Recent Trend of the Decrease in Mean Birthweights of Infants in the Western Provinces of Gifu Prefecture, Japan

Atsushi Hioki

The mean birthweight has decreased recently in Japan. The author assessed the etiology of this trend by comparing the birthweight during the years 1983-1984 and 1993-1994 in Central Japan. All birth certificates of 3767 and 3423 infants were available for 1983-1984 and 1993-1994, respectively. The mean birthweight decreased from 3165 g to 3128 g. The proportion of first infants whose mean birthweight decreased more than that of the other infants increased from 41.0% to 47.1%. Comparison and multivariate analysis revealed the main cause of decreased birthweight as a decrease of the mean birthweight of first infants and changes of the proportion of birth order. Influences of the increases in the proportion of multiple births and that of low birthweight infants to the decrease of mean birthweight were small. The mean birthweight of infants who were born in public hospitals was lower than that of infants born in clinics, private hospitals, and others. The proportion of low birthweight infants was also highest among the infants born in public hospitals. These results indicate that pregnant women with high risk factors are more likely to be referred to the care of public hospitals. *J Epidemiol*, 1997; 7 : 232-237.

birthweight, infant, birth certificate, birth order, birth place

According to vital statistics in Japan, the mean birthweight of infants has decreased gradually, from 3.24 kg for males and 3.15 kg for females at peak in 1975 to 3.20 kg and 3.12 kg in 1985, and 3.12 kg and 3.04 kg in 1994¹. However, the reasons for these trends are not obvious. It is reported that low birthweight results from preterm delivery or intrauterine growth retardation^{2,3}. Several studies revealed that infant's sex, maternal age, marital status, ethnicity, education, current employment, smoking, maternal height, maternal pre-pregnancy weight, gestational weight gain, parity, previous stillbirth, alcohol consumption, inadequate nutrition during gestation, and socioeconomic status are associated with variations in intrauterine growth retardation^{4,5}. Risk factors for preterm birth include ethnicity, single marital status, low socioeconomic status, previous low birthweight or preterm delivery, multiple second trimester spontaneous abortions, in vitro fertilization pregnancy, placental abnormalities, gestational bleeding, cervical and uterine anomalies, multiple gestations, and smoking⁶. Pregnant Japanese women are counseled not to become overweight to prevent toxemia of pregnancy^{7,8}, so the birthweight of infants may become a little lighter. The author assumed that the decrease of the mean birthweight of infants

resulted from (1) an increase in the multiple pregnancy rate, (2) an increase in the proportion of live births of low birthweight infants (LBWI), (3) an increase in the proportion of first children whose birthweight is lighter than that of the others, (4) a decrease in postterm labor, and (5) health/dietary guidance to prevent toxemia of pregnancy. The author attempted to clarify the determinants of the decrease in mean birthweight of infants and the consequent need for public health services.

METHODS

Ibi-Motosu district, the area of this study, is located in the western provinces of Gifu Prefecture, central Japan. This district consists of residential towns, depopulated villages and intermediate towns. In 1994, this district had a population of 160,000 in a 10596 km² area. The birth rate in 1994 in this district was 10.7 per thousand population, a little higher than that in Japan (10.0)⁹.

Birth certificate data (only livebirths) in this district from all 3767 and 3423 births during 1983-1984 and 1993-1994, respectively, were checked for mother's age at delivery, marital status, nationality, multiplicity, live birth order, past history of abortion or stillbirth, birth place, gestational age, infant sex, and birth-

Received January 10, 1997; accepted March 21, 1997.

Medical Treatment Management Division, Public Health and Environment Department, Gifu Prefectural Government, Gifu, Japan. Formerly: Gifu Prefectural Ohno Public Health Center, Gifu, Japan.

Address for correspondence: Atsushi Hioki, Medical Treatment Management Division, Public Health and Environment Department, Gifu Prefectural Government, Gifu, 500-70 Japan.

weight. Birth place was categorized into clinics, private hospitals, public hospitals, midwifery home, home, and others^{11,12}. In Japan, clinics and hospitals are defined as medical institutions with fewer than 20 beds and those with 20 beds or more, respectively. In many cases, public hospitals have more equipment and more staff. Gestational age is expressed as full weeks of pregnancy based on the date of first day of mother's last menstrual period according to the International Classification of Diseases, Ninth Revision (ICD-9). No information was collected about the use of cesarean section from birth certificate data.

Firstly, percentage distributions of birthweight, mean birthweight, and proportion of LBWI were compared on all births data between the periods 1983-1984 and 1993-1994 by nationality of parents, multiplicity, past history of abortion or stillbirth, and infant sex. They were analyzed by χ^2 test in contingency tables, non-paired *t* test, and by one-way analysis of variance (ANOVA), followed by Dunnett's *t*-test when a difference was found by ANOVA. The influences of the changes in the percentage distribution and mean birthweight of each category on the decrease of mean birthweight were also determined.

Next, mean birthweight of single birth infants whose parents were both Japanese (3732 and 3351 infants in 1983-1984 and 1993-1994, respectively) were calculated by gestational age and live birth order in 1983-1984 and 1993-1994. This study analyzed data on infants whose parents were both Japanese to exclude the influence of race on birthweight^{13,14}. Data on illegitimate infants (9 infants in 1983-1984 and 14 in 1993-1994) are not included in the analysis because the nationality of their fathers are unknown. Mean birthweights were compared by

ANOVA followed by Dunnett's *t*-test.

Stepwise regression analyses (*F*-to-enter = 4.000, *F*-to-remove = 3.996) were performed jointly and separately for both periods to estimate the factors affecting infant birthweight on the data of single birth infants whose parents were both Japanese. Birthweight was used as the dependent variable, and maternal age, past history of fetal death, gestational age, infant sex, birth order, and period of birth were the independent variables. In the analysis, scores for mother's age were assigned separately for age class as follows: <20 years, 20-34 years and ≥35 years (yes = 1, no = 0, respectively).

To investigate the perinatal medical care system characteristics, mean birthweight, percentage distributions of birthweight and gestational age were compared by birth place on the data of single birth infants whose parents were both Japanese, using ANOVA followed by Dunnett's *t*-test and χ^2 test.

RESULTS

The mean birthweight ($\pm$ SD) of all infants decreased from 3165 ($\pm$ 429) g in 1983-1984 to 3128 ($\pm$ 435) g in 1993-1994 ($p < 0.001$; Table 1). The overall incidence of LBWI (<2500 g) was 5.1% in 1983-1984 and 6.1% in 1993-1994 (not significantly different); however, the incidence of very low birthweight infants (<1500 g) increased from 0.2% to 0.5% ($p < 0.05$). Fig. 1 shows the birthweight distribution in 1983-1984 and 1993-1994. The distribution curve of birthweights between 3000 g and 4000 g shifted downward in 1993-1994 compared to 1983-1984. The incidence of multiple pregnancy

Table 1. Characteristics of all births in 1983-1984 and 1993-1994 in the western provinces of Gifu Prefecture, Japan.

	Number (%)		Mean ($\pm$ SD) birthweight (g)		Proportion of LBWI* (%)	
	1983-1984	1993-1994	1983-1984	1993-1994	1983-1984	1993-1994
Nationality of parents						
Both Japanese	3758 (99.8)	3392 (99.1) [†]	3166 $\pm$ 429	3128 $\pm$ 435 [‡]	5.1	6.1
≥1 Foreigner	0 (0.0)	17 (0.5) [‡]	—	3118 $\pm$ 515	—	11.8
Unmarried Japanese	9 (0.2)	14 (0.4)	2942 $\pm$ 419	3147 $\pm$ 327	11.1	0.0
Multiplicity						
Single	3741 (99.3)	3382 (98.8) [†]	3170 $\pm$ 424	3135 $\pm$ 429 [‡]	4.8	5.7
Multiple	26 (0.7)	41 (1.2) [‡]	2426 $\pm$ 511	2528 $\pm$ 446	53.8	39.0
Past history of abortion or stillbirth						
With	42 (1.1)	36 (1.1)	2982 $\pm$ 542	3053 $\pm$ 672	16.7	13.9
Without	3725 (98.9)	3385 (98.9)	3167 $\pm$ 427	3128 $\pm$ 431 [‡]	5.0	6.0
Infant sex						
Male	1904 (50.5)	1768 (51.7)	3212 $\pm$ 440	3168 $\pm$ 436 [‡]	4.3	5.7
Female	1863 (49.5)	1655 (48.3)	3117 $\pm$ 412	3085 $\pm$ 429 [†]	5.9	6.5
Total	3767 (—)	3423 (—)	3165 $\pm$ 429	3128 $\pm$ 435 [‡]	5.1	6.1

* Low birthweight infants. [†] $p < 0.05$; [‡] $p < 0.01$; [§] $p < 0.001$ vs. 1983-1984

Table 2. Mean birthweight $\pm$ SE (number) of infants by gestational age in 1983-1984 and 1993-1994, (single births whose parents were both Japanese)

Sex		≤ 36 weeks	37 weeks	38 weeks	39 weeks	40 weeks	41 weeks	≥ 42 weeks
Male	1983-1984	2463 $\pm$ 67 (76)	2984 $\pm$ 34 (138)	3125 $\pm$ 19 (356)	3249 $\pm$ 16 (543)	3339 $\pm$ 17 (474)	3374 $\pm$ 27 (220)	3451 $\pm$ 47 (71)
	1993-1994	2268 $\pm$ 71 [†] (62)	2866 $\pm$ 35* (99)	3064 $\pm$ 19* (320)	3211 $\pm$ 16 (536)	3292 $\pm$ 17 (501)	3354 $\pm$ 30 (171)	3237 $\pm$ 74 (39)
Female	1983-1984	2485 $\pm$ 65 (61)	2882 $\pm$ 38 (102)	3019 $\pm$ 22 (274)	3114 $\pm$ 15 (596)	3227 $\pm$ 16 (523)	3252 $\pm$ 27 (222)	3271 $\pm$ 36 (76)
	1993-1994	2025 $\pm$ 115 [‡] (39)	2895 $\pm$ 36 (76)	2987 $\pm$ 19 (287)	3113 $\pm$ 17 (499)	3175 $\pm$ 16* (468)	3255 $\pm$ 28 (216)	3272 $\pm$ 56 (34)

* $p < 0.05$; [†] $p < 0.01$; [‡] $p < 0.001$ vs. 1983-1984**Table 3.** Mean birthweight $\pm$ SE (number) of infants by gestational age and live birth order, (single births whose parents were both Japanese)

	Birth order	≤ 36 weeks	37-39 weeks	40-41 weeks	≥ 42 weeks	Total
1983-1984	1st child	2429 $\pm$ 84 (57)	3061 $\pm$ 14 (745)	3241 $\pm$ 15 (657)	3310 $\pm$ 40 (75)	3127 $\pm$ 11 (1534)
	2nd child	2529 $\pm$ 59 (39)	3145 $\pm$ 13 (855)	3307 $\pm$ 16 (514)	3377 $\pm$ 51 (48)	3185 $\pm$ 11 (1476)
	≥ 3 rd child	2432 $\pm$ 128 (21)	3170 $\pm$ 19 (409)	3378 $\pm$ 26 (268)	3471 $\pm$ 90 (24)	3236 $\pm$ 16 (722)
	Total	2473 $\pm$ 47 (137)	3119 $\pm$ 9 (2009)	3290 $\pm$ 10 (1439)	3358 $\pm$ 30 (147)	3171 $\pm$ 7 (3732)
1993-1994	1st child	2098 $\pm$ 96 (50)	3016 $\pm$ 13 (794)	3205 $\pm$ 13 (697)	3327 $\pm$ 58 (39)	3078 $\pm$ 11 (1581)
	2nd child	2294 $\pm$ 99 (34)	3164 $\pm$ 12 (890)	3287 $\pm$ 19 (456)	3325 $\pm$ 107 (20)	3178 $\pm$ 12 (1235)
	≥ 3 rd child	2158 $\pm$ 141 (17)	3049 $\pm$ 31 (133)	3344 $\pm$ 27 (203)	3504 $\pm$ 116 (14)	3205 $\pm$ 19 (535)
	Total	2174 $\pm$ 63 (101)	3091 $\pm$ 9 (1817)	3253 $\pm$ 10 (1356)	3360 $\pm$ 48 (73)	3135 $\pm$ 7 (3351)
Mean difference	1st child	-332 [‡]	-45*	-36	+17	-49 [†]
	2nd child	-235 [†]	+19	-20	-52	-6
	≥ 3 rd child	-274*	-121 [†]	-35	+34	-31
	Total	-299 [‡]	-28*	-37*	+2	-36 [‡]

* $p < 0.05$; [†] $p < 0.01$; [‡] $p < 0.001$ vs. 1983-1984**Fig 1.** Distribution of birth weight of all infants during the periods 1983-1984 (●) and 1993-1994 (○).

was 0.35% in 1983-1984 and 0.59% in 1993-1994 (not significant), but the proportion of multiple birth infants increased sig-

nificantly from 0.69% to 1.20% ($p < 0.05$; Table 1). The mean birthweight of multiple birth infants tended to increase in 1993-1994 (not significant). Mean gestational ages ($\pm$ SD) were 39.15 ($\pm$ 1.59) weeks in 1983-1984 and 39.13 ($\pm$ 1.57) weeks in 1993-1994 (not significant). The proportion of postterm labor (≥ 42 weeks' gestation) decreased from 3.9% in 1983-1984 to 2.3% in 1993-1994 ($p < 0.001$). The proportion of preterm infants (< 37 weeks' gestation) was not significantly different: 3.8% in 1983-1984 and 3.1% in 1993-1994. The proportion of very preterm births (< 32 weeks' gestation) was 0.4% for both time periods. The mean age ($\pm$ SD) of mothers increased from 27.3 ($\pm$ 3.6) years old in 1983-1984 to 28.0 ($\pm$ 3.9) years old in 1993-1994 ($p < 0.001$). The proportion of mothers 30 years old and over increased significantly in 1993-1994 ($p < 0.001$). The proportion of parents at least one of whom was foreign increased in 1993-1994. The proportion of first child increased from 41.0% in 1983-1984 to 47.1% in 1993-1994 ($p < 0.001$). The percentage of pregnant women with past history of abor-

Table 4. Results of stepwise regression analysis with birthweight as the outcome and maternal age, past history of fetal death, gestational age, infant sex, birth order, and period of birth as explanatory variables on the data of single births whose parents were both Japanese.

Independent variables	Partial regression coefficient	SE	Standardized regression coefficient	P value
Mother <20 years old	-107.880	53.188	-0.021	0.0426
Gestational age (weeks)	126.186	2.860	0.460	0.0001
Male	106.282	8.889	0.125	0.0001
First infant	-110.187	9.003	-0.128	0.0001
1993-1994	-28.502	8.906	-0.033	0.0014
Intercept	-1778.95	-	-	-
R	0.485	-	-	0.0001

Table 5. Numbers (%) of infants (single births whose parents were both Japanese) by birthweight and birth place.

Birth place	1983-1984					1993-1994				
	<1500 g	1500-2499g	2500-3999g	≥4000g	χ^2 test	<1500 g	1500-2499g	2500-3999g	≥4000g	χ^2 test
Clinic	3 (0.1)	100 (4.3)	2167 (92.8)	64 (2.7)	NS	3 (0.1)	104 (4.7)	2062 (93.0)	48 (2.2)	†
Private hospital	0 (0.0)	13 (2.9)	426 (94.7)	11 (2.4)	NS	0 (0.0)	12 (3.5)	326 (93.9)	9 (2.6)	NS
Public hospital	1 (0.1)	56 (7.1)	705 (89.9)	22 (2.8)	*	14 (1.9)	54 (7.3)	657 (88.4)	18 (2.4)	††
Midwifery home	0 (0.0)	3 (1.9)	148 (93.1)	8 (5.0)	NS	0 (0.0)	3 (8.6)	31 (88.6)	1 (2.9)	NS
Others	1 (20.0)	0 (0.0)	4 (80.0)	0 (0.0)	-	0 (0.0)	0 (0.0)	9 (100.0)	0 (0.0)	-
Total	5 (0.1)	172 (4.6)	3450 (92.4)	105 (2.8)	-	17 (0.5)	173 (5.2)	3085 (92.1)	76 (2.3)	‡

NS, not significant; * $p < 0.01$; † $p < 0.001$ vs. other place; ‡ $p < 0.05$; †† $p < 0.01$ vs. 1983-1984

tion or stillbirth was 1.1% for both periods. Mean birthweight of infants from mothers with this past history tended to increase in 1993-1994 although that of infants from mothers without the history decreased significantly ($p < 0.001$). Proportion of LBWI from mothers with the history tended to decrease in 1993-1994. Influences of household business status on the mean birthweight were not recognized (data not shown).

Table 2 shows the mean birthweights of single birth infants whose parents were both Japanese by gestational age in 1983-1984 and 1993-1994. According to these data, mean birthweight in 1993-1994 tended to be lower than that at the corresponding age in 1983-1984 especially in lower gestational age male infants. The mean birthweight of infants who were born before 37 weeks decreased markedly. Table 3 shows mean birthweight of single birth infants whose parents were both Japanese by gestational age group and live birth order. The mean birthweight of first infants decreased significantly in 1993-1994 compared to 1983-1984 ($p < 0.01$). The mean birthweights of infants decreased significantly in first infants who were born before 40 weeks, in second infants born before 37 weeks, and in third infants born before 40 weeks ($p < 0.05$). The mean ages of mothers of first, second and third infants increased significantly from 25.4, 27.8 and 30.4 years old in 1983-1984 to 26.3, 28.7 and 31.2 years old in 1993-1994, respectively ($p < 0.01$). The mean birthweight of male infants

and, especially, of male first children decreased significantly in 1993-1994 compared to 1983-1984 ($p < 0.01$). The mean gestational age of second children was lower than that of first children except for male infants born in 1993-1994. Mean gestational age was higher in female infants than in male infants ($p < 0.05$). Mean gestational age of first infants tended to decrease in 1993-1994.

Table 4 shows the results of stepwise regression analysis. Gestational age was the leading determinant factor in all analyses. Male infant were positively related to the birthweight. First infant, birth in 1993-1994 and young mother (<20 years old) were negatively associated with birthweight.

Table 5 shows the distribution of birthweight of infants by birth place. The proportion of LBWI was higher in the infants who were born in public hospitals than in those born in clinics, private hospitals, and other places in both 1983-1984 and 1993-1994. The proportion of very low birthweight infants who were born in public hospitals increased significantly in 1993-1994. The mean birthweight of infants born in public hospitals was the lowest of all infants when compared with births in clinics, private hospitals, and other places. Mean birthweight of infants who were born in public hospitals decreased 56 g for males and 52 g for females in 1993-1994, and mean gestational age of those decreased 0.1 week for male and female infants in 1993-1994. Table 6 shows the distribu-

Table 6. Numbers (%) of infants (single births whose parents were both Japanese) by gestational age and birth place.

Birth place	1983-1984				1993-1994			
	≤36 weeks	37-41 weeks	≥42 weeks	χ^2 test	≤36 weeks	37-41 weeks	≥42 weeks	χ^2 test
Clinic	85 (3.6)	2164 (92.7)	85 (3.6)	NS	48 (2.2)	2116 (95.6)	49 (2.2)	*†
Private hospital	11 (2.4)	405 (90.0)	34 (7.6)	*	4 (1.2)	338 (97.4)	5 (1.4)	†
Public hospital	38 (4.8)	722 (92.1)	24 (3.1)	NS	48 (6.5)	679 (91.4)	16 (2.2)	*
Midwifery home	2 (1.3)	153 (96.2)	4 (2.5)	NS	1 (2.9)	32 (91.4)	2 (5.7)	NS
Others	1 (20.0)	4 (80.0)	0 (0.0)	-	0 (0.0)	8 (88.9)	1 (11.1)	-
Total	137 (3.7)	3448 (92.4)	147 (3.9)	-	101 (3.0)	3173 (94.8)	73 (2.2)	†

NS, not significant, * $p < 0.001$ vs. other place, † $p < 0.001$ vs. 1983-1984

tion of gestational age of births by birth place. The proportion of preterm infants was significantly higher in the infants who were born in public hospitals than in those born in clinics, private hospitals, and other places in 1993-1994.

DISCUSSION

Low birthweight generally results from preterm delivery or intrauterine growth retardation^{2,3}. The mean birthweight of infants decreased in 1993-1994 compared to 1983-1984 although the mean gestational ages changed little (from 39.15 weeks to 39.13 weeks). The rate of birthweight increase was 62-113 g per week from 39 weeks to 40 weeks. According to these data, the mean birthweight in 1993-1994 should be less than 3 g lighter than that in 1983-1984, although the mean birthweight in 1993-1994 was 37 g lighter than that in 1983-1984. And, the mean birthweight for each gestational week was mostly lower in 1993-1994 than in 1983-1984. From these results, it is suggested that the decrease of birthweight in 1993-1994 is related to intrauterine growth retardation.

The mean birthweight of infants in Japan was 3.17 kg in 1983 and 1984, 3.09 kg in 1993, and 3.08 kg in 1994¹⁰. The degree of decrease in the mean birthweight was smaller in the studied area than that in Japan as a whole. The percentage of LBWI in Japan was 5.4% in 1983 and 1984, 6.8% in 1993, and 7.1% in 1994. The percentage of LBWI in the studied area was lower than in Japan. As for distribution of birth place, 55.7% were born in hospitals and 43.2% in clinics in 1994 in Japan. More infants were born in clinics in the studied area than in Japan, because the number of hospital beds for pregnant women are fewer than that of clinic beds in the studied area.

The main causes of the mean birthweight decrease in this study were decreases in the mean birthweight of first infants and changes of the proportion of birth order. In Japan, the number of children per couple is decreasing; the total fertility rate has decreased from 1.91 in 1975, to 1.76 in 1985, and 1.50 in 1994¹⁶. In addition, the proportion of high-risk pregnancy, such as higher mother's age, induction of ovulation, medical treat-

ment for sterility, and conditions that need cesarean section, is increasing because many couples want at least one child by any means. In this study, the mean age of mothers increased in 1993-1994, and 20.7% of mothers aged 35 years and over were primiparous. Recently, more women are likely to delay marrying and childbearing. It is reported that advancing maternal age (>35 years) is a risk factor for fetal death¹⁷. This study, however, is constrained by the fact that it is based on data appearing on the birth certificate, and this does not include the important variables such as maternal smoking. The increase in the proportion of female smoker under 39 years of age¹⁸ may be one factor contributing to the decrease of mean birthweight. Influences of decrease in energy intake and those of occupational activity during pregnancy¹⁹ also must be studied.

The proportion of very low birthweight infants increased in 1993-1994. Many of the very low birthweight infants now survive because neonatal intensive care is available, especially in large public hospitals. However, the effects of very low birthweight when these infants become adults are unknown^{20,21}. The lower mean birthweight of infants who were born in public hospitals indicates that pregnant women with higher risk factors are more likely to be referred to the care of large public hospitals with appropriate equipment. In addition, infants with greater risk factors such as very low birth weight and very preterm birth are now transferred immediately to neonatal intensive care units in Prefectural Gifu Hospital. Efforts of the mothers with greater risk factors to have at least one child may explain part of the increase of the ratio of very low birthweights. As for programs to prevent preterm births and low birthweight, health counseling for pregnant women is offered^{16, 22-24}. Health counseling for pregnant women with high-risk factors should be strengthened because most pregnant women in Japan use maternity health services.

The proportion of multiple birth infants increased in 1993-1994. The result is consistent with the trends in Japan²⁵ based on the increased use of assisted reproductive technologies. Infants of multiple gestations are more likely to be premature and likely to be low weight than single birth infants. However,

the mean birthweights of multiple birth infants tended to increase in 1993-1994. These results indicate the contribution of medical care and health services for pregnant women.

Changes of percentage distribution of birth place over the 10-year period reflect the trends that most pregnant women are placed under management by obstetricians, primarily in clinics and secondarily in large public hospitals although pregnant women can consult directly for secondary hospitals in Japan. The ratio of nonhospitalized births in Japan decreased from 82.4% in 1955 to 16.0% in 1965, 1.2% in 1975, 0.2% in 1985, and 0.1% in 1994¹⁸. The ratio of births at midwife homes in Japan also decreased from 12.9% in 1965 to 7.2% in 1975, 2.0% in 1985, and 0.9% in 1994.

As for gestational age, the percentage of births at less than 38 weeks and 42 weeks or more decreased in 1993-1994. These results also indicate the effects of medical management. Decrease of the percentage of postterm labor contributes to the decrease in mean birthweight. The author interpreted that the decrease of postterm labor is a result of active management of labor for highly postterm pregnant women²⁰.

The decrease of the mean birthweight of infants resulted mainly from the decrease of the mean birthweight of first infants, some of whom were born to mothers with risk factors. Antenatal health guidance to prevent toxemia of pregnancy and medical induction of delivery to avoid postterm labor or cesarean section as an iatrogenic effect may contribute to the decrease in the mean birthweight.

REFERENCES

- Ministry of Health and Welfare, Japan. Vital Statistics of Japan, 1994, Volume 2. Health and Welfare Statistics Association, Tokyo, 1996: 116-232.
- Villar J, Belizan JM. The relative contribution of prematurity and fetal growth retardation to low birth weight in developing and developed societies. *Am J Obstet Gynecol*, 1982; 143: 793-798.
- Kramer MS. Determinants of low birth weight: methodological assessment and meta-analysis. *Bull WHO*, 1987; 65: 663-737.
- Fedrick J, Adelstein P. Factors associated with low birth weight of infants delivered at term. *Br J Obstet Gynaecol*, 1978; 85: 1-7.
- Eisner V, Brazier JV, Pratt MW, Hexter AC. The risk of low birth weight. *Am J Public Health*, 1979; 69: 887-893.
- Simpson WJ. A preliminary report on cigarette smoking and the incidence of prematurity. *Am J Obstet Gynecol*, 1957; 73: 808-815.
- Fox SH, Koepsell TD, Daling JR. Birth weight and smoking during pregnancy - effect modification by maternal age. *Am J Epidemiol*, 1994; 139: 1008-1015.
- Berkowitz GS, Papiernik E. Epidemiology of preterm birth. *Epidemiol Rev*, 1993; 15: 414-443.
- Naeye RL. Weight gain and outcome of pregnancy. *Am J Obstet Gynecol*, 1979; 135: 3-9.
- Takeda S, Saitoh M, Kinoshita K, Sakamoto S. Studies of diet management and insulin resistance in obese pregnant women. *Acta Obstet Gynecol Jpn*, 1992; 44: 229-236.
- Ministry of Health and Welfare, Japan, ed. Byoin Yoran, 1983 [Hospital directory in Japan, 1983]. Igaku-shoin, Tokyo, 1983; pp.5-368.
- Ministry of Health and Welfare, Japan, ed. Byoin Yoran, 1993 [Hospital directory in Japan, 1993]. Igaku-shoin, Tokyo, 1993: 1-569.
- Lieberman E, Ryan KJ, Monson RR, Schoenbaum SC. Risk factors accounting for racial differences in the rate of premature birth. *N Engl J Med*, 1987; 317: 743-748.
- Kleinman JC, Kessel SS. Racial differences in low birth weight. *N Engl J Med*, 1987; 317: 749-753.
- Singh GK, Yu SM. Birthweight differentials among Asian Americans. *Am J Public Health*, 1994; 84: 1444-1449.
- Mothers' and Children's Health and Welfare Association. Maternal and Child Health Statistics of Japan, 1995. Mothers' and Children's Health Organization, Tokyo, 1996: 18-132.
- Fretts RC, Schmittiel J, McLean FH, Usher RH, Goldman MB. Increased maternal age and the risk of fetal death. *N Engl J Med*, 1995; 333: 953-957.
- Nishimura C, Nakayama T, Nakayama N, Tsuguma H, Suzuki R. Time-trends of smoking habit by age, sex and birth year - Observations among participants in mass screening for lung cancer in Osaka, Japan. *Jpn J Public Health*, 1996; 43: 1063-1067.
- Matsuda S, Sone T, Doi T, Kahyo H. Secular changes of the mean birth weight and the mean gestational day at an obstetric clinic in Naha. *Jpn J Hyg*, 1990; 45: 665-679.
- McCormick MC. The contribution of low birth weight to infant mortality and childhood morbidity. *N Engl J Med*, 1985; 312: 82-90.
- Breslau N. Psychiatric sequelae of low birth weight. *Epidemiol Rev*, 1995; 17: 96-106.
- Gortmaker SL. The effects of prenatal care upon the health of the newborn. *Am J Public Health*, 1979; 69: 653-660.
- Rautava P. The Finnish family competence study: characteristics of pregnant women with low child birth knowledge. *Soc Sci Med*, 1989; 29: 1105-1109.
- Alexander GR, Mor JM, Kogan MD, Leland NL, Kieffer E. Pregnancy outcomes of US-born and foreign-born Japanese Americans. *Am J Public Health*, 1996; 86: 820-824.
- Frigoleto FD Jr, Lieberman E, Lang JM, Cohen A, Barss V, Ringer S, et al. A clinical trial of active management of labor. *N Engl J Med*, 1995; 333: 745-750.