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Relationship of Circulating Progesterone and Testosterone with BMI in Adult Females of Rajshahi City

Effat Ara Lipi*[1], Latifa Hosna[1], Nasrin Khatun[2]

1 Department of Physiology, Rajshahi Medical College, Rajshahi
2 Department of Forensic Medicine, Rajshahi Medical College, Rajshahi

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ABSTRACT: ***Background:*** Nutritional status is an indicator of nutrient intake and use. Malnutrition occurs due to disruption of this balance, and it has a variety of effects on the physiology of serum progesterone and testosterone levels 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 1 year from July 2021 to June 2022 on 18-40 years 150 adult females in Rajshahi city. Data was collected through a semi-structured questionnaire and purposive sampling technique was used. Data processing and analysis were done via Statistical Package for the Social Sciences (SPSS) software, version 24.0 and the statistical significance was evaluated as appropriate probability level $p < 0.05$ for all tests. ***Results:*** Out of 150 respondents, BMI wise distribution of the serum progesterone levels revealed that 75.00%, 84.60%, 95.00% & 92.70% of the women had high level and 25.00%, 15.40%, 5.00% & 7.30% had normal level in underweight, normal weight, overweight & obese group, respectively. Serum testosterone level revealed that 75.00%, 84.60%, 85.00% & 82.30% of the women had normal level, 0%, 11.50%, 15.00% & 9.40% had low level and 25.00%, 3.80%, 0% & 8.30% had high level of testosterone in underweight, normal weight, overweight & obese group, respectively. There was no statistically significant difference of serum progesterone and testosterone level among the four groups of nutritional status (p=0.12, p=0.15, respectively). ***Conclusions:*** Though hormonal status was found statistically non-significant, adult women should be aware of nutritional status to prevent future hormone related complications.

Keywords: Nutritional Status, BMI, Serum Progesterone and Serum Testosterone.

Article at a glance:

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

Newer findings: *The correlation between serum progesterone and BMI was positive but statistically non-significant ($p > 0.05$) but the relation between testosterone and BMI was negative and statistically non-significant (p=0.06).*

Abbreviations: *BMI: Body Mass Index, Lmics: Low to Middle-Income Countries, Ncds: Non-Communicable Diseases And WHO: World Health Organization.*

INTRODUCTION

While overweight and obesity have been recognized as major public health problems in most developed countries but recently, the focus has been on undernutrition in many low to middle-income countries (LMICs). However, current evidence points to a double burden of malnutrition in LMICs resulting from the coexistence of underweight and overweight individuals in a given population.[1, 2] This double burden is thought to have arisen due to the nutritional transition experienced by these countries, along with a rapid change in food production, dietary habits and physical activity. Both underweight and overweight have multifaceted consequences for individuals in terms of longevity and disability as well as placing an economic burden on societies and health-care systems.[3] A continued focus on undernutrition, at the expense of tackling overweight and obesity, or the development of public health approaches to counter just one of them could be damaging. Recent evidence shows that countries in South Asia, such as India, Bangladesh and Nepal are currently suffering such a double burden of malnutrition.[4]

Not only in South Asia but also worldwide obesity levels have increased unprecedentedly over the past couple of decades. According to the World Health Organization's (WHO) recent global estimates, over 1.9 billion and nearly 600 million adults are overweight and obese. Respectively.[5] In many affluent countries, obesity has reached epidemic levels and is associated with non-communicable diseases (NCDs) including diabetes, hypertension, dyslipidemia and coronary heart disease, all major public health issues.[6] In affluent countries, socio-economic status and education level are negatively associated with the prevalence of obesity, a situation which contrasts to that in South Asia.

Traditionally, infectious diseases and under-nutrition were considered major health problems in South Asia and little attention was paid to obesity by healthcare workers, policy makers or researchers. However, with the rapid emergence of the obesity epidemic in South Asian countries and an increasing body of evidence that people originating from the Indian sub-continent have a high risk for NCDs including diabetes mellitus type 2, coronary heart disease and stroke compared to Europeans, greater attention is being paid.[7] Alarmingly, South Asia has the highest number of patients with diabetes worldwide and 50% of the adult disease burden in South Asia is attributable to NCDs.[8] Undernutrition and overnutrition affect serum hormone concentrations. As a result, normal physiology of the body is altered and cause reduction in serum levels of progesterone and testosterone. Reduced progesterone level causes oligomenorrhea, premenstrual syndrome, reproductive wastage and infertility.[9] Infertility affects one in seven couples associated with anovulation.[10] Serum Progesterone level is decreased even in luteal phase in obese and underweight women. In undernutrition, serum testosterone reduced and increased in overweight. Increased testosterone causes metabolic risk associated with CVD and metabolic syndrome.[11] Improvement in body weight causes improvement in menstrual dysfunction and fertility. The aim of this study was to assess serum progesterone and testosterone levels and its relationship with nutritional status in adult females. The findings derived from the study might create awareness and prevent malnutrition related metabolic and reproductive health problems.

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 progesterone and testosterone 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 progesterone and testosterone were measured by Radioimmunoassay (Siemens Healthcare Diagnostics). Qualitative variables were described by frequency and percentage, while quantitative variables were described by the mean and standard deviation. Mean ranks, median and range of the serum progesterone and testosterone were calculated separately and difference of these parameters among four groups were tested by Kruskal-Wallis H test. Chi square test was applied for categorical data. Spearman's rank order correlation was used to see the correlation of serum progesterone and testosterone with BMI of the respondents. The statistical significance was evaluated as appropriate probability level $p < 0.05$ for all tests.

RESULTS

Marital status of the respondents revealed that majority 101 (67.33%) were married and 67 (32.67%) were unmarried. Educational status showed that nearly half 74 (49.30%) of the respondents were graduate and above degree holder, 73 (48.70%) had

class six to HSC, 2 (1.30%) had primary level of education and only 1 (0.70%) were illiterate (Table 1).

Table 1: Distribution of the Respondents According to Marital Status and Educational Status (N = 150).

Variables	Frequency	Percentage
Marital status		
Married	101	67.33%
Unmarried	67	32.67%
Educational status		
Illiterate	1	0.70%
Primary	2	1.30%
Class six to HSC	73	48.70%
Graduate and above	74	49.30%

BMI wise distribution of the serum progesterone level of the respondents revealed that out of 8 underweight (BMI < 18.5 kg/m^2), 26 normal weight (BMI 18.5 to 22.9 kg/m^2), 20 overweight (BMI 23.0 to 24.9 kg/m^2) and 96 obese (BMI ≥ 25.0 kg/m^2) respondents 75.00%, 84.60%, 95.00% and 92.70% respondents had high progesterone level, respectively and 25.00%, 15.40%, 5.00% and 7.30% respondents had normal progesterone level, respectively. On the other hand, out of 8 underweight (BMI < 18.5 kg/m^2) respondents, 75.00% had normal level and 25.00% had high testosterone level. Out of 26 normal weight (BMI 18.5 to 22.9 kg/m^2) respondents, 84.60% had normal level, 11.50% had low level and remaining 3.80% had high testosterone level. Out of 20 overweight (BMI 23.0 to 24.9 kg/m^2) respondents, 85.00% had normal level and 15.00% had low testosterone level. Out of 96 obese (BMI ≥ 25.0 kg/m^2) respondents, 82.30% had normal level, 9.40% had low level and remaining 8.30% had high testosterone level (Table 2)

Table 2: BMI Wise Distribution of the Serum Progesterone and Testosterone Level of the Respondents (n=150)

BMI	Serum progesterone level Frequency (%)		Total (%)
	Normal level	High level	
Underweight	2 (25.00%)	6 (75.00%)	8 (100.00%)
Normal weight	4 (15.40%)	22 (84.60%)	26 (100.00%)
Overweight	1 (5.00%)	19 (95.00%)	20 (100.00%)
Obese	7 (7.30%)	89 (92.70%)	96 (100.00%)
Total	14 (9.30%)	136 (90.70%)	150 (100.00%)

BMI	Serum testosterone level Frequency (%)			Total (%)
	Low level	Normal level	High level	
Underweight	0 (0%)	6 (75.00%)	2 (25.00%)	8 (100.00%)
Normal weight	3 (11.50%)	22 (84.60%)	1 (3.80%)	26 (100.00%)
Overweight	3 (15.00%)	17 (85.00%)	0 (0%)	20 (100.00%)
Obese	9 (9.40%)	79 (82.30%)	8 (8.30%)	96 (100.00%)
Total	15 (10.00%)	124 (82.70%)	11 (7.30%)	150 (100.00%)

Median progesterone level = 4.92 ng/mL, range = (1.09 – 29.70) ng/mL.
Median testosterone level = 0.33 ng/mL, range = (0.09 – 41) ng/mL

There was no statistically significant difference of serum progesterone level among the four groups of nutritional status, H (3) = 6.09, p=0.12. There was also no statistically significant difference of serum testosterone level among the four groups of nutritional status, H (3) = 5.36, p=0.15 (Table 3).

Table 3: Relationship of Serum Progesterone and Testosterone Level with Nutritional Status of the Respondents (n=150)

BMI	No	Serum progesterone (ng/mL)			χ^2 df p-value
		Mean ranks	Median	Range	
Underweight	8	42.94	3.38	1.60-6.80	6.09
Normal weight	26	68.54	4.05	1.09-25.30	3
Overweight	20	81.03	4.94	1.40-17.00	0.12
Obese	96	78.95	5.21	1.89-29.70	
BMI	**No**	**Serum testosterone (ng/mL)**			
		Mean ranks	**Median**	**Range**	
Underweight	8	75	0.27	0.15-41	5.36
Normal weight	26	72	0.30	0.09-0.83	3
Overweight	20	56.10	0.24	0.1-0.51	0.15
Obese	96	80.42	0.35	0.1-1.2	

* Data were analyzed using Kruskal-Wallis H test

Spearman's rank order correlation was used to explore the relationship between serum progesterone level and BMI of the respondents. The rank order correlation was found positive but statistically non-significant (p > 0.05) (Figure 1).

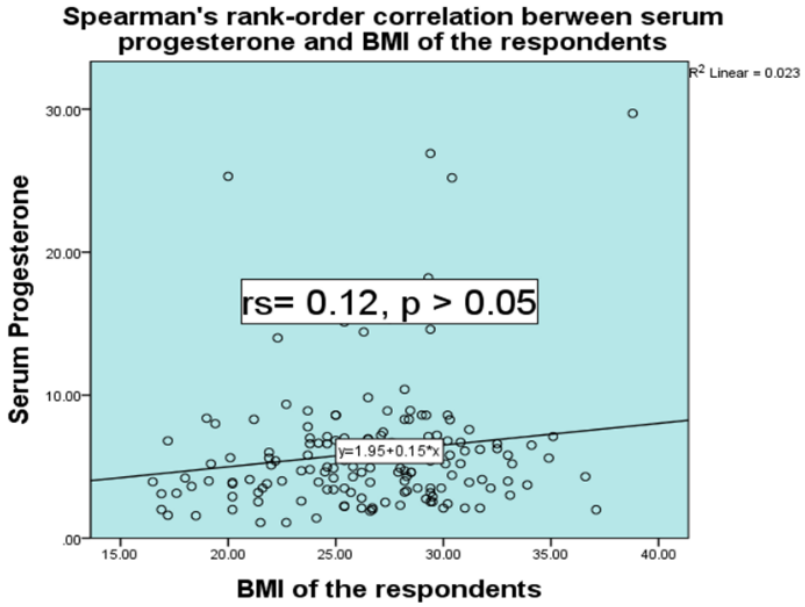

Figure 1: Scatter Diagram Showing Spearman's Rank-Order Correlation Between Serum Progesterone Level and BMI of the Respondents (n=150)

Spearman's rank order correlation was used to explore the relationship between serum testosterone level and BMI of the respondents. The rank order correlation was found negative and statistically non-significant (p=0.06) (Figure 1).

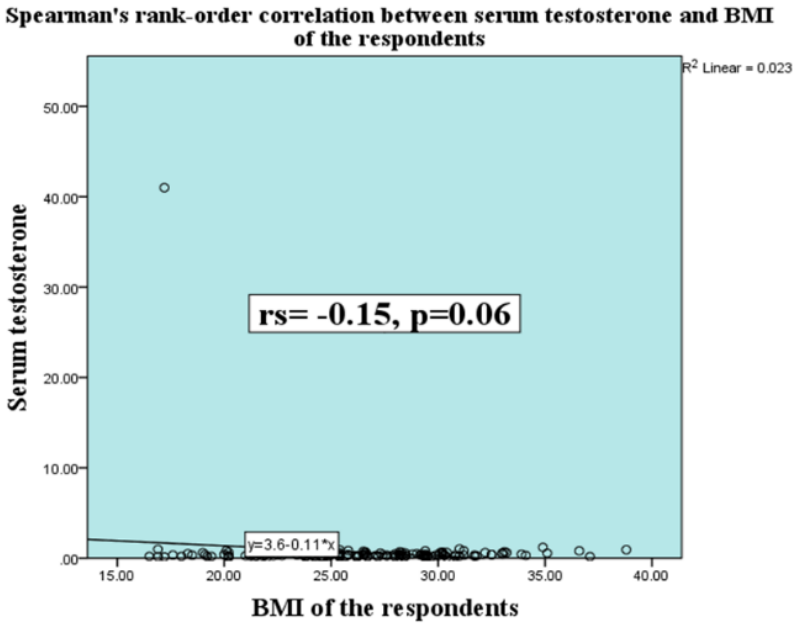

Figure 2: Scatter Diagram Showing Spearman's Rank-Order Correlation Between Serum Testosterone Level and BMI of the Respondents (n=150)

DISCUSSION

Malnutrition is a complex disorder that affects a variety of different ailments. Women with malnutrition are more prone to suffer from infertility and menstrual disorder and they respond less effectively to standard hormone therapy. If pregnancy occurs, the rate of complications is higher during its course as well as during delivery. There is also an increased prevalence of certain gynaecological tumours, for example endometrial or breast cancer, in women with malnutrition. In the present study the marital status of the respondents revealed that more than two third (67.33%) of the respondents were married and less than one third (32.67%) were unmarried which was showed nearly similar pattern with a study conducted by Paxton where 34% were unmarried, 53% married and 13% in another category.[12] The educational status of the respondents reveals that near about half (49.3%) of the respondents were graduate and above degree holder, less than half (48.7) were class six to HSC pass, 1.3% were primary pass and only 0.7% were illiterate. Different educational status categories were observed in a study done by Paxton, (2013) where 72% were ≥ college graduate, 15% were ≤ high school pass and 13% were Some college or technical school pass.[12] In the present study median value and range of serum progesterone level in normal weight and obese women were 4.05 (1.09-25.30) ng/mL and 5.21 (1.89-29.70) ng/mL respectively which findings were not similar with a study done by Kang *et al*. where median value and range of serum estrogen level in normal weight and obese women were 0.60 (0.40-1.10) ng/mL and 0.70 (0.40-1.10) ng/mL respectively.[13] The cause of these dissimilarity may be due to Kang *et al.* done the study on 91 Korean puberty girls.[13]

When progesterone is low it can cause estrogen to rise, and this imbalance can create hot flashes particularly at night. Symptoms of high progesterone are similar to premenstrual syndrome and can include anxiety and agitation, blasting, breast swelling and tenderness, depression, fatigue and weight gain. In the current study median value and range of serum testosterone level in normal weight and obese women were 0.30 (0.09-0.83) ng/mL and 0.35 (0.10-1.20) ng/mL respectively which findings were near about too similar with a study done by Kang *et al*. where median value and range of serum testosterone level in normal weight and obese women were 0.20 (0.10-0.27) ng/mL and 0.31 (0.20-0.47) ng/mL, respectively.[13] Testosterone is an important hormone, not just for men but also for women's health and well-being. However, too much testosterone in women can lead to side effects like acne, abnormal hair growth, weight gain, irregular menstrual cycles and infertility. In general, testosterone can affect muscle and bone growth, hair growth, sex drive/libido and metabolism. In women, the

symptoms of low testosterone can be subtle and include decreased sex drive or decreased sexual satisfaction, fatigue and low energy. In our study by applying spearman's rank-order correlation test, the relation between serum testosterone and BMI of the respondents was found negative and statistically non-significant (P=0.06). Kim *et al.* also established the same relation by pearson's correlation and found statistically significant positive correlation (rs=0.45) which was also contradictory of our result.[14] There were some limitations of the study. This was a cross-sectional type of descriptive study in a single community with comparatively small number of sample sizes. So, the study result may not reflect the exact scenarios of the whole country. Purposive sampling techniques were selected, and selection bias could not be avoided. All samples were collected in the early morning, but secretory dynamics of sex hormones was not clear and nocturnal and morning change of secretions of hormones should be considered together. Only serum total concentration of hormones was considered in the study, but free form was not measured which was an important parameter.

CONCLUSION

The study found no significant difference in serum progesterone and testosterone levels among the four nutritional status groups. However, the fact that more than half of women are obese highlights the need for lifestyle interventions focused on weight loss.

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Authors' Contributions

EAL, LH: Concept and design, data acquisition, interpretation, drafting and final approval. EAL and MNK: Data acquisition, interpretation, drafting, final approval and agree to be accountable for all aspects of the work.

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.

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***Correspondence:** Dr. Effat Ara Lipi, Email: effataralipi@gmail.com

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