POST-DISCHARGE FOLLOW UP OF GROWTH IN LOW BIRTH WEIGHT INFANTS

By

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ABSTRACT

Background: *Low birth weight (LBW) is one of the leading causes of perinatal and infant morbidity and mortality, as well as of impaired growth and neurocognitive development.*

Aim and objectives: *Evaluation of growth parameters (weight, length and head circumference) at birth, 2, 4, and 6 months of LBW infants after discharging from NICU.*

Patients and methods: *A prospective follow up study was conducted on 100 infants weighing < 2,500 g and admitted to NICU of Abulmatamir Central Hospital in Beheira Governorate in the period from May/2018 to March/2020. All infants were selected by simple random method.*

Infant's weigh (g), length (cm), and head circumference (cm) were measured at birth, 2, 4, and 6 months, plotted against WHO growth charts for their catch-up growth follow up. Measurements were calculated using mean and standard deviation. Data were analyzed using SPSS version 15 statistical software.

Result: *There was highly statistical significant difference regarding weight, length and head circumference at 6th month in the studied infants. No statistical significant difference between males and females regarding weight and length except for weight at 6 months when males appeared to have a better weight. There was statistical significant difference in regard of head circumference between males and females. There was highly statistical significant difference as regard weight, length and head circumference between breastfed and formula fed infants.*

Conclusion: *Low birth weight infants showed catch-up growth during the first 6th months, but their weight, length and HC remained less than reference population. Breastfed infants show better catch-up growth than formula fed infants. Both males and females had the same catch up growth for weight and length except for weight at 6 months when females appeared lighter. Girls appeared to have a smaller head circumference than boys.*

Keywords: *LBW, Catch-up, Breast feeding, Growth, Anthropometry.*

INTRODUCTION

Low birth weight is defined as birth weight of a live born infant less than 2500g irrespective of gestational age. It is a public health problem in developing countries especially in sub-Saharan Africa **(Hailu and Kebede, 2018)**. LBW neonates are sub grouped according to the first weight determination after birth: low birth weight (LBW): between 1500 and 2499 g, very low birth weight (VLBW): less than 1500 g and extremely low birth weight (ELBW): less than 1000 g **(Fallah et al., 2011)**.

Globally, WHO estimates that about 30 million low birth weight babies are born annually (23.4% of all births), and they often face short and long-term health consequences **(Hughes et al., 2017)**. Half of all low birth weight babies are born in South-central Asia, where 27 percent are below 2500 g at birth, while LBW levels in sub-Saharan Africa are estimated at 15 percent **(Blencowe et al., 2019)**. The estimated percentage of LBW varied from 5-10% for Egypt **(Mansour et al., 2002)**.

Lack of or no prenatal care is associated with preterm birth and low birth weight. There are many known risk factors, the most important of which are socioeconomic factors, medical risks before or during gestation and maternal lifestyle **(Herbst et al., 2003)**. In developed countries, predominant cause of LBW is preterm birth, whereas in developing countries, Intrauterine Growth Restriction (IUGR) is predominant cause of LBW. Birth weight is an important health status indicator of an infant and is a principal factor that determines the infant's physical, survival, and mental growth. It also indicates past and present health status of the mother **(Clare et al., 2017)**.

Low birth weight is associated with long-term neurologic disability, impaired language development, impaired academic achievement, and increased risk of chronic diseases including cardiovascular disease and diabetes. Preterm infants carry additional risk due to immaturity of multiple organ systems, including intracranial hemorrhage, respiratory distress, sepsis, blindness, and gastrointestinal disorders. Preterm birth is the leading cause of all under-5 child mortality worldwide **(Johnson et al., 2017)**. LBW and prematurity are the second leading causes of infant mortality after congenital anomalies **(Hamilton et al., 2005)**.

Human breast milk is the optimal feeding for all infants including LBW infants. According to World Health Organization (WHO) optimal breastfeeding includes early initiation of breast feeding, exclusive breast feeding for 6 month, frequent feeding, continuous breast feeding for 2 years and increase frequency of feeding during illness **(WHO, 2017)**. Early initiation of breastfeeding within 1 hour after delivery has different health benefits like increase ability to defense infections, reduce the risk of diarrhea, and increase the survival rate of infants **(Oot et al., 2015)**. Neonatal mortality can be prevented by 33% if early initiation of breastfeeding is practiced by mothers **(Mugadza et al., 2018)**.

Breastfeeding may have long-term benefits after the period of breastfeeding. Although evidence is often inconclusive, breastfeeding compared with formula feeding may be associated with lower risk of subsequent acute illnesses, specific chronic diseases and hospitalization, and improved neuro-developmental outcome **(Ajetunmobi et al., 2015)**. Neonatal morbidity and mortality of infants who didn't received breast milk within 1 h is increased by threefold when compared to infants who were fed breast milk within 1 h of birth **(Phukan et al., 2018)**.

Ethical considerations:

1. A written informed consent was obtained from parents or the legal guardians before the study.
2. An approved by the local ethical committee was obtained before the study.
3. The authers declared no potential conflicts of interest with respect to the research authorship and\or publications of this article.
4. All the data of the patients and results of the study are confidential and the patients have the right to keep it.
5. The care giver has the right to withdraw from the study at any time.
6. The authors received no financial support for research, authorship and\or publications of this article.

Sample size:

Sample size was calculated using Lorenz formula as the following:

$$n=\frac{t^2.p.(1-p)}{m^2}=\frac{(1.96)^2\times 0.07\times 0.93}{(0.05)^2}\cong 100\ infants$$

n: sample size; t: 95% confecence level [typical value 1.96]; p:propability of LBW [7% according to demographic and Health surveys of ARE 2014];

m:margin of error [5%]). All infants were selected by simple random method.

Inclusion Criteria:

* Birth weight > 2500 g.
* Admission to NICU.

Exclusion Criteria:

* Multiple Pregnancies.
* Major congenital malformations
* Sever birth asphyxia.
* Chromosomal abnormalities and genetic disorders (e.g. Down syndrome).
* Serious complications during NICU admission
* Death before 6 months.

PATIENTS AND METHODS

A prospective follow up study was conducted on 100 LBW infants. All infants were selected from Abulmatamir Central Hospital in Beheira Governorate after discharging from NICU at the period from May/2018 to March/2020 by simple random method. All infants were subjected to the following:

1. **Full History Taking: including:**

* Mode Of delivery
* Maternal age.
* Maternal illness.
* Sex Determination.
* Birth weight.
* Type of feeding.

2. **Physical Examination: with stress on:**

* Provisional diagnosis for admission.
* Gestational age assessment using new Ballard scoring system **(Ballard; et al, 1991)**.
* Anthropometric measurements: weight (g), length (cm) and H.C (cm) were measured at birth, 2, 4, and 6 months and plotted against WHO percentile growth charts **(WHO, 2006)**.

Weight was measured using an electronic baby scale (Granzia) with a precision of 10 g. Length was measured to the nearest millimeter using flexible non-stretchable tape. The head circumference (HC) was measured as the maximum occipito-frontal circumference using a non-stretchable tape measure to the nearest 0.1 cm.

Statistical Analysis:

The data were analyzed using SPSS (Statistical Packages for Social Sciences) version 15 statistical software.

RESULTS

Table (1): Demographic data of all studied patients

		Studied patients (N = 100)	
Gestational age	**Mean ±SD**	35.3 ± 1.9	
Range	**Min - Max**	32 – 39	
Sex	**Male**	48	48%
	Female	52	52%
Feeding	**BF***	40	40%
	FF**	36	36%
	FF & BF	24	24%
Hospital stay	**Mean ±SD**	21.9 ± 15.6	
Range	**Min – Max**	3 – 47	
Diagnosis	**RDS & PT*****	36	16%
	Congenital Pneumonia	24	20%
	Neonatal Jaundice	20	24%
	TTN****	16	36%
	Neonatal Sepsis	4	4%
Maternal age (years)	**Mean ±SD**	24.4 ± 4.6	
Range	**Min - Max**	18 – 35	

BF*=Breastfeeding
FF**=Formula feeding
RDS & PT***=Respiratory distress syndrome and prematurity
TTN**** = Transient Tachypnea of newborn

Table (1) shows the demographic data of the studied infants.

Table (2): Mean weight in studied patients at different ages

		At birth	2 months	4 months	6 months	p-value
Weight	**Mean**	1889	3703.6	5212.4	6408.4	
(grams)	**±SD**	428.7	672.9	489.3	393.3	< 0.001 HS

Table (2) shows highly statistical significant increase in weight follow up in studied infants at 2nd, 4th and 6th months.

Table (3): Mean length in studied patients at different ages

		At birth	2 months	4 months	6 months	p-value
Length (cm)	**Mean**	44.7	51.4	57.4	63.0	
	±SD	2.6	3.6	3.2	2.3	< 0.001 HS

Table (3) shows highly statistical significant increase in length follow up in studied infants at 2nd, 4th, and 6th months.

Table (4): Mean HC in studied patients at different ages

		At birth	2 months	4 months	6 months	p-value
H.C (cm)	**Mean**	31.6	36.5	39.3	41.8	
	±SD	1.3	1.4	1.2	1.4	< 0.001 HS

Table (4) shows highly statistical significant increase in head circumference follow up in studied infants at 2nd, 4th, and 6th months.

Table (5): Comparison between males and females as regard weight

Weight		Male (N = 48)	Female (N = 52)	P-value
At birth	**Mean**	1830.4	1943.1	0.077
	±SD	380.3	466.0	
At 2 months	**Mean**	3613.3	3786.9	0.294
	±SD	719.0	622.8	
At 4 months	**Mean**	5203.3	5220.8	0.224
	±SD	621.8	329.1	
At 6 months	**Mean**	6618.3	6214.6	**< 0.001 HS**
	±SD	344.7	333.0	

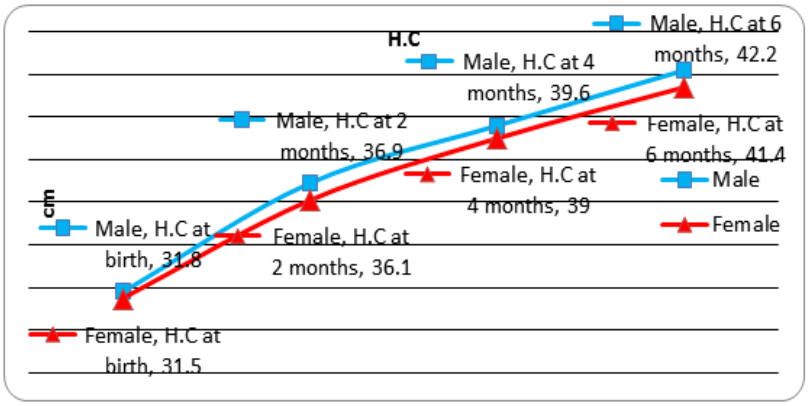

Figure (1): Comparison between males and females as regard weight.

Table (5) and **figure (1)** show that, there was no statistical significant difference between males and females as regard weight at birth, at 2 months and at 4 months, while highly statistical significant difference at 6 months.

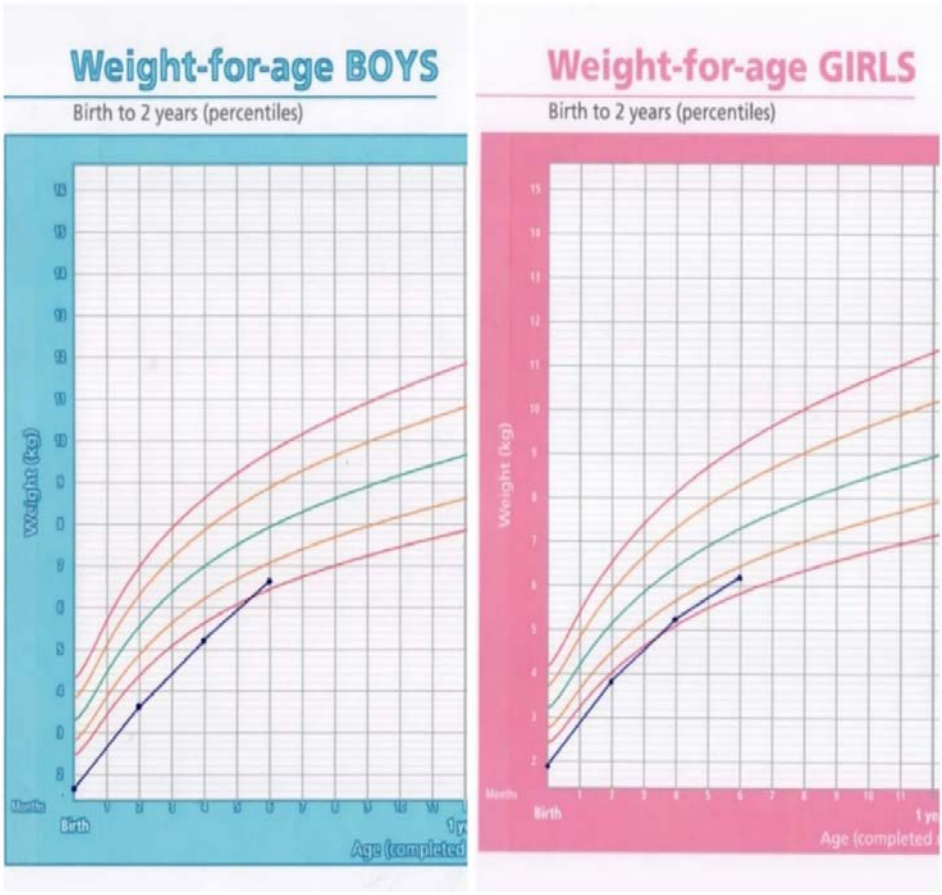

Figure (2): Comparison between males and females as regard weight using WHO chart

Figure (2) shows that, there was catch up in weight in both males and females but still below mean values of reference population after 6 months.

Table (6): Comparison between males and females as regard length

Length		Male (N = 48)	Female (N = 52)	P-value
At birth	**Mean**	44.9	44.5	0.224
	±SD	2.7	2.5	
At 2 months	**Mean**	51.7	51.1	0.294
	±SD	4.0	3.2	
At 4 months	**Mean**	58.0	56.9	**0.002 S**
	±SD	3.9	2.3	
At 6 months	**Mean**	63.3	62.7	0.06
	±SD	2.7	1.8	

As shown in **table (6)**, there was no statistical significant difference between males and females as regard length at birth, 2 months and at 6 months, while there was statistically significant difference between males and females as regard length at 4 months of life.

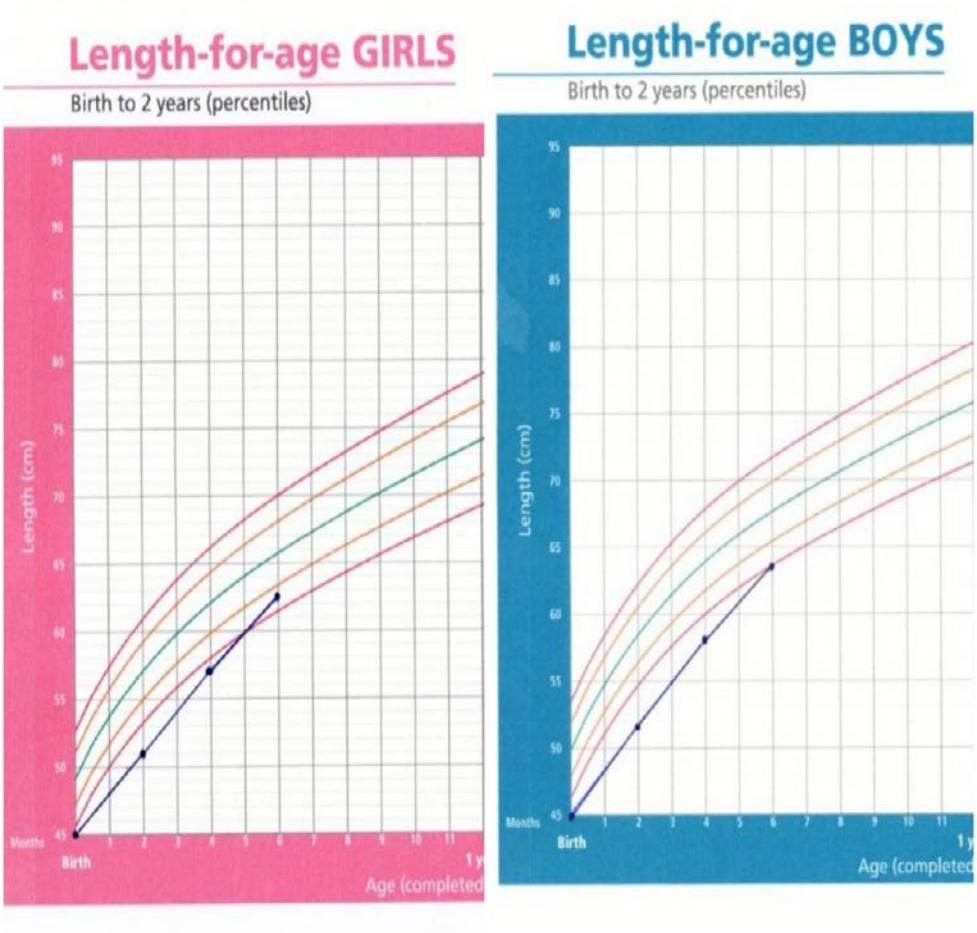

Figure (3): Comparison between males and females as regard length using WHO chart

Figure (3) shows that, there was significant increase in length in both males and females at 2, 4 and 6 months but still below mean values of reference population after 6 months.

Table (7): Comparison between males and females as regard H.C.

Head Circumference		Male (N = 48)	Female (N = 52)	P-value
At birth	**Mean**	31.8	31.5	0.165
	±SD	1.1	1.4	
At 2 months	**Mean**	36.9	36.1	**0.007 S**
	±SD	1.2	1.5	
At 4 months	**Mean**	39.6	39.0	**0.013 S**
	±SD	0.9	1.3	
At 6 months	**Mean**	42.2	41.4	**0.005 S**
	±SD	1.1	1.6	

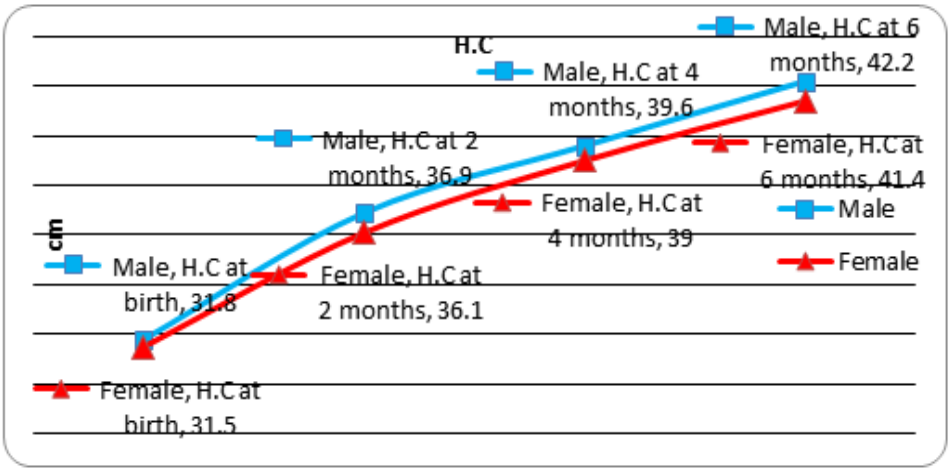

Figure (4): Comparison between males and females as regard HC.

In **table (7)** and **figure (4)**, HC shows no statistical significant increase in males and females at birth, while statistically significant difference between males and females as regard head circumference at 2 months, 4 months and 6 months of age.

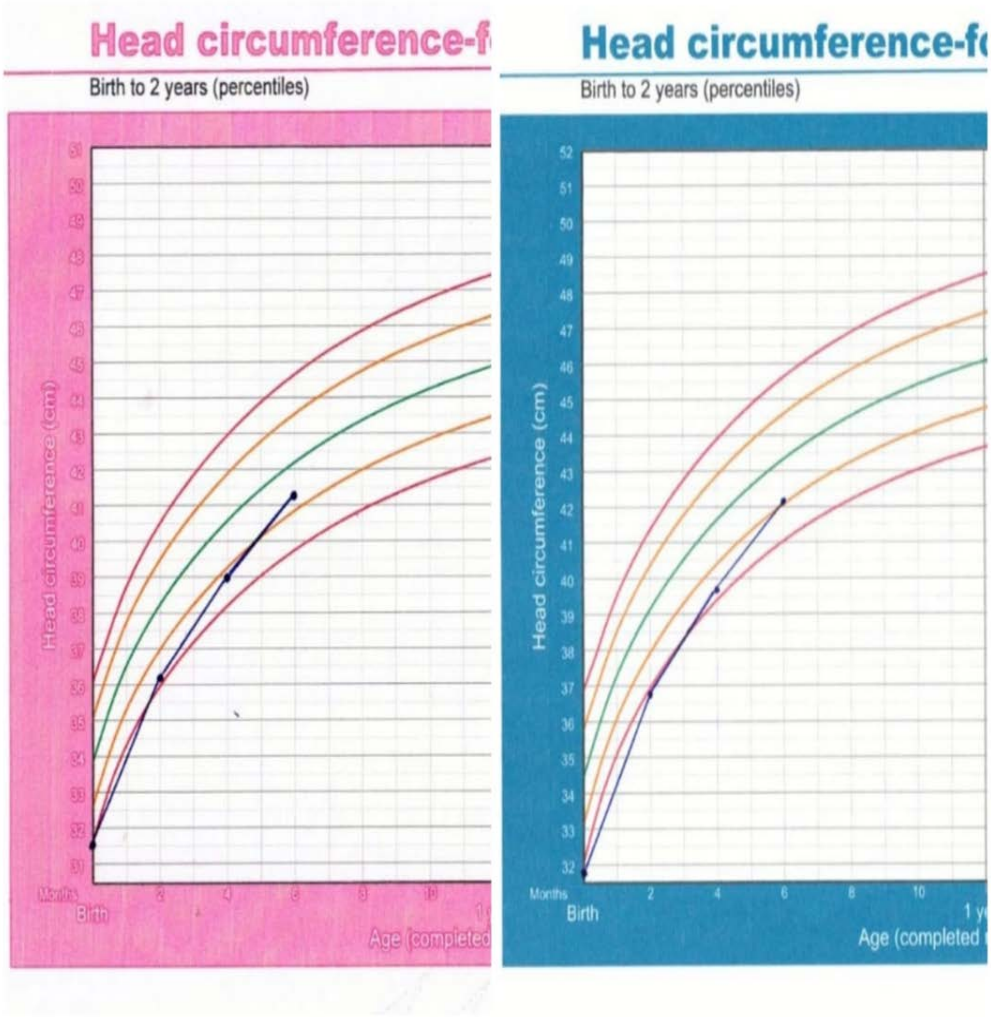

Figure (5): Comparison between males and females as regard HC using WHO chart

Figure (5) shows that H.C in both males and females were still below mean values of reference population after 6 months.

Table (8): Comparison between breast fed and formula fed babies as regard weight

Weight		BF (N = 40)	FF (N = 36)	P-value
At 2 months	**Mean**	4307.5	2939.4	**< 0.001 HS**
	±SD	198.9	432.2	
At 4 months	**Mean**	5633.5	4679.4	**< 0.001 HS**
	±SD	182.7	330.0	
At 6 months	**Mean**	6705.0	6098.9	**< 0.001 HS**
	±SD	278.7	313.0	

Table (8) shows highly statistical significant difference between breast fed and formula fed babies as regard weight at birth, 2 months, 4 months and 6 months.

Table (9): Comparison between breast fed and formula fed babies as regard length

Length		BF (N = 40)	FF (N = 36)	P-value
At 2 months	**Mean**	54.6	47.4	**< 0.001 HS**
	±SD	1.4	2.4	
At 4 months	**Mean**	59.9	54.2	**< 0.001 HS**
	±SD	1.3	2.6	
At 6 months	**Mean**	64.8	60.6	**< 0.001 HS**
	±SD	1.3	1.3	

Table (9) shows highly statistical significant difference between breast fed and formula fed babies as regard length at birth, 2 months, 4 months and 6 months.

Table (10): Comparison between breast fed and formula fed babies as regard H.C.

Head Circumference		**BF (N = 40)**	**FF (N = 36)**	**P-value**
At 2 months	**Mean**	37.7	35.2	**< 0.001 HS**
	±SD	0.7	1.2	
At 4 months	**Mean**	40.4	38.2	**< 0.001 HS**
	±SD	0.7	0.9	
At 6 months	**Mean**	43.1	40.5	**< 0.001 HS**
	±SD	0.8	1.0	

Table (10) shows highly statistical significant difference between breast fed and formula fed babies as regard H.C at birth, 2 months, 4 months and 6 months.

DISCUSSION

Evaluation of growth in LBW infants should be more emphasized since growth failure in such infants might be associated with many complications including increasing the frequency of hospitalization and prolonging the duration, learning disabilities, growth retardation in childhood and reductions in adult lung function and capacity **(Hancox et al., 2009)**.

In this study, the mean maternal age of all studied patients was 24.4 ± 4.6 years with minimum maternal age of 18 years and maximum maternal age of 35 years. **Figuerêdo et al., (2014)** demonstrated that, in Brazilian population, maternal age of less than 20 years old included early adolescence (younger than 16 years old) and those who are aged 16 to 19 years were associated with higher preterm birth rates, while advanced maternal age (>35 years) showed only a borderline association with this outcome.

As regard weight in this study, all patients had low birth weight with poor weight gain during NICU hospitalization until discharge; these may be because of morbidity at NICU and inadequate feeding. Then, weight gain increases gradually from discharge up to 2 month, and continue more increase to 4 and 6 month old. As regard length in our study, length gain was not affected greatly from birth till 2 month, NICU admission included in this period; this is probably because length takes more time of inadequate nutrition to be affected. But, length gain increases more after 2 month and continues more increase till 4 and 6 months. On the other contrary, head circumference had a relatively more increase during first two

months when compared to its increase from 2 till 4 and 6 months. This is may be because that gain of head circumference occurring during first three months normally is greater than its gain from 3 months till 6 months age. This study shows that, catch-up in length, weight and head circumference measurements, especially between 2nd and 6th months in studied patients; however the mean value for length, weight and head circumference measurements seems to be lower than reference population values.

Ane et al., (2010) reported that significant catch-up growth for weight and length was observed during the first year with mean z-score change (SD) of 0.40 (1.05) and 1.01 (1.25) respectively, However, the very low birth weight infants remained lighter and shorter than full-term peers until12 months corrected age with mean z-score of-0.93 (1.09) and 0.48 (1.06) respectively. Head circumference followed a normal growth pattern after 2 months. **Yoon et al., (2021)** demonstrated that mean weight, height, and HC percentiles were persistently below 40 percent among LBW infants. Among children with poor growth, there is a decreasing trend in the incidence of poor growth until the 36 months of ag. Poor growth is still a serious problem in preterm infants, although there is an increase in survival and morbidity free survival. **Islami et al., (2012)** showed that growth parameters of LBW children partially improved at the age of one year as frequency of underweight and short stature decreased and no child had HC > -2 SD in one year. Catch-up in HC occurred before 6 months, followed by a stabilization of values remaining significantly < 0 z score until 11 years of age **(Farooqi et al., 2006)**.

The current study show statistically significance between males and females as regard weight at discharge and at 6 months. This may be explained by that males need more time to be recovered and discharged from NICU than females (Mean for Males=23.16 days and for Females=20.69 days), causing more weight loss during admission in males. As regard length, almost no statistical significance between males and females. As regard H.C there is statistical significance between males and females as females appear to have smaller H.C than males and this may be considered normal variations between both genders.

Chaudhari et al., (2012) showed that preterm SGA males were significantly shorter than

controls, and preterm SGA females showed a smaller head circumference than preterm AGA. **Gladstone et al., (2010)** stated that the growth rates in terms of average monthly height and weight gain were lower in girls. Similarly a report from Brazil was observed, **(Spyrides et al., 2008)**, this could be because of social factors such as the preferential care and nutrition that a boy receives in developing countries.

In the present study, infants who had exclusive breast feeding for six months had better weight, length and H.C gain at the age of six months. This is may be due to that infants with short duration of admission had a better discharge weight, less complications and had a better chance to continue breast feeding after discharge. This is in compliance with other studies which suggested a beneficial effect of breastfeeding on childhood growth rates of LBW newborns and efforts must be continued to breast feed all low birth weight neonates in the NICU and even after discharge **(Jegier et al., 2010)**. In a study carried by **Singh et al., (2009)** for assessment of growth parameters for recording of weight (daily when in the hospital and later weekly), length (weekly) and head circumference (weekly) till the age of four months found that low birth weight infants, both the preterm and the term small for gestational age, on being exclusively breastfed by their own mothers, gained weight and had an increase in their head circumference and length to the levels almost comparable to the standard fetal- infant growth norms.

Our findings are consistent with those of previous international studies, which reported that a lot of preterm infants born lighter and shorter than full-term infants remain growth-restricted beyond the catch-up period **(Van de Pol and Allegaert, 2020)**. A 6-year follow-up study of very preterm infants showed the catch-up growth was mostly achieved before 2 months of age; however, it was continued until 6 years of age in SGA infants **(Toftlund et al., 2018)**. Growth restriction was more common in preterm infants but recent studies have shown positive reports of catch-up growth through nutritional support and quality improvement **(Andrews et al., 2019)**. Small for gestational age infants with less than 28 week's gestation had appropriate catch-up growth at term, in case with high quality postnatal nutrition and care **(Ng et al., 2019)**.

CONCLUSION

Low birth weight infants showed catch-up growth during the first 6 months, but their weight, length and HC remained less than full-term peers. Both males and females have the same catch up growth rate with only little differences regarding weight and length, but females had smaller H.C than males. Males are more liable to growth failure due to long period of NICU hospitalization (Mean for M=23.16 days and for F=20.69 days) and subsequently had lower weight at discharge (Mean for M=2030.4 g and for F=2167.7 g). Breast feeding is important to sustain better growth during first 6 months of life. Breast feeding low birth weight infant showed better growth rate than formula feeding during first 6 months of life.

Limitation of the Study

* Little number of studied patients.
* Short period of follow up.
* Incompliance of some mothers for regular follow up visits.

Recommendation

* Conducting the study on large number of infants.
* Follow up of LBW infants growth for a long period for further assessments.
* Support breast feeding during and after NICU admission, activation of Baby Friendly Hospital program and enhance education about benefits of breast feeding.

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الملخص العربي

المقدمة:

يقدر عدد الاطفال الذين يزنون اقل من 2500 جم عند الولادة حوالي عشرون مليونا سنويا، وهو مايعادل 15,5% من اجمالي المواليد سنويا حول العالم. وتتراوح النسبة في مصر حوالي 5-10% من اجمالي المواليد. ويعتبر الاطفال ناقصي وزن الولادة من اكبر المشكلات الصحية في العالم ويعد قلة وزن الولادة من العوامل الرئيسية التي تؤثر علي صحة الطفل خلال فترة الرضاعة وما بعدها، فهو يتناسب طرديا مع معدل وفيات الاطفال وعكسيا مع معدل النمو والتطور وذلك مقارنة بوزن الاطفال الطبيعيين. ويوصي بالرضاعة الطبيعية كمصدر التغذية الحصري للاطفال خلال الستة اشهر الاولي من العمر، ويستمر مع اضافة الاغذية الجافة بعد الستة أشهر.

الهدف من الدراسة:

تسجيل نمط نمو الاطفال الذين يقل وزنهم عن 2500 جم بواسطة قياس الطول والوزن ومحيط الرأس عند الولادة وبعد خروجهم من وحدة الرعاية المركزة للمبتسرين عند شهرين و أربعة وستة أشهر.

طرق البحث:

هذه الدراسة الوصفية تمت علي مائة طفل وزنهم اقل من 2500 جم عند الولادة بعد خروجهم من وحدة الرعاية المركزة للمبتسرين بمستشفي أبوالمطامير بالبحيرة خلال الستة أشهر الأولي من العمر.

وقد خضع كل الاطفال المشمولين بالدراسة للآتي:

تاريخ الأم: كيفية الولادة، عمر الام، امراض تصيب الأم اثناء الحمل، المتابعة أثناء الحمل.

تاريخ المولود: العمر الرحمي للمولود، وزن المولود بعد الولادة، تشخيصه المبدأي عند دخول وحدة الرعاية المركزة للمبتسرين، الحالة المرضية بين الزيارات والحجز داخل المستشفي ان وجد.

التغذية: رضاعة طبيعية، رضاعة صناعية، رضاعة مختلطة.

تطور النمو:ويشمل:

- الفحص الاكلينيكي الكامل للطفل.
- قياس الوزن والطول ومحيط الرأس عند الولادة وعند شهرين وأربعة وستة أشهر من العمر ووضعهم علي منحنيات نمو منظمة الصحة العالمية كالأتي:
  - الوزن/ العمر.
  - الطول/ العمر.

- محيط الرأس/ العمر.

تم جمع البيانات وتحليلها احصائيا.

النتائج والاستنتاجات:

هناك فروق ذات دلالة احصائية بالنسبة للوزن والطول ومحيط الرأس للاطفال المشمولين بالدراسة حيث كانوا اخف وزنا وطولا ومحيطا للرأس بالنسبة للقيم المرجعية للاطفال الطبيعيين.هناك تسارعا ملحوظا للنمو لاطفال الدراسة بالنسبة للوزن والطول (ولكن بشكل اقل من تسارع الوزن) بدأ من بعد الخروج من وحدة الرعاية المركزة للمبتسرين وحتي سن شهرين، واستمر هذا التسارع بشكل اكبر حتي نهاية الدراسة. علي عكس الطول والوزن، فان تسارع النمو بالنسبة لمحيط الرأس خلال الثلاثة أشهر اكبر منه خلال الثلاثة اشهر التالية من الدراسة.هناك فروق ذات دلالة احصائية بالنسبة للتغذية حيث ان معدل النمو بالنسبة للوزن والطول ومحيط الرأس في اطفال الرضاعة الطبيعية اكبر منه في اطفال الرضاعة الصناعية. ليس هناك دلالة ذات قيم احصائية بالنسبة لجنس المولود من حيث ان معدلات الطول والوزن، بخلاف الوزن عند سن 6 أشهر حيث كان وزن الاناث أخف منه ف الذكور.هناك دلالة ذات قيم احصائية بالنسبة لمحيط الرأس حيث كان في الذكور أكبر منه في الاناث.