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Statistical Analysis of Birth Weight and Gender of Newborn Infants

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Authors' contributions

This work was carried out in collaboration between all authors. Author JO designed the study and performed the literature searches. Authors CHN and JO performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors JO, CHN and ICAO managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Introduction: Birth weight is an important determinant of infant morbidity and mortality. Its effect extends upto adult life and may explain some non-communicable diseases that may occur in adult life. In general, males weigh more than females. Birth weight is categorised into three levels, viz., low, normal and high. This study analysed the relationship between gender and the categories of birth weights.
Materials and Methods: Data on babies' gender and birth weights from 961 term life deliveries in a private general practice hospital were analysed. Test on equality of the mean weight of males and females at the three categorical levels were done using z test and t-tests, as necessary.
Results: Mean birth weight was found to be 3.30 ± 0.495 kg. Males weighed significantly heavier than females at mean weights of 3.343 ± 0.495 kg and 3.258 ± 0.490 kg, respectively. In the low birth weight category, males weighed 1.844 ± 0.297 kg and females weighed 1.992 ± 0.397 kg. There was no significant difference. Similarly, the mean weight of males and females in the high birth weight category were 4.462 ± 0.343 kg and 4.342 ± 0.219 kg, respectively with no significant difference. In the normal weight category, males weighed significantly more than the females with

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the mean weight of 3.30 ± 0.359 kg and 3.248 ± 0.392 kg, respectively.
Conclusion: Male babies weighed more than female babies only in the normal birth weight category. The factor that selectively affected the birth weight of male babies must be acting under the category of normal birth weight only.
More studies are necessary to identify the factors and the reasons, for which they act only at the level of the normal birth weight.

Keywords: Morbidity; term live deliveries; low birth weight; macrosomia.

1. INTRODUCTION

Birth weight of a baby is measured within the first one hour of birth [1]. It is categorized as low, normal and high. Weight less than 2.5 kg is considered as low birth weight (LBW) [1]. High birth weight or macrosomia is birth weight above 4 kg [2]. Some literatures state macrosomia as the birth weight equals to or more than 4.5 kg [3]. For this study, macrosomia is considered as birth weight above 4.0 kg [2]. Normal birth weight is, therefore, the birth weight from 2.5 kg to 4.0 kg.

Birth weight is an important factor in child development. It is one of the important predictors of mental development, survival and physical growth in a child. Child's morbidity and mortality depend to a large extent on the child's birth weight [4,5,6]. Its importance is well highlighted in "Life Depends on Birth Weight" by Professor Nimi Briggs in a keynote address, which he delivered at an annual conference of the Society of Gynecology and Obstetrics in Nigeria (SOGON) in November 2003 [7].

Babies with LBW or babies born as small-for-gestational-age are disadvantaged early in life. They have higher risks of hypoglycemia, hyperbilirubinemia, respiratory distress syndrome, low APGAR score with the resultant poor quality of life with approximately 20 times increased risk of neonatal death more than babies born as appropriate-for-gestational-age weight [8,9,10,11]. Negrato and Gomes have demonstrated a clear relationship between LBW and increased risk of many diseases later in life, such as insulin resistance, cardiovascular diseases, renal diseases [12], etc. LBW is also a substantial risk factor for adult psychiatric morbidity and lowered overall functioning [13]. The global prevalence of LBW is 15.5% which amounts to about 20 million infants born each year, 96.5% of them in developing countries [14].

Macrosomia is also a risk factor for many adult disorders. Macrosomic babies are at increased risk of adolescent obesity [15]. Macrosomia increases the risk of birth injuries like shoulder dystocia, clavicle fractures, brachial plexus injuries and their resultant consequences. It also puts the babies at increased risk of becoming obese at the young age and development of type2 diabetes later in life [16]. Macrosomia complicates 3 to 20% of all pregnancies worldwide and is common in developed countries [17,18].

Birth weight is influenced by intrauterine environment and genetic factors. Intrauterine growth retardation (IUGR) occurs when the fetus for any reason fails to get enough nutrients for its development. Some of the known reasons are hypertension, anaemia and malaria in pregnancy [19,20,21]. When the intrauterine environment is conducive and there is a good supply of nutrients across the normal feto-placental membrane, fetal growth and weight gain may then depend on the genetic factors [22]. The paternal birth weight is associated with birth weight of males but not with females [22]. Female birth weight is affected by the intrauterine environment and maternal glucose values more than males [22].

1.1 Justification for the Study

Much work has been done on birth weight, but little has been done on the gender distribution of the categories of birth weight. LBW and macrosomia are all markers of morbidity in neonatal and adult life. If the morbid birth weight categories are associated with gender, then this knowledge can be helpful in anticipating differences in presentation and severity of anticipated morbidity in adult life when they occur. This knowledge will be useful to epidemiologists. The research will also enrich literature on the gender distribution of birth weight categories.

1.2 Aim of the Study

Since males weigh more than females, it will be expected that there will be more macrosomic males than females and more LBW females than males. These expectations are expressed in the

form of hypotheses by the researchers. Since there are three categories, three hypotheses naturally emerge. This study intended to do a statistical analysis of birth weight categories and gender distributions and test the hypotheses. The objectives were to test the hypotheses that:

1. Female underweight babies weigh less than male underweight babies
2. Male overweight babies weigh more than female overweight babies
3. Male normal weight babies weigh more than female normal weight babies

2. MATERIALS AND METHODS

This is a cross-sectional study on the birth weight categories and gender of newborn babies.

The data were collected from a private general practice hospital situated in Nkpor, an urban satellite town close to Onitsha in the Anambra State of Nigeria. The hospital keeps records of deliveries. The folders of all deliveries from January 2015 to December 2016 were extracted for the study. All full-term live deliveries were studied. Pregnancies carried upto 37 weeks of completed gestational age were considered as full term. Gestational age was calculated in weeks from the first day of last menstrual period or by ultrasound scan done in the first trimester. Babies were weighed with Seca Babies' weighing scale. Birth weight less than 2.5 kg were classified as low birth weight. Weight from 2.5 kg to 4.0 kg were classified as normal weight while weight above 4.0 kg were classified as macrosomia. The baby's gender and birth weight were recorded in a data capture proforma.

Preterm babies and multiple gestations were excluded from the study because these are known factors in LBW. The study was on normal full-term deliveries where birth weight was expected to be influenced by intrauterine environment and genetic factors.

The calculated mean LBW, mean normal birth weight and mean high birth weight and the sex distribution are shown in tables. The analysis was done with the Statistical Package for Social Sciences (SPSS) version 20.

2.1 Statistical Analysis

The mean weight in the three different categories of birth weight were obtained and Z – test was used for the comparison of equality of proportion for large sample sizes and t – test was done for small sample sizes. The analysis was done with the Statistical Package for the Social Sciences (SPSS) version 20.

2.2 Ethical Issues

The study did not involve patients directly, but recorded data on the babies' birth weight and gender. Strict confidentiality of babies' and their mothers' identities were maintained.

2.3 Data Presentation and Analysis

There were 961 live births from 2015 to 2016 that met the inclusion criteria. The mean birth weight was 3.300kg with a standard deviation of 0.4945. Males accounted for 486 (50.6%) of the deliveries while females accounted for 475 (49.4%). The mean weights are shown in Table 1.

Table 1. Distribution of babies' weights by gender

Gender	Number (%)	Mean weight (sd)
Male	486 (50.6%)	3.343 (0.495)
Female	475 (49.4%)	3.258 (0.490)
Total	961 (100%)	3.300 (0.495)

Sd: Standard deviation. P – value 0.0037

The babies' weights were categorised into underweight, normal weight and overweight. Table 2 displays the distribution of categories of babies' mean weights by gender.

2.4 Hypothesis Testing

Test of equality of mean birth weights of male and female babies.

The hypothesis is

$H_0: \mu_1 = \mu_2$ while
$H_a: \mu_1 > \mu_2$.

The null hypothesis is that there is no difference in the mean birth weights and the alternative hypothesis is that the male mean birth weight is more than the female mean birth weight.

z= 2.675, p = 0.0037

Thus H_0 is rejected. Male babies weigh more than female babies at birth.

Table 2. Distribution of categories of babies' mean birth weights by gender

Birth weight	Males	Females
< 2.5 kg	N = 9	N = 13
	Mean low birth weight = 1.844	Mean low birth weight = 1.992
	Sd = 0.297	Sd = 0.397. P – value 0.335
2.5 kg –	N = 448	N = 443
4.0 kg	Mean normal birth weight = 3.30	Mean normal birth weight = 3.248
	Sd = 0.359	Sd = 0.392. P – value 0.0196
>4.0 kg	N = 29	N = 19
	Mean large birth weight = 4.462	Mean large birth weight = 4.342
	Sd = 0.343	Sd = 0.219. P – value 0.166

The mean weights of the different categories of birth weight are calculated and are shown in Table 2.

For equality of mean birth weights in the low birth weight category,

$t = 1.007$, $p = 0.335$.

Hence there is no significant difference between the mean weights of male and female babies in the LBW category.

Using the similar method of analysis for high birth weight babies (macrosomia) and similar hypothesis, there is no significant difference between the mean weights of male macrosomia and female macrosomia $t = 1.355$, $p = 0.166$.

For the test of difference in mean male normal birth weights and mean female normal birth weights, the Z test was used because the samples sizes were large, $z = 2.067$, $P = 0.0196$. Therefore, the mean weight of normal weight male babies was significantly more than the mean weight of normal weight female babies at birth.

3. RESULTS

The mean birth weight was found to be 3.30 ± 0.495 kg. Males had a mean birth weight of 3.343 ±0.495 kg while females had a mean birth weight of 3.258 ± 0.490 kg. Males significantly weighed more than females.

The prevalence of low birth weight was found to be 2.3% while that of macrosomia is 5.0%.

The mean weight of low birth weight male babies were found to be 1.844 ± 0.297 kg. That of low birth weight female babies were 1.992 ± 0.397 kg. There was no significant difference between the mean weight. Similarly, the mean male high birth weight was 4.462 ± 0.343 kg while that for females was 4.342 ± 0.219 kg. There was no significant difference between them.

The mean male normal birth weight was 3.30 ± 0.359 kg and that of the female was 3.248 ± 0.392 kg. The mean weight of male normal weight babies was significantly higher than the mean weight of female normal weight babies.

4. DISCUSSION

The mean birth weight of newborn babies was found to be 3.30 kg in this study. This is higher than 3.13 kg found by Ezugwu et al. in Enugu [21]. Swende found the mean birth weight to be 3.08 kg in Makurdi [23] while Adimorah et al. found it to be 3.17 kg among Igbos in Nigeria [24]. All these values are lower than the one in the present study probably because preterm deliveries were excluded since preterm delivery as noted by Ugboma and Onyearugha, is a significant factor in low birth weight [19].

Mean male birth weight was found to be 3.343 kg and was significantly higher than the mean female birth weight of 3.258 kg. This is in agreement with Voldner et al. [22] but not in agreement with the findings of Swende who did not find any significant difference between the mean birth weight of male and female babies. [23]

4.1 Low Birth Weight Babies

The mean low birth weight for male was found to be 1.833 kg while the mean female low birth weight was found to be 1.992 kg. The difference was not significant. This is same with the findings observed by Ugboma and Onyearugha [19] and Ezugwu et al. [21]. In the low birth weight category, males and females did not have a significant difference in their mean weight.

4.2 Macrosomia

The mean high birth weight for male was found to be 4.462 kg and was not significantly higher than the mean female high birth weight of 4.342 kg. This agrees with other findings in the literature [25,26,27].

4.3 Normal Birth Weight

The mean normal birth weight of males in this study was found to be 3.30 kg and for females, it was found to be 3.28 kg. The difference was significant. Males weighed more than females only at the normal birth weight category. It is known that fetal weight depends on the intrauterine environment [12]. It has also been suggested by Volder et al. that genetic factors also affect fetal weight. They found that paternal birth weight affects the birth weight of male babies and not female babies [22]. They also found that maternal fasting plasma glucose and fasting plasma insulin affect birth weight of female babies and not male babies. These findings suggest that fetal weight depends on their genetic predispositions. The present study suggests that this genetic effect on fetal weight is significantly felt only at the category of normal birth weight babies.

Studies have shown that there is a gender difference in childhood overweight and obesity [28,29]. Boys have higher odds of being overweight/obese compared to girls [29]. Gender difference in childhood overweight and obesity can also be important in predicting the risk of morbidities like asthma [30]. This tendency can be related to the fact that male babies weigh more than female babies at birth. This relationship may be only at a normal birth weight category. Morbid birth weight does not seem to have gender difference and may not be related to the gender difference in childhood obesity/overweight. One may not say that an overweight male baby at birth is likely to be more overweight or obese in childhood or adult than an equally over-weight female baby because he is over-weight at birth but simply because he is male. Wisniewski et al. concluded in their work that the understanding of how gender differences in pediatric populations relate to the pathogenesis of obesity and the subsequent development of associated co-morbid states is critical to develope and implement both therapeutic and preventive interventions [28]. This new knowledge of categorical birth weight differences can add to the understanding of epidemiological differences in gender-related pediatric morbidities.

5. CONCLUSION

Male babies weigh significantly more than female babies at term birth. This significant difference in weight is only noticed in the category of normal birth weight babies. The genetic factor that makes males weigh more than females may have its greatest effect on the term normal weight babies. Epidemiologists should consider the gender differences in birth weight in the evaluation of birth weight related childhood and adult morbidities.

6. RECOMMENDATION

More studies are recommended to identify the genetic factors that selectively act on male babies and why the effect is significantly observed only at the category of term normal birth weight babies.

CONSENT

It is not applicable.

ETHICAL APPROVAL

As per international standard or university standard, written approval of Ethics committee has been collected and preserved by the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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