—Report on Experiments and Clinical Cases—

Resting Energy Expenditure in Pregnant Japanese Women

Hiromitsu Chihara, Yasuo Otsubo and Tsutomu Araki

Department of Obstetrics and Gynecology, Nippon Medical School

Abstract

The subjects were 160 pregnant women with no complications who were examined with indirect calorimetry by a single observer; 20 healthy age-matched non-pregnant women were used as controls. Assessment was performed 12 hours after oral intake of food. Each measurement of resting energy expenditure divided by the body surface area was analyzed and compared with that of the controls. In pregnant women, the mean resting energy expenditure divided by the body surface area did not significantly increase until 32 weeks' gestation. Energy expenditure increased significantly by about 300～600 kJ/m^2 between before 31 weeks' gestation and the end of pregnancy. Significant changes occurred in the 32～35 and 36～40 weeks' gestational stages (3,790±370, 4,110±385 kJ/m^2) ($p < 0.05$). Resting energy expenditure increases at conception, and does not increase until 32 week's gestation, but increases gradually from 32 weeks' gestation to term in normal pregnant women as assessed by indirect calorimetry. (J Nippon Med Sch 2002; 69: 373–375)

Key words: resting energy expenditure, indirect calorimetry, pregnancy

Introduction

Maternal malnutrition is associated with intrauterine growth retardation, premature labor[1] and sometimes increased perinatal mortality and morbidity[2]. Intestinal obstruction or acute pancreatitis, which often occur in the gestational period, readily lead to severe maternal malnutrition[3]. Severe degrees of dehydration, hypokalemia, starvation ketosis or acidosis may occur and may be life threatening[4]. Most patients are able to eat after several days of therapeutic peripheral venous infusion; however, some patients must undergo prolonged starvation before refeeding. Therefore, it is important to determine the amount of energy needed to maintain the pregnancy[1]. To plan optimal therapy for malnourished patients the energy goal must be defined[5].

Some studies have examined intravenous nutrition during pregnancy[6,7,8]. In these studies, the energy expenditure and adjustment of nutrient intake were estimated using predictive equations[4,8].

The objective of this study was to investigate the relationship between the resting energy expenditure and gestational age during pregnancy in Japanese women.

Subjects and methods

Indirect calorimetry was measured in 160 pregnant women from 6 to 40 weeks' gestation and 20 healthy women between January and May 1999. Patients with metabolic and endocrinological diseases such as diabetes mellitus, hyperthyroidism and with any gestational complications were excluded from this study. All patients were examined over 12

Correspondence to Hiromitsu Chihara, Department of Obstetrics and Gynecology, Nippon Medical School, 1–1–5 Sendagi, Bunkyo-ku, Tokyo 113–8602, Japan
E-mail: naru@nms.ac.jp
Journal Website (http://www.nms.ac.jp/jnms/)

Table Characteristics of each group

Subjects (weeks)	Age (year) (mean ± SD)	Weight (kg) (mean ± SD)	BSA * (mean ± SD)	REE † (mean ± SD)	REE/BSA (kJ/m²) (mean ± SD)
control	28.3 ± 3.86	51.4 ± 4.25	1.47 ± 0.07	4,710 ± 488	3,210 ± 304
5—11	28.3 ± 3.59	51.4 ± 3.85	1.47 ± 0.06	5,080 ± 565	3,470 ± 340 ‡
12—15	29.4 ± 3.32	50.9 ± 2.56	1.47 ± 0.05	4,860 ± 684	3,320 ± 462
16—19	27.6 ± 3.05	51.4 ± 4.25	1.51 ± 0.07	5,360 ± 553	3,560 ± 367 ‡
20—23	28.6 ± 3.00	55.5 ± 5.85	1.51 ± 0.09	5,490 ± 608	3,630 ± 342 ‡
24—27	29.3 ± 2.75	59.4 ± 6.08	1.57 ± 0.09	5,650 ± 867	3,600 ± 443 ‡
28—31	29.5 ± 3.90	57.1 ± 5.05	1.54 ± 0.08	5,730 ± 716	3,720 ± 340 ‡
32—35	27.9 ± 3.77	60.7 ± 6.49	1.58 ± 0.10	5,980 ± 629	3,790 ± 370 ‡ §
36—40	29.6 ± 3.29	60.6 ± 6.25	1.58 ± 0.08	6,480 ± 711	4,110 ± 385 ‡ §

* Body surface area (in m^2).
† Resting energy expenditure (in kJ).
‡ Significant difference from the control: $p < 0.05$.
§ Significant difference from the group (5—11, 12—15, 16—19, 20—23, 24—27 28—31): $p < 0.05$.

hours after oral intake of food.

Resting energy expenditure (REE) was measured with a Metavine N machine (Vine Co., Tokyo, Japan). The patients were examined following 15 min of resting time in a quiet environment, and were placed in a semi-recumbent position. Body height and weight were also measured to calculate body surface area (BSA). Resting energy expenditure was estimated from the mean results of three measurements. To exclude inter-observer error, all calorimetric examinations were performed by a single investigator. All examinations were carried out without maternal movements.

Data are presented as mean ± SD. Statistical analyses were performed with unpaired *t*-tests and one-way ANOVA. Differences were considered significant at $p<0.05$.

Results

The means of REE divided by BSA increased by about 200 kJ/m^2 at every gestational stage compared with non-pregnant women (3,210 ± 304 kJ/m^2), and in pregnant women did not significantly increase until 32 weeks' gestation. Significant changes of about 300～600 kJ/m^2 occurred in the 32～35 and 36～40 weeks' gestational stages (3,790 ± 370, 4,110 ± 385 kJ/m^2) ($p < 0.05$) (**Table, Fig.**).

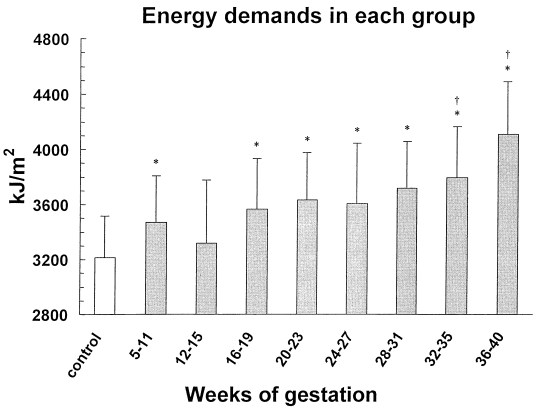

Fig. Energy demands per unit area (REE divided by BSA) in non-pregnant controls and each gestational age of normal pregnant women.
Err bar = standard deviation.
*Values for each gestational age of pregnancy were higher than those for non-pregnant controls with the exception of the 12～15 weeks' gestation ($p < 0.05$ in both cases, unpaired *t*-test).
† Values for both groups (32-35, 36-40) were significant different from those for the other groups (5-11, 12-15, 16-19, 20-23, 24-27 28-31) ($p<0.05$, one-way ANOVA).

Discussion

When malnutrition is accompanied by a prolonged period of inadequate energy intake, active intervention of nutritional support is necessary during pregnancy[1]. With normal intestine function, enteral nutritional

therapy may be a safe and effective method of feeding[9]. Total parenteral nutritional therapy may be an effective method of energy supplementation with or without normal bowel function[1]. For all therapies, it is necessary to determine adequate energy demands to maintain pregnancy and normal fetal growth[1,10].

In general, the management of patients with malnutrition in pregnancy is the same as in non-pregnant patients. The energy expenditure and adjustment of nutrient intake for total parenteral nutrition was estimated using predictive equations[6,7]. These equations of nutrient intake for pregnant woman were calculated according to the body height and weight with experimental adjustment of additional energy[7,8], but the actual nutritional demands during pregnancy have not been clearly established. The objective of this study was to clarify these demands.

Our findings clearly showed that the mean REE divided by BSA increased by about 200 kJ/m^2 at every gestational stage compared with non-pregnant female controls, and especially rose by about 600 kJ/m^2 in the third trimester. In addition, the nutritional demands did not markedly change from 6 to 32 weeks' gestation, but gradually increased after 32 weeks' gestation. These results indicate that the energy demands of pregnant women are different from those of non-pregnant women in all gestational stages, and that the management of pregnant patients with malnutrition should not be the same as for non-pregnant patients. To the best of our knowledge, this study is the first to examine energy expenditure during pregnancy in Japan as assessed by indirect calorimetry. However, our findings must be confirmed by larger studies.

In summary, our preliminary data suggest that the energy demand increases at conception, and does not change in the first or second trimester of pregnancy. These findings may be of therapeutic importance.

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