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Observations on The Relationship Between Ghrelin, Leptin and Growth Hormone in Children with Autism

Doaa Abd Al-hassan. Abboud[1*], Luma Qasim Ali. Samar[2], Abdul Raheem. AL-Gharrrawi[3]

1 Department of Biology, College of Science, Mustansiriyah University, Baghdad, Iraq.
2 Department of Biology, College of Science, Mustansiriyah University, Baghdad, Iraq.
3 Department of Basic Science, College of Dentistry, Mustansiriyah University, Iraq.

Corresponding author email address:
duaa.abdulhasan@uomustansiriyah.edu.iq

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ABSTRACT

Objective: Autism spectrum disorder (ASD) is a neuro-developmental disorder which are characterized by symptoms such as speech difficulties, repetitive and restricted patterns of behavior, and insufficient social interaction. The purpose of this study is to assess the level of a few physiological indicators and hormonal relationships with ASD in children.

Methods and Materials: In the current study, there were 90 Iraqi children (both male and female), 60 children with ASD who visited Pediatric Teaching Hospital in Iraq (48 males and 12 females), and 30 children controls (20 males and 10 females). They ranged in age from 1.5 to 12 years old. The concentrations of serum levels of growth hormone (GH), ghrelin, and leptin were measured by drawing peripheral venous blood from the children. The enzyme-linked immunosorbent assay method was used to evaluate the hormone levels.

Findings: The study's findings revealed: 1. It was noticed that children with autism have noticeably increased leptin levels in females and males compared to controls. Contrariwise, Children with autism have lower ghrelin levels in females and males than in controls; however, this difference reaches statistical significance (P≤0.05). Similarly, GH levels were significantly lower in children with autism in females and males than in controls.

Conclusion: Children with autism may have much greater amounts of leptin, which could indicate that this hormone plays a key part in the pathophysiology of autism. However, GH and ghrelin levels appeared to be low in children with autism.

Keywords: Autism spectrum disorder, Leptin, Ghrelin, Growth hormone, social communiction disorder.

Introduction

During the first three years of life, a complex group of multifactorial neurodevelopmental disorders known as autism spectrum disorder (ASD) can cause a wide range of neuropsychiatric symptoms, such as repetitive behavior, limited interests, and difficulties with social communication (Alshammary et al., 2023; Kawabe et al., 2020). Just about 1% of people globally have autism, although estimates are higher in wealthy nations. Along with these main symptoms, people with autism often have co-occurring neurological or psychiatric disorders, including as attention and hyperactivity disorders (such attention deficit/hyperactivity disorder (ADHD)),

anxiety, depression, and epilepsy (Risi et al., 2006). A cytokine that promotes inflammation, leptin is mostly produced by white adipose tissue. The body's energy reserves and calorie intake are indicated by the plasma level of leptin since this adipokine is released in direct proportion to the quantity of white adipose tissue (Picó et al., 2022)[4]. Through appetite suppression and neuroendocrine effects mediated by hypothalamic receptors, leptin plays a significant role in maintaining energy homeostasis (Picó et al., 2022; Salem, 2021). Leptin is linked to appetite suppression, obesity, and immune dysfunction. These factors may exacerbate feeding difficulties and gastrointestinal tissues frequently reported in ASD (Riikonen, 2016).

Energy metabolism and circadian fluctuations are influenced by leptin (Jbarah & Ali, 2024). The first known hunger hormone to be found in circulation is ghrelin, a special 28-amino-acid peptide. It functions as a neurotransmitter in the neurological system and as a hormone in the endocrine system. It is sometimes referred to as motilin-related peptide or growth hormone secretagogue (Kojima et al., 2001). About 70% of ghrelin is produced in the stomach, with the bulk of the remaining amount coming from the small intestine (Jeon et al., 2004). has the most well known orexigenic hormone. Ghrelin's role in hippocampal synaptogenesis and neuroprotection suggests its deficiency could impair learning memory and stress response in ASD (Riikonen, 2016). Different areas of the brain respond differently to ghrelin. Its primary impact is on nutrition, but it also has an impact on motor and sensory functioning, sleep management, and higher cognitive functions (Micai et al., 2023). Individuals with ASD frequently struggle with executive functioning, food issues, sleep issues, obesity, and sensory impairments (Barón-Mendoza et al., 2019; Braconnier & Siper, 2021).

Ghrelin is involved in hippocampal synaptogenesis and acts on the hippocampus, an important region for memory and learning. In cases of ASD, abnormal hippocampal synaptogenesis has been noted (Steyn et al., 2016). Numerous investigations into the relationship between ghrelin and ASD have produced varying findings.The primary isoform of growth hormone (GH), a single-chain protein with 191 amino acids, is primarily released by somatotropic cells found in the anterior pituitary gland. The pulsatile pattern of GH secretion is regulated by hypophysiotropic hypothalamic neurons. Somatostatin (SST) or GH-releasing hormone (GHRH) are expressed by the traditional neuroendocrine neurons that control the pulsatile secretion of GH (Jumaa et al., 2022). GH synthesis and release are stimulated by GHRH, but GH secretion is inhibited by SST-expressing neurons. IGF-1 and GH play roles in neuroprotection and synaptic function dysregulation in these pathway may contribute to abnormal brain growth and cognitive deficits observed in ASD (Galvez-Contreras et al., 2017). Ncreasing evidence indicates that GFs modulate motor, emotional, and cognitive functions, which may explain several clinical manifestations of psychiatric disorders (Galvez-Contreras et al., 2016). To further understand the turn of these hormones in autism, we examined the scale of ghrelin, growth hormone (GH) and leptin in the blood of children with autism and age-matched healthy control children.

The primary objective of this study is to comprehensively evaluate the levels of selected key physiological indicators to gain deeper insights into overall health status. Also study the growth hormone, ghrelin and leptin the extent to which these hormones affect autistic children.

Methods and Materials

Ninety Iraqi children participated in the study, 60 of them were autistic children who visited child protection Teaching Hospitaland the other 30 subjects were healthy. The subjects were between the ages of 1.5 and 12. Over the course of four months, from April 2024 to July 2024, samples were gathered. According to the final diagnosis given by a specialized physician based on criteria regarding their clinical signs and symptoms, all children were diagnosed with autism at varying stages, ranging from moderate to severe.

The medical history, height, weight, age, gender, and name of each patient including the disease's stage, whether the patient has any other conditions, the kind of treatment they are receiving, and the age of diagnosis—were extracted The information was collected through a set of questions that were answered by the parents of children with autism, as well as through a review of the patients' medical records. The control group's normal patients had no prior medical history of illnesses or other inflammatory conditions. After getting permission from their parents, blood was drawn from all participants—

both healthy and patients—to measure a number of factors, including Physiology hormone, Blood sampling Four milliliters of peripheral venous blood using a sterile syringe. Four milliliters of blood samples were transferred into a gel activator tube and incubated for 15 minutes at 40°C to facilitate clotting. The serum was then separated from the tubes by centrifuging them for 10 minutes at 3000 rpm. Sterilized simple tubes containing the serum were kept at -20 oC until they were needed to measurement Growth hormone, Ghrelin and leptin by ELISA.

Statistical analysis

SPSS was used to conduct the statistical analysis (version 18) to compare between different groups by using Analysis of Variance (ANOVA) and using Lease significant differences (LSD) and probability at 0.05 ($P \leq 0.05$).

Findings and Results

The results showed that the sequences group of first is the most frequent group with 38.33% of the total patients followed by the sequences group second with 25% and 3,>5 sequence same as with 11.66% (Table 1).

Table 1

The distribution in ASD and control according to sequences in the family

Sequences	Autism Number/%	Control Number/%
1	23(38.33)	8(26.66)
2	15(25)	7(23.33)
3	8(13.33)	5(16.66)
4	7(11.66)	5(16.66))
>5	7(11.66)	5(16.66)
Total	**60(100)**	**30(100)**

Table 2 show Growth hormone levels were found to be significantly lower in children with autism in female and male (609.1±64.172, 537.4±14.86), respectively than in healthy control (1487.7±68.526, 1361.6±35.307), respectively.

Table 2

The level of growth hormone in serum of Autism children and control depended on sex

Group / Sex	Growth hormone (pg/ml) (mean± SE)			
	Autism	**Control**	**P-value**	**LSD**
Female	A, b 609.1±64.172	A, a 1487.7±68.526	**0.00032**	**233.45**
Male	A, b 537.4±14.86	A, a 1361.6±35.307	**0.00051**	**196.53**
P-Value	**0.103**	**0.179**		
LSD	**Non**	**Non**		

Capital different letters: Significant difference (P≤0.05) between column.
Small different letters: Significant difference (P≤0.05) between row.

The result show level Ghrelin hormone in serum of ASD children lower in female and male (1.706±0.267,1.4671±0.061), respectively than in healthy control children (2.4333±0.041,2.81±0.135), respectively. in this study, that the percentage of ghrelin in females is higher than males in autistic children, while the opposite is true in healthy children according to the table (3).

Table 3

The level of ghrelin hormone in serum of autistic children compared to control children depended on sex.

Group	Ghrelin ng/ml (mean ±SE)			
Sex	**Autism**	**Control**	**P-value**	**LSD**
Female	A, b 1.706±0.267	A, a 2.4333±0.041	0.024	0.450
Male	A, b 1.4671±0.061	A, a 2.81±0.135	0.0003	0.511
P-Value	0.188	0.165		
LSD	Non	Non		

Capital different letters: Significant difference (P≤0.05) between column.
Small different letters: Significant difference (P≤0.05) between row.

In the table 4 show level Leptin hormone there was significantly higher in children with autism in female and male (208.8±19.774,225.4±10.623), respectively compared than control children (108.18±7.855,119.38±2.493), respectively.

Table 4

he level of leptin hormone in serum of autism children compared to control in terms of sex.

Discussion and Conclusion

The study examined the relationship between the sequence of children and the development of autism and noticed that the first child had the highest percentage 38% (Lord et al., 1994) children. This was likely caused by the early gestational age of most mothers, which is generally linked to more pregnancy complications and unfavorable outcomes. Second order children represent 25% (Jumaa et al., 2022) children, 13.33% (Kojima et al., 2001) children for third order while only 11.66% (Jbarah & Ali, 2024) children of 5th order or more. This finding suggests that the likelihood of having a kid with autism decreases with increasing parity.

Another study identified birth order as one of the most frequently associated factors with autism risk in the literature, highlighting a significant correlation between autism spectrum disorder (ASD) and birth order or parity (Galvez-Contreras et al., 2017). Our findings support this association, indicating that first-born children are more likely to develop ASD compared to their later-born siblings. However, existing research presents mixed conclusions on this relationship. A case-control study by Ugur et al., (2019) found a significant link between being first-born and ASD, while a meta-analysis by Gardener et al., (2009) also reported a higher autism risk among first-born children. Similarly, our results align with those of Galvan et al., (2020), who observed an increased likelihood of ASD in first-borns compared to controls.

It is widely acknowledged that the risk of autism spectrum disorder (ASD) tends to be higher for firstborn children in smaller families and for fourth-born or later children in larger sibships (Turner et al., 2011). This pattern may be partly attributed to the "stoppage rule," a phenomenon where parents choose not to have more children after their first is diagnosed with ASD (Gardener et al., 2009). A limitation of the present study is its lack of data on sibship size, which restricts deeper analysis of this trend. ASD encompasses a broad spectrum of neurodevelopmental disorders, characterized by impaired social communication, restricted and repetitive behaviors Levy & DS, (2009), sensory modulation difficulties Lord et al., (1994), and disturbances in cognitive and motor functions (Esposito et al., 2009).

Although the exact cause of autism remains unknown, it is widely believed that multiple factors or a combination thereof contribute to its etiology (Onore et al., 2012). Recent studies have identified abnormalities in various neurotransmitters Hammock et al., (2012), as well as significant alterations in hormone and neuropeptide levels, which are implicated in the pathogenesis of autism (Tareen & Kamboj, 2012). In the present study, both growth hormone (GH) and ghrelin levels were significantly lower in children with autism compared to the control group. These findings align with earlier research demonstrating notable reductions in GH

and ghrelin levels in males with autism (Al-Zaid et al., 2014). However, unlike that study, which only included male participants, our research incorporated both male and female subjects. Interestingly, Hasan et al., (2019) also examined hormone levels in both genders but did not observe significant decreases in GH or ghrelin (Hasan et al., 2019). Conversely, our results are consistent with the findings of Yazici et al., (2024), who also reported Ghrelin hormonal reduction in autistic children (Yazici et al., 2024).

In our study, serum ghrelin levels were found to be higher in the control group than in the ASD group. This contrasts with another study that reported elevated ghrelin levels in the ASD group compared to controls (Çelikkol Sadıç et al., 2021). Some reports suggest that fluctuations in sex hormones can influence ghrelin levels (Lebenthal et al., 2006). Ghrelin not only stimulates growth hormone (GH) release but also binds to the GH secretagogue receptor (GHSR), with the expression of the ghrelin receptor GH secretagogue type 1a (GHS-R1a) in the pituitary and hypothalamus playing a pivotal role in mediating this effect (Saleri et al., 2004). Additionally, animal models with induced GH deficiency show reduced ghrelin levels, emphasizing the close relationship between these two hormones (Caminos et al., 2002). While our findings indicate lower levels of both ghrelin and GH in children with autism compared to controls, the differences were not statistically significant.

The present study found that children with autism had significantly higher leptin levels compared to their control counterparts. After adjusting for age and sex, multivariate logistic regression analysis confirmed a strong association between elevated leptin levels and the incidence of autism, suggesting a clear link between the two. These results align with previous studies that reported higher leptin levels in children with autism (Çelikkol Sadıç et al., 2021). While other study not show different in serum leptin level in children ASD compared with controls(Yazici et al., 2024).

Research increasingly demonstrates that children with ASD exhibit neurological, immunological, and autonomic abnormalities, with both adults and children showing elevated pro-inflammatory cytokines and alterations in the immune-inflammatory system (Onore et al., 2012). In the current study, we observed elevated leptin levels in children with autism, suggesting that this hormone may play a role in the pathophysiology of the disorder, although the exact mechanism remains unclear. Previous studies have linked elevated leptin levels to early-onset phenotypes in autism, further supporting this hypothesis and its potential connection to the clinical signs and symptoms of the condition (Çelikkol Sadıç et al., 2021).

Given that leptin functions within the immune system in a manner similar to cytokines Fantuzzi & Faggioni, (2000), its elevated levels in children with autism may suggest a role in the immune system's response to inflammation. Previous research has established a link between obesity and alterations in both ghrelin and leptin levels (Çelikkol Sadıç et al., 2021). In our study, children with autism, who did not exhibit signs of obesity, had lower ghrelin levels and higher leptin levels. The findings of this study revealed that leptin levels were significantly higher than both growth hormone and ghrelin in children with autism compared to control subjects, supporting the trends observed in previous studies.

In conclusion, autism appears to have a notable influence on the leptin hormone, significantly elevating its levels to measurable extents. Conversely, this neurodevelopmental disorder is associated with a marked reduction in both ghrelin and growth hormone levels, which fall below the normal range observed in ASD children. These findings suggest that autism may disrupt the delicate balance of hormonal regulation, potentially influencing metabolic and immune responses, beyond their physiological roles in metabolism and growth, these hormones appear to influence emotional regulation, behavior and neurological development. The findings suggest that hormonal imbalances may contribute to the psychological state of children with autism. Further investigation into these biological markers could enhance early diagnosis and inform targeted therapeutic strategies.

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Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. Ethical considerations in this study were that participation was entirely optional.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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Authors' Contributions

All authors equally contribute to this study.

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