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BODY WEIGHT AT BIRTH AND INCIDENCE OF LOW-WEIGHT BABIES IN CALCUTTA (INDIA)

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SUMMARY

Birth weight and distribution of births by weight-group have been studied for 5117 single livebirths. The data were collected from the Ramakrishna Mission Seva Pratisthan (Hospital), Calcutta.

Mean birth weight is 2587.6 $\pm$5.8 g. and the incidences of the low-weight babies (weighing 2500 g. or less) account for 46.5 % cases. The male babies have in general significantly higher mean weight, but this is true only for the high-weight babies.

Among the pre-term births the occurrences of the low-weight babies are significantly higher, while in the term births the incidences of high-weight infants are significantly greater. Gestation time shows statistically the strongest relation with mean weight.

The babies of the poor mothers present the lowest mean birth weight which generally differs significantly from that of the babies of either the moderately well-off or the well-off mothers. But such difference in mean weight is statistically non-significant for the low-weight babies, irrespective of socioeconomic condition of their mothers.

The babies of the teenage adolescent mothers (19 yrs. and below) form a distinct group in presenting significant difference in mean birth weight from the rest of the babies, irrespective of their mother's age. Among these teenage mothers the low-weight babies occur significantly more. In contrast, the young (20—24 yrs) and the adult (25—29 yrs) mothers have significantly more high-weight babies.

The infants of the birth order 2 register the highest mean birth weight which varies significantly from all other mean weights, irrespective of birth order. It is only in the birth order 2/3 the relative incidences of the high-weight babies are found to occur significantly more.

The babies born in the summer season (March, April and May) are observed to offer the largest mean weight which significantly differs only from that of the babies born in the winter season (December, January and February). This is true for the high-weight babies only.

The regression coefficients indicate that the birth weight increases by 2.36 g. with each week of gestation time and again, by 4.25 g. when the mother's age increases by a year.

The low-weight babies are thus found to be (i) mostly pre-term, (ii) mostly female, (iii) borne more by the poor mothers, (iv) borne mostly by the teenage adolescent mothers, (v) mostly of either the birth order 1 or of order 4+, and (vi) delivered mostly in the season of monsoon (June, July and August).

INTRODUCTION

Birth weight and perinatal mortality have been accepted as two useful measures of reproductive efficiency. It has already been established that where environmental conditions are less favourable, perinatal mortality rates increase and birth weights happen to be lower at all stages of gestation. A number of unfavourable factors like malnutrition, low economic position, infections, hard labour, bad housing etc. has been held responsible for causing deterioration in general health of the mothers and loss of reproductive efficiency (WHO: 1961). In the study of the problem of expressed variations in birth weight of human infants importance of some of the biological factors like length of gestation, birth order (parity), parental/maternal age and stature, sex of baby etc. has also been emphasised in a number of interesting research works (Banerjee and Roy: 1962; Banerjee: 1976; Basavarajappa et al: 1962; Datta Banik et al: 1967; Karn and Penrose: 1951; Martin: 1931; Millis and Seng: 1954; Namboodiri and Balakrishnan: 1958; Pachauri et al: 1971; Tampan and Sundaram: 1956).

In spite of several significant findings it is not certain how much of the differences observed in mean birth weight can reasonably be ascribed to environmental causes and how much to genetic differences between various human groups. But Penrose (1960) has remarked that maternal general health and nutrition account for 16 % of the total causes of variation in birth weight. On the other hand, the WHO Study on Birth Weight based on 23,000 births from 18 countries has observed marked differences not only in mean birth weight but also in proportion of low-weight babies ($\leq$ 2500 g.) in different ethnic communities, although mean gestation time did not differ significantly in the groups investigated (Drillien: 1964).

From one of the working documents which were considered by the WHO Study Group, the distributions of livebirths by weight-groups are available for three groups of newborns from Europe ($n = 5078$ babies), China and Japan ($n = 1766$) and India ($n = 1666$) to show a much higher proportion of babies in the 2001—2500 g. range. Such high proportion was more evident in areas like India (21.6 %) or China and Japan (11.5 %) having high incidences of low-weight infants than in areas like Europe (4.2 %) showing low incidences of such under-weight infants (Drillien: 1964). In this context the WHO experts have, thus remarked that 'when the proportion of low-weight babies' is high and the mean birth weight is low, the difference between this situation and that occurring in areas with relatively high mean birth weight and a low proportion of low-weight babies is accounted for in two ways: a slightly higher proportion of babies born before 37 weeks of gestation, and a much higher proportion of low-weight babies born after this time' (WHO: 1961).

In meeting the problem of under-weight or low weight babies in developing countries like India where many of the low-weight babies are in fact the outcomes of pregnancies lasting 37 weeks or more, the important quantitative characteristics like mean birth weight and proportion of live births per weight-group (below or above 2500 g.) as recommended by the WHO, already been examined with due emphasis (Aiyar and Agarwal: 1969; Bahl et al: 1971; Guha et al: 1973; Saigal and Srivastava: 1969; Selvin and Garfinkel: 1972). In such examinations we have to bear out certainly the relative significant role of those biological and environmental factors which are considered to have some influence over the complex interaction between varying birth weights of the newborns and the factors concerned.

In the above context an attempt has been made in the paper to study a sample of 5117 liveborn singletons delivered in a Calcutta hospital in 1976 in finding out answers to the following queries:

(1) How and to what extent body weight at birth and distribution of babies by weight-group are influenced by the biological factors of (a) sex of baby; (b) length of gestation, (c) mother's age, (d) birth order (parity) as well as by the environmental factors of (e) socio-economic position of mother and (f) season of birth?

(2) Do these factors cause significant variations in the same degree in mean birth weight or in incidence of the newborns below the weight-level of 2500 g.?

(3) Among the given factors which one might have the most dominant role in affecting variations either in mean birth weight or in incidence of low-weight babies?

MATERIAL AND METHOD

The data under examination have been collected from Ramakrishna Mission Seva Pratisthan (Hospital), Calcutta. The hospital maintains regularly registers to keep records of all cases of pregnant mothers and their pregnancy-outcomes. From the register for 1976 the records related to 6072 cases were taken down under thirty six items of information like sex of the newborn, time and date of delivery, nature of birth (single or multiple), birth weight and length, mother's age and bed of confinement, length of gestation, parity, husband's occupation, mother's health before and after delivery, obstetric complications, birth defects etc.

It is well known that all hospital data lack representativeness and accordingly in interpreting the results presented here the following issues are especially noted. Regardnig reliability of information elicited for certain items like mother's age, length of gestation, parity, economic condition we have to depend solely upon what was entered in the hospital register.

Socioeconomic position of the mothers has been determined for the purpose of the present study on the basis of the ward of their confinement in the hospital. Depending upon financial condition of the expectant mothers the hospital authorities arrange as a general practice for their individual admission in one of three categories of ward, namely, (I) free ward for poor mothers who are not at all in a position to meet delivery and other ancillary expenses, (II) cabin ward for well-off mothers who are quite able to pay necessary delivery and other charges,and (III) paying ward for those who are moderately well-off to meet partially hospital expenses. Truly speaking, economic position of the mothers of paying ward appears to be very diverse. Nevertheless, sharp economic difference between the mothers confined in the free beds and in the special cabin beds is quite evident to present two very contrasting socioeconomic groups in the hospital. The mothers of the paying beds occupy an intermmediate position.

A thorough scrutiny of all cases of births (6072) has revealed that in many cases relevant information under a number of items was incorrect, incomplete or missing and these cases have been excluded. Again, the cases of multiple births have also not been considered. Thus, for the present study a total of 5117 cases of liveborn singletons has ultimately been utilised for necessary analyses. These singletons account for 84 % of all cases of births and in ninety per cent cases they were the babies of the Bengali-speaking mothers.

The newborns were weighed (without clothing) to the nearest gramme by trained hospital staff in the labour room within a few minutes after delivery. The weights of the infants as recorded in the register, may be taken as fairly reliable. Following the WHO recommendation the newborns have been classified by weight-groups and two principal groups, namely (1) the babies weighing 2500 g. or less (low-weight group), and (2) the babies weighing more than 2500 g. (high-weight group), have been sorted out for relevant examinations.

At the time of admission maternal age as declared by the mothers to the hospital staff, was recorded by single year of age and the same was taken to represent the age of mother. Now it is a common experience that single year of age data is subject to error of digit preference etc. and thus, 5-year grouped age data have been employed. Even then this grouping will not eliminate the bias completely.

In the present material since the primigravidae formed the largest single group and the frequencies of gravidae II, III etc. tended to decrease regularly the birth order of the newborns has been examined against five levels only (Order 1 to 5+). It is assumed that there was no omissions due to memory lapse as far as the earlier viable births are concerned. However, the possibility of not reporting the earlier miscarriages and abortions cannot be ruled out completely.

The period of gestation was recorded as to indicate the total number of days from the last menstrual period to the actual date of child delivery. This information is likely to suffer inaccuracies due to memory lapse. Following international agreement the babies have been classified as (i) preterm (37 weeks or less), (ii) term (38—41 weeks), and postterm (42 weeks or more).

For necessary statistical analysis information on birth weight and other biological and environmental characteristics of the babies and their mothers was copied on predesigned proformas and coded and then punch cards prepared. Processing of data, tabulations and statistical calculations have been made with the help of a Russian third generation computer (EC 1033).

For statistical evaluation of the results obtained in the study, mean and its standard error, standard deviation and coefficient of variation have been calculated. In addition statistical tests like t-test, chi-square test, test for differences in proportions, multiple comparison test are also used. F-statistic (one-way ANOVA model) has been presented. Simple correlations and regression coefficients have been computed in the paper.

ANALYSIS OF DATA

a) *Sex, birth weight and weight-group distribution*

The distribution of births by sex and weight-group is presented in *Table 1.0*. The sample sizes, means, standard

TABLE 1.0 *Distribution of births by sex and weight-group*

Sex	Birth weight-group (in g.)							Total %
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Male	7 (0.3)	38 (1.4)	172 (6.6)	187 (7.2)	688 (26.3)	1,166 (44.6)	357 (13.6)	2,615 (100.0)
Female	8 (0.3)	33 (1.3)	202 (8.1)	233 (9.3)	812 (32.4)	995 (39.8)	219 (8.8)	2,502 (100.0)
Both sexes	15 (0.3)	71 (1.4)	374 (7.3)	420 (8.2)	1,500 (29.3)	2,161 (42.2)	576 (11.3)	5,117 (100.0)

deviations and coefficients of variation of the weight by sex are shown in *Table 1.1.* The mean weight at birth is found to be 2587.6 g. with standard deviation of 412.9. The male babies have in general significantly higher mean birth weight than the females (t-value = 6.84). The variances also are significantly different (F-ratio = 1.08). The coefficient of variation is nearly the same for males and females. The number of the males is little more than that of the females (sex ratio = 104.5).

Though the over-all mean weight comes a little above 2500 g., the babies weighing 2500 g. or less at birth (low birth weight) occurred in as good as 46.5 % cases. On the average the male infants weighed at birth 70 g. more than the females. The single major concentration of the low-weight babies, irrespective of sex, is, of course, obtained in the 2251 to 2500 g. range.

The statistical test of the over-all distributions of both the low and the high-weight babies by sex gives a significant value of χ^2 (48.6 at 1 D.F.).

Difference in the relative proportions of the low-weight and the high-weight babies among the males have been tested and such difference is found to be highly significant. But among the females the difference is not statistically significant *(Table 1.2).*

TABLE 1.1 *Sample size, mean, standard deviation and coefficient of variation of birth weight by sex*

Sex	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
Male	2,615	2,625.9 ± 8.3	426.41	16.24
Female	2,502	2,547.4 ± 7.9	395.06	15.51
Both sexes	5,117	2,587.6 ± 5.8	412.93	15.96

TABLE 1.2 *Distribution of births by sex, birth weight group and mean weight*

Birth weight-group	Sex		
	Male	Female	Total
(1)	(2)	(3)	(4)
—2 500 g. (low-weight group)	1,092 (42.0)	1,288 (51.0)	2,380
Mean weight	2,259.8 ± 9.5	2,272.4 ± 8.4	
Coefficient of variation	13.95	13.23	
2 500 g. + (high-weight group)	1,523 (58.0)	1,214 (49.0)	2,737
Mean weight	2,888.5 ± 7.1	2,839.3 ± 13.7	
Coefficient of variation	9.65	16.08	
All groups	2,615 (100.0)	2,502 (100.0)	5,117
Value of test statistic for differences in proportions	—8.08**	1.00	

** *Significant at 1 % level*

TABLE 1.3 *Sex-wise differences in mean weights for (A) all births, (B) all births with ≦ 2,500 g. weight and (C) all births with > 2,500 g. weight*

Pairs of groups	t-values		
	A	B	C
(1)	(2)	(3)	(4)
Male × Female	6.84**	—0.99	3.30**

** *Significant at 1 % level*

Sex-wise differences in mean birth weights have further been tested separately for the group of low-weight babies and for the group of high-weight infants. In the former group sex difference is not evident, whereas in the latter sex difference is highly significant *(Table 1.3).* This confirms the following facts:

1) the low-weight babies do not vary by sex in mean birth weight, 2) within the high-weight babies the males possess definitely higher mean birth weight than their female counterparts, and 3) the over-all significant difference in mean birth weight by sex as has been obtained in the present series, is ultimately explained, it appears, by the group of high-weight infants only.

It is biologically well established that sex is strictly genetically determined and the weight of the female infant is, on the average, lower than that of the male. But, on the basis of the present finding we may note that in all cases the mean weight of the female babies shall not invariably be lower than that of the male. This eventuality is true only for the group of babies who weigh more than 2500 g. at birth (high weight group).

b) *Gestation time, birth weight and weight-group distribution*

84 % of the babies were reported as having gestation time extending between 38 and 41 weeks (completed). The incidences of the pre-term births (13 %) in the present series tallies closely with the previous findings shown by Mukherjee and Biswas (1959) and Banerjee (1969) from Calcutta as well as by Saigal and Srivastava (1969) from Kanpur, but the same differs appreciably from what was recorded by Aiyar and Srivastava (1969) from Bombay and again, by Ghosh and Daga (1967) and Guha et al. (1973) from Delhi. In the present study mean gestation time is 35.7 weeks with standard deviation of 10.7.

Mean birth weight of the term babies is observed to vary noticeably from the over-all mean value. The pre-term infants differ, as it is expected, significantly from the term babies in presenting much lower mean weight and they show on the average 280 g. less in mean weight than that of the term babies. The distributions of births by gestation time and weight-group is presented in *Table 2.0.* The sample sizes, means, standard deviations and coefficients of variation of the weight by gestation time are shown in *Table 2.1.*

TABLE 2.1 *Sample size, mean, standard deviation and coefficient of variation of birth weight by gestation period*

Gestation period (in weeks)	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
—31	75	1,849.1 ± 80.6	697.71	37.73
32—37	591	2,350.5 ± 19.4	471.49	20.06
38—41	4,282	2,631.2 ± 5.7	374.15	14.22
42+	169	2,638.9 ± 29.5	383.56	14.53

TABLE 2.0 *Distribution of births by gestation period and weight-group*

Gestation period (in weeks)	Birth weight-group (in g.)							Total %
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
—31	12 (16.0)	13 (17.3)	20 (26.7)	8 (10.7)	12 (16.0)	6 (8.0)	4 (5.3)	75 (100.0)
32—37	1 (0.2)	34 (5.7)	119 (20.1)	67 (11.3)	177 (30.0)	157 (26.6)	36 (6.1)	591 (100.0)
38—41	2	24 (0.6)	227 (5.3)	326 (7.6)	1,265 (29.5)	1,921 (44.9)	517 (12.1)	4,282 (100.0)
42+	0	0	8 (1.7)	19 (11.2)	46 (27.2)	77 (45.7)	19 (11.2)	169 (100.0)
All weeks	15	71	374	420	1,500	2,161	576	5,117

TABLE 2.2 *Distribution of births by gestation period, birth weight group and mean weight*

Birth weight-group	Gestation period (in week)				Total (%)
	—31	32—37	38—41	42+	
(1)	(2)	(3)	(4)	(5)	(6)
— 2,500 g.	65 (87.0)	398 (67.0)	1,844 (43.0)	73 (43.0)	238
Mean weight	1,676.6 ±70.2	2,118.7 ±18.4	2,317.4 ±4.5	2,314.2 ±22.3	
Coefficient of variation	33.76	16.98	8.37	8.22	
2,500 g. +	10 (13.0)	193 (33.0)	2,438 (57.0)	96 (57.0)	2,737
Mean weight	2,970.0 ±106.5	2,828.5 ±54.4	2,868.5 ±8.4	2,885.8 ±65.6	
Coefficient of variation	11.34	26.72	14.55	22.28	
All groups	75 (100.0)	591 (100.0)	4,282 (100.0)	169 (100.0)	5,117
Value of teststatistic for differences in proporitions	5.14**	7.82**	—9.09**	—1.80	

** *Significant at 1 % level*

TABLE 2.3 *Gestation period-wise differences in mean weights for (A) all births, (B) all births with ≤2,500 g. weight and (C) all births with >2,500 g. weight*

Pairs of gestation time intervals	*t*-values			Pairs of gestation time intervals	*t*-values		
	A	B	C		A	B	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
—31 × 32—37	—6.05**	—6.09**	1.18	32—37 × 38—41	—13.88**	—10.69**	—0.73
—31 × 38—41	—9.68**	—9.01**	0.95	32—37 × 42+	—8.17**	—6.82**	—0.67
—31 × 42+	—9.21**	—8.66**	0.67	38—41 × 42+	—0.26	0.14	—0.26

** *Significant at 1 % level*

The average birth weights in the successive intervals of gestation period mark a progressive increase with the increasing gestation time. This finding is in conformity with previous studies (Karn and Penrose: 1951; Mukherjee and Biswas: 1959; Pachauri and Marwah: 1970). The means are not only significantly different from each other but the mean obtained for the gestation-interval of 42 weeks and above is the largest. It is interesting that the term and the post-term babies do not show among themselves any significant difference in mean birth weight. This means that in the intra-uterine life beyond 41 weeks the babies concerned do not enjoy any additional gain in birth weight *(Table 2.3)*.

Bartlett's test for homogeneity of variances is applied to the obtained values of variance. The test yields the value of χ^2 with 3 D.F. to be 135.99. This value is highly significant. A definite decrease in the variances with gestation time is apparent. The coefficients of variation are also found to be decreasing with increasing gestation time.

It is noted that the incidences of the low-weight babies tend to decrease regularly as the gestation length advances. Maximum concentration of the low-weight infants is, of course, in the 2251–2500 g. range. About one-third of the pre-term babies show more than 2500 g. at birth. Statistical test of the over-all distributions of both the low and the high-weight babies by gestation length gives a significant value of χ^2 (172.9 at 3 D.F.) and we can conclude that the incidences of birth weight-low or-high are strongly associated with length of gestation.

By examining the differences between the relative proportions of the low against the high-weight infants under each one of the gestation time-intervals (by weeks) we find that 1) among the pre-term babies the occurrences of the low-weight individuals are significantly higher, while 2) in the term babies only the incidences of the high-weight individuals are significantly greater *(Table 2.2)*.

Gestation period-wise differences in mean weights for A) all births, B) all births with 2500 g, weight, and C) all births with more than 2500 g. weight have been tested and the t-values are shown in *Table 2.3*. With respect to all births the means are, as noted earlier, significantly different from each other, but for the high-weight babies only (above 2500 g) none of the pair of means is observed to be significantly different. Thus, the low-weight babies seem ultimately to be responsible in effecting significant differences in mean birth weights between different gestation periods, as are evident for all births.

c) *Birth weight, weight-group distribution and mother's socioeconomic position*

The distribution of birth weight by mother's socioeconomic position is presented in *Table 3.0*. The sample sizes, means, standard deviations and coefficients of variation of the weight by socioeconomic status are shown in *Table 3.1*. The poor mothers are observed to possess the lightest babies. Mean birth weight of the babies of the poor mothers differ significantly from that of the babies belonging to either the moderately well-off or the well-off mothers. As a matter of fact, the infants of the poor mothers present on the average 173 g. less in birth weight than the heaviest infants of the well-off mothers.

The means are not only significantly different from each other but the mean for the babies of the well-off mothers turns out to be the largest. Bartlett's test for homogeneity of variances is applied to the obtained values of variance. The test gives the value of χ^2 with 2 D.F. as 13.02 and this value is highly significant. A definite increase in the variances with maternal socioeconomic position is evident. Coefficients of variation are also found to be increasing with more improved socioeconomic status of the mothers. In agreement with previous studies on the Bengali newborns (Mukherjee and Biswas: 1959; Banerjee: 1969) we have also found that differential socieconomic position of the mothers does effect significant variations in the weight of the babies at birth.

The state of affair that is related to the lowest mean weight of the poor babies may be explained by the fact that a little more than one-half of these babies fall below 2500 g. in weight, the single best concentration being registered in the 2251–2500 g. range. Even then one cannot miss to note that a good proportion of these poor babies happens to weight above 3000 g. The incidences of the low-weight infants decrease regularly with higher economic position of the mothers.

In spite of varying birth weights of the newborns the statistical test of the over-all association between the incidences of the low or high weight babies and mother's economic status gives a significant value of χ^2 (43.9 at 2 D.F.).

TABLE 3.1 ***Sample size, mean, standard deviation and coefficient of variation of birth weight by socioeconomic position of mother***

Socio-economic position of mother	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
Poor	1,396	2,524.9 ± 10.4	389.26	15.42
Moderately well-off	3,433	2,603.8 ± 7.11	416.87	16.01
Well-off	288	2,697.6 ± 26.1	443.61	16.44

TABLE 3.0 ***Distribution of births by socioeconomic position of mother and weight-group***

Socioeconomic position	Birth weight-group (in g.)							Total (%)
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Poor (free bed beneficiaries)	4 (0.3)	22 (1.6)	122 (8.7)	133 (9.5)	464 (33.2)	555 (39.8)	96 (6.9)	1,396 (100.0)
Moderately well-off (Paying bed beneficiaries)	11 (0.3)	44 (1.3)	244 (7.1)	263 (7.7)	969 (28.2)	1 477 (43.0)	425 (12.4)	3,433 (100.0)
Well-off (Cabin bed beneficiaries)	0	5 (1.7)	8 (2.8)	24 (8.3)	67 (23.3)	129 (44.8)	55 (19.1)	288 (100.0)
All positions	15	71	374	420	1,500	2,161	576	5,117

Difference between the relative proportions of the low and high-weight babies in each socioeconomic group has statistically been tested. In the poor group of the mothers the low-weight babies occur significantly more often than the high-weight babies, whereas in both groups of the moderately well-off and the well-off mothers the low-weight babies are present significantly in lesser strength (*Table 3.2*).

Maternal socioeconomic position-wise differences in mean weights have been tested A) for all births, B) for all births with 2500 g. or less weight, and C) for all births with more than 2500 g. weight and the t-values are shown in *Table 3.3*. With regard to all births the means are, as noted earlier, significantly different from each other, but for all the low-weight babies none of the pairs of mean is found to be significantly different. This indicates that it is the high-weight group of babies which causes ultimately significant variations in mean weights between different socioeconomic groups, as are apparent for all births.

That differential socioeconomic condition of the mothers in the developing countries has a positive effect on body weight of the newborns at birth has already been highlighted (WHO: 1961; Banerjee: 1969; Bandopadhyay et al.: 1981), but the present study points out very clearly that such effect is true for only the high-weight babies.

TABLE 3.2 *Distribution of births by mother's socioeconomic position, birth-weight group and mean weight*

Birth weight-group	Socioeconomic position			Total
	Poor	Moderately well-off	well-off	
(1)	(2)	(3)	(4)	(5)
—2 500 g.	745 (53.0)	1.531 (45.0)	104 (36.0)	2,380
Mean weight	2,263.7 ±11.2	2,266.7 ±7.9	2,285.1 ±29.3	
Coefficient of variation	13.50	13.61	13.09	
2 500 g. +	651 (47.0)	1,902 (55.0)	184 (64.0)	2,737
Mean weight	2,823.8 ±9.0	2,875.2 ±6.2	2,930.8 ±24.1	
Coefficient of variation	8.15	9.44	11.16	
All groups	1,396 (100.0)	3,433 (100.0)	288 (100.0)	5,117
Value of test statistic for differences in proportion	2.34*	—5.81**	—4.57**	

* *Significant at 5 % level*
** *Significant at 1 % level*

TABLE 3.3 *Mother's socioeconomic position-wise differences in mean weights for (A) all births, (B) all births with ≦ 2 500 g. weight and (C) all births with > 2 500 g. weight*

Pairs of groups	*t*-values		
	A	B	C
(1)	(2)	(3)	(4)
Poor × Moderately well-off	—6.25**	—0.22	—4.68**
Poor × well-off	—6.44**	—0.68	—4.16**
Moderately well-off × well-off	—3.46**	—0.60	—2.23*

* *Significant at 5 % level*
** *Significant at 1 % level*

d) *Birth weight, weight-group distribution and maternal age*

The mothers have been classified under five broad groups on the basis of age for the present analysis. The groups are i) the adolescent (19 yrs. and below); ii) the young (20—24 yrs.), iii) the adult (25—29 yrs.), iv) the reproductively mature (30—35 yrs.), and v) the older (35 yrs. and above). The young mothers constitute the single largest group in the present series. Mean maternal age is 24.6 years with the standard deviation of 4.6 years.

The distributions of births by mother's age and weight-group are shown in *Table 4.0*. The sample sizes, means, standard deviations and the coefficients of variation of the weight by maternal age are presented in *Table 4.1*. Between most of the age-groups the means differ not only significantly from each other but the mean for the age-group 25—29 happens to be the largest. It is especially noted that the babies of the teenage adolescent mothers form positively a distinct group by themselves in showing highly significant variation in mean weight from the rest of the babies. In fact, the infants of the adolescent mothers are on the average 152 g. less in birth weight than that of the heaviest infants of the adult mothers.

It is further observed that up to the age 29 of the mothers the babies tend to increase in birth weight systematically with the advancing maternal age, but in higher ages beyond 29 years such relationship is not maintained. This feature of increasing or decreasing trend in mean weight by mother's age tallies well with the findings of previous studies (Namboodiri and Balakrishnan: 1958; Basavarajappa et al.: 1962; Mukherjee and Biswas: 1959).

TABLE 4.1 *Sample size, mean, standard deviation and coefficient of variation of birth weight by maternal age*

Maternal age	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
—19	647	2,476.0 ± 15.5	395.39	15.97
20—24	2,028	2,597.1 ± 8.5	384.48	14.80
25—29	1,529	2,627.7 ± 10.8	420.73	16.01
30—34	725	2,581.4 ± 16.6	447.85	17.35
35+	188	2,567.2 ± 37.4	513.49	20.00

The effect of maternal age on the standard deviation of birth weights has been examined by applying Bartlett's test for homogeneity of variances. The value of χ^2 with 4 D.F. is obtained to be 55.07 and the same is highly significant. A definite increase in the variance with maternal age is apparent. The coefficients of variation confirm also a clear increasing trend with increasing age of the mothers.

Among the teenage adolescent mothers the low weight babies occur unmistakably in majority of the cases, though the incidences of high weight infants are not negligible. With the advancing age of the mothers occurrences of the low weight babies decrease regularly, the lowest incidence being in the age group 25—29. On the other hand, the low weight babies give, irrespective of mother's age, the single best concentration in the 2251—2500 g. range. The mothers

TABLE 4.0 *Distribution of births by maternal age and weight-group*

Maternal age (in year)	Birth weight-group (in g.)							Total %
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
—19	1 (0.1)	16 (2.5)	67 (10.4)	76 (11.7)	232 (35.9)	214 (33.1)	41 (6.3)	647 (100.0)
20—24	4 (0.2)	17 (0.8)	135 (6.7)	161 (7.9)	582 (28.7)	928 (45.8)	201 (9.9)	2,028 (100.0)
25—29	6 (0.4)	16 (1.0)	98 (6.4)	109 (7.1)	428 (28.0)	660 (43.2)	212 (13.9)	1,529 (100.0)
30—34	3 (0.4)	16 (2.2)	55 (7.6)	55 (7.6)	214 (29.5)	287 (39.6)	95 (13.1)	725 (100.0)
35+	1 (0.5)	6 (3.2)	19 (10.1)	19 (10.1)	44 (23.4)	72 (38.3)	27 (14.4)	188 (100.0)
All ages	15	71	374	420	1,500	2,161	576	5,117

TABLE 4.2 *Distribution of births by maternal age, birth weight-group and mean weight*

Birth weight-group	Maternal age (in years)					Total
	—19	20—24	25—29	30—34	35+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
—2,500 g.	392 (61.0)	899 (44.0)	657 (43.0)	343 (47.0)	89 (47.0)	2,380
Mean weight	2,252.1 ± 15.7	2,284.7 ± 9.5	2,279.6 ± 11.8	2,238.6 ± 18.7	2,159.5 ± 38.9	
Coefficient of variation	13.35	12.42	13.32	15.47	17.01	
2,500 g. +	255 (39.0)	1,129 (56.0)	872 (57.0)	382 (53.0)	99 (53.0)	2,737
Mean weight	2,820.2 ± 38.4	2,845.8 ± 7.5	2,889.9 ± 9.7	2,889.2 ± 26.5	2,933.6 ± 31.1	
Coefficient of variation	21.76	15.96	18.96	24.41	28.53	
All groups	674 (100.0)	2,028 (100.0)	1,529 (100.0)	725 (100.0)	188 (100.0)	5,117
Value of test statistic for differences in proportions	5.47**	—5.38**	—5.43**	—1.61	—0.82	

* *Significant at 5 % level*
** *Significant at 1 % level*

TABLE 4.3 *Maternal age-wise differences in mean weights for (A) all births, (B) all births with ≦ 2,500 g. weight and (C) all births with > 2,500 g. weight*

Pairs of groups	t-values			Pairs of groups	t-values		
	A	B	C		A	B	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
—19 × 20—24	—6.83**	—1.78	—0.66	20—24 × 30—34	0.84	2.19*	—1.63
—19 × 25—29	—8.02**	—1.40	—1.76	20—24 × 35+	0.78	3.12**	—2.75**
—19 × 30—34	—4.63**	0.56	—1.48	25—29 × 30—34	2.34*	1.85	0.02
—19 × 35+	—2.25**	2.21*	—2.30*	25—29 × 35+	1.55	2.95**	—1.34
20—24 × 25—29	—2.23*	0.33	—3.58**	30—34 × 35+	0.35	1.83	—1.09

* *Significant at 5 % level*
** *Significant at 1 % level*

aged 25 yrs. or more have presented the healthiest babies (weighing 3000 g. or above) relatively more than the younger mothers aged 24 yrs. or less.

In spite of varying weights at birth the statistical test of the over-all distributions of the babies weighing low or high at birth by maternal age gives a significant value of χ^2 (63.2 at 4 D.F.). This confirms that the incidences of birth weight — low or high — are strongly associated with mother's age.

Differences in relative proportions of the low and the high-weight babies under each age group have been tested. It is only among the teenage adolescent mothers the low-weight babies occur significantly more than the high-weight babies. In contrast, the young and the adult mothers have significantly more high-weight infants. In the rest of the mature or older mothers no significant difference between the proportions of the low and the high-weight babies is obtained *(Table 4.2)*.

Maternal age-wise differences in mean weights for A) all births, B) all births with 2500 g. or less weight, and C) all births with more than 2500 g. weight have been tested and the t-values are shown in *Table 4.3.* With respect to all births it is observed that between one lower age group and its immediate higher age group the mean weights differ significantly, except for the age group 30—34 beyond which no further increase in birth weight with increasing age of mother is evident. Significant difference in mean weights is especially true between the age group 19 yrs. and below and each one of the higher age groups.

Moreover, it is interesting that as far as the low weight babies are concerned the older mothers (35+ yrs.) present the lowest mean weight for the babies and as a result between the age group 35+ and each one of the lower age groups, except 30—34, the difference in mean weights turns out to be significant. But with respect to the high weight babies though the older mothers show the highest mean weight for the babies the difference in mean weights is significant only between the age groups 35+ and 20—24 or 19 and below.

e) *Birth weight, weight-group distribution and birth order*

The babies belonging to the birth orders 1 to 3 constitute the largest aggregate. All the viable births at the order 5 and above have been examined as a single group because of the smallness of the numbers involved. Mean birth order is 2 with standard deviation of 2.1.

Table 5.0 shows the distribution of births and weight-group by birth order. The sample sizes, means, standard deviations, and the coefficients of variation by birth order are presented in *Table 5.1.* The infants of the birth order 2 are observed to register the highest mean weight. With the increasing birth order mean weight tends to decrease in the present series and this phenomenon does not conform with the earlier findings which show birth order-wise increase in mean weight (Millis and Seng: 1954; Namboodiri and Balakrishnan: 1958; Mukherjee and Biswas: 1959; Basavarajappa et al.: 1962; Aiyar and Agarwal: 1969). This development may be explained by the facts that in the present material the babies of the first two birth orders only accounted for a little less than three-fourth cases and due to paucity of births above order 2 our data could not possibly disclose if there was any relationship between higher birth orders and increasing weight at birth.

TABLE 5.1 *Sample size, mean, standard deviation and coefficient of variation of birth weight by birth order*

Birth order	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
1	2,266	2,569.3 ± 8.6	408.06	15.88
2	1,472	2,626.4 ± 10.8	413.12	15.73
3	754	2,588.1 ± 14.9	410.48	15.86
4	355	2,560.7 ± 22.9	431.30	16.84
5+	270	2,562.8 ± 26.6	438.04	17.09

Differences in mean weights by birth order have been tested. The t-test shows that only the mean weight for the newborns of the birth order 2 varies significantly from all other mean weights, irrespective of birth order. The heaviest babies (birth order 2) differ from the lightest babies (birth order 4) in birth weight on the average by 65 g.

The effect of birth order on the standard deviation of birth weights has been examined by applying Bartlett's test for homogeneity of variances. The test gives the value of χ^2 with 4 D.F. to be 3.57 which is not significant at 5 % level, though the value falls near the critical region ($\chi^2.05,4 = 9.49$). This may be due to the non-normality of the weight-distribution at different birth orders. The coefficients of variation are nearly the same for the first three birth orders, but beyond order 3 the coefficients are observed to increase.

In the birth order 2 the relative incidences of the high-weight babies are found to be significantly more than the low-weight infants. This feature is equally true for the babies born at order 3. In the remaining birth orders the

TABLE 5.0 *Distribution of births by birth order and weight-group*

Birth order	Birth weight-group (in g.)							Total %
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	3 (0.1)	33 (1.5)	191 (8.4)	193 (8.5)	665 (29.4)	950 (41.9)	231 (10.2)	2,266 (100.0)
2	5 (0.3)	16 (1.1)	75 (5.1)	125 (8.5)	425 (28.9)	622 (42.2)	204 (13.9)	1,472 (100.0)
3	4 (0.5)	8 (1.1)	58 (7.7)	50 (6.6)	228 (30.2)	329 (43.7)	77 (10.2)	754 (100.0)
4	1 (0.3)	9 (2.5)	30 (8.4)	28 (7.9)	104 (29.3)	149 (42.0)	34 (9.6)	355 (100.0)
5+	2 (0.7)	5 (1.9)	20 (7.4)	24 (8.9)	78 (28.9)	111 (41.1)	30 (11.1)	270 (100.0)
All orders	15	71	374	420	1,500	2,161	576	5,117

TABLE 5.2 *Distribution of births by birth order, birth-weight group and mean weight*

Birth weight-group	Birth order 1	2	3	4	5+	Total
(1)	(2)	(3)	(4)	(5)	(6)	(7)
—2,500 g.	1,085 (48.0)	646 (44.0)	348 (46.0)	172 (48.0)	129 (48.0)	2,380
Mean weight	2,257.8 ± 9.1	2,289.2 ± 11.5	2,275.9 ± 17.3	2,242.4 ± 25.6	2,235.4 ± 31.9	
Coefficient of variation	13.28	12.73	14.20	14.95	16.21	
2,500 g. +	1,181 (52.0)	826 (56.0)	406 (54.0)	183 (52.0)	141 (52.0)	2,737
Mean weight	2,855.6 ± 7.6	2,890.2 ± 9.9	2,855.7 ± 13.0	2,859.9 ± 19.6	2,862.3 ± 20.5	
Coefficient of variation	9.13	9.85	9.02	9.28	11.3	
All groups	2,266 (100.0)	1,472 (100.0)	754 (100.0)	355 (100.0)	270 (100.0)	5,117
Value of test statistic for differences in proportions	—1.91	—4.56**	—2.19*	—0.75	—0.66	

* *Significant at 5 % level*
** *Significant at 1 % level*

TABLE 5.3 *Birth order-wise differences in mean weights for (A) all births, (B) all births with ≦ 2,500 g. weight, and (C) all births with > 2,500 g. weight*

Pairs of orders	t-values A	B	C	Pairs of orders	t-values A	B	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1 × 2	—4.15**	—2.14*	—2.77**	2 × 4	2.59**	1.67**	1.38
1 × 3	—1.09	—0.92	—0.01	2 × 5+	2.21*	1.58	1.23
1 × 4	0.35	0.57	—0.20	3 × 4	1.00	1.08	—0.18
1 × 5	0.23	0.67	—0.30	3 × 5+	0.83	1.11	—0.27
2 × 3	2.08*	0.64	2.14*	4 × 5+	—0.06	0.17	—0.08

* *Significant at 5 % level*
** *Significant at 1 % level*

relative proportions of the low and the high-weight babies do not significantly vary (*Table 5.2*).

Birth order-wise differences in mean weights for A) all births, B) all births with 2500 g. or less weight, and C) all births with more than 2500 g. weight have statistically been tested and the *t*-values are shown in *Table 5.3*. From the table it is clearly understood trat i) for the low-weight babies the difference in mean weights between the orders 1 and 2 only is significant, but ii) for the high-weight babies the differences in mean weights between the orders 1 and 2 as well as between 2 and 3 are found to be significant. This suggests that with respect to birth weight the babies born at the order 2 form a distinct group by themselves to differ significantly from the rest of the babies, irrespective of their affiliation to the low or the high-weight group.

f) *Birth weight, weight-group distribution and season of birth*

Seasonal effect on the outcomes of pregnancies has been studied recently on the basis of hospital data of 21722 primipara mothers to show that a) the peak months for births (both live and still) were September, October and November (autumn season) and b) the peak months of miscarriages were March, April and May (summer season) in a year (Nag and Pakrasi: 1980). In this context an attempt has been made here to examine if there is any seasonal effect on birth weight or weight-group distribution. In the present material the autumn births constitute also the largest group, while the summer births explained the lowest concentration.

The distributions of births and weight-groups by season of birth are given in *Table 6.0*. The sample sizes, means,

TABLE 6.1 *Sample size, mean, standard deviation and coefficient of variation of birth weight by season of birth*

Season	Sample size	Mean (g.)	Standard deviation	Coefficient of variation
(1)	(2)	(3)	(4)	(5)
Summer	1,019	2,613.8 ± 13.1	420.18	16.07
Mon-soon	1,313	2,582.9 ± 11.7	424.94	16.45
Autumn	1,588	2,584.5 ± 10.2	402.39	15.57
Winter	1,227	2,574.7 ± 11.7	410.16	15.93

TABLE 6.0 *Distribution of births by season of birth and weight-group*

Season	Birth weight-group (in g.)							Total %
	—1,000	—1,500	—2,000	—2,250	—2,500	—3,000	3,000+	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Summer	2 (0.2)	15 (1.5)	73 (7.2)	66 (6.5)	299 (29.3)	436 (42.8)	128 (12.5)	1,019 (100.0)
Monsoon	5 (0.4)	21 (1.6)	92 (7.0)	113 (8.6)	393 (29.9)	541 (41.2)	148 (11.3)	1,313 (100.0)
Autumn	2 (0.1)	19 (1.2)	117 (7.5)	120 (7.7)	477 (30.7)	654 (42.0)	169 (10.8)	1,558 (100.0)
Winter	6 (0.5)	16 (1.3)	92 (7.5)	121 (9.8)	331 (27.0)	530 (43.7)	131 (10.7)	1,227 (100.0)
All seasons	15	71	374	420	1,500	2,161	576	5,117

TABLE 6.2 *Distribution of births by season of birth, birth-weight group and mean weight*

Birth weight-group	Season of birth				Total
	Summer	Monsoon	Autumn	Winter	
(1)	(2)	(3)	(4)	(5)	(6)
—2,500 g.	455 (45.0)	624 (48.0)	735 (47.0)	566 (46.0)	2,380
Mean weight	2,278.4 ± 14.5	2,259.7 ± 12.5	2,276.4 ± 11.0	2,251.9 ± 13.2	
Coefficient of variation	13.57	13.77	13.08	14.0	
2,500 g. +	564 (55.0)	689 (52.0)	823 (53.0)	661 (54.0)	2,737
Mean weight	2,884.3 ± 11.9	2,875.7 ± 10.7	2,859.5 ± 9.2	2,851.1 ± 9.8	
Coefficient of variation	9.76	9.72	9.19	8.83	
All seasons	1,019 (100.0)	1,313 (100.0)	1,558 (100.0)	1,227 (100.0)	5,117
Value of test statistic for differences in proportions	—3.17**	—1.45	—2.36*	—2.80**	

* *Significant at 5 % level*
** *Significant at 1 % level*

TABLE 6.3 *Season-wise differences in mean weights for (A) all births, (B) all births with ≦ 2,500 g. weight and (C) all births with > 2,500 g. weight*

Pairs of seasons	*t*-values			Pairs of seasons	*t*-values		
	A	B	C		A	B	C
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Summer × Monsoon	1.74	0.97	0.54	Monsoon × Autumn	—0.09	—1.00	1.15
Summer × Autumn	1.76	0.11	1.65	Monsoon × Winter	0.49	0.43	1.70
Summer × Winter	2.21*	1.34	2.16*	Autumn × Winter	0.63	1.42	0.63

* *Significant at 5 % level*
** *Significant at 1 % level*

standard deviations and the coefficients of variation by season of birth can be seen in *Table 6.1.* The summer babies are observed to yield largest mean weight. Though the winter babies show the smallest mean weight, they do not differ sharply from either the monsoon or the autumn babies in birth weight. The summer babies vary significantly from only the winter babies in birth weight. Thus, we find that the difference in mean weights between the heaviest and the lightest babies is not more than 40 g. on the average.

In studying the effect of season of birth on the standard deviation of birth weights Bartlett's test for homogeneity of variances has been applied. The test gives the value of χ^2 with 3 D.F. to be 4.08 and this value is not significant. Thus, it is clear that there is no general tendency for the standard deviation to decrease or otherwise with season of birth. The coefficients of variation mark a tendency to be more or less constant for all the seasons of birth. In spite of significant difference in mean weights between the summer and the winter babies statistical test of the over-all distributions of the low and the high weight babies by season does not give any significant value for χ^2. But with respect to all births, irrespective of weight-group, seasonal variation in frequency of births is highly significant ($\chi^2 = 190.48$ with 3 D.F.). On the other hand, it is interesting to note that in each season, except monsoon, the relative proportions of the high-weight babies are significantly more than those of the low-weight infants. Moreover, in different seasons the magnitudes of the low-weight babies remain nearly constant *(Table 6.2).*

Season-wise differences in mean weights for A) all births, B) all births with 2500 g. or less weight and C) all births with more than 2500 g. weight have been tested and the *t*-values are shown in *Table 6.2.* From the table it is evident that only between the summer and the winter babies the difference in mean weights, as noted above, is significant. But it is the group of high-weight babies which is observed to be particularly responsible to show such significant difference in mean weights. The low-weight babies do not show seasonal effect at all.

Reinhardt et al. (1978) is reported by Huizinga to have found low mean birth weight and high incidence of low birth weight babies between December and April in a rural population of Africa. Our finding on the lowest mean weight for the winter babies tallies to some extent with the above, but differs from that which is shown by Huizinga and Wijngaard (1981) for another population in an African subsistence society.

DISCUSSION

The present examination of the limited data on birth weight of the Bengali newborns has confirmed earlier experiences that the weight of the baby cannot be considered the only criterion in estimating its degree of maturity. Some more criteria-biological and environmental-need to be taken into account in finding solution of various problems related to reproductive efficiency, intra-uterine development of foetus and divers needs of maternal and child care. The present study has highlighted that each one of six factors, namely, i) sex of the baby, ii) gestation time, iii) maternal age, iv) mother's socioeconomic condition, v) birth order and vi) season of birth, has some role to play in causing, though not it the same degree, significant variations or otherwise in mean weights. But in order to comprehend the relative importance of the factors as the source of variation in body weight at birth the F-statistic (one-way ANOVA model) have been computed and the following results are obtained:

Factor	F-value
1. Gestation time	184.55**
2. Sex of the baby	46.56**
3. Mother's economic condition	29.19**
4. Maternal age	15.92**
5. Birth order	4.95**
6. Season of birth	1.81

** Significant at 1 % level

On the basis of the computed F-values the length of gestation in its relation to birth weight appears to be the single most important source of variation. This fact has, of course, been well established in a number of earlier studies. But, that birth weight is influenced by increasing birth order as shown by previous studies, is not observed to be true for the present data. The F-value confirms that the factor of birth order maintained the weakest but significant relation with the birth weight.

The relationship between birth weight and each one of three biological factors, namely a) gestation time, b) maternal age, and c) birth order has further been examined separately by fitting linear regression equations. The results are shown below.

Fitted Regression Equation	Correlation coefficient
a) Weight = 2503.37 +2.33** (gestation time)	0.061**
b) Weight = 2483.04 +4.25** (maternal age)	0.048**
c) Weight = 2591.00 —1.67 (birth order)	—0.006

** Significant at 1 % level

It is immediately understood that significant correlation between gestation time and birth weight exists. The phenomenon is also true for maternal age. But in both the cases the magnitudes of coefficient are rather small. Though the F-value indicates that the factor of birth order is a significant source of variation in birth weight, yet the correlation coefficient between birth weight and birth order is found to be nonsignificant. We have found that the mean weight for the first born infants is significantly lower than that shown by the babies of the order 2. For the babies born above the order 2 there is no significant difference in mean weights. Therefore, no linear relationship could be expected between birth order and birth weight, as reported in some of the earlier studies. The regression coefficients indicate that the birth weight increases by 2.36 g. with each week of gestation time and again, by 4.25 g. when the mother becomes older by a year in age.

With respect to the conspicuous role of gestation time as the most important source of variations in birth weight we have further used multiple comparison procedure by following Scheffe's and multiple-T methods (Afifi and Azen: 1979) to test pairwise differences and some comparisons between mean weights for different gestation time. It has been seen above that at 31 weeks the babies present only 1849.1 g. as mean weight and when the gestation time is increased by 6 weeks the gain in birth weight is by 501.4 g. Again, on increasing gestation time further by 4 weeks from 37 weeks we find that the gain in mean weight is effected further (280.7 g.). This differential amount of gain in mean weight by different gestation time-intervals have been examined by the above two methods and the hypothesis of equality in these two values of weight which are gained during the pre-term and the term period respectively is rejected at 1 % level of significance (see Appendix). This lead us to conclude that the increase in birth weight with increasing gestation time in the *pre-term* period is more than that for the *term* period (38–41 weeks). The same phenomenon is observed to be true only for the babies with birth weight 2500 g. or less (low-weight babies).

Socioeconomic condition of the mothers is another significant source of variations in birth weight. Considering the mean weights of the babies of a) the poor, b) the moderately well-off, and c) the well-off mothers it is evident that the moderately well-off babies weigh, on the average 78.9 g. more than the poor babies, whereas the well-off babies weigh on the average 93.8 g. more than the moderately well-off babies. Multiple comparison tests have been made to examine the equality in these two values of weight-gain. The results given by the tests indicate (see Appendix) that the amount by which the well-off babies gain in body weight over the moderately well-off babies does not significantly vary from that by which the moderately well-off babies gain in weight over the poor babies. This development is observed to be true also for the babies who weighed below or above 2500 g. at birth.

Since in most of the underdeveloped areas a very high incidence of babies weighing 2500 g. or less at birth prevails the World Health Organization (1961) has stressed upon the importance of the empirical knowledge about the distribution of babies by birth-weight groups for all live births. Quantitative information about both mean birth weight and proportion of babies by weight-group has its importance in the study of the issues like maturity or degree of underweight and viability of the newborns. That these two measures are essential to examine the problems of "prematurity" (low birth-weight) in India may be demonstrated by the findings of the present study. The mean birth weight of the liveborn babies is found, irrespective of sex, to be higher than 2500 g. and as such they cannot in general be treated as under-weight or low-weight individuals. But a closer look into the incidences of livebirths below or above 2500 g. reveals at once that while only 58 % of the male babies belong to the high-weight group, the females with low weight (2500 g. or less) occur in a little more than 50 % cases.

A smaller number of babies with relatively lower mean weight has occurred in the present series and this is explained obviously by a small excess of births before 37 week's gestation and a marked excess of low-weight babies born near or at term.

The Bengali babies weighing 2500 g. or less (low-weight) may be characterized in the following manner. The low-weight babies are i) mostly pre-term, ii) mostly female, iii) borne more by the poor mothers, iv) produced mostly by the teenage adolescent mothers, v) mostly the products of either birth order 1 or order 4+, and vi) delivered mostly in the season of monsoon (June, July and August).

In the above context we would like to note that in India the families of low and poor socioeconomic class very largely concentrate and it is no wonder that in all studies of hospital data on live births in the country the mothers are found to belong dominantly to this class. Nevertheless, these poor mothers do not invariably produce the low-weight babies in equal or nearly equal magnitude in different parts of India (*Table 7*). Rather, the incidences of both the low-weight and the pre-term babies do vary between the samples of births examined in several hospitals of the country. It is really a difficult task to ascertain the actual magnitude of the low-weight babies in India.

In a number of studies on birth weight of the Indian babies the researchers have desired a suitable change in the upper limit of the WHO weight-standard assigned to the low-weight babies (2500 g. or less). Several recommendations are alrealy available for the Indian standard of the low-weight group and this standard is observed to vary from 1700 g. to 2272 g. (Saigal and Srivastava: 1969). In spite of the prevailing unfavourable environmental and indigent economic condition the Bengali mothers have been found to deliver the low-weight babies mostly in the 2251—2500 g. range and these babies show 2454 g. as their mean birth weight.

In this particular situation one may suggest that the upper limit of "prematurity" or low birth weight should be at 2250 g. This suggestion finds its support in the statement made long ago by Tabak (1951) with respect to some regions like South Africa, Japan, China where 'biological rhythm of intra-uterine development' is peculiar to the peoples concerned (Lesinski 1962). On the other hand, for a developed coutry like England an upper limit of 2000 g. for the low-weight babies has been recommended as a 'more realistic' indicator (Drillien: 1964).

In an agrarian country like India where inequality in socioeconomic life and inadequacy of hospital facilities for child delivery reign still very high, it is, indeed, a formidable task to have an appropriate standard for either mean weight at birth or incidences of low-weight baby. Reality of the situation may be appreciated from the findings obtained in ten different investigations in different hospitals of India (*Table 7*). It may be stated that the rate of incidence of babies weighing 2500 g. or less at birth may not always be an indicator of the intensity of the problem of low birth weight. A lower rate of incidence of low-weight babies does not always guarantee a corresponding increase in mean birth weight unless the mean birth weight for the 2500 g. + group is considerably high or on the other hand, the distribution of the babies weighing more than 2500 g. is more skewed to the right.

Nevertheless, we agree fully with the views of the WHO experts that the very great majority of the newborns have the biological potential for being born with a birth weight consistent with full viability and health, provided their mothers are born, reared and reproduce in a good environment (WHO: 1961). With the gradual improvement in the reproductive efficiency of the Indian mothers under better nutrition, health care and social education it is expected that we may arrive at a more appropriate weight-standard for the low-weight babies.

TABLE 7. ***Mean birth weight and incidence of low weight babies in different areas of India***

Area	Data related to year	Total births studied	Mean birth weight (kg)	Percent of low weight babies	Author
(1)	(2)	(3)	(4)	(5)	(6)
1. Bombay (western India)	1954—1957	21,258	2.61	36.8	Basavarajappa et al., 1962
2. Bombay	1956	5,018	2.61	36.3	Baxi, 1960
3. Trivandrum (south India)	1956—1957	12,640	2.87	29.6	Namboodiri et al., 1958
4. Coonoor, Hyderabad & Madras (south India)	1956—1959	4,530	2.95	29.3	Venkatachalam, 1962
5. New Delhi (north India)	1959—1961	2,695	2.73	29.3	Ghose & Beri, 1962
6. Kanpur (north India)	1966—1967	1,000	2.49	45.0	Saigal & Srivastava, 1969
7. Benaras (north India)	1966—1967	447	2.49	54.8	Pachauri & Marwah, 1970
8. Bombay (western India)	1966—1967	10,000	?	43.0	Aiyar & Agarwal, 1969
9. Delhi (north India)	1967—1970	9,000	2.55	48.2	Guha et al., 1973
10. Benaras (north India)	?	510	2.40	61.0	Bahl et al., 1971
11. Calcutta (east India)	1976	5,117	2.59	46.5	Present study

APPENDIX

Multiple Comparison Method

To ensure the over-all level of significance of the tests for pair-wise differences and contrasts in mean birth weights at α (5% or 1%) the procedure of multiple comparison has been utilized following Scheffe (1953).

Increments in mean weights within the pre-term and the post-term period separately have been examined to see if the two values representing ultimate weight-gain are equal. The mean weights at different gestation time-intervals are denoted by $\overline{W}_{31}$, $\overline{W}_{37}$, and $\overline{W}_{41}$ respectively and our null hypothesis is H_0: $(\overline{W}_{41} - \overline{W}_{37}) - (\overline{W}_{37} - \overline{W}_{31}) = 0$. Or, H_0: $\overline{W}_{41} - 2\overline{W}_{37} + \overline{W}_{31} = 0$. This is a contrast in means (mean birth weights) as the coefficients associated with these means (namely, 1, —2, and 1) add up to zero. For variation in birth-weight with respect to mother's socio-economic condition the null hypothesis (which we would like to test) is H_0: $(\overline{W}_C - \overline{W}_P) - (\overline{W}_P - \overline{W}_F) = 0$, where $\overline{W}_F$, $\overline{W}_P$ and $\overline{W}_C$ are the mean birth weights for "Poor", "Moderately well-off" and "Well-off" babies. In other words, this states that the differences in mean birth weight between the first two categories and the last two socio-economic classes are equal.

TABLE A. *Multiple comparison for Mean Birth Weights at different gestation periods*

Birth weight-group	Schefee				Multiple-T	
	General		Contrast			
	Level of significance					
	.05	.01	.05	.01	.05	.01
(1)	(2)	(3)	(4)	(5)	(6)	(7)
—2 500	69.04	83.24	60.55	75.06	34.61	39.67
All babies	164.19	197.97	144.00	178.51	82.30	94.35

The value of the contrast in means is 243.4 gms for babies weighing less than 2 500 gms and 220.7 gms for all babies. In no case, the value of the contrast ±S contains zero.

Pairwise Mean Differences:

Gestation time (by week)	Diff. in Mean Birth weights (gms)	Gestation time (by week)	Diff. in Mean Birth weight (gms)
(1)	(2)	(3)	(4)
—31 vs. 37	—501.44	—37 vs. 41	—280.71
—31 vs. 41	—782.15	—37 vs. 42+	—288.43
—31 vs. 42+	—789.87	—41 vs. 42+	—7.72

The value of S for α = .05 and .01 are 109.94 gms and 144.49 gms respectively. Except between —41 weeks and 41 weeks and above none of the pairwise differences in mean birth weight ±S contains zero.

TABLE B. *Multiple comparison for Mean Birth Weights at different socio-economic conditions*

Birth weight-group	Scheffe				Multiple-T	
	General		Contrast			
	Level of significance					
	.05	.01	.05	.01	.05	.01
(1)	(2)	(3)	(4)	(5)	(6)	(7)
—2 500	99.91	120.47	87.63	108.62	50.08	57.42
2 500+	70.85	85.43	62.14	77.03	35.52	40.72
All Babies	83.99	101.28	73.67	91.32	42.10	48.27

The values of the contrast in means are 15.4 gms, 4.3 gms and 14.92 gms respectively for the babies weighing less than 2 500 gms, for those born with weight at birth greater than 2,500 gms and for all babies respectively. In each case, the value of the contrast ±S contains zero.

Pairwise Mean Differences:

Socioeconomic Condition	Difference in mean birth weight (g.)
(1)	(2)
Poor vs. moderately well-off	—78.89
Poor vs. well-off	—172.70
Moderately well-off vs. well-off	—93.81

The values of S for α = .05 and .01 are 58.95 gms and 77.48 gms respectively. None of the pairwise differences in mean birth weights ±S contains zero.

This is also a "contrast" in means. In general, if the null hypothesis is H_0: $\sum_{i=1}^{p} c_i\bar{x}_i = 0$, where $\bar{x}_i$s are the means of the variable under study at different levels of a factor, then H_0 is rejected if the interval $\sum_{i=1}^{p} c_i\bar{x}_i \pm s$ does not contain zero where

$$S^2 = pF_{1-\alpha}(p, n-p)\, MS_W \sum_{i=1}^{p} \frac{c_i^2}{n_i} \qquad (1)$$

$$(p-1)\, F_{1-\alpha}(p-1, n-p)\, MS_W \sum_{i=1}^{p} \frac{c_i^2}{n_i} \qquad (2)$$

$$t_{1-(\alpha/2k)}(n-p)\, MS_W \sum_{i=1}^{p} \frac{c_i^2}{n_i} \qquad (3)$$

The expresions (1) and (2) relate to the method due to Scheffe (1953). The expression (2) is used for a "contrast" while (1) is applicable for any comparison among the means. The formula (3) is used in *Multiple T method*. Here $C_1 = C_3 = 1$, $C_2 = -2$, n_i's are the number of observations at the i[th] level of a factor, $F_{1-\alpha}(p, n-p)$ is the 100 $(1-\alpha)$ th percentile of the F-distribution with p and $n-p$ degrees of freedom, k is the number of preselected contrasts (here $k = 7$ and 4 for comparisons among means with respect to gestation time and socio-economic condition respectively), $t_{1-(\alpha/2k)}$ is the $100 [1 - (\alpha/2k)]$ th percentile of the t-distribution with $(n - p)$ degrees of freedom, MS_W is the error mean square (one way ANOVA model), p the number of means in the contrast (to be tested) etc. For $p = 2$ (i.e., in the test for pairwise differences in means) the method due to Scheffe is equivalent to the usual paired t-test with MS_W as the pooled estimate of the variances. However for the sake of uniformity, only the values of 'S, (g. are given in the following *Tables A) and B*).

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