

Original Article

Assessment of the levels of vasopressin and androgen in the sample of Iraqi children with Autism spectrum disorder



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ABSTRACT

Autism is a very common problem in childhood, especially in boys, and no marker or special test for helping early diagnosis. Androgen, vasopressin and apelin levels are neuropeptides that have been included in a wide range of functions of the brain and the abnormal levels detected and studied in many psychiatric disorders. Aimed to assess salivary levels of androgen, vasopressin and apelin in the autistic male mild and moderate divide in the first and second groups according to age (6-10 and 10- 13 years old) and compared to the normal boys group. Forty-five autistic boys mild and moderate in two groups according to age (6-10 and 10-13years old) were diagnosed early by the specialist child psychiatrist, and 45 healthy normal children were free of neurological and psychiatric disorders were enrolled in this study, saliva samples were gathered, and send for those hormones levels examinations which measured by using indirect enzyme-linked immunosorbent assay (IELISA). Results were analyzed using a special statistic program (SPSS version 18). The mean salivary androgen level was significantly increased in the autistic group than that of the control, also it was found a highly significant increase of salivary androgen levels in the older age group between 6 to 10 years old than in the age group from 10 to 13 years. The mean vasopressin level in Saliva was decreased in the whole autistic group compared to the control, but there was a significant increase in the mean vasopressin level in the older age group 10-< years than in the younger age group. Mean salivary apelin level was a highly significant increase in autistic children compared to control and didn't find statistically significant differences between the age groups of autistic children according to the apelin level in saliva. The levels of these hormones are altered in autistic boys than the normal behavior boys, there is a significant correlation ($p<0.05$) between vasopressin and androgen with simple linear regression.

1. Introduction

Recent epidemiological studies, conducted in different regions of the world, indicated that at least one in every 100 people has some form of autism. Although there is no known unique cause of autism, there is growing

evidence that autism can be caused by a variety of disorders, however, the exact pathophysiology is unknown [1-3].

No disease markers for the diagnosis of autism have been validated, the discovery of such biomarkers something like a blood test,

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or saliva, for autism, may eventually lead to, or would allow earlier and potentially more reliable diagnoses of autism, and would also help researchers achieve an understanding of the biological basis of this disorder [4, 5].

It is four times more common among boys than girls. Its pathogenesis remains unclear, the biological hypotheses concentrating on neuroanatomy, physiology and genetics of CNS. Several endocrine hormones are directly or indirectly linked with the encoding of social behavior, recent studies have focused on whether and how these peptides are involved in the pathogenesis of ASD [6].

Neuroactive steroids (NASs) have the capability of rapidly modifying neural activities and producing a rapid non-genomic effect in the brain, the term neurosteroids used for NASs that are synthesized from cholesterol *de novo* in the brain or formed by metabolism in the brain from precursor compounds coming from endocrine sources [7].

The majority of studies conducted worldwide have found that a number of factors, including gender differences and biological and genetic susceptibilities as well as the effects of certain hormones, contribute to the development of autistic traits. These factors must be investigated in order to better understand the behavioral disorder autism [8].

Many studies in the world showed that some steroid hormones are correlated with autism, but others showed different results, one of them is the androgen hormone deficits for its role in brain functioning [9]. The neuropeptides arginine-vasopressin (AVP), which are synthesized in the paraventricular and supraoptic nuclei of the hypothalamus and transported to the posterior pituitary and released into the blood, are closely connected and have attracted significant interest in research on the genesis of mental illnesses [10].

Numerous projections into other regions of the brain, primarily the limbic system, are made by the vasopressinergic neurons that are generated in the hypothalamus. Act in a neuromodulatory way, for example, while

processing emotions or exhibiting social behavior [11, 12]. Despite having a strong affinity, this neuropeptide has an opposing impact in most brain regions. Vasopressin is shown to be associated with the emotions of fear and anger [13].

Similar to vasopressin, apelin is a relatively recent neuropeptide that regulates the vasopressinergic system and is produced by magnocellular neurons in the paraventricular and supraoptic nuclei of the hypothalamo-neurohypophysial system. A tiny peptide found in the brain in 1998 by Fujinos' team, along with indications that apelin and APJ are also abundantly distributed there [14, 15].

Although less documented, the effects of apelin on neurobehavior have been addressed and its beneficial effects on emotionality have been proven. secreted by the adipose tissue, has been recently characterized as human apelin and its receptor are found in several brain regions including the hypothalamus, thalamus, cerebral nuclei, and pons, the potential effect of apelin, especially its potent form apelin-13, on mood and anxiety had been studied because of high expression in hypothalamus and indicated that APJ includes some effect in the regulation of the HPA axis as a result to stress [16]. Due to the lack of similar study in Iraq, aimed to assessment the salivary androgen and vasopressin and apelin levels in children with Autism to investigate whether those levels differ from those of sex- and age-matched healthy controls for case-control study

2. Materials and Methods

2.1. Subjects

Children include 45 boys with a confirmed professional diagnosis of autism spectrum disorder (early childhood autism) from Al-Safa Center in Zayoonah, Baghdad, Iraq and from Baghdad Teaching Hospital –Medical City- Ministry of Health, with the ages ranging from 6-13 years were enrolled in this study.

The control group included 45 boys -Iraqi pupils from Zamzam primary schools in Baghdad city, who corresponded to the first group in their age, in order to compare the salivary hormones to allow for case-control design. All pupils involved in this study were

interviewed. This study was performed from November 2022 to the end of April 2023.

All the subjects recruited to this study were of similar ethnic backgrounds to Iraqi Arabs people depending on the history taken from them.

2.1.1. Inclusion criteria

Autistic children (mild and moderate) with early diagnosis by the specialist child psychiatrist will be subject in this study and the normal children were free of neurological and psychiatric disorders

2.1.2. Exclusion criteria

Include no present or history of other psychiatric disorders, comorbid disorders were excluded, no significant illness and all children were free medication affect saliva hormonal levels.

2.2. Samples collection

Salivary sample from each subject was collected under standardized conditions, after being asked to sit down and relax as much as possible, then by tilting the head forward, allowing to saliva gather on the floor of the mouth, the entire mixture of unstimulated saliva was collected, and placed in sterile plastic collection tube, centrifuged at 3000 rpm for 10 minutes, clear supernatant frozen and stored at -20 °C [17]. Salivary samples were collected from the study subjects between 8 to 10 a.m., before breakfast.

Commercially available human androgen, vasopressin and apelin kits, all purchased from the company (human Gesellschaft for biochemical and diagnostic mbHmax-Wiesbaden- Germany, were used for determining the level of these hormones.

The samples were measured by using an indirect enzyme-linked immunosorbent assay (IELISA). Hormones analysis was carried out in the National Center of Teaching Laboratory- Ministry of Health.

2.3. Statistical Analysis

The Statistical Analysis System- SAS (2018) program was used to detect the effect of different groups (patients and control) on

study parameters. T-test was used to significantly compare between means in this study.

3. Results

The mean salivary androgen level for all the children included in this study are presented in Table 1, the mean salivary androgen level was highly significantly increased ($P \leq 0.01$) in the autistic group 2.24 ± 0.16 , than that of the control 1.67 ± 0.126 ng/ml. Also, it was found that as appears in the same table highly significant increase of salivary androgen level in the older age group between 10 to 13 years old than in the age group from 6 to 10 years, 1.70 ± 0.23 ng/ml.

Table 1. Comparison between autistic patients and control groups in salivary Androgen levels

Group	No	Mean \pm SE (ng/ml)	T-test	P-value
Control	45	1.696 \pm 0.126	0.402 **	0.0091
Autistic	45	2.236 \pm 0.158		
Autistic Group				
6<10 year		1.707 \pm 0.228	0.578**	0.0021
10-<13		2.650 \pm 0.179		

NS, Significant; * $P \leq 0.05$

The mean vasopressin level in Saliva was significantly lowered in the whole autistic group compared to the control, but there was a significant increase in the mean vasopressin level in the older age group 10-< years than in the younger age group(Table 2).

Table 2. Comparison between autistic patients and control groups in salivary Vasopressin levels

Group	No	Mean \pm SE (ng/ml)	T-test	P-value
Control	45	1.271 \pm 0.091	0.211	0.0
Autistic	45	0.928 \pm 0.054		
Autistic Group				
6-<10 year		0.778 \pm 0.047	0.209 **	0.0101
10-<13		1.047 \pm 0.083		

NS, Significant; * $P \leq 0.05$

In the current study, as appears in Table 3 and 4, mean salivary apelin level was highly significantly decreased in autistic children compared to control and didn't find statistically significant differences between the first group and second group in the group of autistic boys according to the apelin level in saliva.

Table 3. Comparison between autistic patients and control groups in salivary apelin levels

Group	No	Mean \pm SE(ng/ml)	T-test	P-value
Control	45	0.905 \pm 0.038	0.0987 **	0.0001
Autistic	45	0.699 \pm 0.032		
Autistic Group				
6-<10 year		0.646 \pm 0.027	0.127 NS	0.134
10-< 13		0.742 \pm 0.052		

* (P<0.05); ** (P<0.01)

Mean of apelin concentration by ng/ml, highly significant (P<0.01), NS: no significant

Table 4. Correlation between parameters study in Patients Group

Parameters in Patients/ Autism	Correlation coefficient-r	P- value
Vasopressin & apelin	0.16 NS	0.299
Vasopressin & Androgen	0.28 *	0.0482
apelin & Androgen	-0.079 NS	0.620

*(P \leq 0.05); NS: Non-Significant.

4. Discussion

Autism is four times more common in boys than girls, these sex differences suggest that there may be a male vulnerability to developing the major subgroups of autism conditions, this findings caused the extreme male brain theory, which has led the researchers to look for the possible role of testosterone and or androgen in the cause of ASD [18]. To our best knowledge, there is no such study about androgen, vasopressin and apelin levels in autistic primary school children in Iraq.

The results of the current study showed that the androgen level in saliva was significantly increased in the autistic group than in normal boys in the control group, which also suggests the role of androgen hormone in the behavior of those children. These results came in agreement with that of previous research [19], who found significantly higher salivary testosterone levels in boys at prepubertal and concluded that salivary testosterone levels remained stable in this period [19]. Also, it has been found a relationship between serum testosterone levels and psychological behavior in adolescent girls [20].

It has showed alteration of adrenal gland metabolites in relation to some behavioral disorders like Kanner's and Asperger syndromes and stated that the steroid

hormone profiles, especially those of androgens may be useful clinical markers that support the diagnosis of autism and further imply that the mild more severe forms of autism can be distinguished and might be a promising target for pharmaceuticals for the severe form [7].

it has been disclosed that the concentrations of some steroid hormones like 20-alpha dihydropregnenolone also DHEA were high statistically when studied and compared in the saliva of children diagnosed with autism and children without autism (epiandrosterone-C ,allopregnanolone) than control children and were more prominent in older autistic children and boys when analyzed using gas-chromatography-mass spectrometry and radioimmunoassay. In this study, the age of children was allocated into two groups, group one between 6 – 10 years old and group two from 10 to less than 13 years [9]. It has been stated that the testosterone level was found to be associated with autistic traits in children aged 2 years or younger [21]. In contrast to the results of the present study about higher androgen levels in the older age group, it has stated an association between elevated androgen levels in early development and autistic behaviors [22].

Many previous studies in different parts of the world using different methods have indicated that testosterone or androgen may play a central role because of its association with the modulation of psychomotor activity and executive function which are the main clinical features of individuals with autism [23-26]. The results of the present study about reduced vasopressin levels in autistic children agree with the data published by previous research in the Riyadh area when measured vasopressin levels in autistic and control children and found statistically significantly lower plasma levels of vasopressin in autistic children when compared to the controls. Which explained that, might be related to the abnormal social behavior in autistic children [27].

In contrast, it has found elevated concentrations of vasopressin in adults with ASD [28]. It has not find any change in plasma

vasopressin concentration and statistical differences in the concentration of vasopressin when they compared children with autism to normal children from China, even with a relatively large sample size (>70 in each group), well established AVP measurement method, and related that too implies the normal hypothalamic AVP synthesis or release in ASD children [29]. In fact, it has suggested that there is promise for the development of precise and sensitive techniques for laboratory diagnosis of ASD early in infancy since measuring the AVP level in conjunction with the assessment of gene expression levels for the vasopressin receptor properly discriminated neurotypical and ASD people in 84% of the instances. In this study, the salivary apelin level was higher in an autistic group with no significant differences when compared to the control group [30]. Similarly, it has showed No significant difference was found between the groups for girls or across the entire subject cohort, indicating that apelin-13 may play a role in the etiopathogenesis of ADHD either directly affecting the apelin receptor or via its antagonistic effect on the vasopressinergic system. Plasma male children with ADHD had significantly higher mean apelin-13 levels than plasma male control subjects [31].

It has detected higher serum apelin-12 levels in patients who scored higher in the Beck depression inventory [32]. It has found that the serum apelin level was significantly lowered in patients with major depressive disorder than in healthy controls [14]. It has reported that intracerebroventricular apelin-13 infusion reversed memory impairment and depressive-like behaviors in chronically stressed rats [33]. This study also showed that the concentration in saliva hasn't any statistical difference in apelin levels between the two age groups of autistic boys.

It has showed [34] that With observation, it becomes clear that the role of this hormone in the regulation of emotional states is more nuanced. The severity of depression symptoms in elderly individuals is positively connected to plasma apelin levels. These findings highlight apelin's multifaceted role in the control of emotional state, which may vary depending on the participants' ages and

metabolic conditions. To emphasize the therapeutic potential of influencing the apelinergic system in mood-related illnesses, more research is necessary.

Vasopressin and androgen showed the highest correlation in the studied groups in this study ($r = 0.28$, $P = 0.048$) in correlation matrices (Table 4). Whereas the opposite was observed for apelin and androgen ($r = -0.079$, $P = 0.62$). Recently, several patient groups have favoured using saliva as their specimen of choice for steroid detection due to its convenience, non-invasive nature, and stress-free collection [9, 35]. In particular for autistic kids who frequently exhibit excessive stress reactions? Steroid concentrations in saliva mirror those in blood and are significantly lower than those in serum [36, 37], and steroid polarity affects the ratios of various steroids in these bodily fluids. Androgens, which are unconjugated lipid-soluble steroids, May easily cross capillary walls, and salivary concentrations of these substances have been estimated to account for 10% of serum levels [34, 36, 37].

As the adrenal cortex is the primary source of DHEA and DHEAS in people, whose levels were raised, it appears to be the major source of amplified steroid production in autistic children. Despite this, every research subject was a prepuberta. The adrenals also release very little androgen throughout the early years of life. Prior to gonadal maturation, the reticular zone forms during adrenarche changes the adrenal cortex and produces DHEA, DHEAS, and other androgens [38].

5. Conclusion

Finally, steroid hormone profiles may provide as helpful clinical indicators for the diagnosis of autism. It is important to look into how biochemical and genetic factors contribute to increased steroid production in autism. International research should be done to examine any potential links between variations in steroid production and autism and environmental or iatrogenic variables.

Conflict of Interests

All authors declare no conflict of interest.

Ethics approval and consent to participate

No human or animals were used in the present research.

Consent for publications

All authors read and approved the final manuscript for publication.

Informed Consent

The authors declare not used any patients in this research.

Availability of data and material

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Authors' contributions

All authors had equal role in study design, work, statistical analysis and manuscript writing.

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References

1. APA (2013) Diagnostic and statistical manual of mental disorders: DSM-5™ (5th ed.). The American Psychiatric Association. American Psychiatric Publishing, Inc. doi:<https://psycnet.apa.org/doi/10.1176/appi.books.9780890425596>
2. Baxter AJ, Brugha T, Erskine HE, Scheurer RW, Vos T, Scott JG (2015) The epidemiology and global burden of autism spectrum disorders. *Psychological medicine* 45 (3): 601-613. doi:<https://doi.org/10.1017/S003329171400172X>
3. Hashem S, Nisar S, Bhat AA, Yadav SK, Azeem MW, Bagga P, Fakhro K, Reddy R, Frenneaux MP, Haris M (2020) Genetics of structural and functional brain changes in autism spectrum disorder. *Translational psychiatry* 10 (1): 229. doi:<https://doi.org/10.1038/s41398-020-00921-3>
4. Schwarz E, Guest PC, Rahmoune H, Wang L, Levin Y, Ingudomnukul E, Ruta L, Kent L, Spain M, Baron-Cohen S (2011) Sex-specific serum biomarker patterns in adults with Asperger's syndrome. *Molecular psychiatry* 16 (12): 1213-1220. doi:<https://doi.org/10.1038/mp.2010.102>
5. Lukas M, Toth I, Reber SO, Slattery DA, Veenema AH, Neumann ID (2011) The neuropeptide oxytocin facilitates pro-social behavior and prevents social avoidance in rats and mice. *Neuropsychopharmacology* 36 (11): 2159-2168. doi:<https://doi.org/10.1038/npp.2011.95>
6. Tareen RS, Kamboj MK (2012) Role of endocrine factors in autistic spectrum disorders. *Pediatric Clinics* 59 (1): 75-88. doi:<https://doi.org/10.1016/j.pcl.2011.10.013>
7. Gasser BA, Kurz J, Dick B, Mohaupt MG (2019) Steroid metabolites support evidence of autism as a spectrum. *Behavioral Sciences* 9 (5): 52. doi:<https://doi.org/10.3390/bs9050052>
8. Wilczyński KM, Zasada I, Siwiec A, Janas-Kozik M (2019) Differences in oxytocin and vasopressin levels in individuals suffering from the autism spectrum disorders vs general population—a systematic review. *Neuropsychiatric disease and treatment* 2019: 2613-2620. doi:<https://doi.org/10.2147/NDT.S207580>
9. Majewska MD, Hill M, Urbanowicz E, Rok-Bujko P, Bieńkowski P, Namysłowska I, Mierzejewski P (2014) Marked elevation of adrenal steroids, especially androgens, in saliva of prepubertal autistic children. *European child & adolescent psychiatry* 23: 485-498. doi:<https://doi.org/10.1007/s00787-013-0472-0>
10. Zhang H-F, Dai Y-C, Wu J, Jia M-X, Zhang J-S, Shou X-J, Han S-P, Zhang R, Han J-S (2016) Plasma oxytocin and arginine-vasopressin levels in children with autism spectrum disorder in China: associations with symptoms. *Neuroscience bulletin* 32: 423-432. doi:<https://doi.org/10.1007/s12264-016-0046-5>
11. Long M, Ghisari M, Kjeldsen L, Wielsøe M, Nørgaard-Pedersen B, Mortensen EL, Abdallah MW, Bonefeld-Jørgensen EC (2019) Autism spectrum disorders, endocrine disrupting compounds, and heavy metals in amniotic fluid: a case-control study. *Molecular autism* 10: 1-19.

- doi: <https://doi.org/10.1186/s13229-018-0253-1>
12. Young LJ, Nilsen R, Waymire KG, MacGregor GR, Insel TR (1999) Increased affiliative response to vasopressin in mice expressing the V1a receptor from a monogamous vole. *Nature* 400 (6746): 766-768. doi: <https://doi.org/10.1038/23475>
 13. Voinsky I, Bennuri SC, Svigals J, Frye RE, Rose S, Gurwitz D (2019) Peripheral blood mononuclear cell oxytocin and vasopressin receptor expression positively correlates with social and behavioral function in children with autism. *Scientific Reports* 9 (1): 13443. doi: <https://doi.org/10.1038/s41598-019-49617-9>
 14. Burak Acikel S, Artik A, Hosoglu E, Hümeýra Yerlikaya F (2022) Serum Apelin-13 Levels Are Decreased Among Adolescents Diagnosed with Major Depressive Disorder. *Psychiatria Danubina* 34 (4): 677-681. doi: <https://doi.org/10.24869/psyd.2022.677>
 15. Tatemoto K, Hosoya M, Habata Y, Fujii R, Kakegawa T, Zou M-X, Kawamata Y, Fukusumi S, Hinuma S, Kitada C (1998) Isolation and characterization of a novel endogenous peptide ligand for the human APJ receptor. *Biochemical and biophysical research communications* 251 (2): 471-476. doi: <https://doi.org/10.1006/bbrc.1998.9489>
 16. Newson MJ, Pope GR, Roberts EM, Lolait SJ, O'Carroll A-M (2013) Stress-dependent and gender-specific neuroregulatory roles of the apelin receptor in the hypothalamic-pituitary-adrenal axis response to acute stress. *The Journal of endocrinology* 216 (1): 99. doi: <https://doi.org/10.1530%2FJOE-12-0375>
 17. Al-Mizraqchi AS (2023) Anti-microbial activity of Green Tea Extracts and Nicotine on the Growth, Biofilm Formation of Salivary *Mutans Streptococci* (In-vitro study). *Journal of the Faculty of Medicine Baghdad* 65 (2): 122-128. doi: <https://doi.org/10.32007/jfacmedbagdad.2024>
 18. Ferri SL, Abel T, Brodtkin ES (2018) Sex differences in autism spectrum disorder: a review. *Current psychiatry reports* 20: 1-17. doi: <https://doi.org/10.1007/s11920-018-0874-2>
 19. Ostatníková D, Pastor K, Putz Z, Dohnányiová M, Mat'ašeje A, Hampl R (2002) Salivary testosterone levels in preadolescent children. *BMC pediatrics* 2 (1): 1-5. doi: <https://doi.org/10.1186/1471-2431-2-5>
 20. Donbaloglu Z, Tuhan H, Çoban ÖG, Kızılay DÖ, İsmailoğlu E, Önder A, Acar S, Bedel A, Çetiner EB, Singin B (2022) Hyperandrogenism correlates with psychological symptoms in adolescents with polycystic ovary syndrome. *Clinical Pediatric Endocrinology* 31 (2): 68-76. doi: <https://doi.org/10.1297/cpe.2022-0010>
 21. Gasser BA, Buerki SF, Kurz J, Mohaupt MG (2021) Hyperandrogenism? Increased 17, 20-lyase activity? A metanalysis and systematic review of altered androgens in boys and girls with autism. *International Journal of Molecular Sciences* 22 (22): 12324. doi: <https://doi.org/10.3390/ijms222212324>
 22. Coscini N, Williams K, Chew D, Pang KC, O'Connell MA, May T (2021) Association between early androgens and autistic traits: A systematic review and meta-analysis. *Research in Autism Spectrum Disorders* 85: 101789. doi: <https://doi.org/10.1016/j.rasd.2021.101789>
 23. Zito S, Nosari G, Pigoni A, Moltrasio C, Delvecchio G (2023) Association between testosterone levels and mood disorders: A minireview. *Journal of Affective Disorders* 330: 48-56. doi: <https://doi.org/10.1016/j.jad.2023.02.108>
 24. Giwercman A, Sahlin KB, Pla Parada I, Pawlowski K, Fehninger C, Lundberg Giwercman Y, Leijonhufvud I, Appelqvist R, Marko-Varga G, Sanchez A, Malm J (2022) Novel protein markers of androgen activity in humans: proteomic study of plasma from young chemically castrated men. *Elife* 11. doi: <https://doi.org/10.7554/eLife.74638>
 25. Gurralla RR, Kumar T, Yoo A, Munding GS, Womac DJ, Lau FH (2023) The Impact of Exogenous Testosterone on Breast Cancer Risk in Transmasculine Individuals. *Annals of plastic surgery* 90 (1): 96-105. doi:

- <https://doi.org/10.1097/sap.00000000000003321>
26. Yon-Hernandez JA, Canal-Bedia R, Wojcik DZ, Garcia-Garcia L, Fernandez-Alvarez C, Palacio-Duque S, Franco-Martin MA (2023) Executive functions in daily living skills: A study in adults with autism spectrum disorder. *Frontiers in psychology* 14: 1109561. doi: <https://doi.org/10.3389/fpsyg.2023.1109561>
 27. Al-Ayadhi LY (2005) Altered oxytocin and vasopressin levels in autistic children in Central Saudi Arabia. *Neurosciences Journal* 10 (1): 47-50. doi:
 28. Boso M, Emanuele E, Politi P, Pace A, Arra M, di Nemi SU, Barale F (2007) Reduced plasma apelin levels in patients with autistic spectrum disorder. *Archives of medical research* 38 (1): 70-74. doi: <http://dx.doi.org/10.1016/j.arcmed.2006.08.003>
 29. Miller M, Bales KL, Taylor SL, Yoon J, Hostetler CM, Carter CS, Solomon M (2013) Oxytocin and vasopressin in children and adolescents with autism spectrum disorders: sex differences and associations with symptoms. *Autism Research* 6 (2): 91-102. doi: <https://doi.org/10.1002/aur.1270>
 30. Oztan O, Jackson LP, Libove RA, Sumiyoshi RD, Phillips JM, Garner JP, Hardan AY, Parker KJ (2018) Biomarker discovery for disease status and symptom severity in children with autism. *Psychoneuroendocrinology* 89: 39-45. doi: <https://doi.org/10.1016/j.psyneuen.2017.12.022>
 31. Bilgiç A, Toker A, Uysal S (2016) Exploratory study to evaluate plasma vasopressin and apelin-13 levels in children with attention-deficit hyperactivity disorder. *Psychiatry and Clinical Neurosciences* 70 (10): 442-447. doi: <https://doi.org/10.1111/pcn.12415>
 32. Gok Oguz E, Akoglu H, Ulusal Okyay G, Yayar O, Karaveli Gursoy G, Buyukbakkal M, Canbakan B, Ayli MD (2016) Serum apelin is associated with affective disorders in peritoneal dialysis patients. *Renal Failure* 38 (7): 1059-1066. doi: <https://doi.org/10.1080/0886022X.2016.1193873>
 33. Tian S-W, Xu F, Gui S-J (2018) Apelin-13 reverses memory impairment and depression-like behavior in chronic social defeat stressed rats. *Peptides* 108: 1-6. doi: <https://doi.org/10.1016/j.peptides.2018.08.009>
 34. Bullich S, de Souto Barreto P, Dortignac A, He L, Dray C, Valet P, Guiard B (2022) Apelin controls emotional behavior in age- and metabolic state-dependent manner. *Psychoneuroendocrinology* 140: 105711. doi: <https://doi.org/10.1016/j.psyneuen.2022.105711>
 35. Groschl M (2008) Current status of salivary hormone analysis. *Clinical chemistry* 54 (11): 1759-1769. doi: <https://doi.org/10.1373/clinchem.2008.108910>
 36. Hill M, Lapčík O, Havlíková H, Morfin R, Hampl R (2001) 7-Hydroxydehydroepiandrosterone epimers in human serum and saliva: Comparison of gas chromatography-mass spectrometry and radioimmunoassay. *Journal of Chromatography A* 935 (1-2): 297-307. doi: [https://doi.org/10.1016/S0021-9673\(01\)01106-2](https://doi.org/10.1016/S0021-9673(01)01106-2)
 37. Vining RF, McGinley RA, Symons RG (1983) Hormones in saliva: mode of entry and consequent implications for clinical interpretation. *Clinical chemistry* 29 (10): 1752-1756. doi: <https://doi.org/10.1093/clinchem/29.10.1752>
 38. Parker Jr CR (1999) Dehydroepiandrosterone and dehydroepiandrosterone sulfate production in the human adrenal during development and aging. *Steroids* 64 (9): 640-647. doi: [https://doi.org/10.1016/S0039-128X\(99\)00046-X](https://doi.org/10.1016/S0039-128X(99)00046-X)



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