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TIMING AND MAGNITUDE OF CHANGES IN BASAL ENERGY EXPENDITURE DURING PREGNANCY IN INDIAN WOMEN

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Abstract : Basal energy expenditure (BEE) was determined in 291 pregnant women, age 20-35 years, using Benedict Roth Metabolism Apparatus. A control study was undertaken in 38 non pregnant women during both follicular and luteal phases of menstrual cycle respectively. The mean ± SD of BEE were found to be 34.04 ± 3.05, 35.85 ± 2.60 and 39.69 ± 2.75 Kcal/m^2/hr during first, second and third trimesters of pregnancy respectively. BEE was progressively and significantly increased ($P < 0.01$). However, increase in BEE during first trimester of pregnancy compared to that of luteal phase of menstrual cycle was insignificant. The results indicate that Indian pregnant women should maintain energy requirements by increasing caloric intake throughout the gestation.

Key words : BEE pregnancy trimesters

INTRODUCTION

Pregnancy is a physiological condition characterized by increased metabolism and several physiological adaptions. During this period there are significant anatomical and functional changes take place which require proper supply of nutrition. The influence of maternal nutrition on the course and outcome of pregnancy is long recognized; such studies have recently received considerable emphasis (1, 2). Basal energy expenditure (BEE), one of the principal components of total energy output, rises during pregnancy to fulfil the demand of additional growth and maintainance of maternal and foetal tissues. It has been reported that energy cost of pregnancy varies widely among different communities (3). Also, the timing and magnitude of changes in basal metabolism during pregnancy is cotroversial, as reviewed (4). The present study was designed to elucidate the timing and magnitude of changes in basal energy expenditure during the course of pregnancy in Indian women.

METHODS

The experiment was carried out in antenatal clinic of V.S. General Hospital and in the Department of Physiology, Smt. N.H.L Municipal Medical Collage, Ahmedabad, on 291 healthy pregnant women, of 18-35 years of age, at different stages of the gestational period. All pregnant women were either nulliparous or multiporous, and had no evidence of cardiopulmonary, renal or other disorders. Subjects were excluded if

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haemoglobin level was below 10 gm per dl, and if the satisfactory metabolic measurements could not be taken because of lack of cooperation or an inability to perform the tests. They were divided into three groups and each subject was studied as a member of only one gestational group, either in first, second or third trimester. Matching with anthropometric and middle class socioeconomic status criteria, a control study on 38 non pregnant healthy married women was undertaken during their both follicular (F) and luteal (L) phases of menstrual cycle. Criteria of detecting different phases of menstrual cycle were discussed in earlier studies (5).

The basal energy output was determined by measuring basal oxygen consumption using closed circuit indirect calorimetry (Benedict roth Metabolism Apparatus, warren E, Collins Inc., Boston, MA, USA). Details of the measurement was explained earlier (5). In brief, before the actual test, the subjects were trained in mouth breathing, with nose clipped, through the apparatus. They were explained about the basal condition. They were clearly told regarding the nature, usefulness and duration of the experiment. After satisfactory training, the subjects were asked to come to the laboratory in the early morning for the actual test. Besides maintaining strict basal conditions with the cooperation and understanding of the subjects, the procedure involved rigorous criteria to arrive at fairly reliable and conclusive data. Records were taken after 30 min bed rest for at least two consecutive days. Basal oxygen consumption of two consecutive recordings, each of atleast 7–8 min duration, at an interval of 15 min, in one day was taken to be satisfactory when they were in agreement within 5 percent. Again when the average of each day's observation varied within 5 percent, the basal oxygen consumption of one subject was taken as final and was corrected at standard temperature and pressure, dry (STPD). The heat production or BEE was calculated from the oxygen consumption and was expressed as both Kcal/hr and Kcal/m^2/hr. Body surface area (B.S.A) was calculated accouring to DuBois nomogram.

For statistical comparison, we have considered the data of non pregnant women as control. Data were expressed as mean±SD (Standard Deviation). The percentage changes in BEE were calculated for Kcal/m^2/hr to relate the difference to the initial values. Statistical significance between paired values of follicular and luteal phase in non pregnant women was determined by Fisher test. Unpaired Student t test was employed for the comparison between non pregnant and pregnant group. One way analysis of variance was also used for comparisons involving more than two groups. The alpha error for a significant test was set at the 5 percent level.

RESULTS

From Table I, it is evident that, all groups had similar age and height. The increase in maternal body weight and consequently the B.S.A. were significant ($P < 0.001$) at term. In non pregnant group basal energy expenditure was significantly ($P < 0.01$) higher in luteal phase than that of follicular phase of menstrual cycle. BEE was similar in luteal phase of menstrual cycle and first trimester of pregnancy. But it was significantly higher ($P < 0.001$) both in second and third trimester than that of control and first trimester. Again, the difference between second and third trimester was significant ($P < 0.001$). The within and between days coefficient of variation of individual subject's data on BEE was 3.5 and 4.2 percent respectively.

TABLE I : Physical characteristics and basal energy expenditure (Kcal/hr and Kcal/m²/hr) of non pregnant control (c) and of first (I), second (II) and third (III) trimesters pregnant women.

		Age (yr)	*Height (cm)*	*Weight (kg)*	*B.S.A. (m^2)*	*Kcal/hr*	*Kcal/m²/hr*	*% change*
C.	(38)	24.20±6.87	151.80±5.50	49.30±7.83	1.43±.10	45.64±4.41 (F)	32.01±2.69 (F)	–
						48.37±4.37*(L)	33.84±2.48* (L)	+5.71
I.	(70)	24.16±3.81	150.60±5.50	49.60±7.43	1.43±.11	48.53±4.60*	34.04±3.05*	+6.34
II.	(85)	23.91±4.30	151.90±5.91	51.90±7.50	1.47±.12+	52.57±5.40**	35.85±2.60**	+11.99
III.	(136)	23.70±3.51	152.20±5.72	54.20±6.52**	1.50±0.10**	59.50±6.02**	39.69±2.75**	+23.99

Parentheses indicate number of subjects. F= Follicular phase, L= Luteal phase.
+ = P < 0.05, * = P,0.01 ** = P,0.001compared with the values of control (F). calculated from BEE expressed in Kcal/m²/hr

In 260 pregnant women, retrospectively we have collected data of birth weight and gestational age at delivery from hospital records. The data were missing for 31 pregnant women. The birth weight and gestational age at delivery were 2685 ± 423.8 g and 272 ± 11.0 days respectively.

DISCUSSION

Although the basal energy expenditure during pregnancy has been the subject of considerable interest, the time course and the magnitude of changes, however, have been varied and remain controversial. In this series, in non pregnant control group, luteal phase was associated with 5.71 percent higher energy utilization per hour per m^2 of B.S.A. than follicular phase of menstrual cycle. This was in agreement with earlier studies (5, 6). Almost a similar rise, 6.34 percent, was noted in first trimester of pregnancy compared to that of follicular phase. Maximum rise in BEE (Kcal/m²/hr), 23.9 percent was evident in third trimester. We have not found any appreciable change in metabolic rate in first trimester of pregnancy compared to luteal phase of non pregnant women. However, more consistant and abrupt rise in BEE, approximately 5 and 17 percent, was noted in second and third trimesters of pregnancy respectively compared to first trimester group. The luteal increase in BEE may continue to increase at slower rate till initial few weeks of pregnancy, if occured. This early increase in energy expenditure during luteal phase and in first trimester compared to follicular phase is attributed to hormonal and maternal functional adaptive changes (5, 7). In early pregnancy, however, foetal metabolic needs are practically nil (8).

The increase in BEE is more marked from second half of the pregnancy. Maximum rise, 39.69 Kcal/m²/hr, was noted in third trimester. This rise, in terms of absolute value, was more or less similar to that of other Indian studies (9, 10). However, in terms of percent changes it differs, we observed approximately 5 percent more at term, as we have calculated this change from follicular phase of menstrual cycle. This increase in BEE at term is explained by the rapid anatomical and physiological changes occuring in both maternal and foetal systems (4). It was pointed out that, the absolute rise in BEE during the course of pregnancy when expressed per unit of body weight, no increase was found compared with the non pregnant state (11). On the contrary, Flanagen et al. have presented evidence that basal oxygen utilization during pregnancy increases not only in absolute fashion, nearly 30 percent at term, but also per kilogram of lean body tissue (12). By Blackburn and Calloway, the percentage of increase has been reported to be 13 percent when calculated on a kilogram basis, though the total basal rise in metabolism was 28 percent (13). We have also observed the changes in BEE in similar fashion. Although the value of kcal/m^2/hr was 23.99 percent higher at term, the absolute rise in terms of Kcal/hr was found to be 30.36 percent . Interestingly, some studies have shown that the pregnant women do not increase their energy intake above the non pregnant level and there may be a fall in basal metabolic rate (BMR) during 12 to 15 weeks of pregnancy (14). It is proposed that pregnancy represents a unique condition during which BMR is regulated by maternal adipose tissue reserves (15). Although there is a great deal of controversy about basal and total energy cost during pregnancy, it is assumed that pregnant women have to spend some amount of energy to maintain her increased cardiac and respiratory work (4). The energy which the mother has to provide to maintain her extra cardiorespiratory work, to maintain own tissue development and for the foetus, comes from her own food supply, and not from a depletion of her tissues. A recent study in well nourished Indian women showed that a large part of total estimated energy cost of pregnancy was fulfilled by cumulative increase in energy intake (2). Although we have not measured the caloric intake or the activity level, from the questionnaire it is evident that our pregnant subjects increased their food consumption throughout pregnancy and decreased their physical activity particularly during third trimester. As a part of metabolic adaption, diminished body activity or increase in rest period along with increased food intake may combine in some way to conserve energy and body fats during pregnancy. The accumulation of maternal lipid stores early in pregnancy is a preparatory step to later part of pregnancy when the metabolic needs of the conceptus quickly increase; at this time the pregnant woman with limited nutrition significantly utilizes her lipid stores in order to supply more glucose and amino acids to the foetus (16). This may be an important means of protecting foetal growth. In this series, our data of birth weight was almost similar to that reported in other Indian studies (1, 17), representing normal foetal growth. Foetal growth is also influenced by gestational age. Preterm birth (gestational age $<$ 259 days) is associated with lower body weight of the new born baby (18). It has been emphasized that maternal undernutrition may reduce both birth weight and gestational age (19). Thus normal birth weight and gestational age in this study indicate adequate maternal nutrition.

In conclusion, BEE rises progressively during pregnancy and maximum rise was evident during third trimester. The significance of BEE measurement during pregnancy is to ascertain whether more energy should be given than in the non pregnant state, presumably to maintain nutritional status of both mother and foetus. However, BEE and nutrition in pregnancy has been and probably will continue to be a controversial subject. Poor nutrition does not affect the outcome of all women's pregnancies equally, as reviewed (20). Marginally nourished pregnant women conserve energy by supressing metabolic rate and by gaining little fat (3). Again, some feel that good nutrition is an important factor relating to optimal pregnancy outcome (21). However, our observation of increased BEE during pregnancy indicates that Indian pregnant women should meet their energy requirements by increasing caloric intake throughout their pregnancy as recommended by ICMR (22).

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