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Variations in Blood Glucose Level during Different Phases of Menstrual Cycle in Young Female Population

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ABSTRACT

Although Studies have examined variations in certain Physiological parameters during the different menstrual cycle phases, yet reports relating blood glucose level with the menstrual cycle is scanty. This study aimed at examining variations in blood glucose level during the menstrual cycle. 73 randomly selected apparently healthy young female subjects of age range 18-25 years were involved in the study. Their weight and height were measured from where the body mass index (BMI) was calculated. Their blood glucose level during menstrual, follicular and luteal phases of the menstrual cycle was determined by colorimetric method. Results show that among normal weight and overweight subjects there is a phase dependent progressive increase in blood glucose level during follicular (insignificant) and luteal (significant) phases of the menstrual cycle when compared with the menstrual phase. We conclude that blood glucose level vary during the different phases of the menstrual cycle among non obese subjects.
KEY WORDS*:* Blood glucose, menstrual cycle, BMI, female.

INTRODUCTION

The normal reproductive years of female humans are characterized by monthly rhythmical changes in the secretion of reproductive hormones and corresponding physical changes in the ovaries, uterus and other organs and systems of the body. This rhythmical pattern is referred to as menstrual cycle.The female sex-steroid hormones that are mainly responsible for initiating and controlling the menstrual cycle are the gonadotropin-releasing hormone (GnRH), the follicule stimulating hormone (FSH), the luteinizing hormone (LH), estrogen and progesterone [1] The main reproductive hormones produced by the ovaries in women are estrogen and progesterone; the fluctuations in their release aiding in the determination of the different menstrual cycle phases[1]. In the majority of women the menstrual cycle averages 28 days, where the day of onset of menstruation is generallyreferred to as 1st day[2]. The cycle can be divided into four phases: menstruation or early follicular phase (days 1–4), late follicular phase (days 5–11), peri-ovulation (days 12–15) and the luteal phase (days 16–28)[2]

Earlier studies have associated these menstrual cycle phases with variations in certain Physiological parameters such as female reproductive hormones [3]; carbohydrates, fats and protein intake[4]; carbohydrate metabolism[5],total leukocyte countsand immune profile [6,7]as well as cardiovascular changes [8]. In addition, fluctuations in blood glucose levels during menstruation have been reported[9]. However, definite studies on variations in blood glucose level during the different phases of the menstrual cycle are scanty, especially among Nigerians, hence the purpose for this study.Results obtained from this study will be useful for researchers, medical and laboratory scientists as well as clinicians who are involved in the management of especially, female diabetics.

MATERIALS AND METHODS

Study population: This study, carried out between April 2012 and October 2012, was on 73 randomly selected apparently healthy young female subjects in Port Harcourt, Rivers state Nigeria; of age range 18-25 years who willingly gave their informed consent after the study methodology and purpose were fully explained. Those who fulfilled the inclusion criteria: non diabetic, having a regular menstrual cycle of 28±2 days, no gynecological disorders or chronic disease, not on contraceptive for a minimum period of six months and no adverse drug history were enlisted into the study.

Measurements: The parameters measured from the subjects were their weight, height and blood glucose. Each subject filled a questionnaire where basic information about their age, menstrual characteristics, medical, drug

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history was obtained. Menstrual cycle length was estimated from the first day of menses (day 1) to the day preceding the next menses using a typical cycle length of 28 days and ovulation at day 14[10]. The subjects were asked to wear light clothes and remove foot wears while the measurements were taken. The "Harson Emperors" bathroom weighing scale graduated in kilogram (kg) was used for weight measurements. The subjects were asked to mount the scale gazing forward with their hands by the side while the weight was read. This was done twice and the average weight was recorded. A measuring tape graduated in metres (m) was used for height measurements with subject in the upright position. The body mass index **(**BMI) was calculated from the formula: weight (in Kilograms) divided by the square of the height (in metres) kg/m^2.Each subject was followed up and 3ml of venous blood collected by vene puncture during the menstrual (day 2-3), follicular (day 10-12) and luteal(day 20-22) phases in a single menstrual cycle. The blood glucose was determined by colorimetric method.

Analysis of data: Data obtained were analyzed statistically using computer software (SPSS version 17). Results were presented as mean ± standard deviation. Test for significant difference was done using analysis of variance (ANOVA) at 95% confidence interval ($p \leq 0.05$.)

RESULTS

The anthropometric and menstrual characteristics of the population studied (Table 1) reveal normal mean values for BMI (23.60±2.94), menstrual duration (4.46±0.76) and menstrual cycle (27.81±1.80).

Table 1: Anthropometric and menstrual characteristics of the population studied.

Physiological parameter (n=73)	Mean	Std. Deviation
Age(years)	22.46	2.52
Weight (kg)	62.24	9.90
Height (m)	1.62	0.08
BMI (kg/m^2)	23.60	2.94
menstrual duration (days)	4.46	0.76
menstrual cycle (days)	27.81	1.80

The variation in the blood glucose level (figure1) was observed to progressively increase from the menstrual, follicular to the luteal phases of the menstrual cycle respectively. The increase during the follicular phase was insignificant ($p>0.05$), but became significant ($p<0.05$) at the luteal phase, when compared with the menstrual phase.

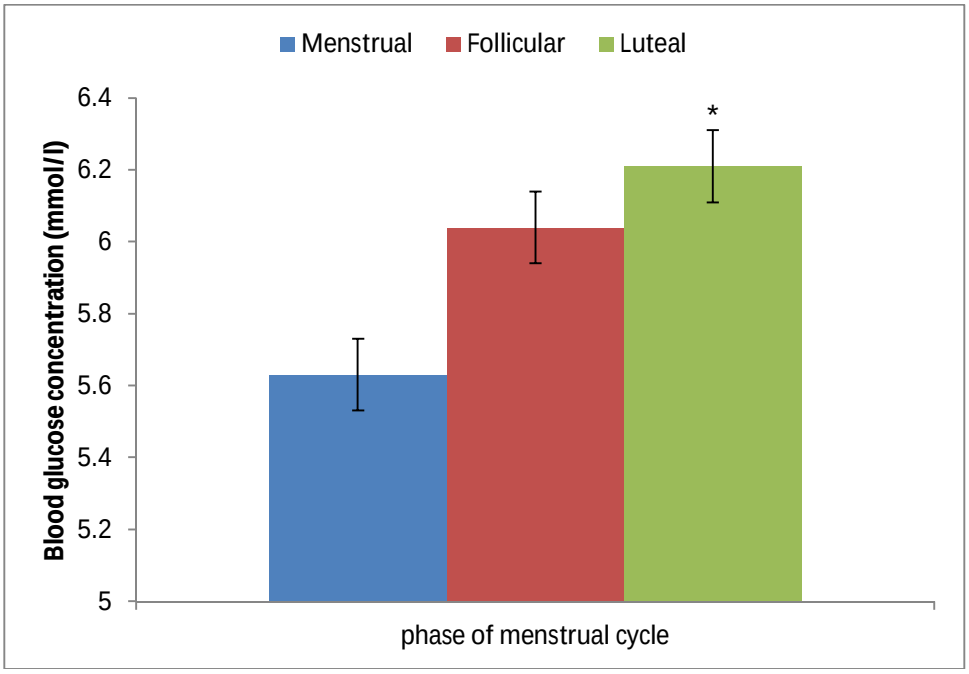

Figure 1: variations in blood glucose level during menstrual, follicilar and luteal phases of the menstrual cycle. (*significantly higher than the menstrual phase).

Further analysis shows that subjects with BMI 18.5-24.9 (normal weight) and 25-29.9 (over weight)have significant variation ($p<0.05$), while the obese (BMI ≥ 30) subjects show insignificant variation in the blood glucose level during the different phases of the menstrual cycle, as shown in table 2.

Table 2: Variations in blood glucose Level during different phases of the menstrual cycle according to body mass index (BMI).

BMI (kg/m^2)	Blood glucose (mmol/l)			P-value
	Menstrual phase	Follicular phase	Luteal phase	
18.5–24.9 (normal weight)	5.77± 0.98	6.1 ± 0.95	6.22 ± 1.13	<0.05
25 – 29.9 (over weight)	5.68± 1.02	6.06±0.76	6.30+ 0.79	<0.05
≥30 (obese)	4.93± 0.25	5.23±0.38	4.93±0.38	>0.05
Total population	**5.63±0.86**	**6.04±0.88**	**6.21±1.10**	**<0.05**

DISCUSSION

Menstrual cycle, a regular cyclical physiological process that occurs in female reproductive system over an approximate monthly time period is under the control of hypothalamopituilary ovarian axis. The endometrium is stimulated and regulated by ovarian steroid hormone, estrogen and progesterone. An increase from the basal levels of these hormones usually begins during the follicular phase with a peak in progesterone during the luteal phase. Therefore, the non-significant ($p>0.05$) increase in the blood glucose level between the follicular phase and the menstrual phase observed in this study may be due to low hormonal levels of estrogen and progesterone during these two phases of the menstrual cycle. However, a significant ($P<0.05$) increase was found during the luteal phase which may be as a result of an increase in the estrogen and progesterone levels during the luteal phase. This agrees with the report of earlier studies [3] who noted a relationship between blood glucose and the levels of estrogen and progesterone released during the phases of menstrual cycle. Progesterone specifically, increases during the luteal phase and also makes the body cells more resistant to insulin action[9]. This allows more glucose stay in the blood stream. This implies that the more progesterone released, the more glucose stays in the blood causing a rise in blood glucose levels as observed in this study. Reports indicate that in humans, energy intake is higher in the luteal phase than in the follicular phase[11,12], and more studies support the findings of luteal hyperphagia[13,14] where women's energy intake has been reported to increase with as much as 90–500 kcal/day compared to the follicular phase[15] indicating that energy intake changes in response to changes in levels of ovarian hormones. The changes in appetite regulation that occur during the menstrual cycle have been suggested to be related to glucose homeostasis; that insulin responsiveness is modified by sex hormones[16] and that insulin sensitivity is lower in the luteal phase than in the follicular phase[17-19] which all affect blood glucose levels, thus, agreeing with the result obtained from this study. Many findings[19-21]suggest that estrogen and progesterone can modulate insulin sensitivity in women. These investigations report a poor control of glucose homeostasis in diabetic women during the luteal phase while sensitivity to insulin action in normal women also decreases. It seems clear, therefore, that physiological variations in the concentrations of sex hormones during the menstrual cycle could have an effect on the receptor for insulin binding. All these considerations imply that progesterone is a modulating factor on receptor insulin binding, at least in adipose tissue[19-21]. This interpretation would agree with the reduction in insulin sensitivity attributed to progesterone in women treated with oral contraceptive pill[21].Therefore, the high craving for carbohydrate intake, rapid carbohydrate metabolism and reduced insulin sensitivity in tissues accompanying the rise in progesterone during the luteal phase may have all collectively been responsible for the significant increase in blood glucose level during the luteal phase of the menstrual cycle observed in this study. The observation that normal weight and overweight subjects had significantly higher blood sugar level during the luteal phase, similar to that observed for the general population, suggests that at these BMI categories the carbohydrate regulatory mechanisms of these subjects may be optimal. Also, the irregular blood glucose levels observed for obese subjects during the different phases of the menstrual cycle suggests that obesity is associated with interference with the normal carbohydrate regulatory mechanisms.

CONCLUSION

In conclusion, this study has shown that for healthy non-obese subjects there is a physiological variation in the blood glucose level in the different phases of the menstrual cycle, being least during menstruation with a peak during the luteal phase.

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