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A comparative study of Johnson's formula and maternal anthropometric measurements for estimation of fetal weight and their correlation with birth weight among term pregnant mothers in antenatal ward at government maternity hospital, Tirupati

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Abstract
In this study, Descriptive correlational research design used on Johnson's formula and Maternal Anthropometric Measurements for estimation of foetal weight and their Correlation with birth weight among Term Pregnant Mothers. Non probability purposive sampling technique with a structured interview schedule was used to collect data from the samples. Result of the 100 samples revealed that the highest knowledge score of the study was to correlate the in utero estimated fetal weight by using Johnson's formula, Anthropometric measurements to the birth weight. It is observed that the mean correlation scores between Anthropometric measurements, Newborn Birth Weight are 3166.16±384.34. The r-value obtained was 0.20 which was statistically significant at $p<0.001$. The correlation between newborn birth weights with Johnson's Estimated Fetal Weight the mean value is 3434.03, ± 411.24. The r-value obtained was 0.12 which was statistically not significant. When the birth weights were compared with the measured birth weight in different weight categories 3,500gms, Anthropometric measurements proved better than Johnson's formula with Chi-square value 243.22 and 224.08 respectively which were significant at $p<0.001$. The study findings revealed that there was a significant association with age, education of mother and education of husband, the Chi-square values of which were 5.92,10.42 and 9.37 respectively at $p<0.05$, while other variables were not found to be statistically significant. The study findings revealed that there was a good correlation between Anthropometric Measurements and Johnson's formula ($r=0.20$, $p<0.001$). Anthropometric Measurements formula was simple and there was better accuracy than Johnson's formula when birth weights were compared with measured birth weights. More over ultrasound is not available in the rural areas, where as SFH ×AG formula is easy and simple to calculate.

Keywords: Johnson's formula, maternal anthropometric, government maternity hospital, Tirupati

Introduction
The research approach adopted was comparative, descriptive correlational design. The study was conducted at Antenatal ward, Government Maternity Hospital, Tirupati, Andhra Pradesh. The sample for the study was chosen by non-probability convenient sampling technique which included 100 samples. Foetal weight in utero was calculated by using Maternal anthropometric measurements (SFH×AG), Johnson's formula in 100 term pregnant mothers. The results were correlated with the birth weight. The data collection tool was validated by Obstetricians and experts from nursing departments. Reliability was established by split half method and pilot study was conducted following with the data collection was carried out. Analysis of data were executed in terms of frequency distribution, percentage, mean, standard deviation, t-test, correlation(r) to estimate the foetal weight by using Johnson's formula and Maternal Anthropometric measurements. Association between demographic variables and impact of maternal anthropometric measurements (SFH×AG) and Johnson's formula and its correlation with birth weight was analyzed by using Chi-square (χ^2) test. The study findings revealed that the average error in foetal weight estimation was less with maternal anthropometric measurements (SFH×AG) in comparison to Johnson's formula. When Karl Pearson's coefficient correlation, 'r' was calculated it was 0.12 by Johnson's formula (moderate correlation) and 0.202 by maternal anthropometric measurements (SFH×AG) (strong correlation). Findings also revealed that the average error in foetal weight estimation was less with maternal anthropometric measurements (SFH×AG) is best and compared with Johnson's formula. The association between demographic variables with maternal anthropometric measurements, Johnson's formula with birth weight, it is revealed that there was significant association with age, education of mother, education of husband on birth weight. Based on this these findings $H_0$1, $H_0$2, $H_0$3 were rejected. It is concluded that there was a good correlation between maternal anthropometric measurements (SFH×AG) and birth weight ($r=0.20$, $P<0.01$). Maternal Anthropometric Measurements [SFH ×AG] Johnson's formula ($r=0.20$, $p<0.001$). Anthropometric Measurements formula was simple and there was better accuracy than Johnson's formula when birth weights were compared with predicted birth weights. More over ultrasound is not available in the rural areas, where as SFH ×AG formula is easy and simple to calculate. Recommendations offered for further research includes that a similar study can be conducted on a large sample and on Antenatal ward or at waiting room before delivery can be undertaken.

Back ground of the study

Precise estimation of birth weight (BW) is one of the most important measures at the beginning of labor. This is especially important in developing countries where many births occur at home or at birth centres without adequate facilities. In these circumstances diagnosis of macrosomic and premature baby's can result in timely referral of diagnosis cases to well equipped hospitals.

Knowledge of the weight of the fetus in-utero is important for the obstetrician to decide whether to deliver or not to deliver the fetus and also to decide on the mode of delivery. Estimation of fetal weight is being done clinically; it was found clinical estimation quite reliable. Various clinical formulas like Johnson's formula and Dawn's formula have come into usage for fetal weight estimation. The product of sumphysiofundal height and abdominal girth measurements in centimeters in obtaining fairly predictable fetal weight estimation.

Correct estimation of fetal weight, along with gestational age and the adequacy of the mother's pelvis, is important information for managing labor and delivery. According to the existing literature, there is no truly accurate technique for evaluating fetal weight. Until the early 1980's, fetal weight estimation (FWE) relied exclusively on clinical methods based on abdominal palpation and uterine measurements. Since the advent of ultrasound and its dissemination over the last three decades, and despite the lack of conclusive evidence, there has been a widespread belief that ultrasound is more accurate than other methods for predicting fetal weight. Since 1990, several papers have reported that weight estimates using abdominal palpation and even the mother's opinion were as accurate as ultrasound fetal weight estimation, with the advantage of being inexpensive and available at any time.

Maternal anthropometry and other nutritional characteristics are known to influence birth weight and in turn, weight at birth is related to neonatal outcome and perinatal mortality. Birth weight and newborn anthropometric proportions have long been of interest to public health researcher and clinicians

Need for the study

Accurate estimation of fetal weight is of paramount importance in the management of labor and delivery. Knowledge of the weight of the fetus in utero is important for the Obstetrician to decide whether to deliver or not to deliver the fetus and also to decide on the mode of delivery. One of the most important factors that decide the chance of newborn to survive is to grow in a healthy way. For this reason increasing attention is now given to birth weight of newborn.

The investigator while working at Government Maternity Hospital found that evaluation of fetal weight in utero can help in early identification of IUGR, Macrosomia, Cephalo Pelvic Disproportion and abnormal presentations. Proper action can be taken regarding safe delivery by Caesarean Section and prevents fetal loss. In rural areas, where ultrasonography is not available there Johnson's formula, Maternal Anthropometric Measurements [SFH x AG] can be used. It is also simple to calculate and thus, it helps in early identification of complications and timely referral to higher centres. This helps in safe delivery of mothers and thus to provide evidence based quality care.

Table 1: Statistics of Complicated Cases in Govt. Maternity Hospital, Tirupati 2009-2011

Year	IUGR	CPD	Abnormal Presentations	Macrosomia
2009	396	456	648	432
2010	360	440	656	437
2011 upto June	140	210	341	227

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"A Comparative Study of Johnson's formula and Maternal Anthropometric Measurements for estimation of fetal weight and their correlation with birth weight among Term Pregnant Mothers in Antenatal ward at Government Maternity Hospital, Tirupati."

Objectives

- To correlate the in-utero estimated fetal weight by using Johnson's formula and Maternal Anthropometric measurements to the birth weight.
- To compare differences of fetal weight estimation by using Johnson's formula and Maternal Anthropometric measurements to the birth weight.
- To associate the relationship between demographic variables with Johnson's formula, Maternal Anthropometric Measurements with birth weight.

Null Hypothesis

- Ho_1 There is no significant correlation between Johnson's formula and Anthropometric measurements with birth weight.
- Ho_2 There is no significant difference between Johnson's formula and maternal Anthropometric measurements with the birth weight.
- Ho_3 There is no significant association between Demographic variables with Johnson's formula, Maternal Anthropometric measurements with birth weight.

Reviews Related To Demographic Variables

Conducted generation R study on mother's education level and fetal growth: Low maternal education is associated with a slower fetal growth and this effect appears among 3545 pregnant women of educational level (high, mid-high, mid-low & low) as a measure of socio-economic status with fetal weight and potential mediators including maternal height, pre-pregnancy BMI and smoking. The results show that in fetuses of low-educated women relative to those of high educated women, fetal growth was slower, leading to lower fetal weight that was observable from late pregnancy onwards. In these fetuses growth of the head 95% P=0.0004, abdomen 95%

P=0.08, femur 95% P=0.01, were all slower, from mid pregnancy onwards. Lindsay M Silva, *et al*., (2010) [1].
Jennifer D Parker (2010)
Conducted a comparative study on associations between measures of socioeconomic status and low birth weight, small for gestational age and premature delivery in the united states among 1000 pregnant mothers. They were compared association between five indicators of socio-economic status (maternal education, paternal education, maternal occupation, paternal occupation, family income) and three reproductive outcomes (low birth weight, small for gestational age, preterm delivery) in a representative same of births. The results show that odds ratios' for relationships between the socioeconomic indicators and birth outcomes, separately by race, after controlling for parity, maternal height, marital status and maternal age. Nearly all socioeconomic indices were associated with low birth weight among both black and white women.

Reviews related to maternal anthropometric measurements and pregnancy
Conducted a descriptive study on maternal height and risk of child mortality and under nutrition among 300 BMI. The results show that short stature <145cm affects more than 10% of women of reproductive age across Asia, Low BMI <18.5 are found among 20% of more women in both regions. Both indicators can predict adverse pregnancy outcomes. They concluded that maternal height is a strong predictor of birth size, independent of pre-pregnancy BMI and weight gain during pregnancy. Short maternal stature is highly associated with uterine volume and blood flow and is associated with risks of fetal growth restriction, cesarean delivery and CPD, the risk of which is likely modified by number size.
Parul Christian (2010)

Reviews related to abdominal circumference x symphysis fundal height
Conducted a prospective cross-sectional study on a simple clinical formula for predicting fetal weight in labor at term-derived and validation among 504 pregnant women, by using SFH 'n' equation. The results show that in the derivation study, birth weight was predicted by the equation birth weight grams = 301+78 (SFH in cm), this was transformed to the simplified formula birth weight gm=100[(SFH in cm)–5], using this formula for the data set, 68.1% of birth weight estimates were correct to within 10% of birth weight SFH measurement of 40cm had a sensitivity of 82% and a specificity of 80%. In the validation study, the derived simplified formula gave 65%, of estimates correct to within 10% of the birth weight. They concluded that the derived simplified formula may be useful for intrapartum of 40cm may identify labor at risk for CPD or shoulder dystocia.
Eckhort Buchmann and Karbo Tlate (2009)

Review Related to Johnson's Formula
Ebrahim Zadeh Zagmai S conducted a prospective study on comparison of clinical estimation of fetal weight at the beginning and end of labor among 214 pregnant women, by using Johnson's formula and multiplying symphysio-fundal height by the abdominal girth measurement AG×SFH. The results show that, using the Johnson's formula at the end of the labor was more accurate that it was at the beginning of labor (p<0.001, P=0.02). They concluded that, the accurate estimation of weight varies depending on time, the method used, and the formula of measurement.

Material and methods

Research approach
Comparative approach adopted to conduct the study.

Research Design
Descriptive correlational research design used for the study

Setting of the Study
Antenatal Ward, Government Maternity Hospital, Tirupati

Population
Population in this study includes the term(>37wks) pregnant mothers

Sample Size
Sample size consists of 100 term pregnant mothers

Sampling Technique
Non probability purposive sampling technique

Inclusion Criteria
- Admitted in the antenatal ward with full term >37 wks both multi and primi
- With a singleton fetus
- With vertex presentation
- Have undergone abdominal ultrasosnography
- Willing to participate in the study

Exclusion Criteria
- Twin pregnancy
- Poly Hydramnios, Oligo Hydramnios
- Pregnancy with fibroid uterus
- Intra uterine fetal demise
- Placental abnormalities in pregnancy
- Pregnancy with congenital anomaly of uterus
- Pregnancy with complicated chronic disease
- Obese patients weight more than 90 Kg
- Preterm labor
- Ruptured membranes

Pilot Study
The patients were selected for the pilot study is non-probability purposive sampling technique. there was significant correlation between Johnson's formula, Maternal Anthropometric Measurements with birth weight. The r-value obtained was 4.321(r-3.32) which is significant at 0.001

Method of Data Collection
- Through the completion of survey instruments via interviews.
- Through fundal height and station level examination, weight checking.

Fundal height Measurement: Placing the tip on the upper

border of the maternal symphysis pubis over the midline of the abdomen, to the top of the uterine fundus.

Abdominal girth: was measured in centimeters using tape around the abdomen at the midline over the umbilicus.

Station Identification: When conducting a vaginal examination, the lower most portion of the presenting fetal part is at the level of Ischial spines. It is designated as being at zero (0) station. Levels above the spines are designated in centimeter by negative values, -1,-2,-3 stations. Levels below the spines are designated by positive values. +1, +2, +3 station, down to the pelvic floor.

Height: encourage the mother to stand strait and legs near at the height scale.

Weight: mother is asked to stand on the weighing scale in straight position an accurate method.

Fetal weight measurement: The baby is placed unclothed in the center of a properly balanced scale. The weight is then recorded in grams.

Plan for Data Analysis

Descriptive statistics were used to analyze

- Percentage, mean and standard deviation for estimation of fetal weight.
- Frequency and percentage distribution were used to assess demographic variables, pregnancy information.

Inferential statics were used to find the

- r-test will be used for correlation between Johnson's formula, Anthropometric fetal weight, and birth weight.
- Comparative analysis test was used to compare the differences between Johnson's formmula and Maternal Anthropometric measurements.
- Chi-Square test to analyze the demographic variables with that of fetal weight estimation.

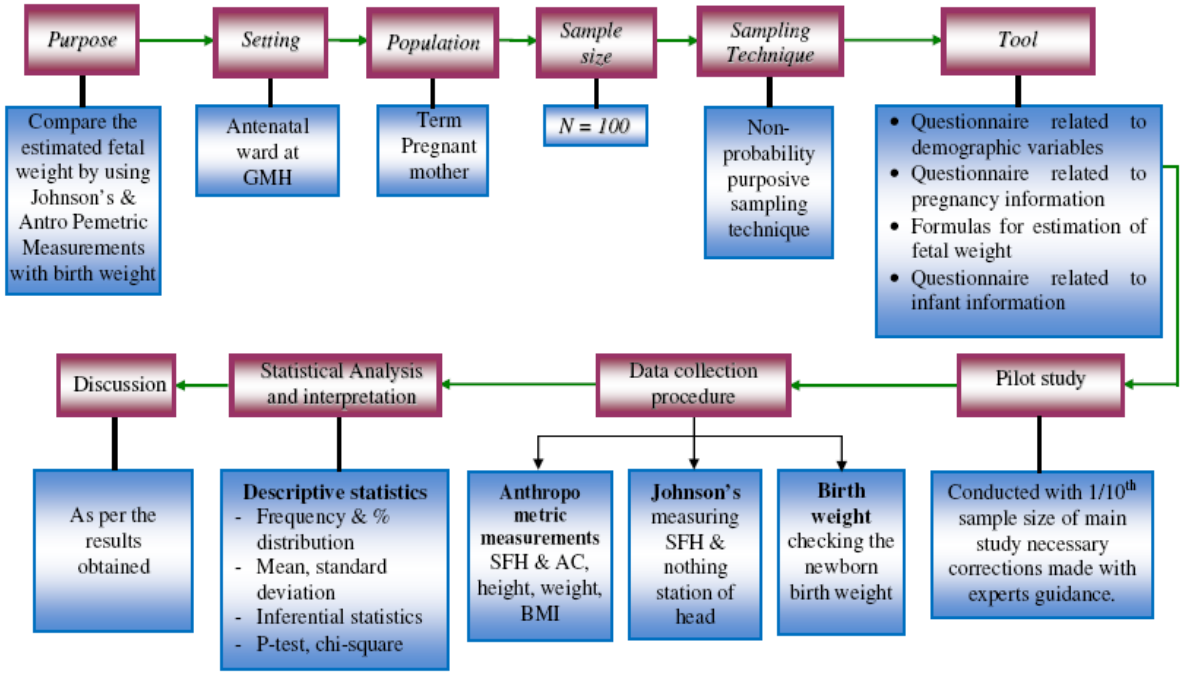

Fig 1: Schematic Representation of Research Design

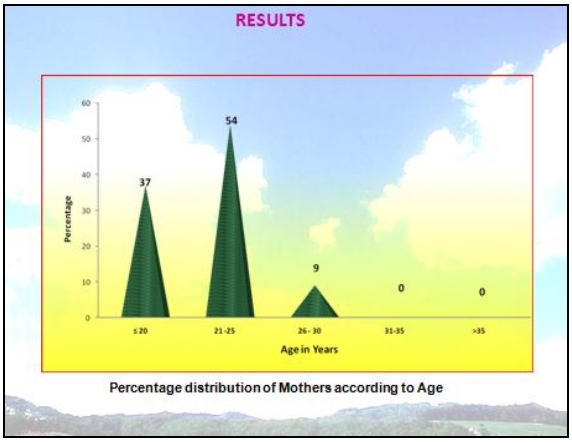

Fig 2

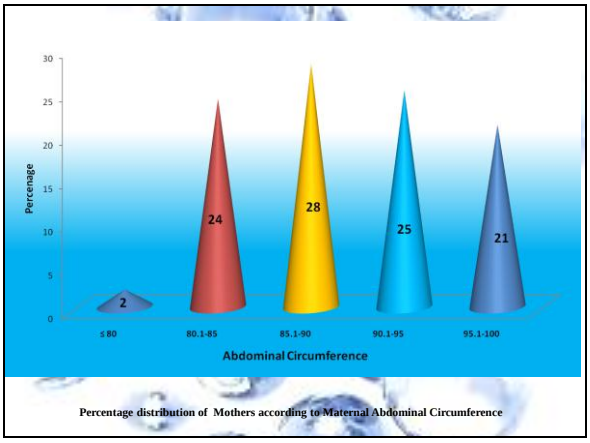

Fig 3

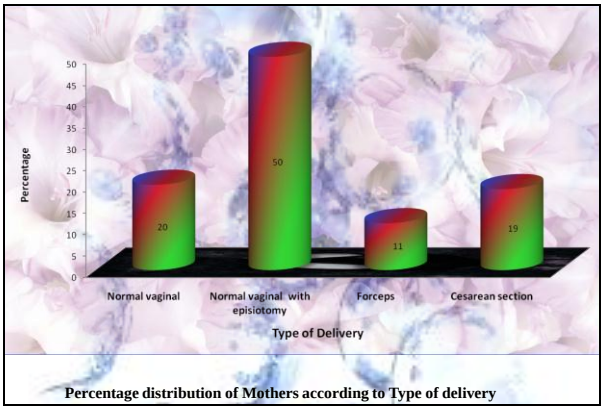

Fig 4

Methods	<2000	2001-2500	2501-3000	3001-3500	Above 3500
	n=1	n=17	n=41	n=28	n=13
Actual birth weight	2000	2479	2851	3329	3658
Anthropometric measurements	2080	2750	3024	3415	3683
Johnson's formula	2025	3095	3319	3637	3858

COMPARISON OF DIFFERENT FETAL WEIGHT BY DIFFERENT METHODS

Fig 5

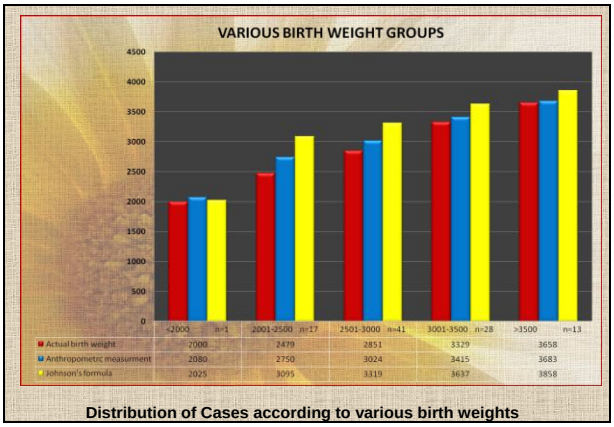

Fig 6

Methods	<2000	2001-2500	2501-3000	3001-3500	Above 3500	χ^2- value	p-value
	n=1	n=17	n=41	n=28	n=13		
Anthropometric measurements	380	281.52	219.37	177.14	466.75	243.22	0.001
Johnson's formula	325	615.97	476.95	356.04	473.99	224.08	0.001

The mean Average errors from actual birth weight with Measured birth weight.

The Anthropometric Measurements method produced the least difference from the birth weight compared to Johnson's formula. From Chi-square analysis, it was found that both methods were statistically significant. (Anthropometric measurements χ^2=243.22, p≤0.01 and for Johnson's formula χ^2=224.08, P≤0.01).

Fig 7

Discussion

- The first objective of the study was to correlate the in utero estimated fetal weight by using Johnson's formula, Anthropometric measurements to the birth weight.
- It is observed that the mean correlation scores between Anthropometric measurements, Newborn Birth Weight are 3166.16±384.34. The r-value obtained was 0.20 which was statistically significant at p<0.001.
- The correlation between newborn birth weights with Johnson's Estimated Fetal Weight the mean value is 3434.03, ± 411.24. The r-value obtained was 0.12 which was statistically not significant.
- So, the null hypothesis H_o1 which states that there is no significant correlation in assessment of fetal weight by using Johnson's Formula and Anthropometric measurements with birth weight was rejected.
- *The second objective* of the study was to compare difference in fetal weight estimation by using Johnson's formula, Anthropometric measurements to the birth weight.
- When the birth weights were compared with the measured birth weight in different weight categories 3,500gms, Anthropometric measurements proved better than Johnson's formula with Chi-square value 243.22 and 224.08 respectively which were significant at p<0.001.
- So, the null hypothesis $H_0$2 which states that there is no significant difference Anthropometric measurements fetal weight and Johnson's formula with actual birth weight is rejected.
- *The Third objective* of the study was to associate the relationship between the selected demographic variables with fetal weight.
- The study findings revealed that there was a significant association with age, education of mother and education of husband, the Chi-square values of which were 5.92,10.42 and 9.37 respectively at p<0.05, while other variables were not found to be statistically significant.
- So, the null hypothesis $H_0$3, which states that there is no association between selected demographic variables with Johnson's formula and Anthropometric measurements to the birth weight was rejected.

Conclusion

The study findings revealed that there was a good correlation between Anthropometric Measurements and Johnson's formula (r=0.20, p<0.001). Anthropometric Measurements formula was simple and there was better accuracy than Johnson's formula when birth weights were compared with measured birth weights. More over ultrasound is not available in the rural areas, where as SFH ×AG formula is easy and simple to calculate.

Recommendations

- This study can be done with larger populations. So the findings can be generalized.
- A correlation study can be conducted to assess the estimated fetal weight by using various other methods like Dawn. Dares Method.

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