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Association between body size and serum estrogen level in reproductive women of Rajshahi city

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Abstract: ***Background:*** Nutritional status is a unique technique for assessment of consumption and utilization of nutrients. Malnutrition affects several aspects of physiology of the body and it is responsible for imbalance of serum estrogen level in women. Methods: This cross-sectional type of descriptive study was carried out in the Department of Physiology in Rajshahi Medical College, Rajshahi over a period of 12 months from July 2021 to June 2022 among the adult females aged 18 to 40 years in Rajshahi city. Pre-designed, validated, structured questionnaire was used to gather information from 150 women residing in Rajshahi City. Results: Out of 150 respondents, BMI wise distribution of the serum estrogen levels revealed that 12.5%, 7.7%, 0% & 8.3% had low level and 25%, 3.8%, 10.0% & 12.5% had high level of estrogen in underweight, normal weight, overweight & obese group, respectively. Relationship between serum estrogen level and nutritional status of the respondents was found statistically non-significant ($p > 0.05$). Conclusions: This study might create awareness about nutritional status of adult females and make them conscious to lead a healthy life.

Keywords: Nutritional status, BMI, Serum estrogen level.

Original Researcher Article

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Article at a glance:

Study Purpose: *The purpose of this study was to evaluate the serum estrogen level and its relationship with nutritional status of adult females in Rajshahi City.*

Key findings: *Serum estrogen level was not significantly related with nutritional status of the women.*

Newer findings: *Though relationship between serum estrogen level and nutritional status of the women was not statistically significant but underweight and obese women had more low and high level of serum estrogen.*

Abbreviations: *BMI: Body mass index, HPA: Hypothalamic-pituitary-adrenal, HPG: Hypothalamic-pituitary-gonadal, WHO: World health organization.*

INTRODUCTION

Nutritional status is a condition of the body due to the intake, absorption and use of nutrition as well as the influence of disease-related factors.[1] Nutritional status is deeply related with health status and helps to identify malnourished persons and at the same time the persons who are at risk of malnutrition. Though there is no gold standard method for identification of malnutrition, multiple parameters are combinedly used to realize the nutritional status. Clinical examination, anthropometric examination, biochemical examination and biophysical examination are the direct methods for assessment of nutritional status.[2]

BMI is a commonly used tool for anthropometric measurement and depending upon it, nutritional status is classified as underweight, normal weight, overweight and obese. According to the WHO, in 2014 more than 1.9 billion adults, 18 years and older, were overweight, while 462 million were underweight worldwide and more than 600 million were obese.[3] The 2018 Global Nutrition Report reveals that the global burden of malnutrition is unacceptably high and now affects every country in the world.[4]

In 2017 among the adult population, 30.4% were underweight, 18.9% were overweight and 4.6% were obese in Bangladesh.[5] Both underweight and obese conditions are associated with increased morbidity and mortality and increase the risk of developing non-communicable diseases. In addition, nutritional status influences serum sex hormone levels of the body which affect reproductive and metabolic functions of the body. Endocrine hormones are released by glands or specialized cells into the circulating blood and influence the function of target cells at another location in the body.[6]

Sex steroid hormones are estrogen, progesterone and testosterone and they are responsible for sexual differentiation and maturation along with development of secondary sexual characteristics. They are also involved in metabolism, accumulation and distribution of adipose tissue. Receptors of sex hormones are located in the adipose tissues and carry out their functions by genomic and non-genomic mechanism.[7] In female, estrogen comes from ovarian follicle, placenta and adrenal cortex and in plasma, principal estrogen is beta estradiol. In a regular menstruating adult woman, serum estrogen level is higher in follicular phase but when ovulation is irregular then serum estrogen hormone is altered.

Reproductive function is altered in under nutrition state and this is due to reduced secretion of GnRH that reduces LH secretion. Low gonadotropin causes hypoestrogenism which causes amenorrhea.[8] In a report, Karl et al., showed that dieting for 6 weeks (800 -1000 Kcal/day) reduced plasma estradiol concentration in comparison to normal concentration.[9] Obese person losses insulin signal to tissue and causes hyperinsulinemic insulin resistance.[10] Insulin is commonly believed to inhibit folliculogenesis. Therefore, hyperinsulinemia and insulin resistance may exert an inhibitory effect on estradiol secretion. Body mass may have an inhibitory effect on gonadotropin secretion.[11] Obesity causes alterations in hypothalamic-pituitary-adrenal (HPA) and hypothalamic-pituitary-gonadal (HPG) axis activities. In another study[12], serum 17 beta estradiol evels were lower in obese group.

Overweight and obesity in childhood responsible for increasing the risk of menstrual problems, hypertension in pregnancy and subfertility.[13] Upper body obesity is more associated with menstrual disorders.[14] Ovulatory dysfunction is commonly occurred among obese women due to dysregulation of the hypothalamic-pituitary-ovarian axis.[15,16] Several studies have been done in different countries but limited studies have yet been done in our country regarding the relation of nutritional status and estrogen hormone in adult females. Therefore, the study was designed to assess serum estrogen hormone level and its relationship with nutritional status of adult females in Rajshahi city.

METHODS

This was a cross sectional type of descriptive study in the Department of Physiology, Rajshahi Medical College, Rajshahi from July 2021 to June 2022 to find out the association between body size and serum estrogen level in reproductive women of Rajshahi City. The study population was adult females aged 18 to 40 years in Rajshahi city. Approval from the Ethical Review Committee (ERC) was obtained prior to the commencement of the study and a purposive sampling technique was used and the final sample size was 150. Consulting with the guide and reviewing the previous published literature, the questionnaire was developed for the study.

Prior to data collection, respondents were briefed about the purpose of the study and their informed written consent was taken. After taking informed written consent, complete history taking and physical examination were done and recorded in preformed data sheet. Then after overnight fasting whole blood (about 5 ml) was collected from

anterior cubital fossa by venipuncture, using 21-gauge hypodermic needle and kept in a sterile container. It was allowed to clot. Serum was separated by centrifugation at 4000 rpm for about 10 minutes at room temperature (29 degrees Celsius to 31 degrees Celsius). On the 2nd to 5th day of the menstrual cycle serum estradiol was measured by Radioimmunoassay (Siemens Healthcare Diagnostics). Data processing and analysis were done via Statistical Package for the Social Sciences (SPSS) software, version 24.0. The statistical significance was evaluated as appropriate probability level $p < 0.05$ for all tests.

RESULTS

More than half (52.7%) of the respondents belonged to the age group of 25-35 years, 26% were < 25 years and 21.3% were > 35 years old. The mean age of the respondents was 29.69 ± 6.34 years (Table-01).

Table 1: Distribution of the respondents according to age (n = 150)

Age (years)	Frequency	Percentage
< 25 years	39	26
25-35 years	79	52.7
> 35 years	32	21.3
Total	150	100

Mean age = 29.69 ± 6.34 years, **range** = (18 – 40) years

Majority (64.0%) of the respondents were obese, 17.3% had normal weight, 13.3% were overweight and only remaining 5.3% were underweight. Mean BMI of the respondents was 26.38±4.5 kg/m² (Table-02).

Table 2: Distribution of respondents by their BMI (n = 150)

BMI (kg/m²)	Frequency	Percentage
<18.5 (Underweight)	8	5.3
18.5 to 22.9 (Normal)	26	17.3
23.0 to 24.9 (Overweight)	20	13.3
≥ 25.0 (Obese)	96	64.0
Total	150	100.0

Mean BMI = 26.38 ± 4.5 kg/m², **range** = (16.5 – 38.8) kg/m²

BMI wise distribution of the serum estrogen level of the respondents revealed that out of 8 underweight (BMI < 18.5 kg/m²) respondents, 62.5% had normal level, 25% had high level and 12.5% had low estrogen level. Out of 26 normal (BMI 18.5 to 22.9 kg/m²) weight respondents, 88.7% had normal level, 7.7% had low level and remaining 3.8% had high estrogen level. Out of 20 overweight (BMI 23.0 to 24.9 kg/m²) respondents, 90.0% had normal level and 10.0% had high estrogen level. Out of 96 obese (BMI ≥ 25.0 kg/m²) respondents, 79.2% had normal level, 12.5% had high level and 8.3% had low estrogen level (Table-03).

Table 3: BMI wise distribution of the serum estrogen level of the respondents (n=150)

BMI	Serum estrogen level Frequency (%)			Total (%)
	Low level	Normal level	High level	
Underweight	1 (12.5)	5 (62.5)	2 (25.0)	8 (100.0)
Normal weight	2 (7.7)	23 (88.5)	1 (3.8)	26 (100.0)
Overweight	0 (0)	18 (90.0)	2 (10.0)	20 (100.0)
Obese	8 (8.3)	76 (79.2)	12 (12.5)	96 (100.0)
Total	11 (7.3)	122 (81.3)	17 (11.3)	150 (100.0)

Median estrogen level = 21.1 Pg/mL, **range** = (2.6 – 188.9) Pg/mL

Median serum estrogen level among underweight respondents was 25.70 Pg/mL, among normal weight respondents was 15.80 Pg/mL, among overweight respondents was 20.65 Pg/mL and among obese respondents was 79.08 Pg/mL. Data were not normally distributed so median was taken as the representative value of central tendency and range for dispersion. There was no statistically significant difference of serum estrogen level among the four groups of nutritional status, H (3) = 5.58, p = 0.13 (Table-04).

Table 4: Relationship between nutritional status and serum estrogen level of the respondents (n=150)

BMI	No	Serum estrogen (Pg/mL)		
		Mean ranks	Median	Range
Underweight	8	82.56	25.70	8.87-188.90
Normal weight	26	57.29	15.80	7.49-137.80
Overweight	20	79.15	20.65	11.60-121.00
Obese	96	79.08	21.80	2.60-180.90

*Data were analyzed using Kruskal-Wallis H test

χ^2=5.58, df=3, p=0.13

Spearman's rank order correlation was used to explore the relationship between serum estrogen level and BMI of the respondents. The rank order correlation was found positive but statistically non-significant (P > 0.05) (Figure-I).

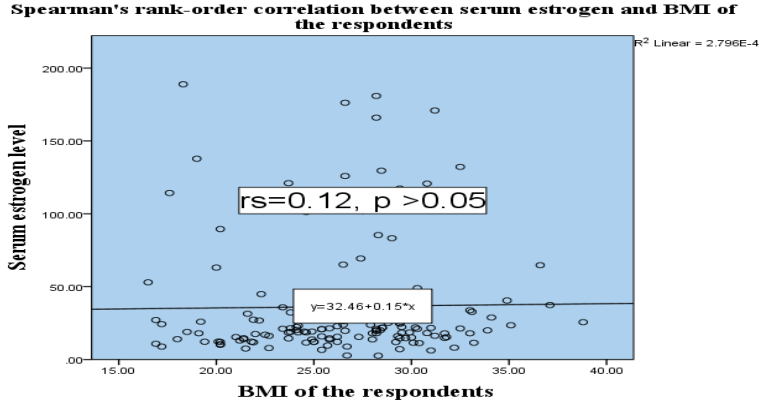

Figure 1: Scatter diagram showing Spearman's rank-order correlation between serum estrogen level and BMI of the respondents (n=150)

DISCUSSION AND CONCLUSIONS

Adequate nutrition is a prerequisite for attaining good health, maintaining good quality of life and accelerating national productivity. Alternatively, malnutrition is considered as a threat for women, increases the susceptibility to diseases by altering the hormones level which also accelerates mortality and morbidity.[17] The aim of this study was to assess serum estrogen level and its relationship with nutritional status of adult females in Rajshahi city. Age is one of the factors for alteration of estrogen hormone. In this study mean age of the respondents was 29.69 ± 6.34 years and range were 18–40 years. The finding was in accordance with the study done by Dorgan et al.,[18] where mean age of the women was 29.6 ±5.1 years and nearly similar mean age was found in a study done by Kim and Bjorn,[19] where mean was 33.2 ± 1.5 (18-44) years. But these findings were not consistent with the study done by Paxton,[20] where mean age of the women was 36.7 ± 5.2 years and majority (62%) of their respondents were within the age group of 36-45 years and only 38% were within 25-35 years.[20]

In this study the mean BMI of the respondents was 26.38±4.5 kg/m2 and range was (16.5 – 38.8) kg/m2. In a study conducted by Dorgan et al.,[18] where the average BMI was 23.3 (4-4.1) kg/m2 and in another study conducted by Kim and Bjorn,[19] where the average BMI was 32.4 ± 1.8 (19.3-48.1) kg/m2. Both findings were slight dissimilar with our study findings. Our result was conflicting with Paxton,20 regarding BMI category, where WHO BMI category was used but in our study BMI category was done by using Asian criteria for Asia-pacific Population.[20] Obesity is a complex condition that influences other life-threatening diseases. Obese women are more likely to suffer from menstrual dysfunction and infertility and respond less well to the usual hormonal treatment.

In the current study, median estrogen level was 21.1 Pg/mL and range were 2.6–188.9 Pg/mL. In another study conducted by Dorgan et al.,18 where the average estrogen level was 141 Pg/mL, range was (57-346) Pg/mL which was very much higher from the present study.[18] Mean value was not comparable because in the present study median was used as the representative value of central tendency due to abnormal distribution of data. On average, women have higher levels of estrogen and in women, estrogen helps initiate sexual development. Along with progesterone, it also regulates a woman's menstrual cycle and affects her entire reproductive system.

On the other hand, in this study median value and range of serum estrogen level in normal weight and obese women were 15.80 (7.49-137.80) Pg/mL and 21.80 (2.60-180.90) Pg/mL, respectively which findings were not similar with a study done by Kang et al.,[21] where median value and range of serum estrogen level in normal weight and obese girls were 0.30 (0.10-32.20) Pg/mL and 28.90 (11.50-41.50) Pg/mL, respectively. The cause of these dissimilarity may be done the study on Korean puberty girls and sample size also was not similar with us. After menopause, overweight and obese women have higher estrogen levels because of their greater adiposity and consequent increased aromatization of androgens to estrogens. In premenopausal women, only ovaries, rather than adipose tissue, are the major source of estrogens which is altered after menopause.

Spearman's rank order correlation between serum estrogen level and BMI of the respondents found positive (rs=0.12) but statistically non-significant (P > 0.05) correlation. A study was done by Kim and Bjorn,19 concluded statistically non-significant negative correlation (r= -0.27) between serum estrogen and BMI level which was contradictory with our findings. One of the strengths of our study was that the collection of all samples was taken during the follicular phase as well as objective measures of body size. One of the weaknesses of our study was that our study is limited to capturing hormone levels at only one-time point and may not be indicative of women's lifetime exposure to estrogen. Another fact that, the use of immunoassays is associated with several limitations.

Though there was no statistically significant difference of serum estrogen levels among the four groups of nutritional status in the study but it is a potentially important issue for women's long-term health. One of the alarming issues in the study that more than half of the women were obese. So, lifestyle interventions emphasizing weight reduction and particular strategies should be taken to prevent future serum estrogen related complications.

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Authors' contributions

EAL, LH, MMH, SM: Concept and design, data acquisition, interpretation, drafting and final approval. MP and AB: Data acquisition,

interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

Declarations

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Conflict of interest: Authors declared no conflict of interest.

Ethical approval: Ethical approval of the study was obtained from the Ethical Review Committee, Rajshahi Medical College, Rajshahi. Informed consent was taken from all participants. All the study methodology was carried out following the relevant ethical guidelines and regulations.

Consent for publication: Taken.

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