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Original Article

Fetal Biometry in the Population of Southern Punjab, Pakistan

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Abstract

Background: Ultrasound estimation of fetal parameters is one of the most important examinations. Hadlock and other foreign fetal biometry curves are used in Pakistan as there are no national normative data derived from local population.
Objectives: To construct local reference charts and equations for fetal biometric measurements and amniotic fluid index (AFI) using a large sample of fetuses examined at 14 – 40 weeks in the population of southern Punjab.
Study design, settings and duration: The prospective, cross sectional study conducted at the Multan Institute of Nuclear Medicine and Radiotherapy (MINAR) over a one year period from December 2010 to November 2011.
Subjects and Methods: A total of 566 randomly selected pregnant females, who fulfilled the inclusion criteria were included in the study after informed consent. Each woman was scanned once only, between 14 and 40 weeks of gestation, and her fetal measurements were also recorded simultaneously. Regression models were used to estimate the mean and standard deviation at each week of gestation. Fetal biometric parameters of local population were compared with those of Hadlock and Singaporean Asian population. Results were statistically analyzed and also presented graphically across the different gestational ages to allow visual comparison.
Results: Biometric measurements were obtained for 566 fetuses. There was no significant difference between fetal parameters of local population and those of Hadlock. When compared with those of the Singaporean Asian population, femur length and head circumference were larger while biparietal diameter was smaller in our population.
Conclusion: We have constructed local reference centiles for fetal measurements and equations for dating of pregnancy for Southern Punjab. The biometric measurements are slightly different from Singaporean Asian population, but there was no statistically significant difference between these measurements and those by Hadlock.
Key words: Fetal biometry, southern punjab, biparietal diameter, head circumference, femur length, abdominal circumference, amniotic fluid index.

Introduction

Fetal biometry is the methodology for measuring various aspects of fetal anatomy and growth.[1] Fetal growth is the time dependent changes in the fetal body dimensions throughout the pregnancy. There is a rapid growth rate of different fetal biometric parameters, especially in first and second trimesters of gestation and this change of biometric parameters should be evaluated and correlated with normal value at that particular age.[2]

Before the development of ultrasound, fetal dimensions were measured using radiological techniques. Introduction of ultrasound made it safer and easier to measure soft tissue structures and bones of the fetus with more reliability and quicker when compared with x-rays. Donald and Brown were the first users of ultrasound for measuring the fetal biparietal diameter.[3] Later others defined the basic methodology and fetal cephalometry.[4] Over the last many decades, there has been a tremendous progress in the use of diagnostic ultrasound in obstetrical management due to its non-ionizing and non-invasive nature and its cost effectiveness resulting in wider acceptability.

Almost all ultrasound machines have standard charts of fetal biometry representing Western population though fetal biometric parameters vary with ethnic, social as well as nutritional status of population. A significant difference has been reported in the growth of Indian vs. non-Indian (Chinese and Malay) fetuses.[5] Similarly, other investigators have also reported that the growth charts and femur length were different from in their local

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Authors Contribution

DS has done the conceptualization of project. DS and KR dis the data collection, literature search, statistical analysis, drafting, writing and revision of the manuscript.

population.[6,7] An Iranian researcher reported that fetal biometry in Iranian population a difference in femur length of local population with that from Hadlock et al used as a standard. The mean difference was 3.4 mm seen from 14 to 22 weeks and 5 mm afterwards.[8]

Similarly investigators from Cameron, Oman and Israel also reported that fetal biometric profile of their respective population was unique and different from other populations.[9-11] Therefore, it is possible that fetal biometric charts for one population may under or over estimate the fetal age for another population and this may lead to erratic gestational age calculations, and wrong diagnosis of large-for-gestational age fetus or intrauterine growth restriction. Thus it is recommended that every country should construct and use biometric charts of its own population.

There is an effect of altitude on fetal weight and studies have shown a reduction of 102 grams - 145 grams in birth weight when altitude was increased up to 1000 meters, while keeping all other variables controlled.[12–16]

Zaidi et al from Pakistan established fetal measurements in population of Karachi, predominantly Urdu-speaking "Mohajirs" [17] but authors were unable to find any study on fetal biometry in the southern Punjab region, therefore this study was undertaken to calculate fetal biometry for this population.

Subjects and Methods

This prospective, cross sectional study was conducted at the Multan Institute of Nuclear Medicine and Radiotherapy (MINAR) over one year. The institute mainly caters for the population of southern Punjab. The study was conducted after approval by the ethics committee of MINAR. All measurements were performed by two trained ultrasound operators. The inclusion criteria were women from the Southern Punjab who had regular menstrual cycles of 26-33 days for at least three cycles before conception and who were certain of the date of the last menstrual period (LMP). The exclusion criteria were:

(1) Multiple pregnancies (2) Uncertainty of LMP (3) Latent/overt diabetes mellitus (4) Pregnancy induced or chronic hypertension (5) History of maternal smoking (6) Rhesus (Rh) incompatibility (7) Fetal anomaly (or anomalies) detected on ultrasonography (8) Transverse lie after 34 weeks of gestation and (9) Any chronic maternal illness like tuberculosis, chronic liver disease or malignancy.

Mothers who gave an informed consent and who fulfilled the inclusion criteria were examined ultrasonographically and their Bi-Parietal Diameter (BPD), Femur Length (FL), Head Circumference (HC), Abdominal Circumference (AC) were measured in mm while Amniotic Fluid Index (AFI) was measured in cm. Only one ultrasound examination of each subject was performed by one of two operators. Real time transabdominal ultrasound was performed using Toshiba® Xario® SSA-660A and Toshiba® Nemio® SSA-550A ultrasound machines equipped with 3.5-MHz curvilinear abdominal probe.

Bi-parietal diameter and head circumference were measured in the axial plane having smooth and bilaterally symmetrical calvaria and where the midline echo in the anterior third was broken by the cavum septi pellucidi with symmetrical appearance of both thalami. Bi-parietal diameter was measured from the outer aspect of the proximal calvarial wall to the inner aspect of the distal calvarial wall. Fetal HC was measured over the outer to outer edges of calvaria by a computer-generated ellipse. Femur length measurement was done in a plane where fetal femoral diaphysis was seen parallel to transducer. In the last trimester, FL was measured more carefully not to include the epiphysis in the measurement. AC measurement was performed on a transverse fetal abdominal plane at the level where stomach bubble, fetal spine, umbilical vein (intra-hepatic portion) and the descending aorta are seen in the same plane. AFI was calculated by adding the vertical depth of the maximal pocket in each quadrant of the uterus.

Only those fetuses were included in the statistical analysis for which all measurements were available. For gestational age, fractions of weeks were computed to the nearest week, with fractions of less than 4 days being assigned to the lower week and equal or more than 4 days being assigned to the higher weeks.

Statistical analysis was done using the statistical software, Minitab® (Minitab Inc. USA). Anderson-Darling test was used to assess the normality of the measurements for each week of gestation and the Least-square regression model was used for the mean by fitting polynomial equation. A quadratic polynomial model was found the best for fitness to mean ($y = a + b \times GA + c \times GA^2$).

Four fetal parameters (i.e, BPD, FL, HC and AC) of the local population were compared with those measured for Asian population of Singapore (visual comparison using graphs). The results were also compared with Western population (measured by Hadlock et al.) using Minitab® software (Minitab Inc. USA). Mean difference between population's parameters at each week of gestation was analyzed by means of independent two-sample t-test, as the data showed normal distribution. Comparison between two populations was done at each week of gestation separately for all four parameters. A p-value of less than 0.05 was taken as statistically significant.

Results

Biometric measurements were obtained for 566 fetuses. The mean maternal age was 26.63 ± 4.42 years. Polynomial regression model was fitted independently to the means of gestational age for each biometric measurement, using Minitab (Figure-1). The goodness of

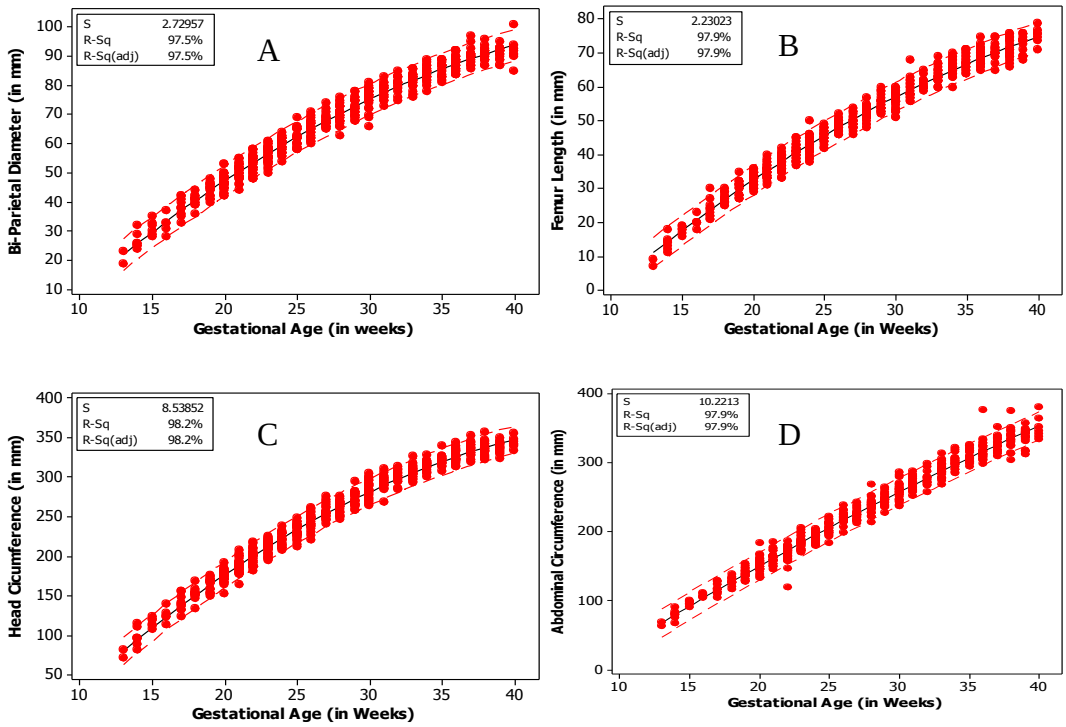

Figure 1: Regression analyses of fetal measurements (A = biparietal diameter, B = femur length, C = head circumference and D = abdominal circumference)

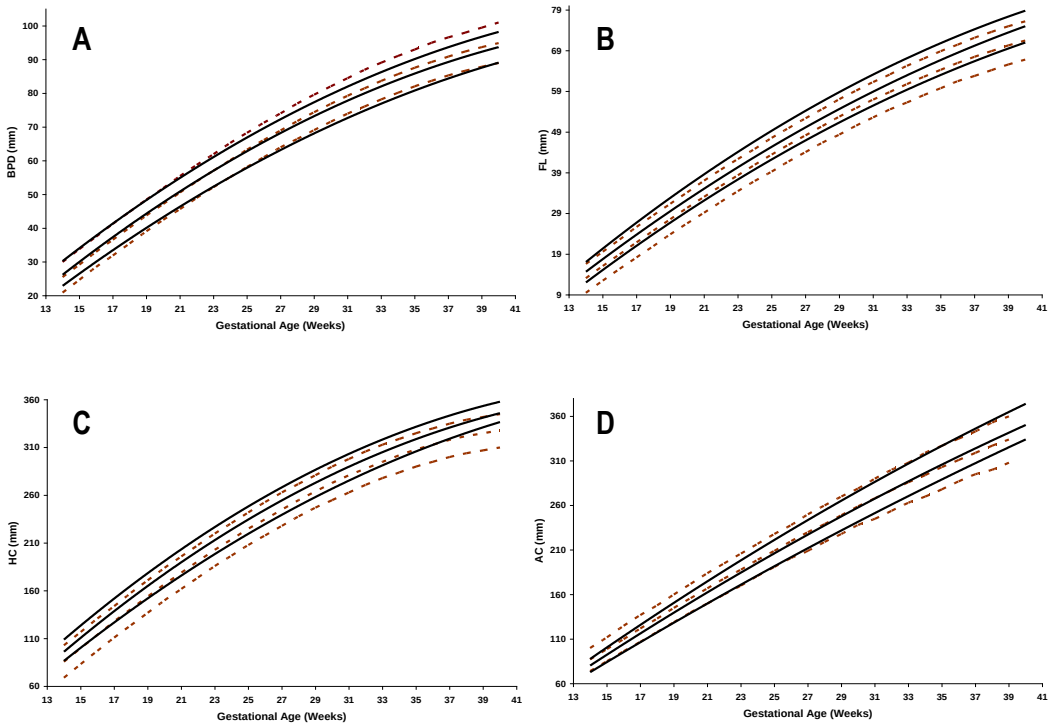

Figure 2: Means, 3rd and 97th percentiles of fetal measurements (A = BPD, B = FL, C = HC and D = AC). Graphs show measurements of local population (constant lines) and those of Singaporean Asian population measured by Lai et al. (interrupted lines)

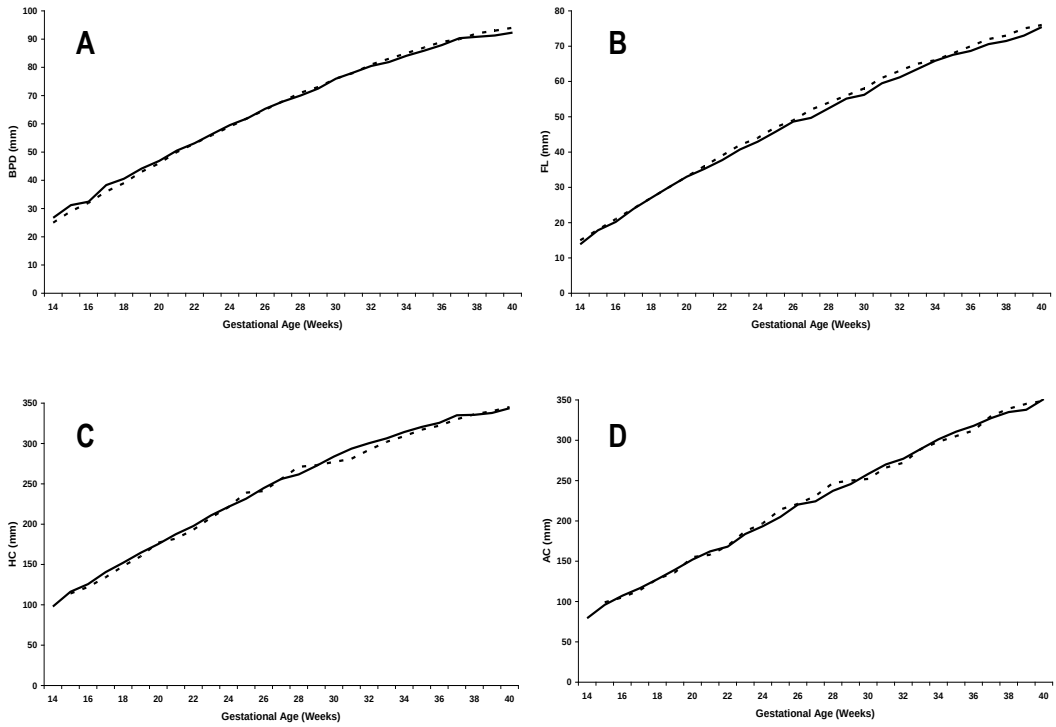

Figure 3: Fetal measurements of local population (constant lines) and those measured by Hadlock et al. (interrupted lines) (A = BPD, B = FL, C = HC and D = AC)

fit was assessed by their correlation coefficient (R^2) and it was evident that quadratic polynomial model was the best model for fitness to mean. The following formula were obtained from the regression models and coefficients of correlation:

(GA = gestational age in weeks, calculated from last menstrual period; BPD = biparietal diameter, FL = femur length, HC = head circumference and AC = abdominal circumference; all measurements in mm):

$$BPD = -37.07 + 5.157\ GA - 0.04709\ GA^2 \quad (R^2 = 97.5)$$
$$FL = -37.46 + 4.185\ GA - 0.03437\ GA^2 \quad (R^2 = 97.9)$$
$$HC = -150.1 + 20.20\ GA - 0.1942\ GA^2 \quad (R^2 = 98.2)$$
$$AC = -102.2 + 13.86\ GA - 0.06197\ GA^2 \quad (R^2 = 97.9)$$

Anderson-Darling test was used to confirm the normality of the measurements for each week of gestation. The results showed that most of our data was normally distributed.

Centiles were calculated for each measurements using the formula: centile = mean + K × SD (K = ±1.88 for 3rd and 97th centiles). Mean, 3rd and 97th percentiles were plotted and comparison of the present study measurements was done with the corresponding measurements from a published study on Asian population by Lai FM et al.[18] (Figure-2). The graphs showed that fetal biometrical parameters of our local population were slightly different from those reported by Lai et al.[18] Our Femur length and head circumference values were slightly larger than those of Singaporean Asian population.

Though our results appeared slightly different from those of Hadlock et al. (Table-1 & Figure-3) but statistically no difference was found in all measurements.

Table 1: Comparison of fetal parameters of local population with those of Hadlock et al.

Gestational Age (weeks)	*Biparietal Diameter (mm)*	
	Our Study	*Hadlock et al.*
14	27	25
15	31	29
16	32	32
17	38	36
18	41	39
19	44	43
20	47	46
21	51	50
22	53	53
23	56	56
24	60	59
25	62	62
26	65	65
27	68	68
28	70	71
29	72	73
30	76	76
31	78	78
32	80	81
33	82	83
34	84	85
35	86	87
36	88	89

37	90	90
38	91	92
39	91	93
40	92	94

Gestational Age (weeks)	*Femur length (mm)*	
	Our Study	*Hadlock et al.*
14	14	15
15	18	18
16	20	21
17	24	24
18	27	27
19	30	30
20	33	33
21	35	36
22	38	39
23	41	42
24	43	44
25	46	47
26	49	49
27	50	52
28	52	54
29	55	56
30	56	58
31	59	61
32	61	63
33	64	65
34	66	66
35	68	68
36	69	70
37	71	72
38	71	73
39	73	75
40	75	76

Gestational Age (weeks)	*Head circumference (mm)*	
	Our Study	*Hadlock et al.*
14	98	
15	116	114
16	126	122
17	141	134
18	152	148
19	165	160
20	175	177
21	188	182
22	198	193
23	211	208
24	222	221
25	232	239
26	245	241
27	256	256
28	262	271
29	272	273
30	284	277
31	293	281
32	300	292
33	306	302
34	314	309
35	321	317
36	326	322
37	335	330
38	336	336
39	338	340
40	344	345

Gestational Age (weeks)	*Abdominal circumference (mm)*	
	Our Study	*Hadlock et al.*
14	79	
15	96	99
16	107	105
17	117	114
18	128	128
19	139	136
20	152	155
21	162	158
22	168	169
23	184	187
24	193	197
25	205	214
26	220	221
27	224	231
28	237	247
29	246	250
30	258	252
31	270	266
32	277	272
33	289	289
34	301	298
35	311	305
36	318	312
37	327	330
38	335	339
39	338	345
40	351	349

Table 2: Amniotic fluid index (AFI) (mean ± SD) at various weeks of gestation.

Gestational Age (Weeks)	AFI (cm) mean	±SD	Gestational Age (Weeks)	AFI (cm) mean	±SD
14	11.1	±1.2	28	15.7	±3.3
15	12.5	±1.0	29	14.7	±2.6
16	11.6	±2.1	30	14.5	±3.4
17	13.3	±2.2	31	15.0	±3.2
18	13.2	±1.2	32	14.8	±2.7
19	14.7	±1.5	33	15.5	±3.3
20	14.3	±2.5	34	14.4	±5.0
21	15.2	±2.1	35	14.8	±3.9
22	15.9	±1.9	36	13.4	±3.2
23	16.2	±2.7	37	14.8	±4.9
24	16.1	±2.8	38	14.1	±4.5
25	17.0	±3.3	39	14.8	±3.3
26	15.8	±3.2	40	14.3	±2.9
27	16.5	±2.2			

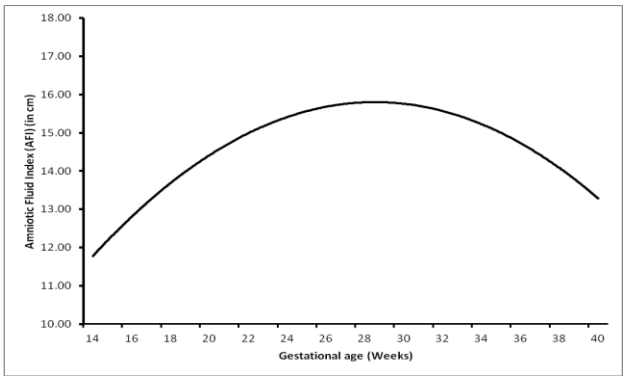

Figure 4: Mean amniotic fluid index in different weeks of gestation.

Results of amniotic fluid index (AFI) was calculated in all subjects and were stratified by week of gestations (Table-2). The mean amniotic fluid index (AFI) was 14.982 cm (SD = 3.201cm). The graphical

form of mean AFI for various weeks of gestation is shown in Figure-4.

Discussion

The present study on fetal biometry between 14 and 40 weeks of gestation was calculated for the population of Southern Punjab and the results showed that our femur length and head circumference values were slightly larger than those of Singaporean Asian population while statistically no difference was found in all measurements when compared with those of Hadlock et al.

Our sample size of 566 was not as big as in some other publications [7,19,20] but Leung et al. described that the sample size in hundreds is enough for data analysis.[21] Increasing the sample further (1000 or in some studies even 2000 cases) increases the probability of including data from abnormal population subgroups.[22] Fetal biometric measurements can be used to generate conversion tables for fetal gestational age [23] and this was also done in the present study. We compared the fetal parameters of our population with with Asian population in Singapore [18] using different gestational ages. The BPD measurements of our population and Singapore population were similar, although the Singapore population had a slightly larger BPD in the 3rd trimester of pregnancy (Figure-2). Femur Length was larger in our population when compared with the Singaporean population (Figure-2). Similarly Head Circumference was also larger in our population (Figure-2). However there was no difference in abdominal circumference of both populations (Figure-2).

We also compared the fetal parameters of local population with those of Hadlock et al. as database of Hadlock is used as the standard reference which is incorporated in most ultrasound machines for fetal age estimation. There was no significant difference between our parameters and Hadlock reference range. Mean amniotic fluid index of our population was 11 cm at 14 weeks, which gradually increased up to 17 cm at 25 weeks of gestation and then reduced gradually to 14 cm at 40 weeks of gestation. This was similar to the pattern described by other worker however their maximum median was 14 cm.[24] Information about local normal range of AFI can immediately help to differentiate extremes of range (greater or less $\pm$ 2SD) and deciding for frequent monitoring of patients who lie beyond this range. The present study not only describes the norms of local data but also validated the classical data (Hadlock) that is used by the local population.

Global data from pooled values has recently been published under the INTERGROWTH-21st project.[25] It has included populations of 8 countries and is promoted as a generic standard of fetal growth. Local values can always be compared with classical Hadlock or the most recent INTERGROWTH-21st study.

Ultrasonologists must be aware that variation in different fetal parameters occur due to differences in the race, ethnicity, genetics and anatomical growth and are not necessarily due to abnormality. The presence of these charts makes it easier to discuss minor variation in fetal parameters within local population.

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Conflict of interest: None declared.

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