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Effect of Starvation on Female Reproductive Hormones of Female Albino Rats

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Abstract

Background: Starvation may alter energy metabolism and physiological activity of the gonads, with their cyclic production of sex hormones and this may affect reproduction.
Aim: The aim of the study is to investigate the effects of intermittent and severe starvation on some female reproductive hormones in female albino Wistar rats.
Methods: Thirty adult female albino rats weighing 160-180g were randomly subdivided into three groups- A, B and C. Group A serves as control and was fed with rat chow and water. Group B were subjected to intermittent starvation of food, each rat was fed 1g of feed and 2mls of water daily for 7 days. Group C was subjected to severe starvation of food, each rat fed with 1g of feed and 2mls of water daily for 14 days. The animals were sacrificed at the end experiment and blood samples were collected through cardiac punctures and stored in sterile plain containers. Serum FSH, LH, progesterone and estrogen were measured by enzyme linked immunoassays for each group of rats.
Results: The mean levels of FSH, LH, progesterone and estrogen were significantly lower in acutely and chronically starved rats (5.96± 0.32; 4.01 ± 0.29 vs 6.40 ± 0.64) when compared with the control ($p < 0.005$). The mean levels of all the assayed hormones in chronically starved rats (group C) were found to be significantly reduced when compared with the acutely starved rats (group B) ($p < 0.005$). This study indicated that starvation may result in decreased release of FSH, LH, estrogen and progesterone.
Keywords: Starvation, FSH, LH, Estrogen, Progesterone.

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Introduction

Starvation is a severe deficiency in caloric energy intake below the level needed to maintain an organism's life (Kalm & Semba, 2005). It is synonymous with fasting, which implies a voluntary cessation of food intake. Major metabolic adaptations occur to deal with starvation, most notable a switch in carbohydrate, lipid and protein metabolisms (Owen & Hanson, 2013). Starvation is an increasing healthcare problem in the world, with the development of complications that ranges from liver failure, decreased in cognitive function, weakened immune system, and derangement in biochemical processes, stunted growth, lack of muscle development and eventually death. Occasional fasting could be a regimen for weight loss but could alter some biochemical process in the body. Studies have suggested that levels of female reproductive hormones may decrease following intermittent and severe starvation and this could lead to potential fertility problems. Nevertheless, this has raised concerns regarding the effects of starvation on the reproductive health of women. For example, most women may disregard intermittent fasting because of the possible negative effect on levels of progesterone, estrogen and other reproductive hormones, thus leading to menstrual cycle irregularities and fertility issues (Kumar & Kaur, 2013). In female animals, reproduction and metabolism are tightly connected and reciprocally regulated **(**Della Torre *et al*., 2014, Mirce *et al.*, 2007). During the reproductive period of life, the physiological activity of the gonads, with their cyclic production of sex hormones, ensures continuous regulation of energy metabolism **(**Della Torre *et al*., 2014, Mirce *et al.*, 2007). On the other hand, in females, in particular in mammals, energy metabolism is tuned on reproductive needs, the energetic costs of puberty, pregnancy and lactation rely on female ability in saving oxidizable fuels (Della Torre *et al*., 2014; Wade *et al*., 1992). Throughout evolution, mechanisms have been developed to store energy in the case of food abundance and to prevent reproduction in nutrient poor environments (Della Torre *et al*., 2011). When this physiological balance between reproduction and metabolism is disrupted problems occur. Pathologies associated with ovarian dysfunction, such as polycystic ovarian syndrome (PCOS) or Turner syndrome are generally more susceptible to developing metabolic disturbances (Essah & Nestler, 2006; Gravholt, 2004), and physiologically, after the cessation of ovarian function, women are also at higher risk for developing metabolic and cardiovascular disorder (Wing *et al.*, 1991).

In some religion, prolong fasting is usually combined with prayers to combat spiritual problems and this often times lead to starvation. Also, the economic hardship of developing countries could lead to severe food scarcity and this can predispose the citizens to severe starvation. Finally, intermittent fasting as a therapy for the control of weight loss may also lead to alterations in female reproductive hormones. Given the tight interconnection between energy metabolism and reproduction, this study is aimed to determine the impact of metabolic state during starvation on female reproductive hormones.

Methodology

A total of 30 female albino Wistar rats weighing 140g to 180 grams were acquired from the animal house of the Faculty of Basic Medical Sciences, Nnamdi Azikiwe University, Nnewi Campus. They were transported in a cage and housed in animal house of Department of Physiology Chukwuemeka Odumegwu Ojukwu University, Uli for two weeks to allow for acclimatization. They were then weighed using a digital scale with accuracy of 0.001gram, and randomly divided into 3 groups of 10 rats each. Group A served as the control and rats here were allowed free access to water and normal rat chow. Group B were subjected to intermittent starvation of food, each rat was fed with 1g of feed and 2mls of water daily for 7 days. Group C was subjected to severe starvation of food, each rat fed with 1g of feed and 2ml of water daily for 14 days. At the expiration of administration period, the rats were weighed. Five milliliter (5ml) blood sample was collected through cardiac puncture into Plain bottles and EDTA bottles for hormonal assay by ELISA. The hormonal assay was analysed at the Department of Chemical pathology Nnamdi Azikiwe University Teaching Hospital, Nnewi, Nigeria.

Data Analysis

Data obtained from the study were analyzed using the SPSS software version 21.0. The quantitative results were expressed as means ± standard deviation (SD). Student's t test was used to compare means between two related variables. One way analysis of variance (ANOVA) was used to analyze the means and significant differences. Comparisons between the groups were made using least significant difference (LSD) post hoc tool. Differences at $P < 0.05$ (95% confidence interval) were taken to be statistically significant.

Results

During the experimental procedures, the rats were weighed before and at the end of the experiment, it was observed that there was a significant increase in mean weights of the control group when compared with the baseline weight before commencement of the experiments. However, there was a significant reduction in mean weights of rats starved for one week and two weeks when compared with the baseline (Table 1). This finding is attributed to loss of adipose tissue and muscle mass since the body switch to the adipose and muscle tissues as alternative source of energy in starvation. The results in Table 2 shows that the mean level of LH, estrogen and progesterone of groups B and C decreased significantly when compared with the control group ($p < 0.05$). The mean levels of FSH in group B does not differ significantly when compared with the control group. Moreover, there was a significant decrease in mean levels of FSH, LH, estrogen and progesterone in group C when compared with Group B.

Discussion

The secretions of sex hormones are known to be regulated by hypothalamic GnRH which acts on the pituitary gland, and thus regulate the secretion of gonadotropins which in turn influence the secretions of gonadal hormones. Estrogen and progesterone in females are produced mostly in the gonads (ovaries) under the influence of FSH and LH secreted by the anterior pituitary gland (Shibeshil *et al*., 2006). The significant decrease in the serum concentration of luteinizing hormone (LH) and follicle stimulating hormone (FSH), estrogen and progesterone in the test groups B and C when compared with the control in this study shows that reproductive needs is highly dependent on energy metabolism. Thus, the energetic costs of puberty, pregnancy and lactation rely on female ability in saving metabolic fuels which are necessary in estrogen and progesterone production, thus, increasing the secretion of gonadotropins (FSH and LH), and then the release of estrogens and progesterone. The finding of this study on the decreased levels of the gonadotropins and estrogen is in line with earlier established findings by Couzinet *et al*. 1999. Starvation due to low food availability is certainly connected with infertility risk (Schneider, 2004). At the level of the CNS, food deprivation was demonstrated to inhibit the hypothalamic-pituitary-gonads axis (HPG), affecting GnRH pulse generator. Inhibition of GnRH secretion leads to a cascade of inhibitory effects, including decreased gonadotropin secretion, retarded follicle development, and inhibited synthesis of gonadal steroids (Leyendecker & Wildt 1984; Devlin *et al*., 1987).

Conclusion

Starvation may decrease production of female hormones and may cause female infertility. Therefore, extreme starvation is to be avoided to prevent hazardous effect on female reproductive hormones.

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Table 1: The weight of rats after the period of starvation (Mean ± SD)

Groups/ Duration of starvation	Average mean weight before experiment	Average mean weight after experiment	P value
A (control) n=10	168.70 ± 5.46	185.10 ± 5.40	0.28
B (1 week) n=10	171.50 ± 5.68	121.20 ± 4.56	0.001
C (2 weeks) n=10	169.20 ± 4.34	90.40 ± 2.27	0.001

*Significant at 0.05 level

Table 2: The mean levels of female FSH, LH, and estrogen of rats before and after the period of starvation.

Groups	FSH (mIU/ml)	LH (mIU/ml)	Progesterone (ng/ml)	Estrogen (Pg/ml)
Group (A) Control	6.40 ± 0.64	9.32.± 0.43	38.80 ± 2.21	133.5± 4.90
Group (B) Intermittent starvation	5.96 ± 0.32	7.56 ± 0.46	34.2 ± 1.76	132.43 ± 5.6
Group (C) Severe starvation	4.01 ± 0.29	6.17 ± 0.20	30.34 ± 3.6	131.51 ± 4.80
P value	0.01	0.01	0.01	0.01
Post hoc analysis	A/B 0.32 A/C 0.01 B/C 0.01	0.01 0.01 0.01	0.01 0.02 0.01	0.08 0.01 0.01

* Significant at 0.05 level of significance.

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