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Significance of Exercise and Bed Rest in Pregnancy — Pregnancy and walk (1) —

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Prior to evaluate the significance of bed rest in managing of obstetric diseases, characteristics of physiology of pregnant women were exermined on the basis of 24hours heart rate changes in eight pregnant women at the third trimester and also distances covered in walking by a total of 53 multiparas and of 87 primiparas during free-living daily activities were measured by means of a pedometer.

A significantly higher mean heart rate was observed in those pregnant women even during sleep than in non-pregnant control.

The primiparas showed significant decreases in the pedometer readings in all stages except for 15-27weeks of gestation, while the multiparas of less than 28weeks exhibited no decrease as compared with non-pregnant control. The decrease in the pedometer readings were marked in both primiparas and multiparas, the value being much lower than that of any other week of gestation. However, the equation of weight × distance covered in walking remains rather constant throughout gestation.

Key words : Pregnancy, Pedometer, Bed rest, Exercise

The significance of exercise for a healthy life has been widely recognized, but little is known about the physiology of exercise during pregnancy, especially during complicated pregnancy. Animal studies have produced much information on the effect of oxygen consumption during exercise on mothers and fetuses, especially the utero-placental circulation, the effect of a temperature rise due to exercise and the fluctuation in the fetal heart rate in association with those in the maternal oxygen distribution (Hale et al., 1981 ; Lotgering et al., 1983 ; Nelson et al., 1983 ; Wilson and Gisolfi, 1980). However, whether or not these results on quadrupeds are applicable to erecting humans is unknown. It is inappropriate to conduct exercise tests on pregnant women in an attempt to observe resultant hemodynamic changes in the uterus and placenta.

On the other hand, bed rest as well as exercise is one of the effective therapeutic procedures in the obstetrical field ; bed rest is basically recommended in the phase of exacerbation of diseases, while exercise is recommended in the recovery phase. Thus, bed rest is included in the basic regimen for such obstetric disease such as abortion, preterm labor, toxemia of pregnancy, placenta previa and so on, but what bed rest achieves and how helpful the

achievements are remain to be defined. Though the effect of bed rest is commonly assessed in terms of energy expenditure, heart rate and oxygen consumption (Knuttgen and Emerson, 1974; Pernoll, 1975), how the energy saved by bed rest is a subject of great interest. In the present study, we examined the heart rate in pregnant women and changes in the amount of their daily exercise of walking as basic parameters of energy expenditures prior to study the significance of bed rest in obstetric management.

Materials and methods

The present study consisted of three parts. The first part involved 8 pregnant women at the third trimester and 11 non-pregnant controls. Heart rates were monitored during 24hours free-living activities by means of electrocardiogram chest leads with Memory Mac^{R} (Vine) for these subjects. In the second part, Isoxsuprine, a β-mimetic drug used as relaxant for uterine contractions, was administered by a drip infusion in doses of 10mg/500ml of glucose solution/hour to healthy male volunteers for examination of the relationship between oxygen consumption and heart rate in comparison with the data on mental and physical exercise in our previous report (Iwanaga et al., 1988).

The third part included measurement of the pedometer readings during a week in 24 non-pregnant women as a control, a total of 53 multiparas and a total of 87 primiparas by using pedometers and calculation of the daily mean distance covered in walking or pedometer readings in each week of gestation.

Results

The minimum heart rate in 24hours in the pregnant group (63±9bpm) was significantly ($p<0.001$) higher than that in the non-pregnant group (51±4bpm), whereas the maximum heart rate in the former group (130±15bpm) showed no significant difference from that in the latter group. The pregnant group also showed a significantly higher mean heart rate during 24hours (86±10bpm) than that of the control group (74±4bpm; $p<0.01$). Even during sleep, the pregnant group showed a significantly higher heart rate (73±10bpm) than that of the control group (60±5.6bpm; $p<0.01$) as shown in Table 1.

The two males given the β-mimetic drug of Isoxsuprine showed increases in heart rate, but low rates of oxygen consumption, which was represented by a regression line resembling that for mental exercise, $Y=6.67X-192$, rather than physical exercise as seen in Fig. 1.

To determine the actual amount of exercise and/

Table 1 Heart Rates During 24 Hours Of Usual Activity For Pregnant Woman And Non-pregnant Woman

Subjects	Heart rates during 24 hours (bpm) mean	max.	min.	range	sleeping
Pregnant					
1	75	151	51	100	62
2	76	108	56	52	68
3	100	137	71	66	84
4	86	118	65	53	72
5	82	119	60	59	66
6	102	130	80	50	91
7	86	134	60	74	71
8	84	145	63	82	72
mean	86	130	63	67	73
SD	10	15	9	17	10
Non-pregnant					
1	79	118	56	62	65
2	78	155	45	110	54
3	71	143	47	96	56
4	78	120	58	62	67
5	73	128	50	78	61
6	74	169	51	118	55
7	76	134	55	79	67
8	66	139	49	90	55
9	70	110	48	62	54
10	72	122	50	72	59
11	76	112	57	55	64
mean	74	132	51	80	60
SD	4	18	4	21	5
P<	0.01	ns	0.001	ns	0.01

or body activity, we measured the pedometer readings per day in 24 non-pregnant women and a total of 140 pregnant women at various weeks of gestation.

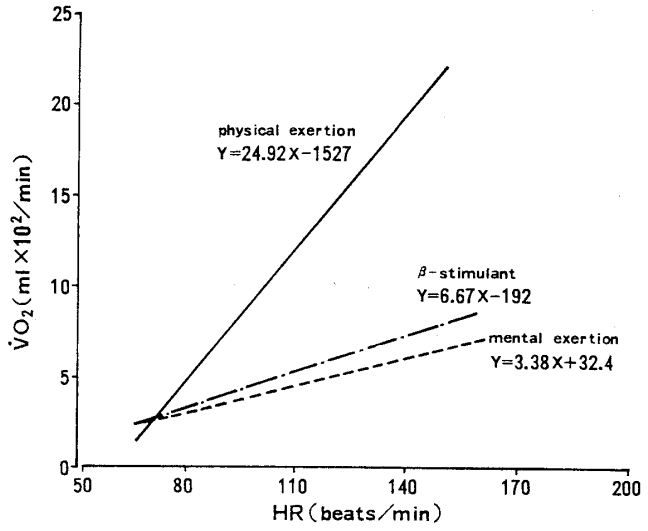

Fig. 1 Comparison of HR-$\dot{V}O_2$ Regression Equation of β-stimulant with Mental and Physical Exertion

As a result, the pedometer readings kept decreasing slightly until the 10th week of gestation, followed by a slow increase to a level similar to that of the non-pregnant controls (Fig. 2). However, the pedometer readings started decreasing in the 25th week of gestation, rapidly from the 36th week. The primiparas showed significant decreases ($p<0.05$) in the pedometer readings in all stages except for the stage of 15 to 27 weeks of gestation, while the multiparas of less than 28 weeks of gestation exhibited no decrease as compared with nonpregnant control. The decrease in the pedometer readings after the 38th week of gestation was marked in both primiparas and multiparas, the value being much lower than that for any other week of gestatios.

Based on the definition of work load, the equation of weight [Kg]×distance [m] covered in walking which was calculated by the pedometer readings × stride length, was used as an exercise index. The

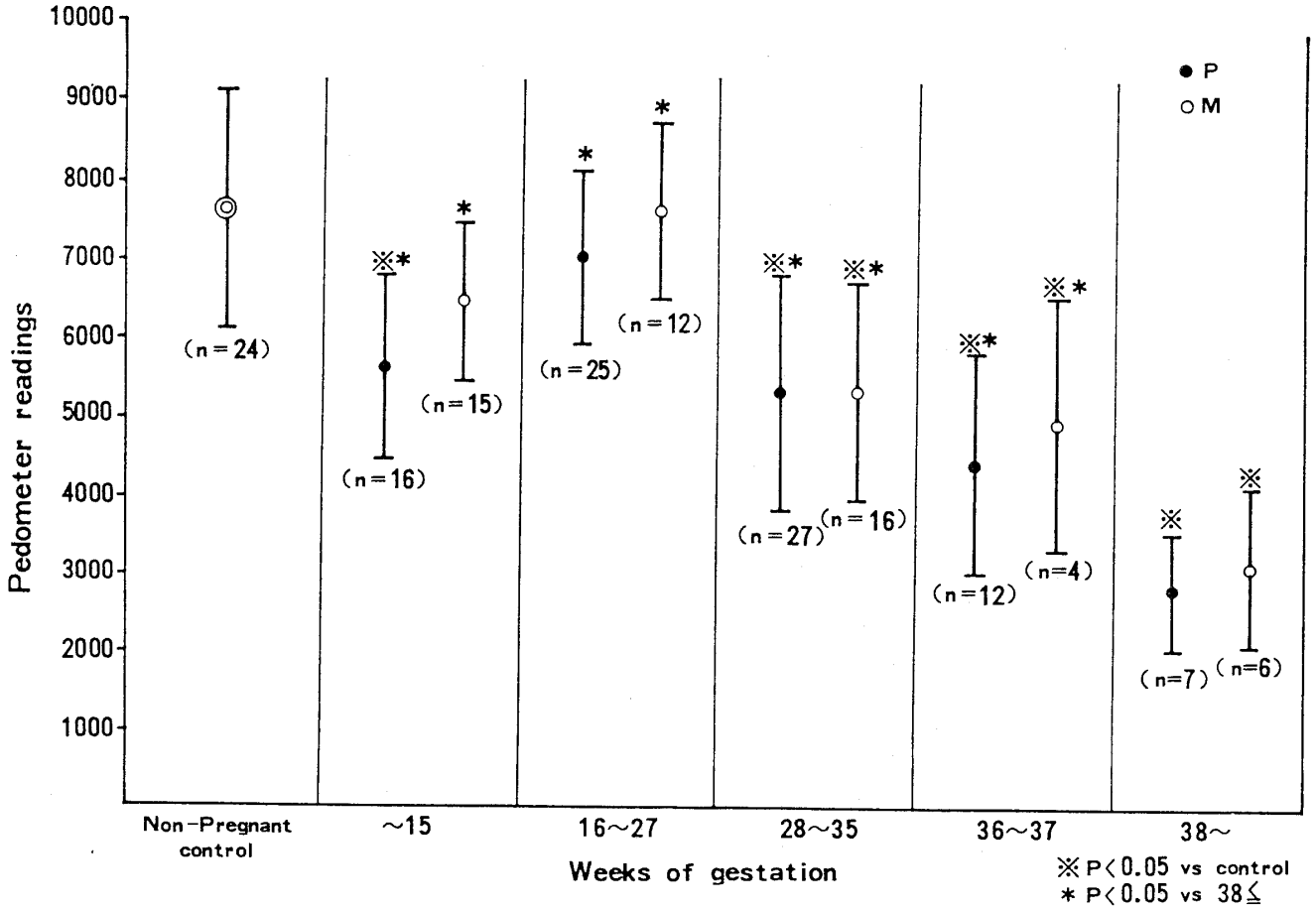

Fig. 2 Pedometer readings during course of pregnancy

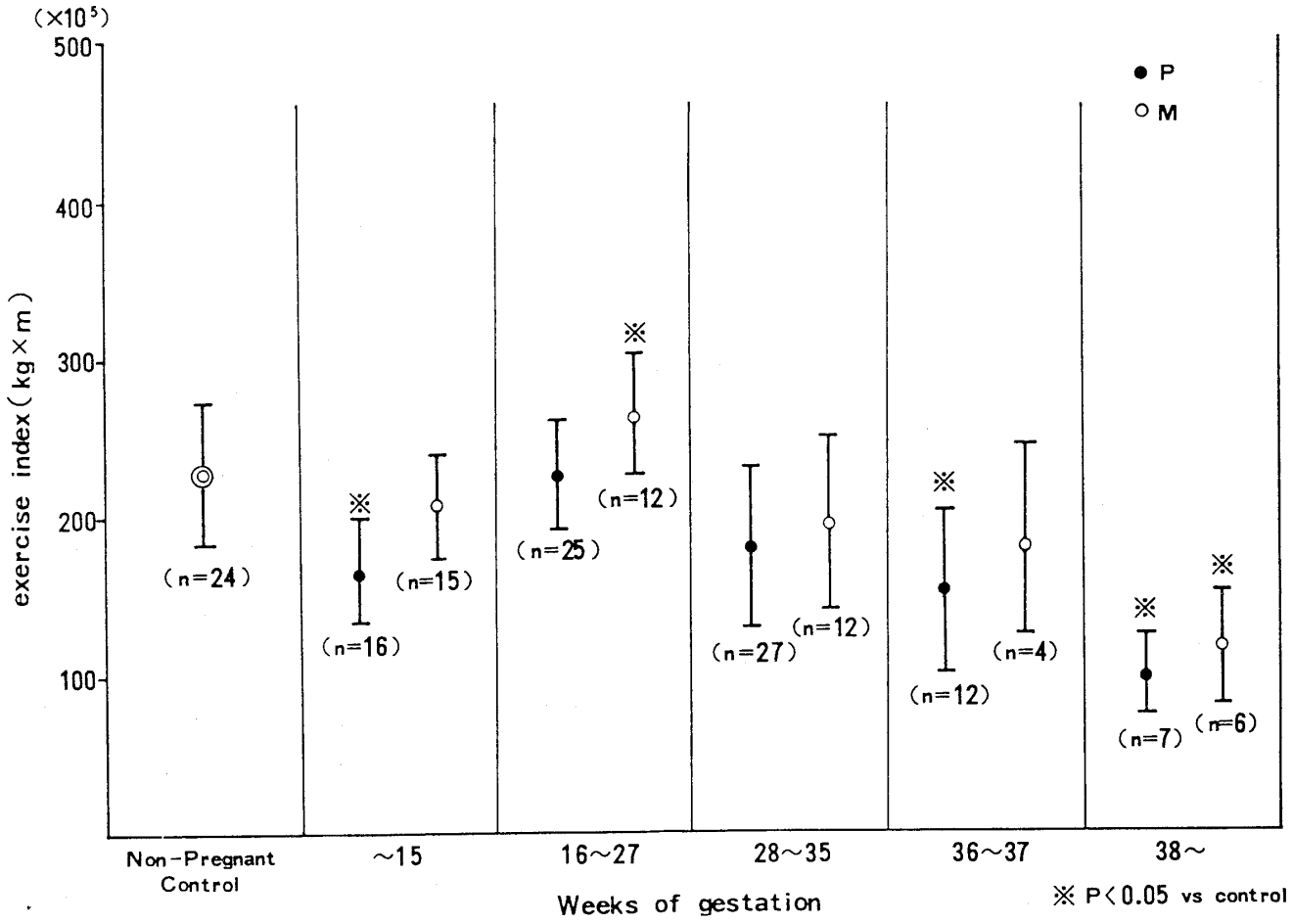

Fig. 3 Change of exercise index during course of pregnancy

primiparas showed significant decreases in the index in the first trimester and at term, compared with the control group as shown in Fig. 3. In contrast, the multiparas exhibited a significant increase in the exercise index at 16-27weeks of gestation, although there was a significant decrease at term.

Discussion

During pregnancy, various hormones including human chorionic gonadotropin (hCG), human placental lactogen (hPL), insulin, thyroid stimulating hormone (TSH) and estrogens and progesteron are secreted in large quantities from the mother and placenta to enhance maternal metabolism directed to nourishing the fetus. Pregnancy is metabolically characterized by the so-called "accelerated starvation" in that both anabolic and catabolic metabolic pathways are activated (Sugawa and Ogita, 1984), and by increased oxygen demands by the increased uterine tissue mass, including the placenta and fetus (Burg et al., 1974 ; Laird-Meeter et al., 1979). In consequence, the maternal cardiac output increases, and the maternal resting oxygen consumption increases near term from 16% to 32% above the nonpregnant values (Pernoll et al., 1975).

Lotgering et al argue that exercise induces slight decreases in the oxygen tension and oxygen content of fetal arterial blood, which are maintained at constant levels by the catecholamine concentration, heart rate, blood pressure, cardiac output, blood flow distribution and blood volume (Lotgering et al., 1983). Such evidence suggested to them that adequate exercise has a positive influence on pregnancy. Kupla et al, who performed a 2.5year prospective study consisting of 141 low-risk pregnant women, reported that recreational athletes showed

no increase in the neonatal morbidity, nor obstetric complications, but improved or maintained their level of aerobic fitness (Kulpa et al., 1987).

More recently. South-Paul et al examined the question of whether pregnancy decreases physical fitness, as measured by maximal oxygen consumption (South-Paul et al., 1988). The exercising group demonstrated greater improvement in aerobic capacity than the control group, manifested by increases in tidal volume and oxygen consumption and stable ventilatory equivalent for oxygen. The pregnancy group did not reduce maximal oxygen consumption between the second and third trimesters of pregnancy. Thus, the adequacy of exercise by pregnant women seemed nearly completely to be determined. Nevertheless, how the amount of exercise by pregnant women basically changes from the pregravidic amount remains unknown.

Energy expenditure is conveniently calculated on the basis of heart rate (Dauncey and James, 1979), which may not be adequate, because the heart rate increases with progress in pregnancy (Iwanaga et al., 1988). The present study has demonstrated a significantly higher mean heart rate in pregnant women than in nonpregnant women. This increase seems to be due to an actual energy demand, rather than a mental factor, as we reported previously, since they showed increased mean heart rate even during sleep. A relaxant of uterine contractions, which was administrated to healthy male volunteers to avoid sexual effects on heart rate, resulted in an increase in the heart rate due to its β_1-mimetic action, but this increase was not associated with oxygen consumption as much as was an increase in the heart rate due to physical exercise.

These results indicate that calculation of the amount of exercise by pregnant women on basis of heart rate is inaccurate as was shown our previous report on heart rate changes in television watching and physical exercise by an ergometer (Iwanaga et al., 1988).

On the other hand, calculation of the amount of exercise from oxygen consumption is time-consuming and is usable only in a limited number of cases. These disadvantages led us to consider the principle of exercise. We examined changes in the amount of exercise and the characteristics of activity in pregnant women during course of pregnancy on the basis of pedometer readings. Although the capacity of the pedometer is limited to detect an exact energy expenditure, the pedometer proved to be a potentially useful device for evaluating the physical activity of a population if its limitations are taken into consideration (Kashiwazaki et al., 1986).

The results showed that in the first trimester of pregnancy, both multiparas and primiparas showed decreases in walking. The decrease in the primiparas was more marked, probably because of emesis gravidarum and vagotonia. This is validated by the fact that walking started increasing toward the second trimester when symptoms of emesis and vagotonia subsided, neither group showing any significant difference from the control group.

It is very difficult to explain the marked decrease in the pedometer readings in the third trimester, especially at term, on the basis of the established factors. It is not clearly accounted for on the basis of any of the changes in the circulatory system, in terms of oxygen consumption and heart rate, hormone system or metabolic system. Turning to the principle of meaning of energy or work load, we proposed the exercise index which involved body $\underline{\text{weight} \times \text{distance}}$ covered in walking. The dimension of the exercise index is expressed as [Kg. m] . Hence, this index reflects an amount of energy which a pregnant woman, whose body weight increased as pregnancy progressed up to about 10kg at term, needed to move by walking in a day. In the present study, we noticed that the pregnant women continued to maintain practically constant levels of the index until term. A Similar result was obtained by Illingworth et al (1987). They measured energy expenditure in seven primigravid women during pregnancy by direct calorimetry and found that the

resting metabolic rate increased steadily during pregnancy but when expressed per unit of body weight no change was found. These findings suggested a possible maternal adaptation to increase energy efficacy at a time when the energy demands of the fetus are high. But the decrease in the exercise index in the third trimester depends largely on a decrease in walking. A most reasonable explanation seems to lie in the difficulty in walking because of a changing body shape due to an engorging uterus in the abdomen. A descending fetal presenting part and/or an increased uterine contractility may be additional factors at term. It is thus highly likely that a decrease in exercise by pregnant women in the third trimester is due to a changed body shape. No reports has been considered of thus anatomically deformed shape of pregnant women whose abdominal aorta and vena cava were compressed by the uterus. In this meaning, exercise and bed rest also should be reconsidered of energy expenditure from a point of characteristic anatomical and postural changes which involved changes in circulatory system.

In relation to the effect of bed rest on the exercise index, the amount of saved energy is very large at absolute bed rest, since the distance covered in walking is zero. However, the effect of redistribution of the blood flow in organs, especially in the uterus and placenta, due to lying posture at bed rest may be more significant for healing obstetric diseases than that of energy-saving. Further investigation of the significance of exercise as well as bed rest should be performed in consideration of anatomically and circulatory changed body shape of pregnant women.

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