# The Effect of Sex on Fetal Ultrasound Measurements: Is It Necessary Sex-Spesific Nomograms?

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**Abstract**

**Objective:** To investigate the effect of gender differences on fetal ultrasound measurements like biparietal diameter, head circumference, abdominal circumference, femur length and estimated fetal weight.

**Methods:** Between 2002 and 2005, 548 women admitted to our obstetrics department were enrolled in the study. 637 ultrasound examination including biparietal diameter, head circumference, abdominal circumference and femur length were performed by 4 different investigators in these women. Fetal weight was estimated using the Hadlock 4 formula. Ultrasound measurements were recorded for each gestational week. The differences in ultrasound measurements between male and female fetuses were investigated using Student t-test. P<0,05 was considered statistically significant.

**Results:** The birth weight was not different between female and male fetuses (3311 ± 518 and 3269 ± 522 gr, respectively) (p>0.05). Femur length and abdominal circumference was significantly higher in male fetuses than females between 15 and 22 weeks of gestation, whereas estimated fetal weight were significantly higher in female fetuses than males between 27-30 weeks of gestation (p<0.05). Furtermore, head circumference was significantly higher in males than females between 35 and 38 weeks of gestation. Other measurements were not different between males and females (p>0.05).

**Conclusion:** The use of sex-spesific nomograms may obtain to evaluate fetal growth and also making accurate diagnosis for intrauterine growth restriction and macrosomia. It may be useful to repeat this preliminary study in a large and heterogenous population.

**Keywords:** Gender differences, estimated fetal weight, head circumference, abdominal circumference, ultrasound.

## *Cinsiyetin fetal ultrason ölçümleri üzerine etkisi: cinsiyete özgü büyüme eğrileri gerekli mi?*

**Amaç:** Fetusun cinsiyetinin, biparietal çap, kafa çevresi, abdomen çevresi, femur uzunluğu ve tahmini fetal ağırlık gibi fetal ultrason ölçümleri üzerine etkisini araştırmak.

**Yöntem:** 2002-2005 yılları arasında, obstetri ve perinatoloji polikliniğimize rutin kontrol amacıyla başvuran 15-40 hafta arasında 548 gebe çalışmaya dahil edildi. Bu gebelerde 637 fetal ultrason, biparietal çap, kafa çevresi, abdomen çevresi ve femur uzunluğunu içerecek şekilde, dört farklı araştırmacı tarafından yapıldı. Tahmini fetal ağırlık hesaplamasında ultrasonografinin programında yer alan Hadlock 4 formülü kullanıldı. Her gebelik haftası için fetal ölçümler kaydedildi. 15. haftadan 40. haftaya kadar yapılan tüm ölçümler 15-22. hafta, 23-26 hafta, 27-30 hafta, 31-34 hafta, 35-38 hafta, 39-40 haftalar arasında gruplanarak karşılaştırıldı. Fetal ölçümlerin kız ve erkek fetuslar arasında farklılık gösterip göstermediği Student t- testi kullanılarak karşılaştırıldı. P<0.05 istatistiksel olarak anlamlı kabul edildi.

**Bulgular:** Kız ve erkek bebeklerin doğum ağırlığı arasında bir fark yoktu (sırasıyla 3311 ± 518 ve 3269 ± 522 gr) (p>0.05). 15-22. gebelik haftaları arasında kız fetuslarda femur uzunluğu ve abdomen çevresi erkek fetuslara göre anlamlı ölçüde kısa iken, 27-30. gebelik haftaları arasında tahmini doğum ağırlığı kız fetuslarda, erkek fetuslara göre anlamlı ölçüde fazla, 35-38. gebelik haftalarında ise kafa çevresi erkek fetuslarda kız fetuslara göre anlamlı ölçüde fazla idi (p<0.05). Diğer ölçümlerde kız ve erkek fetuslar arasında istatistiksel olarak anlamlı bir fark saptanmadı.

**Sonuç:** Kız ve erkek fetuslar için farklı büyüme eğrilerinin kullanılması, intrauterin büyümenin doğru değerlendirilmesini için önerilir. Bir ön çalışma olarak planlanan bu çalışmanın, daha geniş ve daha heterojen bir hasta

**Anahtar kelimeler:** Cinsiyet farklılığı, tahmini fetal ağırlık, baş çevresi, abdominal çevre, ultrason.

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## Introduction

Biparietal diameter (BPD), head circumference (HC), abdominal circumference (AC), femur length (FL) are used to measure the estimated birth weight (EBW) and evaluate intrauterine fetal maturation.[1] These measurements are used for fetal maturation estimation as well as intrauterine growth retardation (IGR) and pathologies like macrosomia.[1,2-5] Some of the researchers are trying to estimate the fetal weight by using maternal weight, length, parity and the sex of the fetus as well as ultrasound monitoring.[6-9] It is a known fact that male fetuses are taller, heavier and have larger cranial diameter in comparison to the female fetus.[10-12] Some contends that this difference is begun as from the early gestational weeks.[10,13] And also, for female and male infants, the length and weight growth is accelerated in different timetables of intrauterine period.[14]

The purpose in this study is to investigate the effect of gender differences on fetal ultrasound measurements like BPD, HC, AC, FL and EBW.

## Methods

Between 2002 and 2005, 548 women admitted to our obstetrics department were enrolled in the study and 637 ultrasonography monitoring were performed. The reason for ultrasonography monitoring is to implement fetal measurement for triple scanning, and second level detailed USG, routine uterine artery Doppler, fetal growth follow up or amnion fluid assessment. Any of the patients didn't get involved to ultrasonographic examination without indications. The gestational week was estimated by the latest menstrual period, if not know, by the first trimester ultrasonography. The patients with endocrinal disorders, preeclampsia, hypertensive, smoking, fetal anomalies, preterm gestation, were excluded from the study. Ultrasonographic scanning was made by 2 different ultrasonic device (Siemens Sonoline Sienna, Siemens Medical System, Erlangen, Germany and Voluson 730 Expert, General Electric, Kretz Ultrasound Systems, Austria) 2-7 megahertz frequency range, using convex probe, conducted by 4 scanner. Biparietal diameter, head circumference, abdominal circumference, at thalamus level, calvarium skull circumference except the soft tissues, transverse abdomen section that umbilical vein intersects with portal vein and the distance from proximal edge to femoral cervix in proximity to the distal metaphysis are measured in a way that includes only ossified sections.[15] TDA was measured through Hadlock 4 formula in the ultrasonic device. The sex of the fetuses, which was determined antenatally, was confirmed after the gestation. All measurement between 15th and 40th weeks, were grouped in 15-22, 27-30, 31-34, 35-38, 39-40th weeks and compared.

Statistical research was performed by using SPSS (SPSS for windows, version 13.0, USA) software. The difference between ultrasonic measurements of the male and female fetuses and that of their birth weight was researched using Student-t test, and the relation between birth weight and fetal measurements was analyzed by Pearson Correlation Analysis. P<0,05 was considered statistically significant.

## Results

All measurements, birth weight and basal values were shown as average ± standard deviation (SD).

The mean age of patients was 28.3 ± 5.3 and 28 ± 4.8. 49. 8% of the fetuses were male, 50.2% were female. 48.6% of the pregnant women delivered the fetus by cesarean, 51.4% delivered with vaginal modality. There wasn't a significant difference between male and female birth weights (consecutively 331 ± 518 and 3269 ± 522 gr) (p>0.05). 548 women admitted to our obstetrics department were enrolled in the study and 637 ultrasonography monitoring were performed. The dispersion of the ultrasonic scanning numbers to the gestational weeks is shown in Figure 1.

Between 15th and 22$^{nd}$ gestational weeks, FL and AC were comparatively short in female fetuses, between 27 and 30$^{th}$ gestational weeks, EBW was significantly greater than male fetuses, between 35 and 38$^{th}$ gestational weeks, HC was significantly greater in male fetuses than the female fetuses (Table 1). In other measurements, no sta-

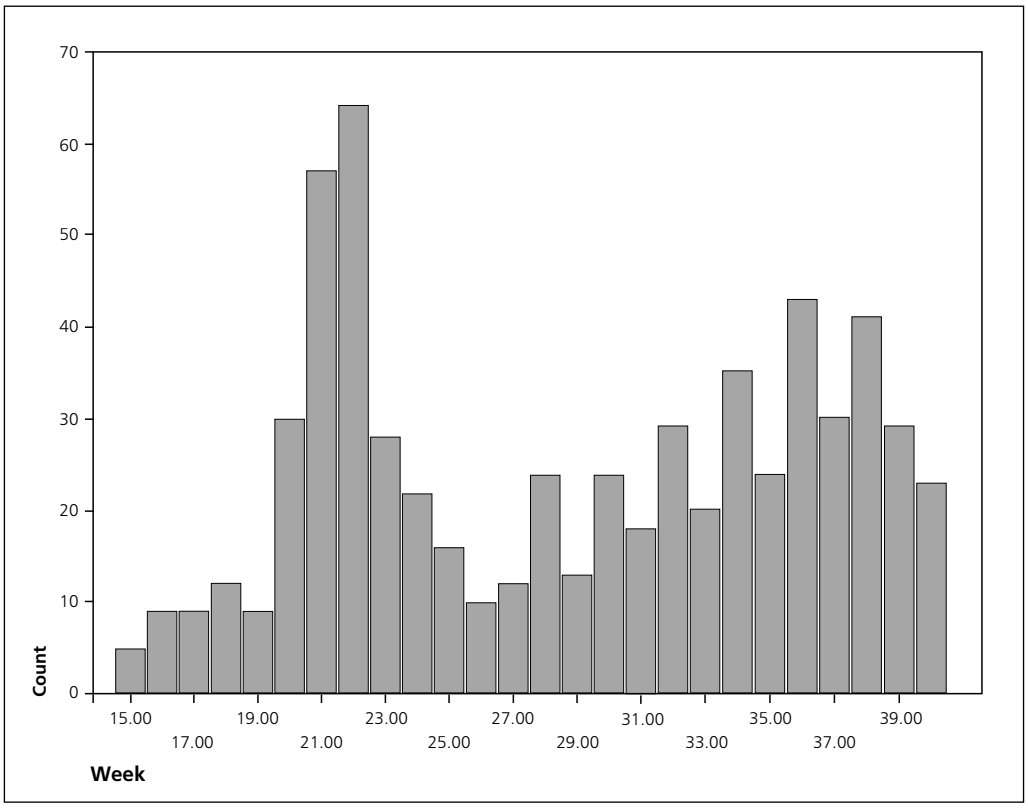


**Figure 1.** Dispersion of the ultrasonic scanning numbers to the gestational weeks (n = measurement).

tistical difference between male and female fetuses has been found.

Considering the relation between birth weight and fetal measurements, there is a slight but significant correlation between fetal measurements in male and female fetuses and birth weight (Table 2).

## Discussion

It is a known fact that male fetuses are taller, heavier and have larger cranial diameter in comparison to the female fetus.[10-12] These natal measurement differences between male and female infants are theoretically depended on different growth rates in intrauterine period. The growth rate of the male and female fetuses differs in intrauterine period, according to their gestational weeks.[14] The femoral length and weight growth of the female infants are more symmetrical and their legs that are growing faster, enable that the ponderal indexes are lower.[14] In another study, noted that the sex of the fetus influence on BPC, HC and FU and that it should be appropriate to use as an independent variable for estimating weight. Supporting this opinion, noted that the measurements of female infants are lower than that of the male infants as from the early periods of the pregnancy.[16-18]

In our study, despite the male fetuses grew faster than female fetuses in early gestational weeks, EBW of the female fetuses outstrips the EBW of the male fetuses in early trimester period, following gestational weeks this difference closed down. Since the measurement differences between male and female fetuses in early gestational weeks, may have effect on the results of the triple scanning tests, these differences are important.

In contrary to our study, Schwarzler et al[17] found that all measurements except FL were dif-

**Table 1.** BPD, FL, AC, HC and EBW measurements for male and female fetus (*p value indicates the ones that are statistically significant).

| Week | 15-22 (n=196) | 23-26 (n=76) | 27-30 (n=72) | 31-34 (n=102) | 35-38 (n=137) | 39-40 (n=52) |
|---|---|---|---|---|---|---|
| **BPD (mm)** | | | | | | |
| Female | 48.6±7.4 | 59.8±5.4 | 76.7±6.5 | 82.3±4.2 | 89.1±4.1 | 94.5±2.7 |
| Male | 49.2±6.2 | 60.3±4.4 | 72±4.9 | 81.3±7.4 | 89.1±3.3 | 94.1±3.3 |
| p | 0.241 | 0.278 | 0.460 | 0.596 | 0.206 | 0.284 |
| **FL (mm)** | | | | | | |
| Female | 33.2±6.6 | 42.4±3.9 | 53.5±7.3 | 62.2±3.9 | 69.9±3.4 | 76.1±2.7 |
| Male | 33.9±5.3 | 42.3±3.1 | 54.1±4.8 | 63±3.5 | 70.7±3.4 | 74.6±3.6 |
| p | 0.017* | 0.609 | 0.118 | 0.482 | 0.766 | 0.962 |
| **AC (mm)** | | | | | | |
| Female | 158±26 | 197±15 | 249.7±29.8 | 280.3±19.5 | 326±45.3 | 345.5±17.5 |
| Male | 160±20 | 209±18 | 242.8±19 | 287±18.4 | 322.5±19.7 | 353.1±16.8 |
| p | 0.026* | 0.561 | 0.113 | 0.482 | 0.275 | 0.649 |
| **HC (mm)** | | | | | | |
| Female | 184±25 | 223±20 | 272±25.4 | 304.7±19.6 | 318±18 | 340.7±11.1 |
| Male | 186±18 | 224±24 | 268±19.5 | 302.7±21.1 | 327±13.1 | 339±9.8 |
| p | 0.052 | 0.563 | 0.745 | 0.590 | 0.004* | 0.578 |
| **EBW (gr)** | | | | | | |
| Female | 395±166 | 684±140 | 1403±517 | 2005±347 | 2914±533 | 3684±394 |
| Male | 407±123 | 695±178 | 1236±289 | 2063±303 | 2986±336 | 3547±296 |
| p | 0.354 | 0.387 | 0.006* | 0.284 | 0.193 | 0.504 |

ferent between 15th and 40th gestational week. Hindmarsh et al[10] observed low risk group single pregnancy cases, between 20-30 weeks and found that the sex of the fetus influence HC, on the other hand, AC is greater in male fetus than female fetus however FL wasn't changed. In the extent of these studies which were performed in different geographical areas, the ethnic particularities may affect the results. In fact, studies showed that ethnic origin and geographical territory have effects on the growth rate of the fetus.[19] Moreover, the weight, length, parity which was supposed to influence the weight of the fetus, are exluded from our study and their influence should be examined.

Schild et al.[20] developed a special formula for estimating the ultrasonographic fetal weight and claimed that it contains lower fault tolerances comparing to other methods. In our study, no difference between male and female weight estimations. But, there isn't ant significant difference between birth weights within our study group. Eventually, it is natural not to find any difference in intrauterine period. Changing climate, nutrition, and living conditions are anthropologically changing the human kind. In this extent, that fact that female fetuses are delivered in smaller size compared to the male fetuses, may be a new research subject.

**Table 2.** Relation between birth weight and fetal measurements for male and female fetus (r = correlation coefficient, p = significance).

| | EBW | BPD | FL | AC | HC |
|---|---|---|---|---|---|
| **Female** | r=216 p=0.003 | r=180 p=0.01 | r=177 p=0.01 | r=185 p=0.01 | r=160 p=0.03 |
| **Male** | r=199 p=0.009 | r=185 p=0.01 | r=160 p=0.03 | r=194 p=0.01 | r=157 p=0.04 |

The significant but slight effects of the ultrasonographic measurements for estimating the fetal weight strengthen the opinions that are claiming the inadequacy of the ultrasonographic scanning in order to estimate the birth weight.

Consequently, the sex of the fetus may be influencing the measurements in some gestational weeks. But, since there are many factors including maternal, genetic, ethnic and geographical differences that influence the growth of the fetus, fetal maturation should be evaluated in single case basis, and serial measurements should be preferred instead of single measurements. Using different growth curves for female and male fetuses may ensure the exact evaluation of intrauterine growth and be useful for diagnosing intrauterine growth retardation and macrosomia. It would be appropriate to repeat this study, which was planned as preliminary and single centered, on larger and heterogeneous patient group.

## Conclusion

Using different growth curves for female and male fetuses may ensure the exact evaluation of intrauterine growth and be useful for diagnosing intrauterine growth retardation and macrosomia. We think that it would be appropriate to repeat this study, which was planned as preliminary and single centered, on larger and heterogeneous patient group.

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