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Ultrasonic estimation of gestational age and fetal weight

By

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Ultrasonic fast-scanning analysis was carried out during the 2nd and 3rd trimesters of pregnancy. In 1690 cases biparietal diameter, in 784 chest transverse diameter measurements were done and suitable growth charts constructed for the estimation of gestational time. Both the biparietal and chest transverse diameter values were taken into consideration in 582 cases and the results analysed by mathematical methods. A method has been worked out for the estimation of fetal weight with an absolute standard error of 261 g. On the basis of comparative studies it is suggested that obstetrical teams working with ultrasonic devices should establish their own set of parameters and methods.

Exact knowledge of gestational age and fetal weight is of utmost importance in obstetrical practice. If these data are reliably assessed they will be of help in determining:

(1) The expected time of delivery;

(2) Abnormal development of the fetus (hypertrophy, retardation, macrosomia, etc);

(3) Assessment of maturity

(a) imminent preterm delivery or one in progress;

(b) early rupture of membranes;

(c) in the case of cervical incompetence the planning of therapy (induction of labour, conservative therapy, cerclage);

(d) estimation of the optimum time of delivery when the fetus is exposed to some intrauterine noxa such as Rh iso-immunization, diabetes, chronic nephritis, toxaemia, severe heart disease, placenta praevia, etc.

(4) Choosing the optimum mode of delivery when there is abnormal position or presentation of the fetus with or without contracted pelvis and in the case of previous Caesarean section;

(5) Assessment of fitness for programmed delivery.

Analysis of the mother's menstrual cycle by Naegele's rule gives an estimate of the gestational age with an accuracy of $\pm$ 10 days. Since approximately 20% of the expectant mothers have scanty or unreliable anamnestic data, this rule cannot always be employed. When looking at the birth-weight of babies known to be born between the 39th and 42nd gestational weeks, Hansmann [7] found a deviation of 420 g from the average value of 3437 g.

Assessment of gestational age from the estimated time of conception by clinical examination will carry an error of $\pm$ 2 weeks, even with experienced obstetricians. Estimation of fetal weight by inspection and palpation of the mother's ab-

domen is an obsolete method, since in this way even specialists cannot judge fetal weight more accurately than 450 g above or below the actual birthweight. X-ray are helpful in the determination of maturity and fetal weight [7, 10]; the appearance and development of osseous centres, measurement of spinal length, estimation of the thickness of fat in the subcutis, examination of the cranium and the limbs are useful data, but regular examinations are impossible because of the irradiation hazard. Besides, in view of the phenomenon of projection, erroneous conclusions are frequent.

Ultrasonic measurements offer data that none of the aforementioned techniques can yield. Besides, the amount of energy used is harmless to both mother and fetus, so there is no need to limit either the time or the frequency of ultrasonic examinations [1, 10, 13, 15, 16].

Donald et al [6] in 1958 were the first to measure the biparietal diameter (BD) by means of ultrasonic B scan. Then Willocks et al [18] introduced the method into clinical practice. Since that time a number of authors [1, 2, 3, 4, 7, 8, 11, 12, 14, 18] described BD curves that hardly differed from one another. The differences originate from the use of various types of equipment, the calibration of curves, and from ethnic, social and nutritional factors. Common to all curves is that the BD shows a steady increase from the time it can first be measured (11th—12th week) till the 30—31st week. Thereafter the curves flatten and their rise may stop altogether. The weekly increase in mean fetal length drops from a value of 3—4 mm in week 11—12 to less than 1 mm in week 40 [1, 3, 7, 8, 12]. Since in ultrasonic diagnostics a measuring error of $\pm 1-2$ mm is acceptable and weekly growth during the third trimester is in this low range, estimation of gestational age can only be carried out until the BD has reached 8.0 cm [3, 7]. While measurements during the first two trimesters will help in estimating Naegele's rule with ± 10 days accuracy in cases with a BD of over 9.2 cm, the error can be ± 24 days.

There are a number of reports in the literature describing the average growth rate of other parts of the body [7, 10, 14]. These include the fronto-occipital diameter, head circumference, anterio-posterior or lateral diameter of the chest, diameter of the abdomen or the length of the spine. A shortcoming common to all these procedures is that they have considerable deviation from the mean and can thus give only approximate information about gestational age [1, 7, 12, 15]. Because of the well-known relationship between BD and fetal growth, the former has been widely used for estimating the size of the fetus [7, 9, 10, 13]. The majority of authors calculated linear regression using the following general formula:

$$\text{weight} = a \times BD + b.$$

By this approach they found a 400—600 g difference between the estimated weight and that found at birth. This method cannot, however, be used

in the two critical periods, at the time when the fetus becomes mature enough to survive and in the 2nd part of the 3rd trimester, as a standard deviation of 400—800 g in a low birth —weight infant is much too considerable. Although the growth rate of the BD comes to a halt, the weight of the fetus continues to increase due to the growth of other parts of the body such as the thorax, abdomen and extremities. The 1100 g mean weight gain during the 33rd to 38th gestational weeks corresponds to 110 g per mm of BD. A measuring error of ± 2 mm thus means a difference of ± 220 g and this is further accentuated by the great individual variations that characterize this period [10].

Because of the above-mentioned reasons fetal weight estimations by ultrasonic devices originally provided no greater accuracy than the classical palpation method. A number of authors therefore concluded that it is more reasonable to give the expected minimum weight values for any given BD. Thus, with a value of 8.5 cm the fetus will weigh at least 2000 g, but in fact in about 80% of the cases it will be 2500 g; and with a BD of 9.0 cm or over, 91% of the fetuses will be over 2500 g [2, 7, 9, 13, 15, 18]. In our own material 88.6% of the fetuses with a BD of 8.5 cm can be expected to weigh 2500 g or more, while of those with a BD of 9.0 cm will exceed this weight.

Thompson et al in 1965 [17] reported a significant improvement in ultrasonic weight estimation, using beside the BD value the chest measurement. On this basis Hansmann [7] studied the relationship to fetal weight of the BD, and the anterio-posterior and transverse diameters of the chest. As a result, they could estimate fetal growth with an error of ± 240 g.

The aim of our studies was to analyse a large material using a Siemens Vidoson 635-S fast-scanning ultrasonic device and to construct reliable growth-charts for the estimation of fetal weight.

Material, methods and results

Estimation of gestational age

Data from single, live fetuses from pregnancies with a reliable history were used. BD was determined in 1690 cases, the chest transverse diameter (CTD) in 784 cases. Mean BD and CTD are shown in Fig. 1 together with their standard deviations and the number of cases for each period. The growth charts were constructed by regression analysis in such a way that the optimum function was sought in the set of second-order algebraic polynominals and when analysing their coefficient, data from the different weeks were taken into account with the same weighting factor. Compression of the available data in this way allowed estimations even in the early periods of pregnancy, when because of the very nature of the investigations, fewer measurements were available. The second-order nonlinear regression curves are seen in Figs 2 and 3. The BD growth curve (Fig. 2) is, in accordance with literary data, concave

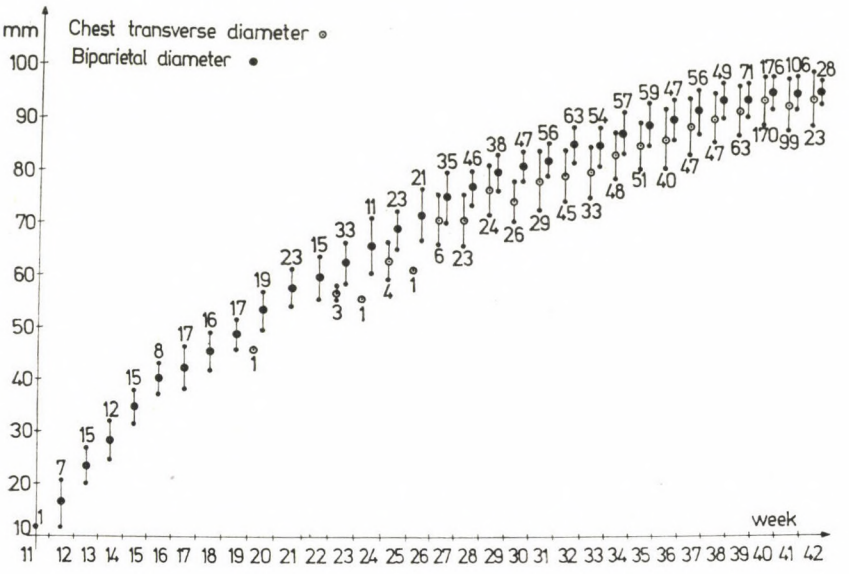

FIG. 1. Biparietal and chest transverse diameter, Mean ± S.D.

in shape. The growth-rate shows a diminishing tendency, and deviations from the mean are largest in the weeks 33—38 [3]. Regression analyses were carried out for the mean, for the range of standard deviation and two standard deviations. The CTD values in the function of time are shown in Fig. 3. Owing to the lack of data from early pregnancies, only measurements taken after the 24—25th week were taken into consideration. Results for earlier periods were derived from the analytic extension of the curves.

In contrast with some authors, we used the growth charts directly for gestational age estimation. According to Hansmann [7], regression analysis, based on algebraic polynomials, the method used by us too, is sensitive to the choice of dependent and independent variables, so that the estimation of term and growth should be carried out independently. Campbell's results [3] on the other hand suggest that the growth-charts are suitable for the estimation of term since the inverse function method of Hansmann did not lead to any great increase in accuracy.

For comparison we included Hansmann's results in Figs 2 and 3. The discrepancy proves our original scepticism in applying Hansmann's data directly for the assessment of foreign populations.

Term estimations were carried out using both growth-charts. In 102 cases where the date of the last menstual period was unknown, we estimated the time that could have elapsed since the last bleeding by the use of the BD in the range of 2.0—8.0 cm. The date of birth was accepted as correct when the newborn weighed 2500 g or more. We

found an average error of ± 7.63 days when using Hansmann's chart and an average of ±7.58 days when using our own. The difference is not significant. There was a greater positive error of the mean in our series (a greater number of births estimated for later than the actual delivery), due

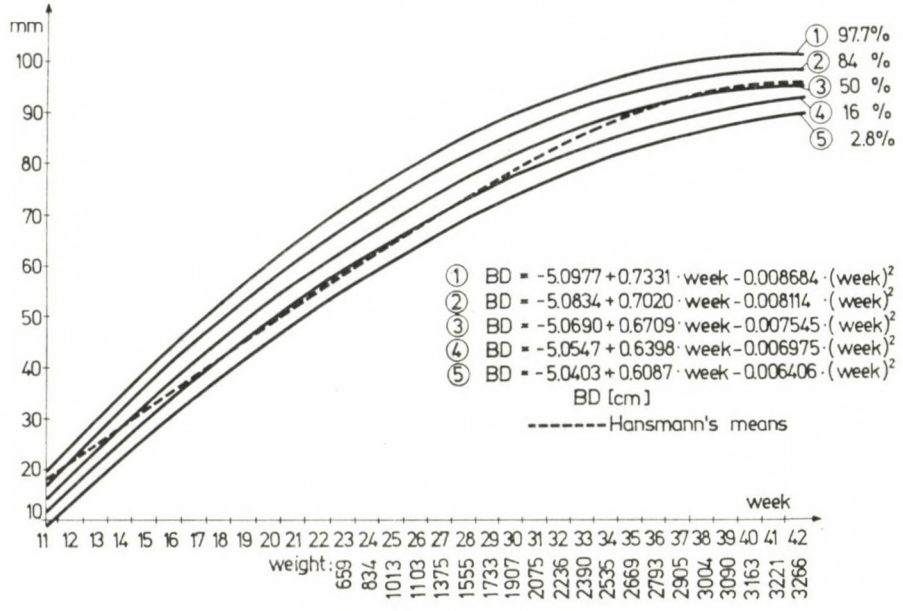

FIG. 2. Regression curves for biparietal diameter

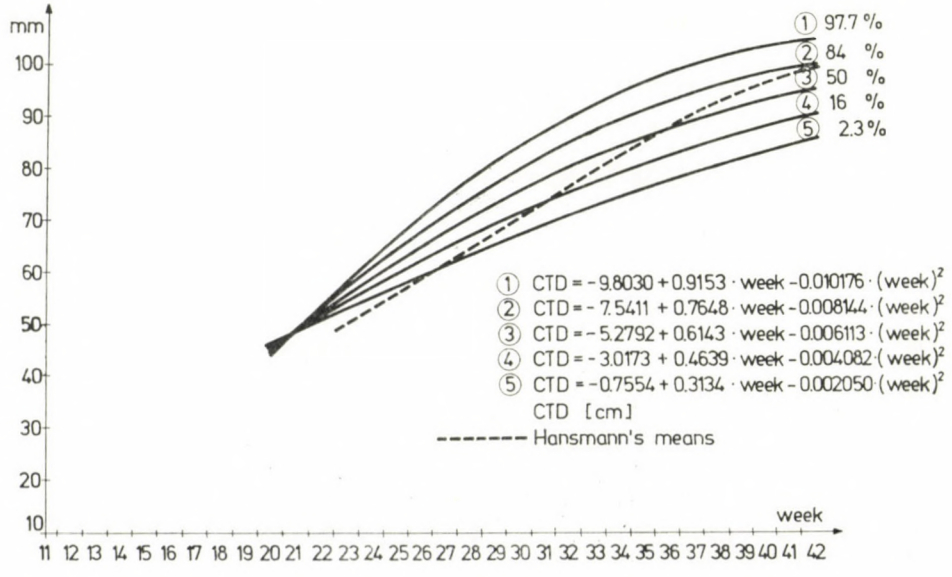

FIG. 3. Regression curves for chest transverse diameter

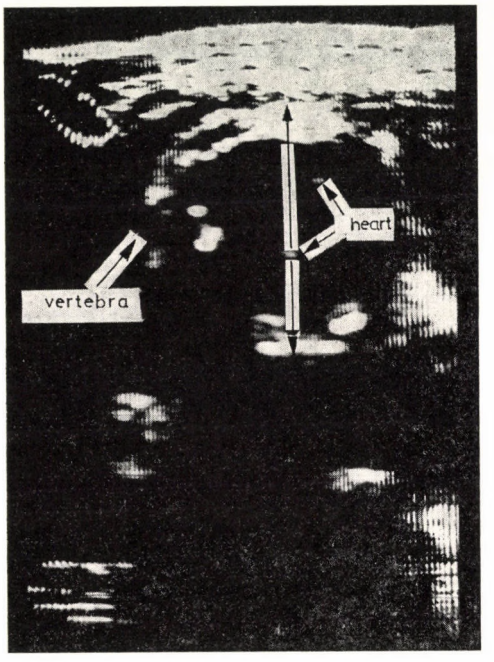

FIG. 4. Horizontal section of fetal chest in the plane used for the ultrasonic studies

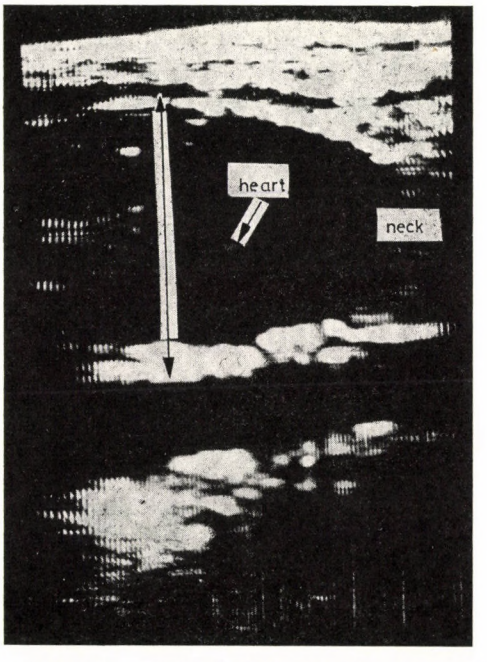

FIG. 5. Longitudinal section of fetal chest, at the dome of the diaphragm

to the 2500 g limit that we set up beforehand. Among the 102 newborns a number could have actually been premature normal-weight babies. This phenomenon, however, did not alter the absolute values of the estimations.

Estimation of fetal weight

Fetal weight can be calculated by complicated methods requiring many measurements [10] or by easy but fairly crude methods relying on a single parameter [2, 9, 13]. We chose one that will provide the clinician with accurate data yielded by short, repeated examinations. We estimated the weight in the function of the BD and the CTD. For a comparison we studied the correlation of fetal weight with the BD, but omitted the anterio-posterior diameter values. The reason for this was that in presentation I or II, the contours to be measured are somewhat smudged in the transverse plane, and for an estimation of the sagittal diameter of the chest in the longitudinal plane the mother and the ultrasonic probe must be moved in a complicated manner. For chest measurements we used the plane perpendicular to the body axis at the widest point of the chest, at the height of the dome of the diaphragm.

All the cases have been included in the analysis, where we found a live fetus without any major deformity and its weight could be estimated during the 5 days preceding delivery, including pregnancies with suspected placental dysfunction such as diabetes, Rh iso-immunization, chronic nephritis or heart disease, since in

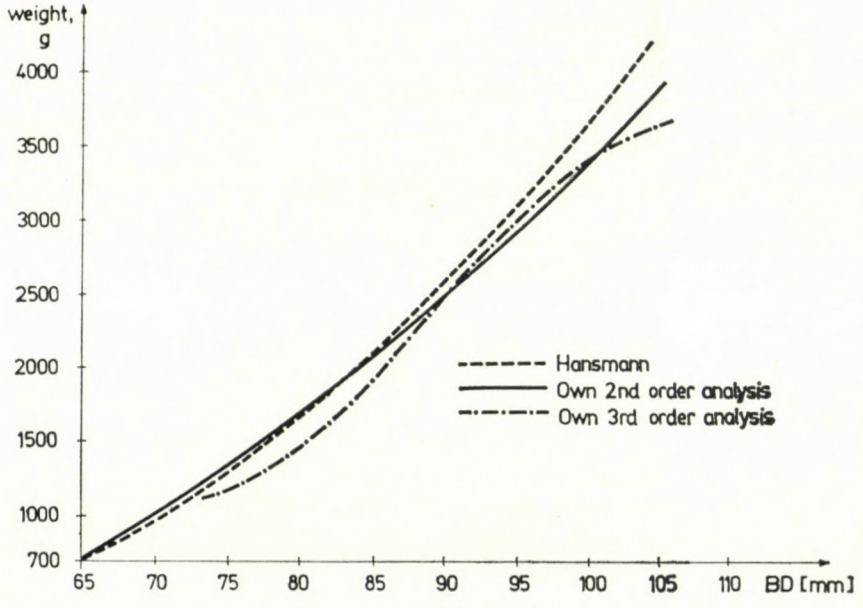

FIG. 6. Weight curves based on biparietal diameter

TABLE I

Error in weight estimations based on biparietal diameter. Own data and those of Hansmann [7]

No. of cases	Average absolute error g	Standard deviation g	Standard error g
Own compiled data			
582	312	405	0
>2500 g			
466	304	402	—66
≤2500 g			
116	345	416	267
Hansmann's compiled data			
582	368	459	189
>2500 g			
466	364	455	159
≤2500 g			
116	386	474	313

these cases knowledge of fetal weight is of importance. 582 cases fulfilled our criteria; of these 116 deliveries produced babies weighing less than 2500 g.

The optimum regression curve for the BD alone can be given as:

$$G = -0.0019931 - 0.3225983\ (BD) + 0.0669517\ (BD)^2$$

where G is the weight in kg, and BD is given in cm. The regression curve is shown in Fig. 6 together with that of Hansmann. It can be seen that in the range of greater weights of the latter curve all the estimations are higher than the values obtained by us. The different values of error for newborns under and above 2500 g birth weight are given in Table I. With the aid of our curve, fetal weight can be determined with an accuracy of — 312 g. To help the practising obstetrician in making a rough estimation of fetal weight, we show the average weights for each gestational week in Fig 2, as derived from measurements of the BD.

If in order to increase the accuracy of estimations, the CTD too is taken into consideration, the formula will be

$$G = 0.0457484 - 1.3148142\ (BD) + 0.0955847\ (BD)^2 + 1.0677968\ (CTD) - 0.035646\ (CTD)^2.$$

The results can be seen in Table IV, where BD values are shown horizontally and the CTD and fetal weight values vertically. This Table is suitable for direct weight estimation in the range of 7.0—10.9 cm BD.

The values characterizing the accuracy of the regression calculations are shown in Table II together with those of Hansmann. The mean error of our method is 261 g, considerably less than that derived from single-parameter analyses.

The errors of estimation are more clearly illustrated in Figs 7 and 8; they show the frequency of percentual difference between the estimated and found values. The differences over 25% are collected in the columns +25 and —25. Fig. 7 represents Hansmann's data, and Fig. 8 our own re-

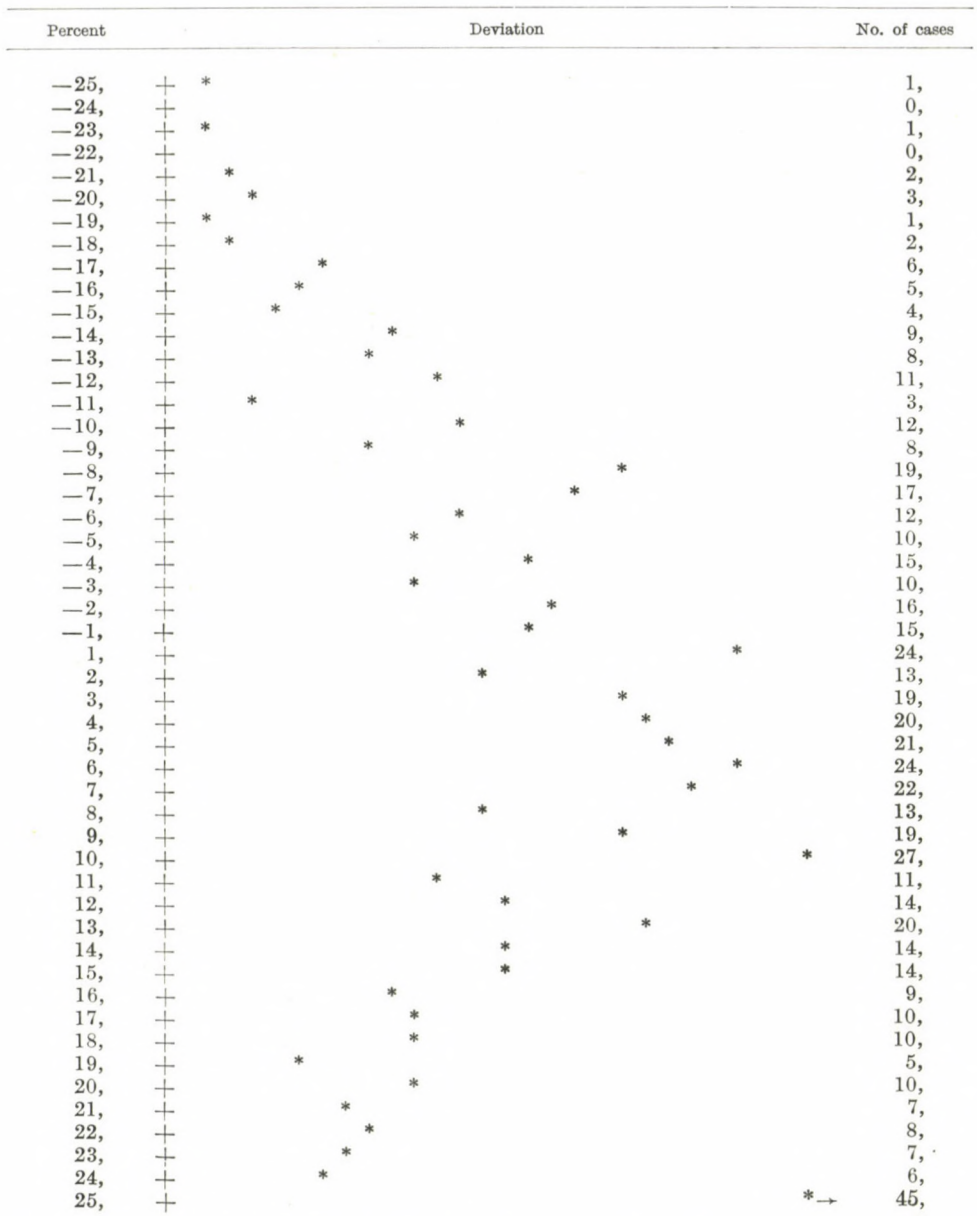

FIG. 7. Frequency of percentual difference between estimated and observed values of fetal weight. Estimation based on biparietal and chest transverse diameter, Hansmann's [7] data

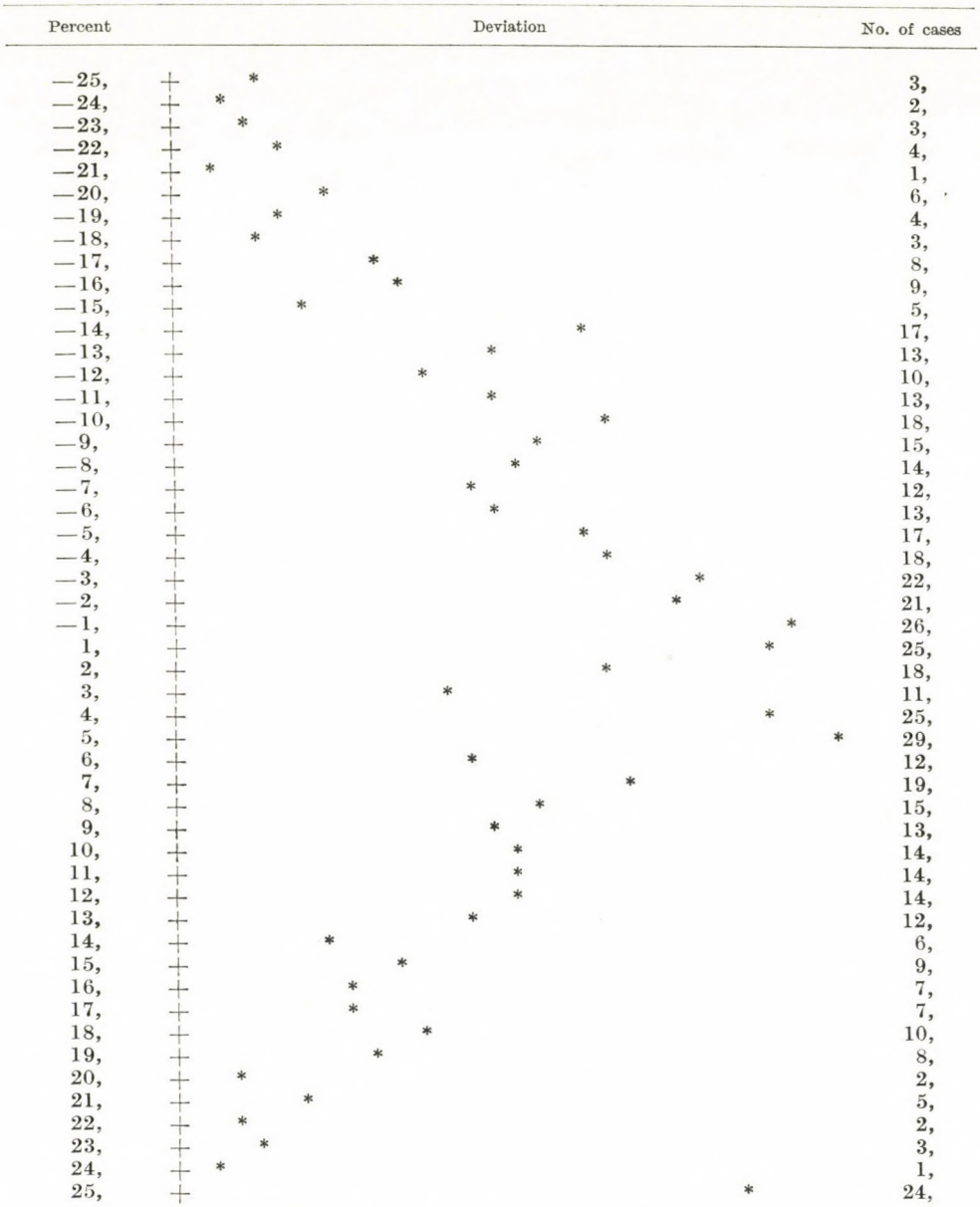

FIG. 8. Frequency of percentual difference between estimated and observed values of fetal weight. Estimation based on biparietal and chest transverse diameter own data

sults. There is no positive shift, thus bringing the standard error to 0 (see also Table II).

In an attempt further to improve the accuracy of estimations ,we have made trials with other mathematical models. If we suppose a third-order correlation between body measurements and weight, since the weight of homogeneous masses increases cubically with linear measurements, the regression curve or plane should be sought in the set of third-order algebraic polynomials. The results for the BD are shown in Fig. 6 and the data characterizing the error of esti-

TABLE II

Error in weight estimation based on biparietal and chest transverse diameters. Own data and those of Hansmann [7]

No. of cases	Average absolute error g	Standard deviation g	Standard error g
Own compiled data			
582	261	328	0
>2500 g			
466	267	333	−29
≤2500 g			
116	234	304	118
Hansmann's compiled data			
582	292	359	117
>2500 g			
466	290	357	86
<2500 g			
116	299	371	244

TABLE III

Error in weight estimation using third-order regression analysis based on biparietal, and biparietal and chest transverse diameters

No. of cases	Average absolute error g	Standard deviation g	Standard error g
Third-order analysis of BP			
Total			
582	306	386	0
>2500 g			
466	299	378	−45
≤2500 g			
116	333	415	183
Third-order analysis of BP and CTD			
Total			
582	258	324	0
>2500 g			
466	267	331	−23
≤2500 g			
116	224	295	91

TABLE IV

Table for weight estimation. Horizontally: biparietal diameter in mm; vertically: chest transverse diameter in mm, with corresponding weights in g

70,	71,	72,	73,	74,	75,	76,	77,	78,	79,	
649,	652,	657,	664,	673,	684,	697,	712,	729,	747,	60,
712,	716,	721,	728,	737,	748,	761,	776,	792,	811,	61,
775,	779,	784,	791,	800,	811,	824,	839,	855,	874,	62,
838,	841,	846,	853,	862,	873,	886,	901,	917,	936,	63,
899,	902,	908,	915,	924,	935,	947,	962,	979,	997,	64,
960,	963,	968,	975,	984,	995,	1008,	1023,	1040,	1058,	65,
1020,	1023,	1028,	1036,	1045,	1056,	1068,	1083,	1100,	1118,	66,
1079,	1083,	1088,	1095,	1104,	1115,	1128,	1142,	1159,	1178,	67,
1138,	1141,	1146,	1154,	1163,	1174,	1186,	1201,	1218,	1236,	68,
1196,	1199,	1204,	1212,	1221,	1231,	1244,	1259,	1276,	1294,	69,
1253,	1256,	1262,	1269,	1278,	1289,	1302,	1316,	1333,	1352,	70,
1310,	1313,	1318,	1325,	1334,	1345,	1358,	1373,	1390,	1408,	71,
1365,	1369,	1374,	1381,	1390,	1401,	1414,	1429,	1445,	1464,	72,
1421,	1424,	1429,	1436,	1445,	1456,	1469,	1484,	1500,	1519,	73,
1475,	1478,	1483,	1491,	1500,	1511,	1523,	1538,	1555,	1573,	74,
1529,	1532,	1537,	1544,	1553,	1564,	1577,	1592,	1608,	1627,	75,
1582,	1585,	1590,	1597,	1606,	1617,	1630,	1645,	1661,	1680,	76,
1634,	1637,	1642,	1649,	1658,	1669,	1682,	1697,	1714,	1732,	77,
1685,	1689,	1694,	1701,	1710,	1721,	1734,	1749,	1765,	1784,	78,
1736,	1739,	1745,	1752,	1761,	1772,	1785,	1799,	1816,	1835,	79,
1786,	1790,	1795,	1802,	1811,	1822,	1835,	1849,	1866,	1885,	80,
1836,	1839,	1844,	1851,	1860,	1871,	1884,	1899,	1915,	1934,	81,
1884,	1888,	1893,	1900,	1909,	1920,	1933,	1947,	1964,	1983,	82,
1932,	1936,	1941,	1948,	1957,	1968,	1981,	1995,	2012,	2031,	83,
1980,	1983,	1988,	1995,	2004,	2015,	2028,	2043,	2059,	2078,	84,
2026,	2029,	2035,	2042,	2051,	2062,	2074,	2089,	2106,	2125,	85,
2072,	2075,	2080,	2087,	2097,	2107,	2120,	2135,	2152,	2170,	86,
2117,	2120,	2125,	2133,	2142,	2153,	2165,	2180,	2197,	2215,	87,
2161,	2165,	2170,	2177,	2186,	2197,	2210,	2225,	2241,	2260,	88,
2205,	2208,	2214,	2221,	2230,	2241,	2254,	2268,	2285,	2304,	89,
2248,	2251,	2257,	2264,	2273,	2284,	2296,	2311,	2328,	2347,	90,
2290,	2294,	2299,	2306,	2315,	2326,	2339,	2354,	2370,	2389,	91,
2332,	2335,	2340,	2347,	2356,	2367,	2380,	2395,	2412,	2430,	92,
2373,	2376,	2381,	2388,	2397,	2408,	2421,	2436,	2453,	2471,	93,
2413,	2416,	2421,	2428,	2437,	2448,	2461,	2476,	2493,	2511,	94,
2452,	2456,	2461,	2468,	2477,	2488,	2501,	2515,	2532,	2551,	95,
2491,	2494,	2499,	2507,	2516,	2526,	2539,	2554,	2571,	2589,	96,
2529,	2532,	2537,	2545,	2554,	2564,	2577,	2592,	2609,	2627,	97,
2566,	2569,	2575,	2582,	2591,	2602,	2615,	2629,	2646,	2665,	98,
2603,	2606,	2611,	2618,	2627,	2638,	2651,	2666,	2683,	2701,	99,
2639,	2642,	2647,	2654,	2663,	2674,	2687,	2702,	2718,	2737,	100,
2674,	2677,	2682,	2689,	2698,	2709,	2722,	2737,	2754,	2772,	101,
2708,	2711,	2717,	2724,	2733,	2744,	2757,	2771,	2788,	2807,	102,
2742,	2745,	2750,	2757,	2766,	2777,	2790,	2805,	2822,	2840,	103,
2775,	2778,	2783,	2790,	2799,	2810,	2823,	2838,	2855,	2873,	104,
2807,	2810,	2816,	2823,	2832,	2843,	2856,	2870,	2887,	2906,	105,
2839,	2842,	2847,	2854,	2863,	2874,	2887,	2902,	2919,	2937,	106,
2870,	2873,	2878,	2885,	2894,	2905,	2918,	2933,	2949,	2968,	107,
2900,	2903,	2908,	2915,	2924,	2935,	2948,	2963,	2980,	2998,	108,
2929,	2932,	2938,	2945,	2954,	2965,	2978,	2992,	3009,	3028,	109,
2958,	2961,	2966,	2973,	2982,	2993,	3006,	3021,	3038,	3056,	110,
2986,	2989,	2994,	3001,	3010,	3021,	3034,	3049,	3066,	3084,	111,
3013,	3016,	3022,	3029,	3038,	3049,	3062,	3076,	3093,	3112,	112,
3040,	3043,	3048,	3055,	3064,	3075,	3088,	3103,	3120,	3138,	113,
3066,	3069,	3074,	3081,	3090,	3101,	3114,	3129,	3145,	3164,	114,
3091,	3094,	3099,	3106,	3115,	3126,	3139,	3154,	3171,	3189,	115,
3115,	3118,	3124,	3131,	3140,	3151,	3164,	3178,	3195,	3214,	116,
3139,	3142,	3147,	3154,	3163,	3174,	3187,	3202,	3219,	3237,	117,
3162,	3165,	3170,	3177,	3186,	3197,	3210,	3225,	3242,	3260,	118,
3184,	3187,	3193,	3200,	3209,	3220,	3233,	3247,	3264,	3283,	119,

70, 71, 72, 73, 74, 75, 76, 77, 78, 79,

TABLE IV (cont.)

80,	81,	82,	83,	84	85,	86,	87,	88,	89,	
768,	790,	814,	841,	869,	899,	931,	965,	1000,	1038,	60,
831,	854,	878,	904,	932,	962,	994,	1028,	1064,	1102,	61,
894,	917,	941,	967,	995,	1025,	1057,	1091,	1127,	1165,	62,
956,	979,	1003,	1029,	1058,	1088,	1120,	1154,	1189,	1227,	63,
1018,	1040,	1065,	1091,	1119,	1149,	1181,	1215,	1251,	1289,	64,
1079,	1101,	1126,	1152,	1180,	1210,	1242,	1276,	1312,	1349,	65,
1139,	1161,	1186,	1212,	1240,	1270,	1302,	1336,	1372,	1409,	66,
1198,	1221,	1245,	1271,	1299,	1329,	1361,	1395,	1431,	1469,	67,
1257,	1279,	1304,	1330,	1358,	1388,	1420,	1454,	1490,	1527,	68,
1315,	1337,	1362,	1388,	1416,	1446,	1478,	1512,	1548,	1585,	69,
1372,	1394,	1419,	1445,	1473,	1503,	1535,	1569,	1605,	1643,	70,
1429,	1451,	1475,	1502,	1530,	1560,	1592,	1626,	1661,	1699,	71,
1484,	1507,	1531,	1557,	1586,	1616,	1648,	1681,	1717,	1755,	72,
1539,	1562,	1586,	1612,	1641,	1671,	1703,	1737,	1772,	1810,	73,
1594,	1616,	1641,	1667,	1695,	1725,	1757,	1791,	1827,	1864,	74,
1648,	1670,	1694,	1721,	1749,	1779,	1811,	1845,	1880,	1918,	75,
1700,	1723,	1747,	1773,	1802,	1832,	1864,	1898,	1933,	1971,	76,
1753,	1775,	1799,	1826,	1854,	1884,	1916,	1950,	1986,	2023,	77,
1804,	1827,	1851,	1877,	1905,	1935,	1967,	2001,	2037,	2075,	78,
1855,	1877,	1902,	1928,	1956,	1986,	2018,	2052,	2088,	2126,	79,
1905,	1928,	1952,	1978,	2006,	2036,	2068,	2102,	2138,	2176,	80,
1955,	1977,	2001,	2028,	2056,	2086,	2118,	2152,	2187,	2225,	81,
2003,	2026,	2050,	2076,	2104,	2134,	2166,	2200,	2236,	2274,	82,
2051,	2074,	2098,	2124,	2152,	2182,	2214,	2248,	2284,	2322,	83,
2098,	2121,	2145,	2171,	2200,	2230,	2262,	2295,	2331,	2369,	84,
2145,	2167,	2192,	2218,	2246,	2276,	2308,	2342,	2378,	2416,	85,
2191,	2213,	2238,	2264,	2292,	2322,	2354,	2388,	2424,	2461,	86,
2236,	2258,	2283,	2309,	2337,	2367,	2399,	2433,	2469,	2506,	87,
2280,	2303,	2327,	2353,	2381,	2412,	2443,	2477,	2513,	2551,	88,
2324,	2346,	2371,	2397,	2425,	2455,	2487,	2521,	2557,	2595,	89,
2367,	2389,	2414,	2440,	2468,	2498,	2530,	2564,	2600,	2638,	90,
2409,	2432,	2456,	2482,	2510,	2540,	2572,	2606,	2642,	2680,	91,
2451,	2473,	2498,	2524,	2552,	2582,	2614,	2648,	2684,	2721,	92,
2492,	2514,	2538,	2565,	2593,	2623,	2655,	2689,	2724,	2762,	93,
2532,	2554,	2578,	2605,	2633,	2663,	2695,	2729,	2765,	2802,	94,
2571,	2594,	2618,	2644,	2672,	2702,	2734,	2768,	2804,	2842,	95,
2610,	2632,	2657,	2683,	2711,	2741,	2773,	2807,	2843,	2880,	96,
2648,	2670,	2695,	2721,	2749,	2779,	2811,	2845,	2881,	2918,	97,
2685,	2708,	2732,	2758,	2786,	2816,	2848,	2882,	2918,	2956,	98,
2722,	2744,	2768,	2795,	2823,	2853,	2885,	2919,	2954,	2992,	99,
2758,	2780,	2804,	2830,	2859,	2889,	2921,	2955,	2990,	3028,	100,
2793,	2815,	2839,	2866,	2894,	2924,	2956,	2990,	3025,	3063,	101,
2827,	2849,	2874,	2900,	2928,	2958,	2990,	3024,	3060,	3098,	102,
2861,	2883,	2908,	2934,	2962,	2992,	3024,	3058,	3094,	3131,	103,
2894,	2916,	2941,	2967,	2995,	3025,	3057,	3091,	3127,	3164,	104,
2926,	2948,	2973,	2999,	3027,	3057,	3089,	3123,	3159,	3197,	105,
2958,	2980,	3004,	3031,	3059,	3089,	3121,	3155,	3190,	3228,	106,
2988,	3011,	3035,	3061,	3090,	3120,	3152,	3185,	3221,	3259,	107,
3019,	3041,	3065,	3092,	3120,	3150,	3182,	3216,	3251,	3289,	108,
3048,	3070,	3095,	3121,	3149,	3179,	3211,	3245,	3281,	3319,	109,
3077,	3099,	3123,	3150,	3178,	3208,	3240,	3274,	3310,	3347,	110,
3105,	3127,	3151,	3178,	3206,	3236,	3268,	3302,	3338,	3375,	111,
3132,	3154,	3179,	3205,	3233,	3263,	3295,	3329,	3365,	3403,	112,
3159,	3181,	3205,	3232,	3260,	3290,	3322,	3356,	3391,	3429,	113,
3184,	3207,	3231,	3257,	3286,	3316,	3348,	3381,	3417,	3455,	114,
3210,	3232,	3256,	3283,	3311,	3341,	3373,	3407,	3442,	3480,	115,
3234,	3256,	3281,	3307,	3335,	3365,	3397,	3431,	3467,	3505,	116,
3258,	3280,	3305,	3331,	3359,	3389,	3421,	3455,	3491,	3528,	117,
3281,	3303,	3328,	3354,	3382,	3412,	3444,	3478,	3514,	3551,	118,
3303,	3326,	3350,	3376,	3404,	3434,	3466,	3500,	3536,	3574,	119,

80,	81,	82,	83,	84,	85,	86,	87,	88,	89,	

TABLE IV (cont.)

90,	91,	92,	93,	94,	95,	96,	97,	98,	99,	
1078,	1119,	1163,	1208,	1255,	1305,	1356,	1409,	1464,	1520,	60,
1141,	1183,	1226,	1272,	1319,	1368,	1419,	1472,	1527,	1584,	61,
1204,	1246,	1289,	1335,	1382,	1431,	1482,	1535,	1590,	1647,	62,
1267,	1308,	1352,	1397,	1444,	1493,	1544,	1597,	1652,	1709,	63,
1328,	1370,	1413,	1458,	1506,	1555,	1606,	1659,	1714,	1771,	64,
1389,	1430,	1474,	1519,	1566,	1616,	1667,	1720,	1775,	1831,	65,
1449,	1491,	1534,	1579,	1627,	1676,	1727,	1780,	1835,	1892,	66,
1508,	1550,	1593,	1639,	1686,	1735,	1786,	1839,	1894,	1951,	67,
1567,	1609,	1652,	1697,	1745,	1794,	1845,	1898,	1953,	2010,	68,
1625,	1667,	1710,	1755,	1803,	1852,	1903,	1956,	2011,	2068,	69,
1682,	1724,	1767,	1813,	1860,	1909,	1960,	2013,	2068,	2125,	70,
1739,	1780,	1824,	1869,	1916,	1965,	2017,	2070,	2124,	2181,	71,
1795,	1836,	1879,	1925,	1972,	2021,	2072,	2125,	2180,	2237,	72,
1850,	1891,	1935,	1980,	2027,	2076,	2127,	2180,	2235,	2292,	73,
1904,	1946,	1989,	2034,	2082,	2131,	2182,	2235,	2290,	2347,	74,
1958,	1999,	2043,	2088,	2135,	2184,	2236,	2289,	2343,	2400,	75,
2011,	2052,	2096,	2141,	2188,	2237,	2288,	2341,	2396,	2453,	76,
2063,	2104,	2148,	2193,	2240,	2290,	2341,	2394,	2449,	2505,	77,
2114,	2156,	2199,	2245,	2292,	2341,	2392,	2445,	2500,	2557,	78,
2165,	2207,	2250,	2296,	2343,	2392,	2443,	2496,	2551,	2608,	79,
2215,	2257,	2300,	2346,	2393,	2442,	2493,	2546,	2601,	2658,	80,
2265,	2306,	2350,	2395,	2442,	2491,	2543,	2596,	2650,	2707,	81,
2313,	2355,	2398,	2444,	2491,	2540,	2591,	2644,	2699,	2756,	81,
2361,	2403,	2446,	2492,	2539,	2588,	2639,	2692,	2747,	2804,	83,
2409,	2450,	2494,	2539,	2586,	2635,	2686,	2739,	2794,	2851,	84,
2455,	2497,	2540,	2585,	2633,	2682,	2733,	2786,	2841,	2898,	85,
2501,	2542,	2586,	2631,	2679,	2728,	2779,	2832,	2887,	2944,	86,
2546,	2588,	2631,	2676,	2724,	2773,	2824,	2877,	2932,	2989,	87,
2590,	2632,	2675,	2721,	2768,	2817,	2868,	2921,	2976,	3033,	88,
2634,	2676,	2719,	2764,	2812,	2861,	2912,	2965,	3020,	3077,	89,
2677,	2719,	2762,	2807,	2855,	2904,	2955,	3008,	3063,	3120,	90,
2719,	2761,	2804,	2850,	2897,	2946,	2997,	3050,	3105,	3162,	91,
2761,	2802,	2846,	2891,	2939,	2988,	3039,	3092,	3147,	3203,	92,
2802,	2843,	2887,	2932,	2979,	3029,	3080,	3133,	3188,	3244,	93,
2842,	2883,	2927,	2972,	3019,	3069,	3120,	3173,	3228,	3284,	94,
2881,	2923,	2966,	3012,	3059,	3108,	3159,	3212,	3267,	3324,	95,
2920,	2962,	3005,	3050,	3098,	3147,	3198,	3251,	3306,	3363,	96,
2958,	3000,	3043,	3088,	3136,	3185,	3236,	3289,	3344,	3401,	97,
2995,	3037,	3080,	3126,	3173,	3222,	3273,	3326,	3381,	3438,	98,
3032,	3073,	3117,	3162,	3209,	3259,	3310,	3363,	3418,	3474,	99,
3068,	3109,	3153,	3198,	3245,	3294,	3345,	3398,	3453,	3510,	100,
3103,	3144,	3188,	3233,	3280,	3330,	3381,	3434,	3489,	3545,	101,
3137,	3179,	3222,	3268,	3315,	3364,	3415,	3468,	3523,	3580,	102,
3171,	3212,	3256,	3301,	3348,	3398,	3449,	3502,	3557,	3613,	103,
3204,	3245,	3289,	3334,	3381,	3431,	3482,	3535,	3590,	3646,	104,
3236,	3278,	3321,	3366,	3414,	3463,	3514,	3567,	3622,	3679,	105,
3268,	3309,	3353,	3398,	3445,	3494,	3546,	3599,	3653,	3710,	106,
3299,	3340,	3384,	3429,	3476,	3525,	3576,	3629,	3684,	3741,	107,
3329,	3370,	3414,	3459,	3506,	3555,	3607,	3660,	3714,	3771,	108,
3358,	3400,	3443,	3488,	3536,	3585,	3636,	3689,	3744,	3801,	109,
3387,	3428,	3472,	3517,	3564,	3614,	3665,	3718,	3773,	3829,	110,
3415,	3456,	3500,	3545,	3592,	3642,	3693,	3746,	3801,	3857,	111,
3442,	3484,	3527,	3572,	3620,	3669,	3720,	3773,	3828,	3885,	112,
3469,	3510,	3554,	3499,	3646,	3695,	3747,	3800,	3854,	3911,	113,
3495,	3536,	3580,	3625,	3672,	3721,	3773,	3825,	3880,	3937,	114,
3520,	3561,	3605,	3650,	3697,	3747,	3798,	3851,	3906,	3962,	115,
3544,	3586,	3629,	3675,	3722,	3771,	3822,	3875,	3930,	3987,	116,
3568,	3609,	3653,	3698,	3745,	3795,	3846,	3899,	3954,	4010,	117,
3591,	3632,	3676,	3721,	3769,	3818,	3869,	3922,	3977,	4033,	118,
3613,	3655,	3698,	3744,	3791,	3840,	3891,	3944,	3999,	4056,	119,

90,	91,	92,	93,	94,	95,	96,	97,	98,	99,	

TABLE IV (cont.)

100,	101,	102,	103,	104,	105,	106,	107,	108,	109,	
1579,	1640,	1702,	1767,	1833,	1901,	1972,	2044,	2118,	2194,	60,
1643,	1703,	1766,	1830,	1897,	1965,	2035,	2107,	2181,	2257,	61,
1706,	1766,	1829,	1893,	1960,	2028,	2098,	2170,	2244,	2320,	62,
1768,	1829,	1891,	1956,	2022,	2090,	2160,	2233,	2307,	2383,	63,
1829,	1890,	1953,	2017,	2083,	2152,	2222,	2294,	2368,	2444,	64,
1890,	1951,	2013,	2078,	2144,	2213,	2283,	2355,	2429,	2505,	65,
1950,	2011,	2073,	2138,	2204,	2273,	2343,	2415,	2489,	2565,	66,
2010,	2070,	2133,	2197,	2264,	2332,	2402,	2474,	2548,	2624,	67,
2068,	2129,	2192,	2256,	2322,	2391,	2461,	2533,	2607,	2683,	68,
2126,	2187,	2249,	2314,	2380,	2449,	2519,	2591,	2665,	2741,	69,
2184,	2244,	2307,	2371,	2438,	2506,	2576,	2648,	2722,	2798,	70,
2240,	2301,	2363,	2428,	2494,	2562,	2633,	2705,	2779,	2855,	71,
2296,	2356,	2419,	2483,	2550,	2618,	2688,	2760,	2835,	2910,	72,
2351,	2412,	2474,	2539,	2605,	2673,	2743,	2816,	2890,	2966,	73,
2405,	2466,	2529,	2593,	2659,	2728,	2798,	2870,	2944,	3020,	74,
2459,	2520,	2582,	2647,	2713,	2781,	2852,	2924,	2998,	3074,	75,
2512,	2573,	2635,	2700,	2766,	2834,	2904,	2977,	3051,	3127,	76,
2564,	2625,	2687,	2752,	2818,	2887,	2957,	3029,	3103,	3179,	77,
2616,	2676,	2739,	2803,	2870,	2938,	3008,	3080,	3154,	3230,	78,
2667,	2227,	2790,	2854,	2921,	2989,	3059,	3131,	3205,	3281,	79,
2717,	2777,	2840,	2904,	2971,	3039,	3109,	3181,	3255,	3331,	80,
2766,	2827,	2889,	2954,	3020,	3088,	3159,	3231,	3305,	3381,	81,
2815,	2875,	2938,	3002,	3069,	3137,	3207,	3279,	3353,	3429,	82,
2863,	2923,	2986,	3050,	3117,	3185,	3255,	3327,	3401,	3477,	83,
2910,	2971,	3033,	3098,	3164,	3232,	3302,	3375,	3449,	3525,	84,
2956,	3017,	3080,	3144,	3210,	3279,	3349,	3421,	3495,	3571,	85,
3002,	3063,	3125,	3190,	3256,	3325,	3395,	3467,	3541,	3617,	86,
3047,	3108,	3171,	3235,	3301,	3370,	3440,	3512,	3586,	3662,	87,
3092,	3152,	3215,	3279,	3346,	3414,	3484,	3556,	3630,	3706,	88,
3135,	3196,	3259,	3323,	3389,	3458,	3528,	3600,	3674,	3750,	89,
3178,	3239,	3302,	3366,	3432,	3501,	3571,	3643,	3717,	3793,	90,
3221,	3281,	3344,	3408,	3475,	3543,	3613,	3685,	3759,	3835,	91,
3262,	3323,	3385,	3450,	3516,	3585,	3655,	3727,	3801,	3877,	92,
3303,	3364,	3426,	3491,	3557,	3625,	3696,	3768,	3842,	3918,	93,
3343,	3404,	3466,	3531,	3597,	3666,	3736,	3808,	3882,	3958,	94,
3383,	3443,	3506,	3570,	3637,	3705,	3775,	3847,	3921,	3997,	95,
3421,	3482,	3544,	3609,	3675,	3744,	3814,	3886,	3960,	4036,	96,
3459,	3520,	3582,	3647,	3713,	3782,	3852,	3924,	3998,	4074,	97,
3497,	3557,	3620,	3684,	3751,	3819,	3889,	3961,	4035,	4111,	98,
3533,	3594,	3656,	3721,	3787,	3855,	3926,	3998,	4072,	4148,	99,
3569,	3630,	3692,	3757,	3823,	3891,	3961,	4034,	4108,	4184,	100,
3604,	3665,	3727,	3792,	3858,	3926,	3997,	4069,	4143,	4219,	101,
3638,	3699,	3762,	3826,	3893,	3961,	4031,	4103,	4177,	4253,	102,
3672,	3733,	3795,	3860,	3926,	3995,	4065,	4137,	4211,	4287,	103,
3705,	3766,	3828,	3893,	3959,	4028,	4098,	4170,	4244,	4320,	104,
3737,	3798,	3861,	3925,	3992,	4060,	4130,	4202,	4276,	4352,	105,
3769,	3830,	3892,	3957,	4023,	4091,	4162,	4234,	4308,	4384,	106,
3800,	3861,	3923,	3988,	4054,	4122,	4192,	4265,	4339,	4415,	107,
3830,	3891,	3953,	4018,	4084,	4152,	4223,	4295,	4369,	4445,	108,
3859,	3920,	3983,	4047,	4114,	4182,	4252,	4324,	4398,	4474,	109,
3888,	3949,	4011,	4076,	4142,	4211,	4281,	4353,	4427,	4503,	110,
3916,	3977,	4039,	4104,	4170,	4239,	4309,	4381,	4455,	4531,	111,
3943,	4004,	4067,	4131,	4198,	4266,	4336,	4408,	4482,	4558,	112,
3970,	4031,	4093,	4158,	4224,	4292,	4363,	4435,	4509,	4585,	113,
3996,	4057,	4119,	4184,	4250,	4318,	4388,	4461,	4535,	4611,	114,
4021,	4082,	4144,	4209,	4275,	4343,	4414,	4486,	4560,	4636,	115,
4045,	4106,	4169,	4233,	4300,	4368,	4438,	4510,	4584,	4660,	116,
4069,	4130,	4192,	4257,	4323,	4392,	4462,	4534,	4608,	4684,	117,
4092,	4153,	4215,	4280,	4346,	4415,	4485,	4557,	4631,	4707,	118,
4115,	4175,	4238,	4302,	4369,	4437,	4507,	4579,	4653,	4729,	119,

100,	101,	102,	103,	104,	105,	106,	107,	108,	109,	

mation using third-order regression analysis for BD and CTD in Table III. It was concluded that third-order regression analysis will only give realistic values in a limited range (in this case between 7.5 cm and 10.5 cm) and is therefore too sensitive to show the range of primary data; further, third-order regression analysis will not significantly improve the accuracy of results; and finally, this approach reduces the standard error of weight estimations in babies with short body measurements.

The inhomogeneous distribution of primary data has prompted us to carry out separate estimations for small and large body measurements. This approach, however, similarly to third-order regression analysis, failed to add to the accuracy of results. It has therefore been concluded that for practical purposes the results of second-order regression analysis are suitable.

Our statistical approach proved reliable, as its standard derivation was only 24.0 g in the control group.

The practical importance of the method was further illustrated by the experience gained in determinations of the optimum condition for programmed delivery. Out of the 231 cases where programmed delivery was carried out following weight estimations, two babies were born with a weight of 2500 g and none below this weight.

It is concluded that in the 2nd and 3rd trimesters of pregnancy the method offers considerable help in determination of the exact gestational age, fetal weight and maturity and can therefore improve the standard of obstetrical care. We suggest that obstetrical teams should establish their own set of parameters and methods in order to obtain optimum results.

*

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