OPEN ACCESS
Scholars International Journal of Obstetrics and Gynecology
Abbreviated Key Title: Sch Int J Obstet Gynec
ISSN 2616-8235 (Print) |ISSN 2617-3492 (Online)
Scholars Middle East Publishers, Dubai, United Arab Emirates
Journal homepage: https://saudijournals.com

Original Research Article

Accuracy of Johnson's Formula for Estimating Fetal Weight Compared to Actual Birth Weight: A Study of 600 Cases in Rangpur Medical College

Dr. Rabeya Khatun[1*], Dr. Md. Abul Kalam Azad[2], Dr. Md. Nawsad Ali[3], Dr. Rehana Parvin[4], Dr. Shamima Tabassum[5]

[1]Outdoor Medical Officer, Department of Gynaecology and Obstratics, Rangpur Medical College, Rangpur, Bangladesh
[2]Assistant Professor, Department of Medicine, Rangpur Medical College, Rangpur, Bangladesh
[3]Associate Professor, Department of Gastroenterology, Rangpur Medical College, Rangpur, Bangladesh
[4]Junior Consultant, Department of Radiology and Imaging, Rangpur Medical College, Rangpur, Bangladesh
[5]Indoor Medical Officer, Department of Gynaecology and Obstratics, Rangpur Medical College, Rangpur, Bangladesh

DOI: 10.36348/sijog.2023.v06i07.002 | **Received:** 03.06.2023 | **Accepted:** 08.07.2023 | **Published:** 11.07.2023

***Corresponding author:** Dr. Rabeya Khatun
Outdoor Medical Officer, Department of Gynaecology and Obstratics, Rangpur Medical College, Rangpur, Bangladesh

Abstract

***Introduction*:** The estimation of fetal weight during pregnancy has a significant impact on the survival of newborns and some immediate and late sequelae of the life of newborns. Estimation of fetal weight also plays a paramount role in determining time, mode, and place of delivery. There are many methods to estimate fetal weight like the palpation method, fundal height measurement, and radio frequency volume reduction. Johnson's method is one of the clinical methods that require no expense and is easier to estimate the precise birth weight and fetal weight. This study aimed to analyze the accuracy of the Johnsons formula for estimating fetal weight compared to actual birth weight. ***Methods*:** This cross-sectional prospective study took place in the Gynecology and Obstetrics Department of Rangpur Medical College Hospital, Rangpur, between May 2015 to October 2015, six (06) months after approval. The sample size was 600 as per inclusion criteria. Data were collected through face-to-face interviews with the women by using a pre- design questionnaire after proper counseling and informed written consent. The purposive sampling method was used in the study. Data processing was consisting of registration schedule, editing, computerization, preparation of dummy table, analyzing & matching of data. Statistical analysis was carried out by using the Statistical Package for Social Sciences version 16.0 for Windows. The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Paired t-test was used for continuous variables. Pearson's correlation coefficients were used to test the relationship between the groups. P values <0.05 was considered statistically significant. ***Result*:** The mean age was found 24.5±5.1 years with a range from 18 to 38 years. The mean symphysio fundal height was found 32.4±2.0 cm with a range from 28 to 36 cm. The mean estimated fetal weight was found 3205.2±287.9 grams with a range from 2635 to 3875 grams. The mean actual birth weight after delivery was found 3019.0±359.0 grams with a range from 2200 to 3800 grams. The difference was statistically significant ($p<0.05$) between the two groups. A positive significant correlation ($r=0.929$; $p=0.001$) was found between actual birth weight and estimated fetal weight by Johnson's formula. A positive significant correlation ($r=0.517$; $p=0.001$) was found between actual birth weight and symphysio fundal height. A positive significant correlation ($r=0.129$; $p=0.002$) was also found between the actual birth weight neonate and the BMI of the mother. ***Conclusion*:** Antenatal and intranatal fetal weight can be estimated with reasonable accuracy, clinically using Johnson's formula. Ultrasound is not available in remote areas where Johnson's formula is easy and simple to calculate and can be included in the training program of medical and paramedical staff and birth attendants.

Keywords: Johnsons Formula, Fetal Weight, Birth Weight, Pregnancy.

INTRODUCTION

Birth weight (BW) is an important predictive parameter of neonatal outcome, and its estimation helps to determine obstetric management. Accurate prenatal estimation of birth weight would be extremely useful in the management of labor and delivery [1]. Basically, three groups of birth weights are important to clinicians; thus, low birth weight, normal birth weight, and macrosomic babies. Since neonatal complications

are more associated with low birth weight and labor abnormalities as well as neonatal complications with fetal macrosomia, accurate estimation of fetal weight is of greater importance in taking management decisions as regards delivery of these extremes of fetal weight [2]. In our country perinatal mortality is extremely high which is 50/1000 live birthst [3] and one of the causes of this high perinatal mortality is the high rate of low birth weight Again, extremely overweight fetuses have a relatively increased perinatal mortality and morbidity and perinatal mortality is 2-3 times for overweight fetuses [4]. To prevent the adverse consequences of macrosomia in such cases, accurate estimation of fetal weight is of utmost importance and the burden of extreme fetal weight on maternal and neonatal health has thus necessitated research into accurate ways of estimating fetal weight especially when estimation of fetal weight would help in taking appropriate management decisions [5]. In preterm deliveries and intrauterine growth restriction, perinatal counseling on the likelihood of survival, the intervention taken to postpone the delivery, the optimal route of delivery or the level of the hospital where delivery should occur is completely based on the estimated fetal weight: A large proportion of this problem (perinatal mortality and morbidity) is related to birth weight which remains the single most important parameter that determines the neonatal survival. It is estimated that 16% of live-born infants have low birth weight, a condition associated with high perinatal mortality and morbidity [6]. According to the existing literature, there is no truly accurate technique for evaluating fetal weight. Until the early 1980s, 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. However, 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 (FWE) with the advantage of being inexpensive and available at any time [7]. Johnson's method requires no expense and is easier to estimate the precise birth weight and fetal weight. Johnson's method was predicting a fetal weight of more than>60% [8]. In experienced hands, intrapartum clinical estimation of birth weight for terms infants is at least as good as USG-based prediction being correct to within 10% of birth weight in 55-72%. A more objective estimate of fetal weight may be offered by measuring symphysio-fundal height using a tape measure. This required minimal exposure, relying only on the upper edge of the symphysis pubis and the highest point of the uterus [9]. Sauceda Gonzales *et al.*, reported in a multicenter study involving 504 full-term patients, it is in agreement with other studies that confirmed that Johnson's formula correctly predicts actual birth weight [10]. Cury and Garria reported that using Johnson's formula was as accurate as ultrasound estimation. Clinical fetal weight estimation is proved to be relatively accurate and comparable to ultrasound in measuring fetal weight when compared with the actual weight after delivery. The study also proved that clinical estimation is better than ultrasound when the actual fetal weight is more than 3 kg [11].

OBJECTIVE

General Objective

- To compare the estimated fetal weight by Johnson's formula with actual birth weight.

Specific Objectives

- To measure the estimated fetal weight by Johnson's formula.
- To correlate fetal weight estimated by Johnson's formula with neonatal birth weight.
- Application of Johnson's formula in low-resource areas.

METHODS

This cross-sectional prospective study took place in the Gynecology and Obstetrics department of Rangpur Medical College Hospital, Rangpur, between May 2015 to October 2015, six (06) months after approval. The sample size was 600 as per inclusion criteria. Data were collected through face-to-face interviews with the women by using a pre- design questionnaire after proper counseling and informed written consent. Gestational age was calculated in the number of weeks from the beginning of the first day of the last menstrual period and also from the USG in the early weeks of pregnancy if available. The previous medical and surgical record was reviewed. Symphysio-fundal height was measured using a tape. Pelvic examination was done to evaluate cervical dilation, station of the fetal head, and the degree of descent of the fetal head into the pelvis if the patient is in labor. The fetus was considered to be at a minus station when the vertex was above the level of the ischial spines, at zero station (engaged) when the vertex was at the level of the ischial spines, and a plus station when it is below this level. If the patient is not in labor the rule of the 5^{th} formula station of fetal head was calculated by abdominal examination. Then the Newborns were weighed using a digital balance immediately after birth either vaginally or caesarian section and compared with the estimated fetal weight prerecorded by Johnson's formula. Birth weight is classified as <2500 gm, 2500-2999 gm, 3000-3499 gm, and >3500 gm. The purposive sampling method was used in the study. Johnson's formula is "Height of the uterus above the symphysis pubis in centimeters minus 12, if the vertex is at or above the level of ischial spine or minus 11, if the vertex is below the level of ischial spines multiplied by 155, in either case, gives the weight of the fetus in grams". Data processing was consisting of registration schedule, editing, computerization, preparation of

dummy table, analyzing & matching of data. Statistical analysis was carried out by using the Statistical Package for Social Sciences version 16.0 for Windows. The mean values were calculated for continuous variables. The quantitative observations were indicated by frequencies and percentages. Paired t-test was used for continuous variables. Pearson's correlation coefficients were used to test the relationship between the groups. P values <0.05 was considered statistically significant.

Inclusion Criteria

- Women with a live singleton pregnancy.
- Gestational age beyond 34 weeks.
- Cephalic presentation.
- Patients who had given consent to participate in the study.

Exclusion Criteria

- Pregnancy, complicated chronic diseases like hypertension, diabetes mellitus, heart disease, or any other medical disease.
- Pregnancy, diagnosed oligohydramnios or polyhydramnios.
- Death of fetus in utero.
- Pregnancy, uterine, and/or abdominal mass.
- Malpresentation.
- Congenital anomaly.
- Intrauterine Growth Restriction (IUGR).
- Bad Obstetric History (BOH).
- Patients who did not give consent to participate in the study.

RESULTS

Table 1: Socio-demographic profile of the patients (N=600)

Socio-demographic profile	Number of patients (%)
Age (years)	
s20	192(32.0)
21-25	240(40.0)
26-30	96(16.0)
31-35	36(6.0)
>35	36(6.0)
Mean± SD	24.5±5.1
Range (min, max)	18,38
Gravida	
1st	336(56.0)
2nd	144(24.0)
3rd	48(8.0)
4th	24(4.0)
5th	48(8.0)
Educational status	
Illiterate	94(15.7)
Primary	368(61.3)
Secondary	108(18.0)
Higher Secondary	30(5.0)
Occupational status	
Housewife	522(87.0)
Employee	78 (13.0)

It was observed that the majority (40.0%) of patients belonged to age 21-25 years. The mean age was found 24.5±5.1 years with a range from 18 to 38 years. Majority (56.0%) patients were 1s gravida, 368(61.3%) patients had completed primary education and 522(87.0%) patients were housewives [Table 1].

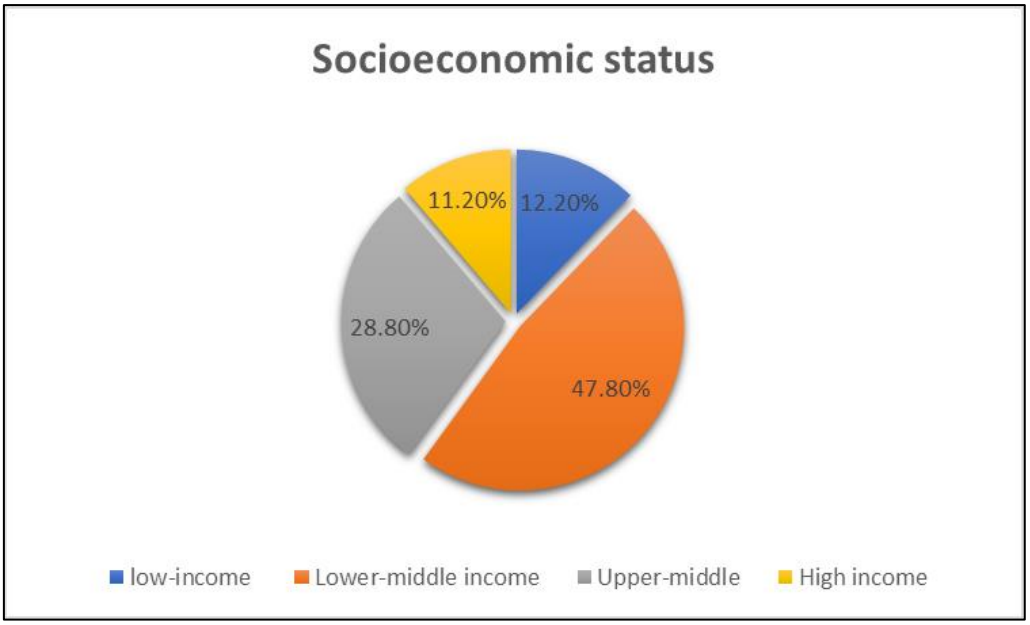

Figure 1: Pie chart showing the socioeconomic status of the study patients

Low-income (≤ 6000 TK)
Lower-middle income (6001-15000 TK)
Upper-middle (15001-30000 TK)
High income (>30000 TK)"

Figure 1 shows the socioeconomic status of the study patients, it was observed that almost half (47.8%) of the patients came from a lower middle-class family, 73(12.2%) from lower, 173(28.8%) from the upper middle, and 67(11.2%) from higher class family.

Table 2: Distribution of the study patients according to the weight of the mother and BMI (N=600)

Number of patients (%)	
Weight for mother(kg)	
≤54	144(24.0)
55-60	180(30.0)
>60	276(46.0)
Mean± SD	58.3±4.9
Range (min, max)	50,68
BMI (kg/㎡)	
19-25.0(normal)	48(8.0)
>25.0(overweight)	552(92.0)
Mean± SD	27.1±3.0
Range (min, max)	22.2,32.1

Almost half (46.0%) of patients weighted mother >60 kg. The mean weight for the mother was found 58.3±4.9 kg with a range from 50 to 68 kg. The majority (92.0%) of patients had BMI>25.0 kg/㎡ 2. The mean BMI was found 27.1±3.0 kg/㎡ with a range from 22.2 to 32.1 kg/㎡ 2 [Table 2].

Table 3: Distribution of the study patients according to gestational age and antenatal care(N=600)

Number of Patients (%)	
Antenatal care	
None	126(21.0)
1-2 times	222(37.0)
3 times	138(23.0)
>3 times	120(20.0)
Gestational age (weeks)	
≤36 (Preterm)	72(12.0)
37-40(Term)	492(82.0)
>40(Postdated)	36(6.0)
Mean± SD	38.5±1.8
Range (min, max)	35,41

More than one-third (37.0%) of the patients received antenatal care 1-2 times. The majority (82.0%) of patients were found in 37-40 weeks of estimated fetal weight. The mean gestational age was found 38.5±1.8 weeks with a range from 35 to 41 weeks [Table 3].

Table 4: Distribution of the study patients according to symphysio fundal height (N=600)

SFH (cm)	**Number of Patients (%)**
≤30	78(13.0)
31-35	408(68.0)
>35	114(19.0)
Mean ± SD	32.4±2.0
Range (min, max)	28,36

It was observed that more than two-thirds (68.0%) of patients were found symphysio fundal height of 31-35 cm. The mean symphysio fundal height

was found 32.4±2.0 cm with a range from 28 to 36 cm [Table 4].

Table 5: Distribution of the study patients according to estimated fetal weight before delivery, by Johnson's formula (N=600)

Estimated fetal weight delivery (gram)	Number of Patients (%)
2500-2999	168(28.0)
3000-3499	396(66.0)
≥3500	36(6.0)
Mean ± SD	3205.2±287.9
Range (min, max)	2635,3875

Two-thirds (66.0%) of patients were found estimated fetal weight of 3000-3499 grams. The mean estimated fetal weight was found 3205.2±287.9 grams with a range from 2635 to 3875 grams [Table 5].

Table 6: Distribution of the study patients according to actual birth weight of neonate immediately after delivery (N=600)

Actual birth weight after delivery(gram)	Number of Patients (%)
<2500	60(10.0)
2500-2999	180(30.0)
3000-3499	330(55.0)
≥3500	30(5.0)
Mean± SD	3019.0±359.0
Range (min, max)	2200, 3800

More than half (55.0%) of patients wore found actual birth weight after delivery of 3000-3499 grams. The mean actual birth weight after delivery was found 3019.0±359.0 grams with a range from 2200 to 3800 grams [Table 6].

Table 7: Comparison between actual birth weight after delivery and estimated fetal weight before delivery (by Johnson's formula) (N=600)

	Birth weight (gram)		P value
	N	Mean ± SD	
Estimated fetal weight delivery	600	3205.2±287.9	0.001
Actual birth weight after delivery	600	3019.0±359.0	

s= significant

P value reached from paired t-test

The mean birth weight was found 3205.2±287.9 grams in estimated fetal weight before delivery and 3019.0±359.0 gram in actual birth weight after delivery. The difference was statistically significant ($p<0.05$) between the two groups [Table 7].

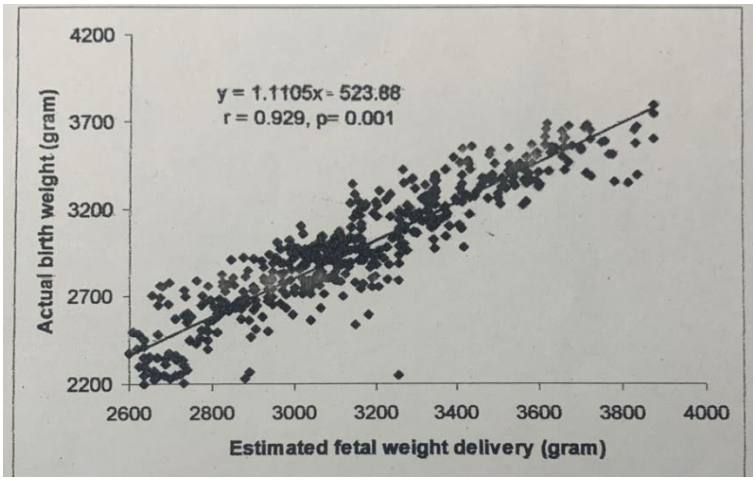

Figure 2: Scatter diagram showing positive correlation (r=0.929; p=0.001) between actual birth weight and estimated fetal weight by Johnson's formula

The value of Pearson's rank correlation coefficient was 0.929, which is a significant correlation ($p<0.05$). Therefore, there was a linear positive strong correlation between actual birth weight and estimated fetal weight (Fig. 2).

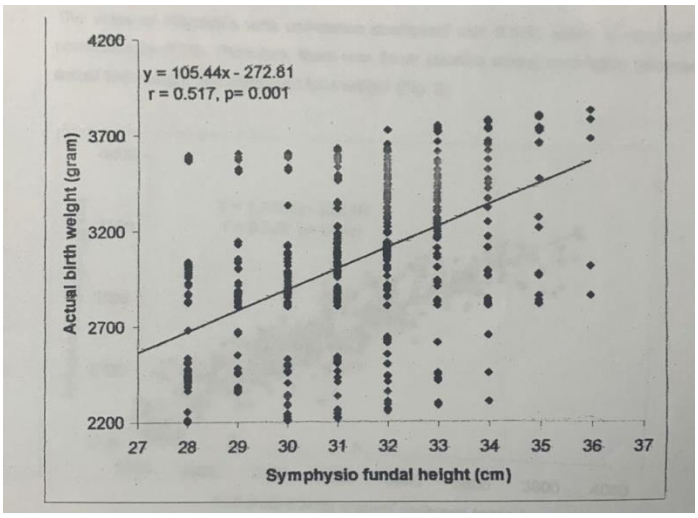

Figure 3: Scatter diagram showing positive correlation (r=0.517; p=0.001) between actual birth weight and symphysio fundal height

The value of Pearson's rank correlation coefficient was 0.517, which is a significant correlation ($p<0.05$). Therefore, there was a linear positive moderate correlation between actual birth weight and symphysio fundal height (Fig. 3).

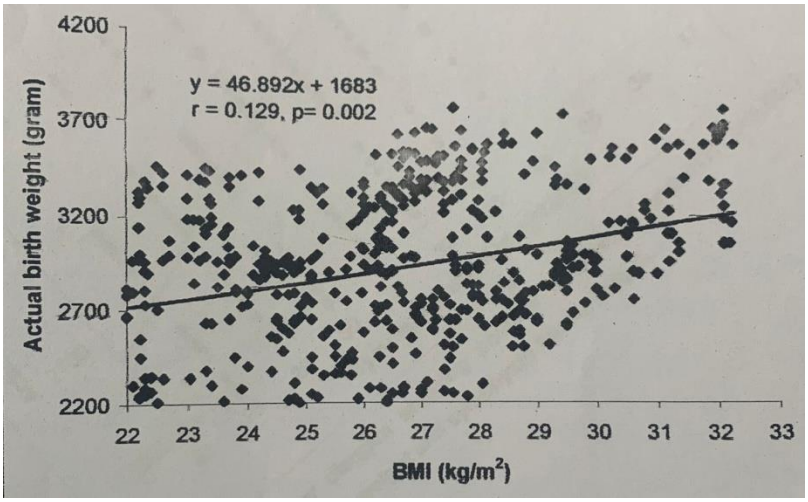

Figure 4: Scatter diagram showing positive correlation (r=0.129; p=0.002) between actual birth weight and BMI

The value of Pearson's rank correlation coefficient was 0.129, which is a significant correlation ($p<0.05$). Therefore, there was a linear negligible correlation between actual birth weight and BMI (Fig. 4).

DISCUSSION

In this present study, it was observed that the majority (40.0%) of patients belonged to age 21-25 years. The mean age was found 24.5±5.1 years with a range from 18 to 38 years. In our country, Parvin *et al.*, [12] found 60.0% of patients belonged to age 20 to 30 years. Shittu *et al.*, [13] found the mean age was 30.5±4.7 years ranging from 22 to 41 years, which is comparable with the current study. In this study, it was observed that the majorities (56.0%) of patients were 1st gravida, 61.3% of patients had completed primary education and 87.0% of patients were housewives. Similarly, Numprasert [14] found primigravida was predominant, and 59.1% of patients had completed Grade 9 education. Shittu *et al.*, [13] found the median gravidity was 2 varied from 1-8 and medium parity was 1 varied from 0-6. 35% percent of gravidas were nulliparous, 60% were multiparous, and 5% were grand multiparous. In this current study, almost half (47.8%) of the patients came from lower-middle-class families, 73(12.2%) from lower, 173 (28.8%) from upper-middle, and 67(11.2%) from higher-class families. In

our country, Parvin *et al.,* [12] studies showed a strong association between socioeconomic conditions and fetal weight. Mother's nutritional study is influenced by the socioeconomic conditions of the family income. In this series, almost half (46.0%) of patients weighed mother >60 kg. The mean weight for the mother was found 58.3±4.9 kg with a range from 50 to 68 kg. The majority (92.0%) of patients had BMI >25.0 kg/㎡. The mean BMI was found 27.1±3.0 kg/㎡ with a range from 22.2 to 32.1 kg/㎡. Similarly, Numprasert[14] found nearly half had a body mass index less than 19.8, and half had a body mass index between 19.8-26.0 kg/㎡, which is comparable with the current study. In this study, more than one-third (37.0%) of the patients received antenatal care 1-2 times. The mean gestational age was found 38.5±1.8 weeks with a range from 35 to 41 weeks. Shittu *et al.,* [13] found the mean gestational age was 38.6± 1.3 with a range from 37.0 to 42 weeks. A similar gestational age range was also observed by Numprasert [14]. As the frequency of antenatal care is not satisfactory, this may be due to a lack of awareness of the low socioeconomic permission of the study population. Estimation of fetal weight by symphysio fundal height (SFH) measurement has been reported by various authors including Edwards [15], Bothner, *et al.,* [16], Promvijit *et al.,* [17]. They reported fundal height is useful on an individual basis and they recommended that individual biometry or sonographic measurement is more useful in assessing the growth of an at-risk fetus. In this present study, the mean symphysio fundal height was found 32.4±2.0 cm with a range from 28 to 36 cm. In our country, Parvin *et al.,* [15] found symphysio fundal height ≤30 cm in 22.0% of cases; 31-35 cm was 66.0% of cases and >35 cm was 12.0% of cases. Numprasert [14] found the mean SFH was 37.0±3.6 cm which is comparable with the current study and this may be due to more height of the pregnant women in their study population than the present study. In this series the mean actual birth weight after delivery was found 3019.0±359.0 grams with a range from 2200 to 3800 grams. In Bangladesh Parvin *et al.,* [15] found the mean actual weight of the baby (after birth) was observed to have 2999 grams with std. deviation of 370 grams and after categorizing the birth weight, maximum neonates were found either in the 3000–3499-gram group (48%) or in the 2500–2999-gram group (31%) in her study. Alnakash and Mandan [18] found the mean actual birth weight was 3376±486.9 grams with a range from 2200 to 5000 grams. Numprasert [14] found actual baby weight ranged from 1,900 g to 5,300 g (mean=3,175.57, SD=414.67). In this current study mean birth weight was found 3205.2±287.9 grams in estimated fetal weight and 3019.0±359.0 grams in actual birth weight after delivery. The difference was statistically significant ($p<0.05$) between the two groups. In 1954, Johnson and Toshach reported that fetal weight was within 353g of the actual birth weight in 68.0% of their 200 cases [19]. Similarly, Mhaskar *et al.,* [20] found the estimated weight by using Johnson's formula of an average of 310 g higher than the actual weight. In this present study it was observed a positive significant correlation ($r=0.929$; $p=0.001$) between actual birth weight and estimated fetal weight by Johnson's formula which means the estimation of fetal weight is accurate by Johson's formula when compared with the actual birth weight. Shittu *et al.,* [13] found the correlation coefficient for the clinical and ultrasonic methods, compared to actual birth weight, were +0.78 and +0.74 respectively and results of statistical analysis showed the relationships to be statistically significant ($p<0.001$). Dare *et al.,* [21] tested this method on 498 full-term patients and obtained a good correlation between the clinical estimate and actual birth weight ($r=0.742$).

Limitations of the Study

The study was conducted in a single hospital with a small sample size. So, the results may not represent the whole community.

CONCLUSION

Ultrasound is not available in remote areas of our country and is also costly in our socioeconomic aspect where Johnson's formula is easy and simple to calculate and can be implemented in the estimation of birth weight in primary health care centers and satellite centers in a convenient way.

Funding: No funding sources.
Conflict of Interest: None declared.
Ethical Approval: The study was approved by the Institutional Ethics Committee.

RECOMMENDATION

Antenatal and intranatal fetal weight can be estimated with reasonable accuracy by Johnson's formula and the method is simple, safe, easy to perform, and economical. Further studies should be conducted involving a large sample size and multiple centers.

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