

Estimation of Fetal Weight in Utero by Ultrasound

Theera Tongsong MD,
Chanane Wanapirak MD,
Wanchai Chaichonlatrap MD.

*Department of Obstetrics and Gynaecology,
Faculty of Medicine, Chiang Mai University,
Chiang Mai, Thailand*

Abstract: *In order to find the best fitting regression equation to estimate fetal weight in utero using ultrasonic fetal parameters i.e. biparietal diameter (BPD), abdominal circumference(AC), and femur length(FL), ultrasonic measurements were carried out among 162 fetuses at Maharaj Nakorn Chiang Mai Hospital between February 1990 and June 1991. The ultrasonic measurements were conducted within 24 hours before delivery. The fetal weight was obtained from neonatal records. The data was analysed by using stepwise multiple linear regression analysis. It was found that the best fitting equation was: $\text{Log } 10 (\text{EFW}) = 1.85479 + 0.09008(\text{BPD}) + 0.02466(\text{AC})$ [coefficient of determination(R^2) = 0.939, multiple $R = 0.969$, $p < 0.000$]. The absolute mean error $\pm$ SD(%) calculated by [estimated fetal weight - actual fetal weight / actual weight $\times$ 100] for the equation derived in this study group was 6.980 ± 7.017 . The absolute mean error $\pm$ SD (%) for Shepard's equation applied to the fetal parameters from this study was 6.885 ± 6.397 . Furthermore, a table of predicted fetal weight at various lengths of BPD and AC was prepared with computer assistance to read the estimated fetal weight directly (Thai J Obstet Gynaecol 1992;4: 15-22.)*

Key words: abdominal circumference(AC), biparietal diameter(BPD), estimated fetal weight(EFW), femur length(FL), ultrasound

An accurate assessment of fetal weight may be important in the management of a patient with preterm labour, intrauterine growth retardation (IUGR), premature rupture of membranes (PROM), macrosomia, or breech presentation. Perinatal mortality rates correlate with the accuracy of obstetric estimates of fetal weight. The importance of an accurate estimation has increased as improved neonatal

care has lowered the gestational age of viability and increased the survival rates of low birth weight infants. Increasing attention is being paid to the accuracy of using various ultrasound measurements in estimating weight. Campbell et al⁽¹⁾ suggested that a single measurement of biparietal diameter (BPD) in late pregnancy was not clinically useful in assessing birth weight, and he reported that the use of

the abdominal circumference (AC) at the level of the ductus venosus was an accurate means of estimating fetal weight in utero⁽²⁾. Warsof et al⁽³⁾, however, found that measurement of more than one parameter improved the correlation with birth weight. Since then, multiple fetal parameters for the prediction of fetal weight have been employed; these are the biparietal diameter, abdominal circumference, femur length (FL), total intrauterine volume (TIUV), etc..

The purpose of the present study was to 1) determine the best fitting regression equation to estimate fetal weight in utero using ultrasonic fetal parameter i.e. biparietal diameter (BPD) abdominal circumference (AC), and femur length (FL), and 2) compare the absolute mean error $\pm$ SD between our equations with Shepard's equation⁽⁴⁾ which was commonly used in our institutes.

Materials and Methods

Sonographic measurements of BPD, AC, and FL were made in 162 live-born fetuses of Thai pregnant women within 24 hours before delivery, using commercially available linear-array real-time systems with 3.5 MHz transducers (Aloka SSD 650). Techniques of imaging and measurement have been described elsewhere⁽⁵⁻⁷⁾. BPD was measured from the outer margin of proximal skull table to the inner margin of the distal one⁽⁵⁾ and FL from the greater trochanter to the distal metaphysis⁽⁶⁾, us-

ing internal electronic calipers and speed of sound of 1540 m/sec in tissue. AC was measured along the outer boundaries of the abdomen at the level of the porto-umbilical vein complex⁽⁷⁾. The measurements were performed by two experienced perinatal sonographers who had no information about the patients and neonatal outcomes.

The case of study must meet the criteria of inclusion i.e. delivered within 24 hours after examination, live fetus, good quality of sonographic imaging, no brachycephaly or dolichocephaly of fetal head, no fetal anomalies.

The relationship between sonographic measurements and birth weight was evaluated by stepwise multiple regression analysis, which requires that all coefficients be significantly different from zero ($p \leq 0.05$). In order to be convenient for clinical application, the variables entered into the equation would be analyzed from one parameter and presented only the equation that R^2 or coefficient of determination were more than 0.90. We examined in order 1) one parameter :- AC, AC^2 , BPD, BPD^2 , FL, FL^2 , 2) two parameters : AC, BPD (AC, BPD, AC^2 BPD^2 , $AC \times BPD$) AC, FL (AC, FL, AC^2 , $AC \times FL$) BPD, FL (BPD, FL, BPD^2 , FL^2 $BPD \times FL$), and 3) three parameters :-AC, BPD, FL, AC^2 , BPD^2 , FL^2 , $AC \times FL$, $BPD \times FL$.

Calculated fetal weight by regression equation was presented in the formula : $\text{Log}_{10}(\text{EFW}) = a + b_1X_1 + b_2X_2 + \dots + b_9X_9$ (EFW=estimated fetal

weight, a=inter-cept, b1...b9= coefficient of X1.....X9 respectively, X1.....X9=AC, BPD, AC², BPD², ACxBPD, FL, FL², ACxFL, BPDxFL, respectively).

The errors in prediction by the various equations were evaluated by absolute mean error (%) (=estimated fetal weight - actual weight/actual weight x 100).

Results

The sonographic parameters of 162 live-born fetuses which met the completed criteria were measured and born at Maharaj Nakorn Chiang Mai Hospital from February 1990 to June 1991.

Maternal age range was 16-44 years, average 27.6±4.95 years. 55.6% of them were primiparae.

Ultrasound fetal parameters from 162 fetuses are shown in Table 1.

Birth weight range was 500-4500 g, mean±SD=2236.97±738.71 g. 67.3% of the newborns were less than 2500 g and consisted of 83 male and 79 female babies.

By multiple linear regression analysis, five equations that R² were

more than 0.90 and p value < 0.05 were formulated as shown below.

$$1. \text{Log}_{10}(\text{EFW}) = 1.28537 + 0.10436(\text{AC}) - 0.00116(\text{AC})^2$$

$$2. \text{Log}_{10}(\text{EFW}) = 1.85479 + 0.09008(\text{BPD}) + 0.02466(\text{AC})$$

$$3. \text{Log}_{10}(\text{EFW}) = 2.40549 + 0.002643(\text{BPD})(\text{AC}) + 0.0325(\text{BPD})$$

$$4. \text{Log}_{10}(\text{EFW}) = 2.03714 + 0.0254(\text{AC}) + 0.08567(\text{FL})$$

$$5. \text{Log}_{10}(\text{EFW}) = 2.24784 + 0.09122(\text{FL}) + 0.002798(\text{BPD})(\text{AC}) - 0.0010112(\text{AC})(\text{FL})$$

R² and p value for each equation are shown in Table 2.

When we estimated the fetal weight from the sonographic parameters of the samples in this study by each equation and also Shepard's equation⁽⁴⁾ [$\text{Log}(\text{EFW}) = -1.7492 + 0.166(\text{BPD}) + 0.046(\text{AC}) - 2.646(\text{ACxBPD})/1000$] and then calculated absolute mean error(%) from actual weight. Of 5 equations in this study, equation was the best one and the absolute mean error was nearly the same as that of Shepard's equation⁽⁴⁾.

Additionally, estimated fetal weight at various lengths of BPD and AC was calculated by equation 2 [$\text{Log}_{10}(\text{EFW}) = 1.85479 + 0.09008(\text{BPD})$]

Table 1 Sonographic parameters of the samples

Parameters	Numbers	Mean±SD (cm)	Range
BPD	162	8.30±0.77	5.0 - 9.7
AC	162	29.14±4.13	17.6 - 41.2
FL*	161	6.35±0.73	3.9 - 7.6

*FL could not be determined in one case.

Table 2 R² and p-value for each equation of estimated fetal weight

Equation	R ²	p-value
1	0.908	<0.000
2	0.939	<0.000
3	0.919	<0.000
4	0.919	<0.000
5	0.939	<0.000

Table 3 Absolute mean error for each equation

Equation	Absolute mean error+SD(%)
1	8.841 ± 7.816
2	6.980 ± 7.017
3	8.199 ± 8.081
4	8.344 ± 7.744
5	7.327 ± 6.568
Shepard's	6.885 ± 6.397

+ 0.02466(AC)] with computer assistance and presented in tabular form (Table 4).

Discussion

The knowledge of fetal weight in utero is important for obstetric decision making, especially in cases of preterm labour, abnormal fetal growth, breech presentation, macrosomia, etc., and is helpful in the follow-up of intrauterine fetal growth. This study was undertaken to determine the equation for estimation of fetal weight in utero. The equation was derived from various sonographic parameters obtained within 24 hours before delivery, i.e. BPD, AC, FL, and actual birth

weight.

This study showed that the absolute mean errors of all equations were slightly different but equation 2 was the best, absolute mean error(%) = 6.980±7.017. The second best was equation 5. In spite of three incorporated parameters, the absolute mean error of equation 5 was slightly more than that of equation 2. This suggests that only BPD and AC were sufficient to predict the fetal size in utero, the incorporation of FL into various equations as a third parameter has not enhanced the accuracy of prediction. The extra time involved in the measurement of the third parameter is therefore unrewarding. Obviously, a quick, easy, repeatable measurement would be of advantage to a busy clinical practice. From this study, therefore, equation 2 was the most appropriate for clinical purpose use.

When we estimated the fetal weight from ultrasound parameters in this study using Shepard's equation⁽⁴⁾, it was found that mean absolute error was very similar to that of equation 2. This finding indicates that racial factor may not influence equations of estimated fetal weight. When compared to previous Western studies^(3, 4, 8-11) the absolute means error were not so different.

The factors providing reliability of this study include 1) the ultrasound parameters were measured by only two experienced perinatal sonographers, 2) the sonographers had no information of the patients and neonatal outcomes, 3) all measurements were

TABLE 4 Estimated fetal weight (grams) from BPD and AC from equation 2

AC BPD																	
	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5	20.0	20.5	21.0	21.5	22.0	22.5	23.0	23.5
3.1	328	338	347	357	368	378	389	400	412	424	436	449	462	475	489	503	517
3.2	335	345	355	365	375	386	397	409	421	433	445	458	471	485	499	513	528
3.3	342	352	362	373	383	394	406	417	429	442	455	468	481	495	509	524	539
3.4	349	359	370	380	391	403	414	426	438	451	464	477	491	505	520	535	550
3.5	357	367	378	388	400	411	423	435	448	461	474	487	501	516	531	546	562
3.6	364	375	385	397	408	420	432	444	457	470	484	498	512	527	542	558	574
3.7	372	383	394	405	417	429	441	454	467	480	494	508	523	538	553	569	586
3.8	380	391	402	413	425	437	450	463	476	490	504	519	534	549	565	581	598
3.9	388	399	410	422	434	447	460	473	486	500	515	530	545	561	577	593	610
4.0	396	407	419	431	443	456	469	483	497	511	526	541	556	572	589	606	623
4.1	404	416	428	440	453	466	479	493	507	522	537	552	568	584	601	618	636
4.2	412	424	437	449	462	475	489	503	518	533	548	564	580	597	614	631	650
4.3	421	433	446	459	472	485	499	514	528	544	559	575	592	609	627	645	663
4.4	430	442	455	468	482	495	510	524	540	555	571	587	604	622	640	658	677
4.5	439	452	465	478	492	506	520	535	551	567	583	600	617	635	653	672	691
4.6	448	461	474	488	502	516	531	547	562	579	595	612	630	648	667	686	706
4.7	458	471	484	498	513	527	542	558	574	591	608	625	643	662	681	700	721
4.8	467	481	494	509	523	538	554	570	586	603	620	638	657	676	695	715	736
4.9	477	491	505	519	534	550	565	582	598	616	633	652	670	690	710	730	751
5.0	487	501	515	530	545	561	577	594	611	629	647	665	685	704	725	745	767
5.1	497	511	526	541	557	573	589	606	624	642	660	679	699	719	740	761	783
5.2	507	522	537	553	569	585	602	619	637	655	674	694	714	734	755	777	799
5.3	518	533	548	564	580	597	614	632	650	669	688	708	728	749	771	793	816
5.4	529	544	560	576	593	610	627	645	664	683	703	723	744	765	787	810	833
5.5	540	556	572	588	605	622	640	659	678	697	717	738	759	781	804	827	851
5.6	551	567	584	600	618	636	654	673	692	712	732	754	775	798	821	844	868
5.7	563	579	596	613	631	649	668	687	707	727	748	769	791	814	838	862	887
5.8	575	591	608	626	644	662	681	701	721	742	763	785	808	831	855	880	905
5.9	587	604	621	639	657	676	696	716	736	758	779	802	825	849	873	898	924
6.0	599	616	634	652	671	690	710	731	752	774	796	819	842	867	891	917	944
6.1	612	629	647	666	685	705	725	746	768	790	812	836	860	885	910	936	963
6.2	624	642	661	680	700	720	740	762	784	806	829	853	878	903	929	956	984
6.3	638	656	675	694	714	735	756	778	800	823	847	871	896	922	949	976	1004
6.4	651	670	689	709	729	750	772	794	817	840	865	890	915	942	969	997	1025
6.5	665	684	703	724	744	766	788	811	834	858	883	908	934	961	989	1017	1047
6.6	678	698	718	739	760	782	805	828	852	876	901	927	954	981	1010	1039	1069
6.7	693	713	733	754	776	798	821	845	869	894	920	947	974	1002	1031	1060	1091
6.8	707	728	749	770	792	815	839	863	888	913	939	966	994	1023	1052	1083	1114
6.9	722	743	764	786	809	832	856	881	906	932	959	987	1015	1044	1074	1105	1137
7.0	737	758	780	803	826	850	874	899	925	952	979	1007	1036	1066	1097	1129	1161
7.1	753	774	797	820	843	867	892	918	945	972	1000	1029	1058	1089	1120	1152	1185
7.2	768	791	813	837	861	886	911	937	964	992	1021	1050	1080	1111	1143	1176	1210
7.3	785	807	830	854	879	904	930	957	985	1013	1042	1072	1103	1135	1167	1201	1236
7.4	801	824	848	872	897	923	950	977	1005	1034	1064	1095	1126	1159	1192	1226	1262
7.5	818	841	866	890	916	942	970	998	1026	1056	1086	1118	1150	1183	1217	1252	1288
7.6	835	859	884	909	935	962	990	1018	1048	1078	1109	1141	1174	1208	1242	1278	1315
7.7	852	877	902	928	955	982	1011	1040	1070	1101	1132	1165	1198	1233	1268	1305	1343
7.8	870	895	921	948	975	1003	1032	1062	1092	1124	1156	1189	1224	1259	1295	1332	1371
7.9	888	914	940	967	995	1024	1053	1084	1115	1147	1180	1214	1249	1285	1322	1360	1399
8.0	907	933	960	988	1016	1045	1076	1107	1138	1171	1205	1240	1275	1312	1350	1389	1429
8.1	926	953	980	1008	1037	1067	1098	1130	1162	1196	1230	1266	1302	1340	1378	1418	1459
8.2	946	973	1001	1030	1059	1090	1121	1153	1187	1221	1256	1292	1329	1368	1407	1448	1489
8.3	965	993	1022	1051	1081	1113	1145	1178	1212	1246	1282	1319	1357	1396	1436	1478	1520
8.4	986	1014	1043	1073	1104	1136	1169	1202	1237	1273	1309	1347	1386	1426	1467	1509	1552
8.5	1006	1035	1065	1096	1127	1160	1193	1227	1263	1299	1337	1375	1415	1455	1497	1540	1585
8.6	1027	1057	1087	1119	1151	1184	1218	1253	1289	1326	1365	1404	1444	1486	1529	1573	1618
8.7	1049	1079	1110	1142	1175	1209	1244	1279	1316	1354	1393	1433	1475	1517	1561	1606	1652
8.8	1071	1102	1133	1166	1200	1234	1270	1306	1344	1383	1422	1463	1506	1549	1593	1639	1687
8.9	1093	1125	1157	1190	1225	1260	1296	1334	1372	1412	1452	1494	1537	1581	1627	1674	1722
9.0	1116	1148	1181	1215	1250	1286	1323	1362	1401	1441	1483	1525	1569	1614	1661	1709	1758
9.1	1140	1172	1206	1241	1277	1313	1351	1390	1430	1471	1514	1557	1602	1648	1696	1745	1795
9.2	1163	1197	1231	1267	1303	1341	1380	1419	1460	1502	1545	1590	1636	1683	1731	1781	1832
9.3	1188	1222	1257	1293	1331	1369	1408	1449	1491	1534	1578	1623	1670	1718	1768	1819	1871
9.4	1213	1248	1284	1321	1359	1398	1438	1479	1522	1566	1611	1657	1705	1754	1805	1857	1910
9.5	1238	1274	1311	1348	1387	1427	1468	1510	1554	1599	1645	1692	1741	1791	1842	1896	1950
9.6	1264	1301	1338	1377	1416	1457	1499	1542	1586	1632	1679	1727	1777	1828	1881	1935	1991
9.7	1291	1328	1366	1405	1446	1487	1530	1574	1620	1666	1714	1764	1814	1867	1921	1976	2033
9.8	1318	1356	1395	1435	1476	1519	1562	1607	1654	1701	1750	1801	1853	1906	1961	2017	2075
9.9	1345	1384	1424	1465	1507	1550	1595	1641	1688	1737	1787	1838	1891	1946	2002	2060	2119
10.0	1373	1413	1454	1496	1539	1583	1629	1675	1724	1773	1824	1877	1931	1987	2044	2103	2163

TABLE 4 Estimated fetal weight (grams) from BPD and AC (continued)

BPD	AC																
	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.5	28.0	28.5	29.0	29.5	30.0	30.5	31.0	31.5	32.0
3.1	532	547	563	579	596	613	631	649	668	687	707	727	748	769	792	814	838
3.2	543	559	575	591	608	626	644	663	682	701	721	742	764	786	808	831	855
3.3	554	570	587	604	621	639	657	676	696	716	737	758	780	802	825	849	873
3.4	566	582	599	616	634	652	671	691	710	731	752	774	796	819	842	867	892
3.5	578	595	612	629	647	666	685	705	725	746	768	790	813	836	860	885	910
3.6	590	607	625	643	661	680	700	720	741	762	784	806	830	854	878	903	929
3.7	602	620	638	656	675	694	714	735	756	778	800	823	847	871	896	922	949
3.8	615	633	651	670	689	709	729	750	772	794	817	841	865	890	915	942	969
3.9	628	646	665	684	703	724	745	766	788	811	834	858	883	908	934	961	989
4.0	641	660	679	698	718	739	760	782	805	828	852	876	901	927	954	982	1010
4.1	655	673	693	713	733	754	776	798	821	845	869	895	920	947	974	1002	1031
4.2	668	688	707	728	749	770	792	815	839	863	888	913	940	967	994	1023	1053
4.3	682	702	722	743	764	786	809	832	856	881	906	932	959	987	1015	1045	1075
4.4	697	717	737	759	780	803	826	850	874	899	925	952	979	1008	1037	1066	1097
4.5	711	732	753	774	797	820	843	868	893	918	945	972	1000	1029	1058	1089	1120
4.6	726	747	769	791	813	837	861	886	911	937	964	992	1021	1050	1080	1112	1144
4.7	741	763	785	807	830	854	879	904	930	957	985	1013	1042	1072	1103	1135	1168
4.8	757	779	801	824	848	872	897	923	950	977	1005	1034	1064	1095	1126	1159	1192
4.9	773	795	818	841	866	891	916	943	970	998	1026	1056	1086	1118	1150	1183	1217
5.0	789	812	835	859	884	909	935	962	990	1019	1048	1078	1109	1141	1174	1208	1243
5.1	805	829	853	877	902	928	955	983	1011	1040	1070	1101	1132	1165	1199	1233	1269
5.2	822	846	870	895	921	948	975	1003	1032	1062	1092	1124	1156	1189	1224	1259	1295
5.3	840	864	889	914	941	968	995	1024	1054	1084	1115	1147	1180	1214	1249	1285	1322
5.4	857	882	907	933	960	988	1016	1046	1076	1107	1139	1171	1205	1240	1276	1312	1350
5.5	875	900	926	953	980	1009	1038	1068	1098	1130	1162	1196	1230	1266	1302	1340	1378
5.6	893	919	946	973	1001	1030	1059	1090	1121	1154	1187	1221	1256	1292	1330	1368	1407
5.7	912	938	965	993	1022	1051	1082	1113	1145	1178	1212	1247	1282	1319	1357	1396	1437
5.8	931	958	986	1014	1043	1073	1104	1136	1169	1202	1237	1273	1309	1347	1386	1426	1467
5.9	951	978	1006	1035	1065	1096	1127	1160	1193	1228	1263	1299	1337	1375	1415	1456	1498
6.0	971	999	1027	1057	1088	1119	1151	1184	1218	1253	1289	1327	1365	1404	1445	1486	1529
6.1	991	1020	1049	1079	1110	1142	1175	1209	1244	1280	1316	1354	1393	1434	1475	1517	1561
6.2	1012	1041	1071	1102	1134	1166	1200	1234	1270	1306	1344	1383	1423	1464	1506	1549	1594
6.3	1033	1063	1093	1125	1157	1191	1225	1260	1297	1334	1372	1412	1452	1494	1537	1582	1627
6.4	1055	1085	1116	1149	1182	1216	1251	1287	1324	1362	1401	1441	1483	1526	1570	1615	1661
6.5	1077	1108	1140	1173	1206	1241	1277	1314	1351	1390	1430	1472	1514	1558	1602	1649	1696
6.6	1099	1131	1164	1197	1232	1267	1304	1341	1380	1419	1460	1502	1546	1590	1636	1683	1732
6.7	1122	1155	1188	1222	1257	1294	1331	1369	1409	1449	1491	1534	1578	1624	1670	1718	1768
6.8	1146	1179	1213	1248	1284	1321	1359	1398	1438	1480	1522	1566	1611	1658	1705	1754	1805
6.9	1170	1204	1238	1274	1311	1348	1387	1427	1468	1511	1554	1599	1645	1692	1741	1791	1843
7.0	1195	1229	1264	1301	1338	1377	1416	1457	1499	1542	1587	1632	1679	1728	1778	1829	1881
7.1	1220	1255	1291	1328	1366	1406	1446	1488	1531	1575	1620	1667	1715	1764	1815	1867	1921
7.2	1245	1281	1318	1356	1395	1435	1476	1519	1563	1608	1654	1702	1751	1801	1853	1906	1961
7.3	1271	1308	1345	1384	1424	1465	1507	1551	1595	1641	1689	1737	1787	1839	1892	1946	2002
7.4	1298	1335	1374	1413	1454	1496	1539	1583	1629	1676	1724	1774	1825	1877	1931	1987	2044
7.5	1325	1363	1402	1443	1484	1527	1571	1616	1663	1711	1760	1811	1863	1917	1972	2029	2087
7.6	1353	1392	1432	1473	1516	1559	1604	1650	1698	1747	1797	1849	1902	1957	2013	2071	2131
7.7	1381	1421	1462	1504	1547	1592	1638	1685	1733	1783	1835	1887	1942	1998	2055	2114	2175
7.8	1410	1451	1492	1535	1580	1625	1672	1720	1770	1821	1873	1927	1983	2040	2098	2159	2221
7.9	1440	1481	1524	1568	1613	1659	1707	1756	1807	1859	1912	1967	2024	2082	2142	2204	2267
8.0	1470	1512	1556	1601	1647	1694	1743	1793	1845	1898	1952	2009	2066	2126	2187	2250	2315
8.1	1501	1544	1588	1634	1681	1730	1779	1831	1883	1938	1993	2051	2110	2171	2233	2297	2364
8.2	1532	1576	1622	1668	1716	1766	1817	1869	1923	1978	2035	2094	2154	2216	2280	2346	2413
8.3	1564	1609	1656	1703	1752	1803	1855	1908	1963	2020	2078	2138	2199	2262	2328	2395	2464
8.4	1597	1643	1690	1739	1789	1841	1894	1948	2004	2062	2121	2182	2245	2310	2376	2445	2515
8.5	1630	1677	1726	1775	1827	1879	1933	1989	2046	2105	2166	2228	2292	2358	2426	2496	2568
8.6	1665	1713	1762	1813	1865	1919	1974	2031	2089	2149	2211	2275	2340	2408	2477	2548	2622
8.7	1700	1748	1799	1851	1904	1959	2015	2073	2133	2194	2257	2323	2389	2458	2529	2602	2677
8.8	1735	1785	1837	1889	1944	2000	2057	2117	2178	2240	2305	2371	2439	2510	2582	2656	2733
8.9	1772	1823	1875	1929	1985	2042	2100	2161	2223	2287	2353	2421	2491	2562	2636	2712	2790
9.0	1809	1861	1914	1969	2026	2084	2145	2206	2270	2335	2402	2472	2543	2616	2691	2769	2849
9.1	1847	1900	1954	2011	2069	2128	2189	2253	2317	2384	2453	2523	2596	2671	2748	2827	2908
9.2	1885	1940	1995	2053	2112	2173	2235	2300	2366	2434	2504	2576	2650	2727	2805	2886	2969
9.3	1925	1980	2037	2096	2156	2218	2282	2348	2416	2485	2557	2630	2706	2784	2864	2947	3031
9.4	1965	2022	2080	2140	2201	2265	2330	2397	2466	2537	2610	2685	2763	2842	2924	3008	3095
9.5	2006	2064	2123	2185	2248	2312	2379	2447	2518	2590	2665	2742	2821	2902	2985	3071	3160
9.6	2048	2107	2168	2230	2295	2361	2429	2499	2571	2645	2721	2799	2880	2963	3048	3136	3226
9.7	2091	2151	2213	2277	2343	2410	2480	2551	2624	2700	2778	2858	2940	3025	3112	3202	3294
9.8	2135	2197	2260	2325	2392	2461	2532	2604	2680	2757	2836	2918	3002	3088	3177	3269	3363
9.9	2180	2243	2307	2374	2442	2512	2585	2659	2736	2814	2895	2979	3065	3153	3244	3337	3433
10.0	2226	2290	2356	2423	2493	2565	2639	2715	2793	2873	2956	3041	3129	3219	3312	3407	3505

TABLE 4 Estimated fetal weight (grams) from BPD and AC (continued)

AC BPD																
	32.5	33.0	33.5	34.0	34.5	35.0	35.5	36.0	36.5	37.0	37.5	38.0	38.5	39.0	39.5	40.0
3.1	862	887	912	939	966	993	1022	1051	1082	1113	1145	1178	1212	1247	1283	1320
3.2	880	905	931	958	986	1014	1043	1074	1104	1136	1169	1203	1237	1273	1310	1347
3.3	898	924	951	978	1007	1036	1065	1096	1128	1160	1193	1228	1263	1300	1337	1375
3.4	917	944	971	999	1028	1057	1088	1119	1151	1184	1218	1254	1290	1327	1365	1404
3.5	937	963	991	1020	1049	1079	1110	1142	1175	1209	1244	1280	1317	1355	1394	1434
3.6	956	984	1012	1041	1071	1102	1134	1166	1200	1235	1270	1307	1344	1383	1423	1464
3.7	976	1004	1033	1063	1094	1125	1157	1191	1225	1260	1297	1334	1372	1412	1453	1494
3.8	997	1025	1055	1085	1117	1149	1182	1216	1251	1287	1324	1362	1401	1442	1483	1526
3.9	1018	1047	1077	1108	1140	1173	1207	1241	1277	1314	1352	1391	1431	1472	1514	1558
4.0	1039	1069	1100	1131	1164	1197	1232	1267	1304	1341	1380	1420	1461	1503	1546	1590
4.1	1061	1091	1123	1155	1188	1222	1258	1294	1331	1369	1409	1449	1491	1534	1578	1624
4.2	1083	1114	1146	1179	1213	1248	1284	1321	1359	1398	1438	1480	1522	1566	1611	1658
4.3	1106	1137	1170	1204	1239	1274	1311	1349	1387	1427	1469	1511	1554	1599	1645	1693
4.4	1129	1161	1195	1229	1264	1301	1338	1377	1417	1457	1499	1542	1587	1633	1680	1728
4.5	1152	1186	1220	1255	1291	1328	1366	1406	1446	1488	1531	1575	1620	1667	1715	1764
4.6	1177	1210	1245	1281	1318	1356	1395	1435	1477	1519	1563	1608	1654	1702	1751	1801
4.7	1201	1236	1271	1308	1346	1384	1424	1465	1507	1551	1596	1642	1689	1737	1787	1839
4.8	1226	1262	1298	1335	1374	1413	1454	1496	1539	1583	1629	1676	1724	1774	1825	1877
4.9	1252	1288	1325	1363	1403	1443	1485	1527	1571	1617	1663	1711	1760	1811	1863	1917
5.0	1278	1315	1353	1392	1432	1473	1516	1559	1604	1650	1698	1747	1797	1849	1902	1957
5.1	1305	1343	1381	1421	1462	1504	1547	1592	1638	1685	1734	1784	1835	1888	1942	1998
5.2	1332	1371	1410	1451	1493	1536	1580	1625	1672	1720	1770	1821	1873	1927	1983	2040
5.3	1360	1400	1440	1481	1524	1568	1613	1659	1707	1756	1807	1859	1913	1968	2024	2083
5.4	1389	1429	1470	1512	1556	1601	1647	1694	1743	1793	1845	1898	1953	2009	2067	2126
5.5	1418	1459	1501	1544	1589	1634	1681	1730	1780	1831	1884	1938	1994	2051	2110	2171
5.6	1448	1489	1532	1576	1622	1669	1717	1766	1817	1869	1923	1978	2035	2094	2154	2216
5.7	1478	1521	1564	1609	1656	1704	1753	1803	1855	1908	1963	2020	2078	2138	2199	2263
5.8	1509	1553	1597	1643	1691	1739	1789	1841	1894	1948	2004	2062	2122	2183	2246	2310
5.9	1541	1585	1631	1678	1726	1776	1827	1879	1934	1989	2047	2105	2166	2228	2293	2359
6.0	1573	1618	1665	1713	1762	1813	1865	1919	1974	2031	2089	2150	2211	2275	2341	2408
6.1	1606	1652	1700	1749	1799	1851	1904	1959	2015	2073	2133	2195	2258	2323	2390	2459
6.2	1640	1687	1735	1785	1837	1890	1944	2000	2058	2117	2178	2241	2305	2372	2440	2510
6.3	1674	1722	1772	1823	1875	1929	1985	2042	2101	2161	2224	2288	2353	2421	2491	2563
6.4	1709	1758	1809	1861	1915	1970	2026	2085	2145	2207	2270	2336	2403	2472	2543	2616
6.5	1745	1795	1847	1900	1955	2011	2069	2128	2190	2253	2318	2384	2453	2524	2596	2671
6.6	1781	1833	1886	1940	1996	2053	2112	2173	2236	2300	2366	2434	2505	2577	2651	2727
6.7	1819	1871	1925	1980	2037	2096	2157	2219	2283	2348	2416	2485	2557	2631	2706	2784
6.8	1857	1910	1965	2022	2080	2140	2202	2265	2330	2397	2467	2538	2611	2686	2763	2843
6.9	1896	1950	2007	2064	2124	2185	2248	2313	2379	2448	2518	2591	2665	2742	2821	2902
7.0	1936	1991	2049	2108	2168	2231	2295	2361	2429	2499	2571	2645	2721	2800	2880	2963
7.1	1976	2033	2092	2152	2214	2277	2343	2411	2480	2551	2625	2700	2778	2858	2941	3025
7.2	2018	2076	2135	2197	2260	2325	2392	2461	2532	2605	2680	2757	2836	2918	3002	3089
7.3	2060	2119	2180	2243	2308	2374	2442	2513	2585	2659	2736	2815	2896	2979	3065	3153
7.4	2103	2164	2226	2290	2356	2424	2494	2565	2639	2715	2793	2874	2957	3042	3129	3219
7.5	2147	2209	2272	2338	2405	2475	2546	2619	2695	2772	2852	2934	3019	3105	3195	3287
7.6	2192	2255	2320	2387	2456	2526	2599	2674	2751	2830	2912	2996	3082	3171	3262	3356
7.7	2238	2302	2369	2437	2507	2579	2654	2730	2809	2890	2973	3058	3146	3237	3330	3426
7.8	2285	2351	2418	2488	2560	2633	2709	2787	2868	2950	3035	3122	3212	3305	3400	3498
7.9	2333	2400	2469	2540	2613	2689	2766	2846	2928	3012	3099	3188	3280	3374	3471	3571
8.0	2382	2450	2521	2593	2668	2745	2824	2905	2989	3075	3164	3255	3348	3445	3544	3646
8.1	2432	2502	2574	2648	2724	2802	2883	2966	3052	3139	3230	3323	3419	3517	3618	3723
8.2	2483	2554	2628	2703	2781	2861	2944	3028	3116	3205	3298	3393	3490	3591	3694	3801
8.3	2535	2608	2683	2760	2839	2921	3005	3092	3181	3272	3367	3464	3563	3666	3772	3880
8.4	2588	2662	2739	2818	2899	2982	3068	3157	3248	3341	3437	3536	3638	3743	3851	3962
8.5	2642	2718	2796	2877	2960	3045	3133	3223	3316	3411	3509	3610	3714	3821	3931	4045
8.6	2697	2775	2855	2937	3022	3109	3198	3290	3385	3483	3583	3686	3792	3901	4014	4129
8.7	2754	2833	2915	2999	3085	3174	3265	3359	3456	3556	3658	3763	3872	3983	4098	4216
8.8	2812	2893	2976	3061	3150	3240	3334	3430	3528	3630	3735	3842	3953	4067	4184	4304
8.9	2870	2953	3038	3126	3216	3308	3404	3502	3602	3706	3813	3923	4036	4152	4271	4394
9.0	2931	3015	3102	3191	3283	3378	3475	3575	3678	3784	3893	4005	4120	4239	4361	4487
9.1	2992	3078	3167	3258	3352	3448	3548	3650	3755	3863	3974	4089	4207	4328	4452	4581
9.2	3055	3143	3233	3326	3422	3521	3622	3726	3834	3944	4058	4175	4295	4418	4546	4677
9.3	3119	3209	3301	3396	3494	3594	3698	3804	3914	4027	4143	4262	4385	4511	4641	4775
9.4	3184	3276	3370	3467	3567	3670	3775	3884	3996	4111	4230	4351	4477	4606	4738	4875
9.5	3251	3344	3441	3540	3642	3747	3855	3966	4080	4197	4318	4443	4570	4702	4837	4977
9.6	3319	3415	3513	3614	3718	3825	3935	4049	4165	4285	4409	4536	4666	4801	4939	5081
9.7	3389	3486	3587	3690	3796	3905	4018	4134	4253	4375	4501	4631	4764	4901	5042	5188
9.8	3460	3559	3662	3767	3876	3987	4102	4220	4342	4467	4595	4728	4864	5004	5148	5296
9.9	3532	3634	3738	3846	3957	4071	4188	4309	4433	4560	4692	4827	4966	5109	5256	5407
10.0	3606	3710	3817	3927	4040	4156	4276	4399	4526	4656	4790	4928	5070	5216	5366	5521

examined with the same scanner, 4) all newborns were weighed by the same equipment, and 5) the measurement was done within 24 hours of delivery, unlike many previous studies.

The limitations of this study may include 1) variations in measurements between the two sonographers, 2) the measurements may be erroneous in cases of obesity or engaged fetal head, and 3) no comparison between sonographic parameters and actual neonatal ones, therefore, systematic error was not known.

However, the equation from this study should be further tested in another sample to evaluate the precision and accuracy of prediction.

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