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Impact of Social Isolation on Serum Sodium and Cortisol Level in Male Wistar Rats

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ABSTRACT

Background/Aim: Loneliness due to social isolation is a source of psychological stress in adults. This study evaluated the impact of social Isolation on serum sodium and cortisol level in male wistar rats

Methods: Sixteen male wistar rats were randomly divided into two groups (n = 8), Group 1 served as control. And were socially housed. Group 2; consisted of eight individually caged Wistar rats. The animals had access to food and water *ad libitum* and their level of physical activity was observed. After six weeks of Isolation, blood was collected from the animals via ocular puncture for Serum Cortisol and Sodium ion analysis, all data was analysed using SPSS software version 25.0. Values were considered significant at $P < 0.05$.

Results: Results showed significant increase in the mean cortisol (33.82 ± 1.17), decrease in mean sodium ion (113.875 ± 5.24) and negative correlation between sodium and cortisol.

Conclusion: The results from this study have shown that social isolation is a source of psychological stress which leads to depression and hyponatraemia.

KEYWORDS: *Social Isolation, Stress, Sodium, Cortisol*

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INTRODUCTION:

Social isolation (SI) is a condition which occurs when an individual lacks social interaction/connection. Thus, loneliness is a measure of the quality of the relationship rather than the quantity of the relationship. [1] Hawkley and Capitanio [2] viewed sociality as a measure of behaviours that either encourages or discourages the initiation and maintenance of a mutual social relationship. The shortcomings which occur in these relationships give researchers the opportunity to evaluate or investigate the level of significance of social interaction(s) to the health and fitness of human race [2]. Also, an understanding of the relevance of social interactions to healthy or normal human functioning also begs the question; what happens in the absence of these interactions or relationships. [3] Social isolation (SI) and loneliness have been reported as sources of stress (chronic) in adults. [4] The brain is vulnerable and susceptible to alterations under both genetic and environmental alteration and influences. [5] Social Isolation is a known stressor and results in alterations in reactivity to social behaviour, function of neuroendocrine, neurosteroids levels [5] and neurochemical system (decreases dopamine and noradrenaline levels),. Physiological, and behavioural changes in both animals and humans. [6] Research also indicates that psychosocial stress is a strong independent risk factor for cardiovascular disease (CVD). [7, 8] Social isolation and loneliness have also been reported as risk factors for poor mental and physical health. [9]

Stress is any situation or condition which tends to alter the balance between an animal/organism and its immediate environment. As we carry our daily activities we encounter varying degrees of stressful

conditions such as stress of work pressure, psychosocial and physical stresses due to trauma and various medical/health conditions. [10] Activation of the pituitary-adrenal axis is a prominent neuroendocrine response to stress, stimulation of this axis results in hypothalamic secretion of corticotrophin-releasing factor (CRF). [10, 11] CRF stimulates adrenocorticotrophic hormone (ACTH) secreting cells to release ACTH into the bloodstream. ACTH acts on the adrenal cortex promoting the release of Cortisol into the bloodstream Plasma levels of these hormones can increase two- to fivefold during stress. [11]

Sodium is an anion and one of the most important electrolytes in the extracellular fluid (ECF). It is responsible for maintaining the extracellular fluid (ECF) volume, and also for regulation of the membrane potential of cells. [12] The regulation of sodium concentration in blood takes place in the kidneys. [12, 13] Sodium ion is essential in body fluid volume and osmotic regulation, myocardial rhythm and contractility, and neuromuscular excitability. [13] An imbalance, in sodium ion concentration can disrupt normal bodily functions and can result to life-threatening complications. [13]

MATERIALS AND METHODS

Location of the Study: This study was carried out in the Department of Physiology, College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus.

Experimental Animals: A total of sixteen wistar rats were obtained from the animal house of the Department of Human Physiology Nnamdi Azikiwe University, weighing between 130-150g was used for this study. They were housed in well aerated laboratory cages, under room temperature and 12hr light and 12hr dark cycle in the animal house of the Department of Human physiology Nnamdi Azikiwe University. They were fed with standard rat feed and distilled water *ad libitum.*

Ethical Approval

Ethical approval consent was obtained for the progress of this study from the Faculty of Basic Medical Sciences, College of Health Sciences, Nnamdi Azikiwe University, Nnewi Campus. Rats handling and treatments conform to guidelines of the Nnamdi Azikiwe University Animal Research Ethics Committee (NAU-AREC) for laboratory animal care and use.

Determination of Sample Size

The sample size was determined using the resource equation method. [14]

E = Total number of animals – Total number of groups

$E = (8 \times 2) - 2$

$E = 16 - 4 = 12$

Experimental Design

This study spanned for six weeks. Animals were grouped into two groups (1 and 2) as follows;

Group 1: social group (SG) consisted of 8 male Wistar rats in a cage and served as control.

Group 2: isolated group (IG) consisted of 8 male Wistar rats individually caged.

Experimental Protocol: The level of physical activity of the animals was observed daily. At the end of 6 weeks of isolation, the animals were sedated with chloroform and 5 mils of blood was collected from the animals via ocular puncture. Afterwards, serum Sodium ion was analyzed using the Ion Selective Electrode (ISE) machine, by Biobase Bioindudtry Co.ltd. Model: BKE-C. Serum cortisol was assayed using the ELISA reader and ELISA cortisol kit.

Laboratory Procedure for Na^+ Determination

Blood samples were centrifuged at 3000 rpm for 15mins to separate serum from plasma.

Serum from centrifuged blood samples was pipetted into plain bottles.

The Probe of the already powered Ion Selective Electrode (ISE) Machine was introduced into the serum and the readings for Na^+ were taken.

Laboratory Procedure for Cortisol Determination

The coated wells were secured in a holder. 25ul of standard, serum and control was dispensed into the appropriate wells and thoroughly mixed gently for 10seconds. 100ul of conjugate reagent was dispensed into each well and mixed properly; the mixture was allowed to incubate for 60 minutes at room temperature. The incubated mixture was poured out and the microplates where rinsed 5 times with the buffer solution. 100ul of TMB substrate was added into each well and allowed to incubate in a dark room at room temperature for 20 minutes. 100ul of stop solution was added to each well and gently mixed until the blue colour became yellow. Optical density was read with the ELISA reader at 450 nm.

Statistical Analysis

Data collected were analyzed using SPSS version 25 and the results expressed as mean ±SEM. The comparison between the control and test groups was done using independent sample t-test. Pearson correlation was used to determine the relationship amongst variables. P-value < 0.05 and r- value < 0.01 were considered statistically significant.

RESULTS

Table 1: Showing mean serum level of Sodium (mmol/L) (Data is presented as mean ± standard error of mean and P- value < 0.05 is considered statistically significant).

Variable	Group	Mean ± SEM (mmol/L)	P-value
Na	Social Group	137.78 ± 1.12	0.004
	Isolated Group	113.88 ± 5.24*	

***: Significant at p<0.05**

Table 1. Shows a significant difference in serum sodium level in isolated males 113.88 ± 1.12 when compared to social males 137.78 ± 5.24

Table 2: Showing the mean serum cortisol level across all groups (Data is presented as mean ± standard error of mean and P- value < 0.05 is considered statistically significant).

Parameter	Group	Mean ± SEM (ng/ml)	P-value
Cortisol	Social Group	32.25 ± 0.85	0.321
	Isolated Group	33.82 ± 1.17	

***: Significant at p<0.05**

Table 2. Shows no significant difference in serum cortisol level in isolated males group 33.82± 0.81 when compared to social males group 30.96 ± 0.81

Table 3: Showing correlation between mean serum Cortisol level and Sodium levels.

	CORT /NA
r- value	-0.431*
P –value	0.048

***: significant at the 0.05 level (2-tailed).**

****: significant at the 0.01 level (2-tailed).**

-: negative correlation

CORT/NA = negative correlation

DISCUSSION

This present study investigated the impact of social isolation on serum sodium and cortisol. The individual housing/caging of the animals in this present study revealed increase in aggression and agitation. [15] Also observed, decrease in food intake compared to the socially housed group which also agrees with the earlier findings of Ana[15] and Hurst[16]

Santini[9] defined stress as any change or alteration that causes emotional, psychological or physical strain. Stress can be either chronic or acute depending on the duration and frequency of occurrence and chronic stress often results in depression. [9] Cortisol commonly referred to as the stress hormone is usually released into the blood stream in response to stress; increased production and circulatory concentration of cortisol has been implicated in depressive and anxiety disorders. [11] This study showed a drastic reduction in physical activity during the last two weeks of the study among rats which were subjected social isolation, which suggests that prolonged social isolation leads to Depression. [17] The reduction in physical activity and consequent depressive state of the isolated rats can be attributed to the increased cortisol level as shown in the result of this study and agrees with the findings of Soaleha[18]. Pearson correlation revealed negative correlation between Na and Cortisol, this finding agrees with that of Eleanor[19].

Hyponatraemia has been reported to be the most common electrolyte disorder recorded by clinical biochemist, diagnosis is when the serum sodium level is below 135 mmol/L. [13, 19, 20] Hypernatraemia has also been reported as a risk factor for mortality. [19] Results obtained from this study shows a significant decrease in serum sodium level in the isolated rats which indicates possible Hyponatraemia [20], the decrease in sodium level might be the reason for the increased agitation and aggression observed in the isolated rats as earlier reported by Ana[15]

CONCLUSION

The results of this study has shown that social isolation is a source of stress which can to depression and hyponatraemia.

RECOMMENDATION

Further studies should also be carried out to find out the impact of social isolation serum levels of other electrolytes.

Further studies should also be carried out to find out if the impact of social isolation on serum levels of Sodium and other electrolytes is responsible for cardiovascular diseases induced by social isolation.

REFERENCES

[1] Holt-Lunstad J and Smith TB. Loneliness and social isolation as risk factors for CVD: implications for evidence based patient care and scientific inquiry. Heart BMJ. 2016 Apr; 102:987–989.

[2] Hawkley LC, Capitanio JP. Perceived social isolation, evolutionary fitness and health outcomes: a lifespan approach. Philos Trans R Soc Lond B Biol Sci, 2015 May; 370: 1669.

[3] Donovan NJ, Okereke OI, Vannini P, Amariglio RE, Rentz DM, Marshall GA, et al, Association of higher cortical amyloid burden

with loneliness in cognitively *Normal* Older Adults. JAMA Psychiatry. 2016 Dec; 73 (12):1230–1237.

[4] Steptoe A and Kivimaki M. Stress and cardiovascular disease: an update on current knowledge. Annu Rev Public Health. 2013 Mar; 34:337–354.

[5] Serra M, Pisu MG, Littera M, Papi G, Sanna E, Tuveri F. Social isolation-induced decreases in both the abundance of neuroactive steroids and GABA (A) receptor function in rat brain. J Neurochem. 2000 Aug; 75(2):732–740.

[6] Mumtaz F, Khanc M1, Zubaire M, Dehpour AR. Neurobiology and consequences of social isolation stress in animal model — a comprehensive review. Biomed Pharmacother. 2018 Jun; 105: 1205–1222.

[7] O'Keefe EL, O'Keefe JH, Lavie CJ. Exercise counteractss the cardiotoxicity of psychosocial stress. Mayo Clin. Proc. 2019 Aug; 94 (9) 1852–1864.

[8] Ning Xia and Huige Li. Loneliness, social isolation and cardiovascular health. Antioxid Redox Signal, 2018 Nov; 28(9):837 – 851.

[9] Santini ZI. Social disconnectedness, perceived isolation, and symptoms of depression and anxiety among older Americans (NSHAP): a longitudinal mediation analysis. Lancet Public Health. 2020 Jan; 5(1):62–70.

[10] Ranabir S, Reetu K. Stress and hormones. Indian J Endocr Metab. 2011 Mar; 15(1):18-22.

[11] De Souza DN, De Almeida CL, Assunção, L, De Menezes, A, De Castro O, Teixeira L. Relation between Depression and Hormonal Dysregulation. J Depress Anxiety, 2017 Jul; 6, 69-78.

[12] Shiferaw BW, Waqtola CG, Delebo LA. Assessment of selected serum electrolyte and associated risk factors in diabetic patients. Diabetes Metab Syndr Obes. 2019 Dec; 12:2811-2817.

[13] Shrimanker I, Bhattarai S Electrolytes [Updated 2020 sep]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2021 Jan. Available from: https://www.ncbi.nlm.nih.gov/books/NBK541123/.

[14] Festing MF, Altman DG. Guidelines for the design and statistical analysis of experiments using laboratory animals. ILAR J. 2002 Jan; 43(4):244-58.

[15] Ana IE, Fernando C, Vanessa J, Carlos FR, Daniel PC. 24-hour changes in circulating prolactin, follicle stimulating hormone, luteinizing hormone and testosterone in male rats subjected to social isolation. J Circadian Rhythms. 2004 Feb; 2:1

[16] Hurst JL, Barnard J, Tolladay U, Nevison CM, West CD. Housing and welfare in laboratory rats: effects of cage stocking density and behavioural predictors of welfare. Anim Behav Cogn. 1999 Sep; 58 (3):563-586.

[17] Mohale DS, Chandewar AV. Effect of Social Isolation on Oxidative Stress and Transaminase Level Asian Journal of Biomedical and Pharmaceutical Sciences. 2012; 2(15) 41-44.

[18] Soaleha S, Diane S, Amanda F, Diptendu C, Robert G. Effect of social isolation on anxiety-related behaviors, cortisol and monoamines in adult zebrafish. Behav Neurosci. 2017 Dec; 131(6):492-504.

[19] Eleanor M, Julian HB. An analysis of the relationship between serum cortisol and serum sodium in routine clinical patients. Pract Lab Med. 2017 Aug; 8:30 -33.

[20] Walls RM, Hockberger RS, Gausche-Hill M. Rosen's emergency medicine: concepts and clinical practice. 9th ed. Philadelphia, Elsevier; 2018. 1516–1532.