal & ASD children (n=96 each).**

Question	Mean			p value
	Normal	Autistic	Mean diff	
Response Initiation	1.57	1.23	0.33	<0.001
Working Memory	1.84	1.36	0.47	<0.001
Emotional Control	1.68	1.47	0.20	<0.001
Emotional Control	1.73	1.32	0.41	0.03
Sustained Attention	1.70	1.35	0.35	<0.001
Planning	1.76	1.27	0.48	<0.001
Organization	2.05	1.35	0.69	0.04
Time Management	1.67	1.15	0.52	0.21
Flexibility	1.79	1.31	0.47	<0.001
Metacognition	1.76	1.22	0.53	<0.001
Goal Directed Persistence	1.68	1.21	0.46	<0.001

**DISCUSSION**

The study compared the Executive Functioning profile in terms of working memory, emotional control, response inhibition sustained attention, task inhibition, flexibility, planning, time management, organization, goal directed persistence and meta cognition in children with Autism Spectrum Disorder (ASD) and normal children. Each battery of EF tasks had three sub-scales.

In 2018 Garon et al<sup>16</sup> investigated the Executive Function’s simple and complex abilities in specific domains such as inhibition, working memory and shifting. The results showed significant differences between the two groups in the three EF abilities. The current study shows the significant relationship among Response Inhibition and Working Memory.

In 2018 Berenguer et al<sup>21</sup> investigated Theory of Mind (ToM), EF, and behavioral problems in children with Typical Development (TD), ADHD, ASD, and ASD + ADHD along with relationships between these variables. Impairments of EF were seen in affected children; inattention symptoms were significantly associated with EF metacognitive deficits and ToM difficulties in ASD with ADHD. The present study also showed a significant difference in metacognition among Autistic and non-autistic children.

In 2014 Blijd-Hoogewys et al<sup>22</sup> investigated the relationship between IQ and Executive Functioning by using the Behavior Rating Inventory Executive Functioning (BRIEF) in children with Autism Spectrum Disorder (ASD). EF deficits were found in the areas of inhibition, emotional control, monitoring, planning, and organizing. The current study also documented significant differences among Emotional Control, Task

Inhibition, Planning and Organization among autistic and non-autistic children.

Another study<sup>23</sup> evaluated the inhibition, working memory, flexibility, and planning in ADHD children, ASD children with and without ADHD, and normal Typically Developing children. Results showed children with ASD were impaired in planning and flexibility, as also shown in the present study.

In 2015, Minhas et al<sup>24</sup> evaluated parents' perspectives on care of children with ASD in South Asia, obtaining views from Pakistan and India. Results suggested that burden of care of these children rested entirely on mothers leading to higher stress. This is

compounded by poor awareness about ASD that leads to poor management. Associated stigma is another factor that delays or prevents social integration. Task shifting strategies were recommended so that other members of society could help the families in managing the condition and maintain societal links. Similar trends were observed in the present study so that parents could benefit from task shifting strategies.

## CONCLUSION

Executive Function is significantly affected in Autistic children in almost all the domains when compared to normal children; some of the sub-domains were more affected than others.

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