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Original article

Morbidity and weight gain patterns amongst babies with fetal malnutrition in Port Harcourt, Nigeria

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Abstract

Background: Low birth weight babies including those with fetal malnutrition (FM) reportedly have higher rates of perinatal morbidities, persistence of poor growth and poor cognitive development. Follow up of babies with FM is important to allow for early intervention where necessary. The paper aimed to determine morbidities and weight gain patterns in term newborns with FM in the first 6 weeks of life.

Materials and methods: This was a cross-sectional study of morbidities and weight gain patterns in term babies with FM, delivered at the University of Port Harcourt Teaching Hospital (UPTH). Infants were recruited consecutively in the labor wards shortly after birth. The CANSCORE was used to determine nutritional status within the first 24 hours of life. Weights were obtained at birth and at 6 weeks. Data were analyzed using the Statistical Package for Social Sciences (SPSS®) Version-17, Spearman's Chi-Square test (χ^2-test) or the Fisher's Exact Test (FET) of significance were used to determine statistical significance.

Results: The results from the research revealed that there was a statistically significant relationship between FM and occurrence of birth asphyxia (FET-derived p-value = 0.02). There was no difference in occurrence of morbidities during the 6 week follow up period between babies with and without FM (FET-derived p-value = 0.61). At 6 weeks, the mean weight gain of babies with and without FM was 1,746.87 ± 510.0 g and 1,492.67 ± 649.6 g, respectively (t = 2.46; p = 0.02). Despite higher mean weight gain at 6 weeks, the babies with FM had lower mean weight than their counterparts without FM.

Conclusion: Birth asphyxia occurred more commonly in babies with FM. There was persistence of low weight at the chronological age of 6 weeks despite higher mean weight gain in babies with FM. Therefore, babies with FM need follow up to detect and treat problems early.

Keywords

Fetal malnutrition, morbidities, weight gain pattern.

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Background

Fetal malnutrition (FM) is an important contributor to many early and late neonatal morbidities. Reported morbidities include an increased risk for neonatal sepsis, prolonged new-born hospitalization, on-going risks for malnutrition and hypoxia with all their associated complications [1-3]. The risk and outcome of neonatal morbidities have been reported to be worse in babies with FM compared with babies without FM born in similar circumstances [1-3]. Thus, nutritional status, in addition to the weight-for-gestational-age, tends to influence neonatal morbidity and mortality [4]. Catch-up growth has been described as acceleration in growth of majority of small for gestational age infants soon after birth, most of which occurs in the first 6 months of life [5, 6]. This accelerated postnatal weight gain has been reported to benefit the child in the early years, by improving nutritional status, resistance to infection, and survival and has also been associated with lower risk for hospital admission. Although complications such as cardio-metabolic diseases have been reported to occur in later life in children or adults who had a low birth weight and subsequent postnatal mismatch, evidence from resources in some countries suggests that greater infant weight gain is associated with benefits for survival and human capital which is neutral in terms of later cardio-metabolic risk [7]. Growth monitoring and follow up are therefore important for early interventions to reduce morbidity and mortality.

The aim of the study was to determine morbidities and weight gain patterns in the first 6 weeks of life in term babies with FM delivered in a tertiary hospital in Southern Nigeria.

Materials and methods

Singleton term babies whose mothers received antenatal care, delivered in the University of Port Harcourt Teaching Hospital (UPTH) and gave informed consent for the study were consecutively selected from the labor wards for the study. Babies with major congenital anomalies were excluded. The hospital is baby friendly and thus has a breastfeeding policy that promotes, supports and protects breastfeeding. Mothers are encouraged to exclusively breastfeed their babies in the first 6 months of life unless otherwise medically indicated.

Babies were weighed at birth using a weighing scale (Weighmaster, Leicestershire, England) which had a precision of 50 g. The scale was standardized daily using known weights and zero adjustment was made before each measurement. For each baby, 3 measurements were taken and the average recorded in a data collection sheet. Weights were recorded to the nearest 0.1 kg. APGAR scores were also obtained at birth and 5 minutes after, and babies duly resuscitated when indicated. APGAR scores were used to categorise babies into severe (score ≤ 3), moderate (score of 4-5) and mild (score of 6-7) asphyxia.

Nutritional status was assessed using the Metcoff's Clinical Assessment of Nutritional Status Score (CANSCORE) chart [8] and babies were categorised into those with FM (total score less than 25) and those with normal nutrition. All babies underwent routine neonatal examination.

Baseline investigations were also done for each of the babies within 24 hours of birth. These included a random blood glucose test, packed cell volume (PCV) estimation and a blood film for malaria parasites. The cost of these was borne by the researchers. The blood glucose levels were estimated by colorimetric analysis and hypoglycemia was defined as a random blood glucose level of less than 2.6 mmol/l [9]. PCV was determined by centrifugation and reading off a haematocrit reader. Malaria parasite identification was done by microscopy using standard staining techniques with Field's stains A and B. Results of the tests were collected daily by the researchers and communicated to the parents of the baby before they were entered into the study proforma. Other tests required for the management of ill neonates were determined by the managing team and were paid for by the parents as practiced in the hospital.

During the period of maternal admission and post-delivery, all neonates were assessed daily by the reasearchers for symptoms or signs of any morbidity and admitted into the Special Care Baby Unit (SCBU) of the hospital where necessary. Mothers whose babies were admitted into the SCBU were counselled on the indication(s) for admission,

progress of the baby and the probable outcome. At discharge, mothers were also counselled on home-care of the newborn, and optimal feeding practices using exclusive breastfeeding (except where the mother opted out for medical reasons). All clinically stable babies with FM as well as babies who had been discharged from the SCBU were referred to the neonatal clinics for routine follow up. Before discharge, breastfeeding mothers were taught hand expression of milk and its storage. Mothers of babies with FM were taught to give extra feeds with cup and spoon. This, it was stressed, would enable the babies catch up on their weight and also reduce the likelihood of continued malnutrition and other complications in infancy. Each mother was also counselled to report to the hospital as frequently as the babies needed medical attention. At the 6th-week post-natal visit, the mothers were interviewed by one of the authors to get information about the symptoms and signs of any past or current illness. These included symptoms of respiratory tract infection, fever, convulsion and passage of watery stools amongst others, and how these were managed especially if the child was not brought to UPTH. All babies were again weighed at 6 weeks and weights were recorded.

Data was collected on a proforma designed for the study and analysed using the SPSS® software version 17. Descriptive statistics were computed using simple frequency tables and charts. Spearman's Chi-Square test (χ^2-test) or the Fisher's Exact Test (FET) of significance were used to determine statistical significance. A comparative analysis of the continuous variables such as weights and lengths was done, using the Student's t-test and Analysis of Variance (ANOVA) to get the means and standard deviations. The confidence interval was set at 95% and a p-value of less than 0.05 was considered statistically significant.

Ethical clearance was obtained from the Ethics committee of UPTH and informed consent from the mothers.

Results

Three hundred term babies were recruited into the study. Of these, 176 were males while 124 were females giving a male:female ratio of 1.4:1. Fifty babies (16.7%) had FM. Birth weights ranged from 1,550.0 g to 4,700 g with a mean of 3,281.8 ± 505.1 g. **Tab. 1** shows the relationship between weight and nutritional status and between laboratory parameters and nutritional status.

Morbidities associated with fetal malnutrition immediately after birth

Birth asphyxia

Out of the 300 babies, 46 (15.3%) had some degree of birth asphyxia; 3 (1.0%) had severe, 16 (5.3%) moderate and 27 (9.0%) mild birth asphyxia respectively. One (2.0%) baby with FM had severe birth asphyxia while 7 (14.0%) and 5 (10.0%) had moderate and mild birth asphyxia, respectively. There was a statistically significant relationship between FM and birth asphyxia (FET-derived p-value = 0.02).

Glycemia

Random blood sugar (RBS) of the babies ranged from 0.8 mmol/l to 11.0 mmol/l with a mean of 2.8 ± 1.2 mmol/l. Of the 300 babies, 122 (40.7%) had hypoglycemia, while 172 (57.3%) were normoglycemic (2.60-5.50 mmol/l) and 6 (2.0%) had hyperglycemia. Twenty-four (48.0%) babies with FM compared with 98 (39.2%) of those without FM had hypoglycemia. The mean ± SD RBS was 2.86 ± 1.54 mmol/l for babies with FM

Table 1. Relationship between weight, laboratory indices and nutritional status.

	Nutritional status				t-value	p-value
	Mean		SD			
	FM	No FM	FM	No FM		
Weight						
Birthweight (g)	2,766.00	3,385.00	417.65	456.00	-9.42	0.00
Weight at 6 weeks (g)	4,512.90	4,881.10	616.71	749.65	-2.59	0.01
Laboratory indices						
PCV (%)	42.90	44.70	4.67	6.23	-1.93	0.54
RBS (mmol/l)	2.86	2.80	1.54	1.07	0.23	0.82

SD: standard deviation; FM: fetal malnutrition; PCV: packed cell volume; RBS: random blood sugar.

compared with 2.80 ± 1.07 mmol/l for babies with no FM. While a higher percentage of babies with FM than those with no FM had hypoglycemia, the observed difference was not statistically significant ($\chi^2 = 1.34$; df = 1; p = 0.23).

Packed cell volume levels

The PCV of the babies ranged between 29.0% and 62.0% with mean ± SD of 44.4% ± 6.0%. No baby had polycythemia (venous PCV greater than 65.0%). Of the 300 babies, 41 (13.7%) had anemia (venous PCV less than 39.0%) and 259 (86.3%) had normal PCV. The mean ± SD PCV for babies with FM was 42.90% ± 4.67%, compared with 44.70% ± 6.23% for babies with no FM. In addition, out of the 50 babies who had FM, 11 (22.0%) had anemia, while 39 (78.0%) had normal PCV. There was no statistically significant difference in the PCV levels recorded amongst babies with FM compared with the corresponding findings in those with no FM (p = 0.06; $\chi^2 = 3.50$; df = 1). The relationship between nutritional status of the babies and occurrence of birth asphyxia, hypoglycemia and anemia is shown in **Tab. 2**.

Nutritional status and neonatal malaria parasitemia

Fifty-nine (19.7%) of all the babies in the study had malaria parasitemia in their peripheral blood films. Out of the 50 babies with FM, 13 (26.0%) had malaria parasitemia, while 46 (18.4%) of the babies without FM had malaria parasitemia. Although a higher percentage of babies with FM had malaria parasitemia, the difference was not statistically significant (FET-derived p-value = 0.22).

Nutritional status and the risk of admission at birth

Out of the 300 babies, 57 (19.0%) were admitted into the SCBU after birth. The commonest indications for admission were presumed neonatal sepsis, hypoglycaemia and birth asphyxia. From the babies admitted, 12 (21.1%) had FM while 45 (78.9%) did not have FM. From the 50 babies who had FM, 12 (24.0%), compared with 38 (15.2%) of 250 babies with no FM, were admitted. Although a higher percentage of babies with FM than those without FM were admitted, the difference was not statistically significant ($\chi^2 = 0.98$; df = 1; p = 0.32).

Outcome of admission

From the 57 (19.0%) babies admitted, 55 (96.5%) were discharged. The two babies who were not discharged did not have FM; 1 (1.8%) had bilateral congenital hydronephrosis and was transfered to another facility for further management as the parents were domiciled outside the state; the other

Table 2. Relationship between nutritional status of the babies and occurrence of birth asphyxia, hypoglycemia and anemia.

Features	Nutritional status		Total No. (%)	χ^2	p-value
	FM No. (%)	NO FM No. (%)			
Birth asphyxia					FET = 0.02
Severe	1 (2.0)	2 (0.8)	3 (1.0)		
Moderate	7 (14.0)	9 (3.6)	16 (5.3)		
Mild	5 (10.0)	22 (8.8)	27 (9.0)		
None	37 (74.0)	217 (86.8)	254 (84.7)		
Total	50 (100.0)	250 (100.0)	300 (100.0)		
Glycemia				1.34	0.23
Hypoglycemia	24 (48.0)	98 (39.2)	122 (40.7)		
Normoglycemia	24 (48.0)	148 (59.2)	172 (57.3)		
Hyperglycemia	2 (4.0)	4 (1.6)	6 (2.0)		
Total	50 (100.0)	250 (100.0)	300 (100.0)		
Anemia				3.50	0.06
Present	11 (22.0)	30 (12.0)	41 (13.7)		
Absent	39 (78.0)	220 (88.0)	259 (86.3)		
Total	50 (100)	250 (100.0)	300 (100.0)		

FM: fetal malnutrition; FET: Fisher's Exact Test.

baby, on the other hand, had severe birth asphyxia and overwhelming septicemia which eventually led to the death of the baby.

Post-natal symptoms/morbidities during the first 6 weeks

Among the 299 living babies, the baby who was transferred remained ill throughout the 6 weeks of follow up. Of the remaining 298 babies, 29 (9.7%), among whom were 2 babies with FM, had various morbidities during the period (**Tab. 3**). Respiratory tract infection was the most frequent morbidity in the babies, accounting for 48.3% of all the illnesses recorded, while skin infections were reported for 6 (20.7%) babies. Among these babies, only 2 with FM had acute respiratory infections alone. The differences in the occurrence of morbidities during the follow up period between babies with FM, and those without FM was not statistically significant (FET-derived p-value = 0.61).

Feeding practices at 6 weeks

Two hundred and ninety eight babies attended the post-natal clinic at 6 weeks and from that number, 214 (71.8%) babies were still being exclusively breastfed, 45 (15.1%) were having mixed feeding, while 39 (13.1%) were on breast milk substitutes only. Although 33 (66.0%) babies with FM compared to 181 (73.0%) babies without FM were being exclusively breastfed, the difference in the feeding practices was not statistically significant (χ^2 = 5.21; df = 2; p = 0.07) (**Tab. 4**).

Weight of babies at 6 weeks

The weights of all the babies at the 6th-week post-natal visit ranged from 2,900.0 g to 6,900.0 g with a mean of 4,828.2 ± 742.1 g. The mean weight at 6 weeks of babies with FM was 4,512.90 ± 616.71 g, compared to 4,881.10 ± 749.65 g for babies without FM. The mean weight gain of babies with FM was 1,746.87 ± 510.0 g, compared with 1,492.67 ± 649.6 g for babies with no FM. The observed difference was statistically significant (t = 2.46; p = 0.02).

Table 3. Distribution of morbidities among the babies during the first 6 weeks.

Illnesses within 6 weeks	Nutritional status		Total No. (%)
	FM No. (%)	NO FM No. (%)	
Diarrheal diseases	0 (0.0%)	3 (10.3%)	3 (10.3%)
Fever	0 (0.0%)	4 (13.8%)	4 (13.8%)
Respiratory tract infection	2 (6.9%)	12 (41.4%)	14 (48.3%)
Abnormal movements	0 (0.0%)	2 (6.9%)	2 (6.9%)
Skin sepsis	0 (0.0%)	6 (20.7%)	6 (20.7%)
Total	2 (6.9%)	27 (93.1)	29 (100.0%)

FET-derived p-value = 0.61.
FM: fetal malnutrition.
In this table, all percentages are calculated against the total (n = 29).

Table 4. Nutritional status and feeding practice at 6 weeks.

Feeding practice at 6 weeks	Nutritional status		Total No. (%)
	FM No. (%)	NO FM No. (%)	
Exclusive breastfeeding	33 (66.0%)	181 (73.0%)	214 (71.8%)
Mixed feeding	13 (26.0%)	32 (12.9%)	45 (15.1%)
Exclusive formula feeding	4 (8.0%)	35 (14.1%)	39 (13.1%)
Total	50 (100.0%)	248 (100.0)	298 (100.0%)

χ^2 = 5.21; df = 2; p = 0.07.
FM: fetal malnutrition.

Discussion

The prevalence of FM of 16.7% has been published in an earlier report [10] and is similar to findings by other Nigerian authors [11]. FM is known to be associated with significant perinatal morbidity and mortality [12]. Common morbidities that have been reported in babies with FM include birth asphyxia, hypoglycemia, neonatal polycythemia, hypothermia, increased risk of neonatal infections such as diarrhea, pneumonia and poor growth [1, 3]. The finding of a significant relationship between FM and birth asphyxia, and hence a likelihood of neurological sequelae in the long term, agrees with other studies [8, 13-16]. This risk is attributable to chronic fetal hypoxia superadded with acute fetal hypoxia and other maternal risk factors like abruptio placenta and pre-eclampsia which lead to placental insufficiency [17].

Hypoglycemia was common in the study population. It is noteworthy that there are controversies in the definition of hypoglycemia and this may affect prevalence in different settings [9]. The occurrence of hypoglycemia in the newborns may have been aggravated by the strict observance of the policy of exclusive

breastfeeding in our institution, where mothers are encouraged to continue to attach the baby to the breast without giving alternative sources of calories, even when the mother is not yet lactating. This practice is a means of encouraging lactation and ensuring that breast milk substitutes (with all its risks) are not introduced to the babies, that early in life. The high prevalence of hypoglycemia in the study population suggests the possibility that a large population of newborn babies develop hypoglycemia before lactation is established. However, even though breast milk supplies in the first days of life is low, healthy newly born babies largely rely on gluconeogenesis and fatty acid mobilization for energy expenditure and maintenance of glucose homeostasis [18, 19]. This normal adaptation to transiently low nutrient intake during the establishment of lactation protects most breastfed infants from adverse effects of low glucose levels on the developing brain [19, 20]. Authors also report that hypoglycaemia in healthy term infants is transient, asymptomatic and self-limiting and there is weak evidence for a causative link between asymptomatic hypoglycemia alone and neurodevelopmental sequelae [19-21].

It is important to screen high risk infants for hypoglycemia as this adaptation may be impaired and hypoglycemia when not corrected in such infants may lead to apnoea, cyanosis, heart failure and severe neurological deficits [1-3]. However, while small for gestational age and large for gestational age babies may be routinely screened for hypoglycemia, those who are appropriate for gestational age but have FM may be missed. Although hypoglycemia was more commonly found among the babies with FM, unlike other reports [16, 22], there was no statistically significant relationship. This may be explained with the evidence that some babies had been breastfed before the assessment and blood collection was done.

Contrary to earlier reports [16, 22], polycythemia was not found in any of the babies in this study. The reason for this cannot be readily explained. However, these were babies of mothers who had received antenatal care in the hospital and thus complications such as anemia may have been detected and corrected early. Severe maternal anemia is reported to reduce fetal oxygen supply creating a state of hypoxia which induces polycythemia in the fetus through the increased production of erythropoietin [23, 24].

The high prevalence of neonatal malarial parasitemia in the present study, especially among the babies with FM, was comparable with the findings in other Nigerian studies in Calabar, Ibadan, Ile-Ife and Benin and is also a reflection of maternal malarial parasitemia [25-27].This may be related to the geography of the study location. Port Harcourt is in the Niger Delta mangrove rain forest, which is in the malaria holo-endemic region of the country with a perennial transmission of malaria parasites all through the year. The high prevalence of neonatal malaria parasitaemia is an indication that efforts at reducing FM and neonatal mortality should necessarily include malaria control. Intermittent preventive treatment of malaria in pregnancy has been reported as an effective tool in the prevention of intrauterine growth restriction [27].

The finding of higher admission rates of babies with FM during the immediate post-natal period is similar to a previous report in Ilesha, South-West Nigeria [16]. The indications for such admissions were also similar to those in other studies [8, 16]. It is also noteworthy that no baby with FM died. This is probably because mothers received antenatal care in the hospital and problems were dealt with promptly as identified. Early interventions have been reported to reduce morbidity and mortality in babies with FM [28].

The finding of a predominance of respiratory tract infections as the commonest diagnoses during the 6-week post-natal period agrees with the report by Pedro and others [1]. The difference in morbidities was not statistically significant probably due to the small number of babies. However, FM babies are reported to have increased susceptibility for infections probably due to associated deficiencies in proteins, essential vitamins and minerals [29]. It has been postulated that disorders of fetal growth affect immune function and result in higher rates of respiratory symptoms [30].

The finding of a lower mean weight at 6 weeks in babies with FM despite a higher mean weight gain agrees with other reports [2, 31]. This finding was despite the non-significant differences in their feeding practices and may have been influenced in babies with FM by the nutritional counselling given to their mothers. It can therefore be inferred that early diagnosis and appropriate nutritional management can significantly improve the outcomes of babies with FM. It can be further expected that purposeful feeding will allow for catch-up growth of babies with FM which may help mitigate the long-term complications and ultimately improve outcome in affected babies. Although human studies

consistently report higher risks of cardio-metabolic disease and its risk factors in children or adults who had a low birth weight but became relatively heavy, there is no evidence to support limiting post-natal nutrition in low birth weight babies in infancy. Indeed current evidence suggests that greater infant weight gain is associated with benefits for survival and human capital and it is neutral in terms of later cardio-metabolic risk [7].

Conclusion

Birth asphyxia occurred more commonly in babies with FM. There was no significant difference in the morbidity pattern between babies with FM and normal weight babies in the first 6 weeks of life. There was persistence of low weight at the chronological age of 6 weeks despite better mean weight gain in babies with FM. Attention should be paid to the early detection and appropriate management of babies with FM to reduce associated morbidity and mortality.

Abbreviations

ANOVA: Analysis of Variance
CANSCORE: Clinical Assessment of Nutritional Status Score
FET: Fisher's Exact Test
FM: fetal malnutrition
PCV: packed cell volume
RBS: random blood sugar
SCBU: Special Care Baby Unit
SD: standard deviation
UPTH: University of Port Harcourt Teaching Hospital

Declarations

The Ethics Committee of the University of Port Harcourt Teaching Hospital gave approval for the study. Written informed consent was obtained from parents or guardians for the participation of the children prior to enrolment in the study.

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Declaration of interest

The Authors declare that they have no competing interests. Funding: the research was funded by the Authors.

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