

# Clinical Studies on Biometrics of the Placenta

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## ABSTRACT

With increasing concern for the study of the fetal aspects of pregnancy and child-birth the availability of normal standards becomes more and more important. It is very difficult to test the functional capacity of the placenta, and for this reason anatomic studies to determine the normal relationship between the placenta and the newborn infant have come to be of considerable importance.

Three hundred seventy eight placentas randomly collected in the past three years and ranged of the twenty-fourth gestation week to term which were delivered at Severance Hospital of Yonsei Medical College. These were analysed statistically as to whether there was any correlation between the size of the placentas, weight of newborn, and age and parity of the mother and were studied to see if there was any clinical and statistical significance in the change of the placental coefficients. We have also tried to search for any relationship between the specific gravity and the size of the placenta and the newborn weight.

In addition to these factors, clinical com-

plications such as toxemia, anemia, intrauterine fetal death, giant baby and infarction of the placentas were included in this study to seek any relationship with the above mentioned factors. Another purpose was to obtain the proper values for Korean placentas.

We have summarized this study briefly as follows.

1. The average weight of the 378 newborns was 3168 gm and for the 340 normal cases it was 3270 gm.
2. The average weight of 378 placentas was 616 gm and for the 340 normal cases it was 621 gm.
3. The average volume of 378 placentas was 588 cc and for normal cases it was 596 cc.
4. The average placental dimensions were  $17.9 \times 14.2$  cm.
5. The average surface area of the 340 normal cases was  $276 \text{ cm}^2$ .
6. The specific gravity of 340 normal cases was 1.0475 and there was no relationship to the gestation weeks and baby weight.
7. The average placental coefficient of 378 cases was 0.194 and for 340 normal cases it was 0.190 (varying from 0.100 to 0.333). The placental coefficients were greater in toxemia, syphilis, intrauterine fetal death, prematurity, twin pregnancy and immaturity. However it was lower in placental infarction and in re-

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latively small placentas. In anemia and giant baby it was close to the normal average but in extremely large baby placenta coefficients was greater than Normal averages. (Baby wt. >4500 gm.).

8. The weight of baby and the size of the placenta showed no demonstrable relationship to the age and parity of the mother.

9. statistically there was a high correlation between the weight of the infants and the weight of the infants and the weight and volume of the placenta but somewhat low relationship to the surface area of the placenta

## INTRODUCTION

An earlier writer, Mackness(1889), pointed out that the uterus of elderly women had large mucosal folds and elevations which favored the formation of a large placenta. Previous to this, Bustamente(1868), Kruger(1877), Sfameni(1901), Laurent(1913) and Holland(1922), as noted by Adair and Thelander(1925), agreed that the weight of the placenta is greater in the newborn of greater weight. In 1925 Adair and Thelander summarized the literature and reported the relationship of the weight, area, volume, thickness and specific gravity of the placenta all in their relationship to the weight of baby.

Lavake(1924) also studied the relationship of surface area of the placenta to the birth weight of a child. Dow and Torpin(1939), quoted by William A. Little(1960), commented on the relationships among the placental weight, placental surface area, gestation sizes and fetal weight.

Schaffer(1898), as noted by Needham(1931) described a decrease in placental/fetal weight ratio as gestation progressed. Baird and asso-

ciates(1957) concluded that that the 'small baby syndrome' was a rarity from a study of birth weights and placental weights in pre-eclampsia. Thomson, Billewicz and Hytten(1968) recently published a paper on the assessment of birth weights in relation to gestation age, sex, parity and maternal height and weight. Sinclair(1948) observed that with a high placental/fetal weight ratio the infants were frequently lethargic or suffered from hydrops fetalis of Rh incompatibility or were reactors to maternal diabetes or hypothyroidism. With the above historical background we studied the significance of placental morphology such as the relationships among the weight, volume, surface area and dimensions of the placenta, the weight of newborn, age and parity of mothers, and coefficients(placental/fetal weight ratio). We also added complicated cases such as toxemia, anemia, syphilis, giant baby, intrauterine fetal death and placental infarction.

## MATERIALS AND METHOD

This paper is the result of a study of 378 placentas at Severance Hospital, collected randomly during the past 3 years. In this study the placentas were from 24 weeks gestation to term and 93 percent of 378 cases were term placentas (340 cases).

All infants were weighed on admittance to the nursery a very short time after birth. The placentas were studied very soon after delivery to avoid errors due to drying. The membranes were not stripped off and the umbilical cords were excised three centimeters from the attachment. As much of the blood as possible was drained from the placenta via the umbilical cord. The volume was obtained by simple water displacement. A relative surface

area was obtained by multiplying the width of the placenta by its length, thus obtaining an area in square centimeters considerably larger (nearly one third) than the actual area of the placenta. The relative surface area of this type in a large series of cases is sufficiently uniform so that the value, thus obtained, is quite as reliable as the 'true' area would be.

The thickness was uniformly measured as the depth of the placenta in the central portion. The specific gravity was determined by dividing the weight by the volume, and the placental coefficient was calculated by dividing the placental weight by the fetal weight (placental/fetal weight ratio). All these data were analysed by computer.

## RESULTS

Table 1 shows 378 total placentas which were analysed according to gestation age, parity, and sexual difference. In this series there were 182 placentas of primiparous women and 196 of multiparous women; 340 of the placentas were placed in the normal full term group and there were 32 prematures. Six cases of twins were included in this series. (Table 1)

The averages for normal and premature infants have been tabulated in Table 2. The average weight at birth of the 340 normal infants was 3270 gm. The lowest birth weight was 2750 gm and the greatest one was 5100 gm at term. The average weight of the normal cases was 621 gm. (minimum-350 gm maximum-1200 gm.) It was 621 gm in normal males and 632 gm in normal female infants. The average volume of the term placentas was 536 cc, being 593 cc and 600 cc for the placentas of the normal male and female.

**Table 1. Placentas analysed**

Gestation	Sex	Multiparity	Primiparity	Total
Term	M.	86	82	168
	F.	96	76	172
Total	M. & F.	182	158	340
Premature	M.	7	10	17
	F.	5	10	15
Total	M. & F.	12	20	32
Twins	M.	—	—	—
	F.	2	4	6
Total	M. & F.	2	4	6
Grand	M.	93	92	185
	F.	103	90	193
Total	M. & F.	196	182	378

The average surface of the term placentas was 276 cm<sup>2</sup>, being 272 cm<sup>2</sup> and 262 cm<sup>2</sup> for the placentas of the normal male and female. The specific gravity of the term placenta was 1.047 and for 32 prematures it was 1.006. The placental coefficients in term placentas was 0.190, varying from 0.100 to 0.333. The placental dimension of term placentas was 17.9 by 14.7 cm. The averages of the prematures also was tabulated in Table 2.

Table 3 shows averages of newborn and placentas in 378 cases and the averages are lower than those of the normal term cases because the former included 38 cases of earlier gestation.

Table 4 shows the positive correlation existing among weight, volume, and surface area of placenta and the weight of the newborn. The indices of correlation were determined according to the formula  $r = \frac{(xy)}{I(n_1n_2)}$  with the

Table 2. Comparison of placenta and newborn averages (in normal cases and prematures)

	Sex	No. of Cases	Average	Minimum	Maximum
<b>1. Normal Cases</b>					
Newborn averages (gm)	M	168	3,299	2750	4,250
	F	172	3,241	2700	5,100
	M & F	340	3,270		
Placental weight (gm)	M	168	621	350	900
	F	172	632	380	1200
	M & F	340	621	380	
Volume(cc)	M	168	593	038	830
	F	172	600	410	980
	M & F	340	596		
Surface area (cm <sup>2</sup> )	M	168	272	140	500
	F	172	262	110	506
	M & F	340	276		
Thickness (cm)	M & F	340	2.79	1.7	4.3
Dimension length (cm)	M & F	340	17.9	11.0	28.0
	M & F	340	14.7	10.0	22.0
Specific gravity	M & F	340	1.0475	0.1160	1.4110
Placental coefficients	M & F	340	0.190	0.100	0.330
<b>2. Premature</b>					
Newborn wt. (gm)	M & F	32	2062		
Placenta					
weight (gm)	"	32	509		
volume (cc)	"	32	504		
surface area (cm <sup>2</sup> )	"	32	228		
sp. gravity	"	32	1006		
placental Coefficients	"	32	0.254		

Table 3. The weights of newborn infant. weight and volume with surface area of the placenta in each sex.

	Male	Female	Total
Newborn weight (gm)	3243±493	3214±521	3168±512
Placental weight (gm)	611±107	621±122	616±115
Placental volume (cc)	585± 87	592± 94	588± 91
Placental surface area (cm <sup>2</sup> )	267± 64	261± 64	264± 64
No. of cases	183	195	378

above results.

There is a high correlation between the weight of the newborn and weight and volume

of placentas and a somewhat lower correlation between the newborn weight and the placental surface area.

**Table 4. Correlation coefficients between the newborn weight and the weight, volume and surface area of placenta.**

	Newborn weight	Placental weight	Placental volume	Placental surf. area
Newborn weight	1.000	0.5162	0.5071	0.3179
Placental weight	0.5162	1.0000	0.9198	0.5240
Placental volume	0.5071	0.9198	1.0000	0.5691
Placental surface area	0.3179	0.5240	0.5691	1.0000

**Table 5. Weight of newborns, placental weight and placental coefficients according to gestation weeks**

Gestation weeks	No. of cases	Newborn weight(gm)	Placental weight(gm)	Placental coefficients
Less than 26	2	650	210	0.312
26-27	1	930	320	0.330
28-30	2	1245	375	0.300
31-32	4	1590	556	0.294
33-34	7	2178	575	0.272
35-36	9	2805	637	0.220
37-41	285	3207	618	0.190
42 or over	67	3332	638	0.189
Total averages	378	3168	616	0.194

**Table 6. Weight of newborn, size of the placenta and placental coefficients according to the parity**

Parity	No. of cases	Placental weight(gm)	Placental volume (cc)	Newborn weight(gm)	Placental coefficients
0	175	607	585	3135	0.194
1	109	622	593	3149	0.197
2	52	649	615	3269	0.200
3	27	592	562	3083	0.189
4	9	593	562	3305	0.179
5	4	712	670	4000	0.180
6	—	—	—	—	—
7	2	557	545	3250	0.165
Total averages	378	616	588	3168	0.194

**Table 7. Weight, volume and surface area of the placenta by age of the mother**

Age	No. of cases	Placental weight(gm)	Placental volume(cc)	Placental surf. area(cm <sup>2</sup> )
Less than 20	1	650	580	150
20-25	31	580	559	253
26-30	218	619	591	267
31-35	106	622	590	263
36-40	19	599	586	260
41 or over	3	716	646	284
Total averages	378	616	588	264

**Table 8. Analysis of the placenta according to newborn weight and parity**

Newborn weight group	Number of cases		Newborn weight (gm)		Placenta weight (gm)		Placenta surf. area (cm <sup>2</sup> )		Placental coefficients	
	Multi	Primi	Multi	Primi	Multi	Primi	Multi	Primi	Multi	Primi
Less than 2000	8	4	1750	1700	488	290	194	152	0.303	0.303
2000—2499	9	11	2200	2250	567	556	250	256	0.258	0.247
2500—2999	42	43	2700	2750	551	591	240	259	0.204	0.247
3000—3499	93	86	3250	3250	627	607	260	254	0.193	0.187
3500—3999	41	25	3750	3750	681	683	295	295	0.182	0.182
4000—4499	9	6	4250	4245	813	709	298	299	0.191	0.167
4500 or over	2		4925		1150		396		0.234	
Total averages	203	175	3195	3150	624	607	267	260	0.195	0.194

**Table 9. Placental weight distribution in anemia**

Placental weight (gm)	Anemia	Normal deliver
0—100	—	—
101—200	1	—
201—300	—	1
301—400	4	7
401—500	15	39
501—600	28	105
601—700	23	98
701—800	3	31
801—900	3	9
901—1000	3	3
1001—1100	1	1
1101—1200	2	—
Total	83	295

Table V shows clearly that the size of the placentas and the weight of newborns increase as the pregnancy advances but the placental coefficients decrease as the gestation progresses.

The size of the placenta, the baby weight and placental coefficients were tabulated against the age and parity of the mother in Table 6 and Table 7. There is no real correlation

between them.

Table 8 shows a comparison between placentas of multiparous and primiparous mothers for different weights of newborns. There is only small or no significant difference with either parity. We can also note a change of weight and surface area of the placentas with increase of baby weight, but placental coefficients are decreased with increase of newborn weight.

Table 9 shows the placental weight distribution in anemia and normal delivery. The cases were distributed systemically without deviation but we found two cases of abnormally large placentas in the anemic group.

Table 10 gives the mean placental weight, mean newborn weight and mean placental coefficients in abnormal clinical conditions such as in toxemia, anemia, syphilis, giant baby and intrauterine fetal death. In the present series two cases of Rh negative primipara were included without complications. Birth weight was definitely lower in syphilis, intrauterine fetal death, and slightly lower in toxemia. In placental infarction only the placental weight was lower than the average normals. The placental weights in toxemia and giant baby were definitely greater than in normal averages. The placental coefficient

**Table 10. Weight of newborn, weight of placental and placental coefficients in complicated pregnancy**

Complicated casee	No. of cases	Newborn weight	Placental weight	Placental coefficients
Hypertensive disorders in pregnancy	36	3027	664	0.200
Anemia	83	3099	603	0.196
Syphilis	8	2518	600	0.241
Intrauterine fetal death	5	1523	578	0.379
prematurity	32	2062	509	0.254
*Placental infarction	26	3114	570	0.151
*Giant baby	17	4329	810	0.189
*Rh-mother	2	3250	650	0.200

\*Placental infarction: included in this table for comparison with other values.

\*Giant bady: defined as a baby weitht over 4000 grams.

\*Rh negative mother: in primigravida.

was higher in intrauterine fetal death, toxemia, syphilis, and prematurity. It was lower in placental infarction. It was nearly normal in anemia and giant baby but as seen in Table 8, the placental coefficient is higher in giant baby weighing more than 4500 gm. ( $p.c=0.234$ ). (Table 10)

We compared the weight value and clinical condition in case of extremes of obtained placental coefficients: a) placental coefficient

over 0.300 and b) placental coefficient below 0.150. We noted that a greater proportion of prematurity, intrauterine fetal death and syphilis was included in the group where the placental coefficient was over 0.300, but we noted more frequent placental infarction and relatively small placentas in the group where the placental coefficients was less than 0.150. We also noted relatively larger placentas in the group where the placental coefficient was over 0.300. (Table 11).

**Table 11. Weight value in two groups:**

- a) placental coefficients  $>0.300$   
 b) \* P. C.  $<0.150$  and in addition clinically abnormal findings

	P. C. $>0.300$	P. C. $<0.150$
Newbron weight	1170 gm.	3475 gm.
Placental weight	650 gm.	485 gm.
No. of cases	11	20
Remarks	Premature 9 * IUFD 5 Syphilis 3 Twins 1 Relatively large placenta	Infarction 7 Placenta previa 2 Relatively small placenta

\* IUFD : Intra uterine fetal Death

\* P C : Placental coebbicient

## DISCUSSION

### 1. Newborn Weight

According to several reports published previously newborn weights show only small and not significant differences for sex and race. (Table 12)

Laga and Shirley(1972) asserted that baby weight varied according to the socioeconomic level and he noted a lower weight in a low socioeconomic area such as Guatemala than in a middle area such as Boston. Hirvonen and Toivanen(1971) showed that birth weight without fetal or maternal complications increased until parity 5, but Thomson, Billewicz and Hytten(1968) did not agree with this

opinion.

We also found, as previously mentioned, that there is no relation between the newborn weight and the parity. Thomson et al(1968) reported that the birth weight is related to maternal height and weight-for-height and the same holds for placental weight, i.e. tall and heavy mothers had larger placentas than short and light mothers.

Calkin(1937) summarized the reports as follows; there is apparently a very close relationship between both height and weight of the baby and placental size. The next closest relationship exists between duration of pregnancy and placental size. In our present series we also agree with Calkin's opinion.

## 2. Placental weight

The average weight of the placenta in the present series was compared with those obtained by the following researchers. (Table 13)

As seen in Table 13, placental weight var-

Table 12.

Name of Reporter	Newborn weight
Adair and Thelander(1925)	Average: 3368 gm Male: 3443 gm Female: 3276 gm
Ramsey and Alley (by Adair's report)	Male: 3391 gm Female: 3276 gm
Laga and Shirley(1972)	Boston: 3412 gm Guatemala: 3005 gm
Present study (Chung & Park)	Average: 3270 gm Male: 3299 gm Female: 3241 gm

Table 13.

Name of Reporter	Placental weight
Adair and Thelander(1925)	Average: 473 gm
Mackness(1889)	Average: 646 gm
Beisher et al(1968)	Normal cases: 561 gm Erythroblastosis fetalis: 637 gm Diabetes mellitus: 661 gm
Laga and Shirley(1972)	Boston: 469 gm Guatemala: 404 gm
Snoeck and Crawford(1959)	Average: 464 gm
Present study(chung & park)	Average: 621 gm

ied within a wide range and the difference seemed to be due to method of preparation, race, socioeconomic level, and maternal condition etc.

Thomson, Billewicz(1968) and Hytten pointed out that the size of the placenta could be increased up to 50% if much of the umbilical cord and membrane remain and the blood clots are not drained, so the average placental weight may be different according to variable methods of preparation in each report.

Really, the chief concern to be discussed is the nature of placental adequacy and the extent to which it can be inferred from weight. A placenta may be considered adequate if it's capacity for transmission of nutrients and other essential supplies imposes no restriction on the growth and vitality of the fetus. Flexner and his colleagues(1948) showed that the transfer of sodium across the normal placenta at term is about 1100 times greater than the amount being incorporated in the fetal tissue. For sodium, therefore, there seemed to be an enormous margin of placen-



tal adequacy even if the placenta is small.

Walker and Turnbull(1953) reported that fetal hypoxia not uncommonly occurs near term and the risk is increased if placental function has been impaired by threatened abortion, preeclampsia or postmaturity. As the outer margin of the placenta is thinner and transmits less oxygen supply, the hazard may be greater if the placenta is small. However neither Flexner nor Walker commented on placental weight itself.

Hirvonen and Toivanen(1971) reported as follows. The mean placental weight was statistically greater in toxemia, pyelonephritis, anemia and latent and manifest diabetes. The placental weight was lighter in chronic hypertension, prematurity, immaturity, and twin pregnancy. Our present study showed the placenta is lighter in anemia, syphilis, prematurity, immaturity and placental infarction. The mean placental weight was greater in toxemia and giant baby. Laga and Shirley (1972) found lighter placentas in low socioeconomic areas. Beisher et. al (1968) reported that the placental weight is greater in erythroblastosis fetalis and maternal diabetes.

In our present series 2cases of Rh negative mother were encountered but they were no complications.

### 3. Placental Volume

In our series the placental volume was 593 cc for normal term males and 600 cc in normal females, making the average 596 cc. This value is four times that obtained by Adair and Thelander(1928). Snoeck and Crawford(1959) reported the average was 430 cc for normal infants. The placental volume is best correlated with placental weight(correlation coefficient=0.9198.)

### 4. The Placental Surface Area

The average surface area of the placenta for 378 cases was 264cm<sup>2</sup>. and for normal cases it was 267 cm<sup>2</sup>. This value is greater than that obtained by Adair and Thelander(male-251 cm<sup>2</sup>, female-244 cm<sup>2</sup>). The surface area is best correlated with placental volume(correlation coefficient=0.5691).

### 5. The Placental Dimensions and Thickness

The average placental dimensions of term placentas was 17.9 by 14.7 cm. The average dimensions of term placentas obtained by Zentler, as noted by Adair and Thelander, was 16 to 19 by 13 $\frac{1}{2}$  to 16 cm.; the thickness varied from 1 $\frac{1}{2}$  to 3 cm. The thickness in the present series was 2.7 cm for normal cases and for permatures it was 1.87 cm.

### 6. Placental Coefficients(placental/fetal weight ratio)

There has been considerable variation in measurement of the placental/fetal weight ratio by many investigators as seen in Table 14.

The placental coefficient decrease as the gestation advances as in Table 15. We have compared our data with that obtained by Snoeck and Crawford(1959). We noted high placental coefficients in toxemia, syphilis, intrauterine fetal death, twin pregnancy and prematurity but in anemia and giant baby it was close to the normal average. We noted lower placental coefficients in placental infarction and in the relatively small placenta group. (Table 11)

Hirvonen and Toivanen(1971) observed that the placental coefficients showed no change with parity, as Pitkänen already showed in

**Table 14. Placental/fetal weight ratio(placental coefficients) reported previously**

Smith (1891)	0.222
Sfameni (1901)	0.129
Laurent (1912)	0.200
Holland (1922)	0.132
Adair et al (1927)	0.138
Klooster (1954)	0.148
Snoeck (1959)	0.137
William (1960)	0.10—0.18
Gruenwald (1961)	0.143
Little (1968)	10:1—5.6:1
Chung and park (1974)	0.190(0.100-0.333)

**Table 15. Placental weight and placental coefficients as gestation advances**

Gestation days	Placental weight (gm)		Placental coefficients	
	a.	b.	a.	b.
145—165	245	520	0.313	0.323
166—195	245	375	0.240	0.301
196—225	365	556	0.207	0.349
226—240	407	575	0.150	0.264
241—296	464	638	0.137	0.191

NOTE: a. Data from Snoeck 'Le placenta Humain', Masson et Cie; and from Crawford. J. Obstet. Gynecol. Empire. 66: 885, 1959 (quoted from William Obstetrics, 14th Ed p. 148)

b. from present series. (Chung & Park)

large infants.

Hirvonen and Toivanen(1971) noted that the placental coefficient was statistically high in toxemia, pyelonephritis, prematurity, immaturity, anemia, Rh incompatibility, twin pregnancy, fetal asphyxia, and latent and manifest diabetes. The only disease pronounced associated with a reduced placental coefficient is chronic hypertension. Beiser. Beisher and Holsman(1968) described the significance of change of the placental coefficients in maternal complications such as in diabetes, anemia, toxemia and erythroblastosis etc.

The pathogenesis of abnormal placental size is not well understood. They felt that it is probable that when a large placenta in diabetes and erythroblastosis would fit with such concepts of hypertrophy as a result of a work stimulus initiated by fetal nutritional requirements. Fetal anemia and edema are present in erythroblastosis but not in diabetes mellitus because here the fetal hemoglobin is usually above normal.

It is probable that maternal anemia, particularly when severe, is associated with chronic oxygen deprivation which results in intrauterine death unless placental compensation occurs. The situation is analogous to that seen in diabetes and erythroblastosis although these conditions are characterized by a large placenta. it may be that placental hypertrophy is less often associated with fetal death in anemia, because it represents a state of compensation.

Fox(1964) reported that there is hypertrophy of villous Langhan's cells in toxemia. Beischer and Holsman et al (1968) reported that anemia is the commonest condition associated with abnormally large placenta or abnormally small placenta.

1948. We also agree with this opinion. Adair and Thelander(1925) noted that higher placental coefficients were found in prematures, very small babies which are really on the borderline of prematurity, and in pathologic cases, especially those where toxemia of pregnancy is present. He also noted that a lower ratio is found chiefly in postmature or

We also noted in our series two cases of giant placenta in severe anemia where blood hemoglobin was 5.5 gm% but the baby show normal averages.

In summary, we have made somewhat extensive study of 378 placentas but the data and analysis are not entirely satisfactory, and we will attempted a more extensive study on the basis of this experience in the future.

## REFERENCES

- Adair and Thelander, H.: *A study of the weight and dimensions of the human placenta in it's relationship to the weight of the newborn infant.* *Am. J. Obstet. Gynecol.* 10:172, 1925.
- Aherne: *A weight relationship between the human foetus and placenta.* *Biol. Neonat.* 10:113, 1966.
- Baird, D., Thomson, A.M., and Billewicz W.Z.: *A study of birth weights and placental weights in preclampsia.* *J. Obstet. Gynecol. Brit. Empire,* 64:370, 1957.
- Beischer, N.A. and Holsman, H.: *Relation of various forms of anemia to placental weight.* *Am. J. Obstet. Gynecol.* 101:801, 1968.
- Calkin, D.A.: *Placental variation. Analytical determination of it's clinical importance.* *Am. J. Obstet. Gynecol.* 33:280, 1930.
- Crawford: *A study of human placenta gross with observation on the placenta in erythroblastosis foetalis.* *J. Obstet. Gynecol. Brit. Empire.* 66:885, 1969.
- Duncan, S.L.B. and Lewis, B.V.: *Meternal placenta and myometrial blood flow in the pregnant rabbit.* *J. Physiol* 202:471, 1969.
- Flexner, L.B., Cowie, D.B., Hellman, L.H., Wilde, W.S., and Voxburgh, G.J.: *The permeability of the human placenta to sodium in normal and abnormal pregnancy and the supply of sodium to the human foetus as determined with radioactive sodium.* *Am. J. Obstet. Gynecol.* 55:469, 1950.
- Fox, H.: *The villous cytotrophoblast as an index of the placental ischemia.* *J. Obstet. Gynecol. Brit. Cwlth.* 71:885, 1964.
- Gruenwald and Minh: *Evaluation of body and organ weights in perinatal pathology.* *Am. J. Obstet. Gynecol.* 84:312, 1961.
- Laga, E.M. and Shirley, D.G.: *Comparisons of placenta from two socioeconomic groups.* *Pediatrics,* 50:24, 1972.
- Liewllyn-Jones, D.: *Australia and Newzealand J. Obstet. Gynecol.* 5:191, 1965.
- Mackness, G.O.C.: *Endinburgh Med. J.* 136:114-144, 1889 (sited from Adair's report in 1925)
- Needham, J.: *Chemical embryology,* London, 1931, Cambridge University Press, 3:1496 (sited from William A Little's Report in *Am. J. Obstet. Gynecol.* 79:134, 1960)
- Sinclair, J.G.: *A significance of placental and fetal birth weight ratios.* *Anat. Rec* 102:245, 1948.
- Thomson, A.M., Billewicz, W.Z.: and Hytten, F.E. *The weight of the placenta in relation to birth weight.* *J. Obstet. Gynecol. Brit. Cwlth.* 76:865, 1969.
- Toivo Hirvonen and Toivanen, P.: *Parity, birth and placental weight in normal and complicated pregnancy.* *Acta Obstet. Gynecol. Scand.* 50:67, 1971.
- Toshi Fujikura: *Placental calcification and meternal age.* *Am. J. Obstet. Gynecol.* 87:41, 1963.
- Wiggleworth, J.C.: *Morphologica variation in the insufficient placenta.* *J. Obstet. Gynecol. Brit. Cwlth.* 71:871, 1964.
- William A. Little: *The significance of placental fetal weight ratios.* *Am. J. Obstet. Gynecol.* 79:1960.
- Walker, J. and Turnbull, E.P.N.: *Hemoglobin and red cell in the human foetus, and their relation to the oxygen content of the blood in the vessels of the umbilical cord.* *Lancet* 2:312, 1953.
- Wylie, B., and Amidon, B.F.: *Correlation of weight, length and time factors in fetal age.* *Am. J. Obstet. Gynecol.* 61:193, 1951.