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Original Research Article

Weight gain in low-birth-weight newborns and associated factors in Central Benin settings

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ABSTRACT

Background: There is an association between low birth weight (LBW) and neonatal morbidity and mortality. The aim of the study was to identify associated factors with low 4-week weight gain among low-birth-weight newborns benefiting from the "optimized mother-newborn care model" within Bohicon health district in Benin.
Methods: This was a retrospective, analytical study of 124 low-weight newborns benefiting from the "optimized mother-newborn care model", monitored for four weeks, and their mothers. Data on newborns and mothers as well as on the healthcare system were gathered through documentary review and interviews. Logistic regression was used to investigate associated factors with weight gain.
Results: Of the 124 newborns monitored, more than half (54.84%) were female, their average birth weight was 2110.24±217.05 grams, and 103 (83.06%) reached the weight threshold of 2500 grams after four weeks. The mean age of the 101 mothers surveyed was 23.47±5.23 years. High household size (OR=5.65; CI95%: [1.04-30.71]), absence of home visits by community health workers (OR=10.93; CI95%: [1.54-77.14]), breastfeeding by expressing milk directly from the breast into baby's mouth (OR=13.90; CI95%: [2.57-74.97]) and non-consumption of hindmilk by the newborn (OR=10.93; CI95%: [1.72-47.08]), were associated with weight gain in these low-weight newborns.
Conclusions: The "optimized mother-newborn care model" appears to improve weight gain in low-birth-weight newborns. Taking into account the factors associated with low weight gain in low-weight newborns could improve the effectiveness of the implemented model in this health district.

Keywords: Newborns, LBW, Weight gain, Benin

INTRODUCTION

The world health organization (WHO) defines LBW as a birth weight of less than 2,500 grams. LBW is a public health concern worldwide, most notably in low-income countries.[1] Around 14.6% of newborns had LBW worldwide in 2015.[2] In sub-Saharan Africa, around 14% of babies are born with low birthweight.[3] In Benin, the prevalence of LBW was 12% in 2017.[4] The survival of LBW newborns depends on their nutritional status and the prevention of hypothermia.[5] Weight gain enabling these newborns to exceed the 2,500-gram threshold could help reduce neonatal morbidity and mortality.[5] Compared to normal-weight newborns, LBW infants are born with insufficient energy and micronutrient reserves for their development, and therefore require considerable energy for tissue synthesis. Low weight gain thus exposes newborns to wasting and stunted growth. On the other hand, rapid weight gain in the first few weeks will enable these newborns to reach normal birth weight, and build a more effective immune system capable of fighting off disease. Accordingly, UNICEF Benin, in collaboration with the ministry of health, has set up an "optimized

mother-newborn care model" in Bohicon health district located in central Benin.[6]

An evaluation of the model's results, carried out between September 2018 and February 2019, showed that 52% of low-birth-weight newborns experienced a weight gain that enabled them to reach the weight threshold of 2500 grams after 4 weeks of follow-up, compared with 48%.[5] In the current study, the aim was to investigate the associated factors for low weight gain in LBW newborns benefiting from this model.

METHODS

Settings

The survey was performed within Bohicon health district located in central Benin's Zou department. The health district had a population of 471,927 and 32 public health centers. Out of these 32 health centers, 20 were involved in the implementation of the "optimized mother-newborn care model", whose main objective is to improve the survival of both mother and newborn. The model includes care at the health center complemented by community follow-up, including:- early breastfeeding and exclusive breastfeeding, -systematic "kangaroo mother" care (KMC) and hypothermia treatment; -systematic wearing of an electronic hypothermia detection bracelet; -mandatory 48-hour hospital stay and -home visits by community health workers.

Children's discharge criteria were: well-tolerated kangaroo position, weight gain 15 grams/kg/day for 3 successive days. Weight at the end of the four-week follow-up period must exceed 2,500 grams.

The "kangaroo mother" method: consists of carrying a premature baby on the stomach in the skin-to-skin contact.

Study design

This was a retrospective, analytical study. The study population consisted of LBW newborns benefiting from the "optimized mother-newborn care model", their mothers as well as the health workers from the health district.

To be included in the study, you had to be: an LBW newborn benefiting from the "optimized mother-newborn care model" with weight monitoring during the first four weeks of life. -a mother of an LBW newborn benefiting from the "optimized mother-newborn care model" with weight monitoring during the first four weeks of life; -a health worker involved in the "optimized mother-newborn care model" during the study period.

LBW newborns with a chronic disease (HIV infection, sickle cell disease, heart disease) were not included in the study.

Selecting newborns

Of the 20 health centers in the health district involved in the optimized mother-newborn care model, 12 were retained by simple random selection. All newborns meeting the inclusion criteria and born in the chosen health centers were surveyed.

Selecting mothers

The mothers selected were those who delivered an LBW newborn enrolled in the optimized care model. Their selection was made by convenience.

Selecting health workers

By reasoned choice, the midwife responsible for implementing the model was surveyed.

Study variables

The dependent variable was weight gain in LBW newborns. Weekly weight measurements during the four-week follow-up period were used to assess weight gain: adequate weight (greater than 2,500 grams) and low weight (less than or equal to 2,500 grams).

Independent variables were: socio-demographic and economic factors: mother's age, marital status, mother's level of education, household size, mother's occupation, monthly income, income-generating activities, father's profession; health system factors: allocation of a "Bempu" electronic bracelet, monitoring during the first 48 hours, temperature monitoring of newborns, monitoring of newborns admitted to KMC, home visits by community outreach workers; newborn characteristics : birth weight, colostrum consumption, postnatal hospital stay, Bempu bracelet worn, hypothermia episodes, sucking capacity, morbidity, vaccination status, weekly weights; mother-related factors: parity, inter-gestational interval, LBW experience, "kangaroo mother" care practices, newborn feeding knowledge and practices, basic hygiene, mother's diet.

The occurrence of hypothermia was assessed through the ringing or non-ringing of the Bempu electronic bracelet given to newborns by health workers. It signals hypothermia in the child and prompts mothers to perform "mother kangaroo care".

The number of KMCs performed by mothers during the follow-up period was collected on newborn follow-up sheets in the health centers.

The method of feeding was assessed by the following modalities: sucking of breast milk by the newborn, milk expressed directly into the infant's mouth and milk expressed using a cup. The consumption of hindmilk by the newborn was assessed by the "yes" and "no" modalities. Hindmilk is the breast milk remaining in the

breast after the first milk (breast milk secreted first during breastfeeding) has been extracted.

Data collection

Data were collected through documentary review and a questionnaire survey led by two nutritionist-dietitians and two socio-anthropologists. An appointment was made with the newborn mothers, after which the team went to their homes to collect the data.

Data analysis

Data were analyzed using STATA 11 software. The chi-square test was used to compare proportions and look for statistical relationships between dependent and independent variables. The student's t test was used to compare means. Multivariate logistic regression was applied to identify factors associated with the weight gain.

RESULTS

General features of the sample

A total of 124 newborns were monitored, 54.84% of whom were female. Mean birth weight was 2110.24±217.05 grams. Hypothermia was reported in 64.52% of newborns, and the average number of SMKs performed was 30.65±24.27 times. The mean weight at discharge from the health center was 2105.27±216.02 grams, with extremes ranging from 1500 to 2450 grams. The median number of hypothermia episodes recorded was 9 (0; 39) times. The mean duration of KMC performed by the mothers was 48.59±15.67 minutes. The duration of postnatal hospitalization was greater than or equal to 48 hours for all newborns surveyed. All newborns surveyed had up-to-date vaccination status at the end of follow-up.

A total of 101 mothers were surveyed, with a mean age of 23.47±5.23 years, 32.67% had never attended school and 57.43% were housewives. Most households (61.39%) consisted of 1 to 4 people, and 87.13% of mothers lived in couples. The predominant feeding method (86.14%) was sucking by the newborn, and 67.33% of newborns received hindmilk from their mothers (Table 1).

As far as care providers were concerned, 12 midwives were surveyed, all of whom had been trained in the implementation of the model. Among the children surveyed, 65.32 percentages had benefited from the Bempu bracelet and 48.39% from home visits by the community relays.

Weight gain in low-birth-weight newborns

Overall, out of 124 newborns surveyed, 103 (83.06%) exceeded the weight threshold of 2500 g at the end of the four-week follow-up period, compared with 21 (16.94%). Weight gain was therefore adequate in the majority of newborns.

Factors associated with weight gain

Bivariate analysis

Sociodemographic and economic variables associated with weight gain in low-birth-weight newborns at the 10% threshold were ethnicity, mother's marital status, father's occupation and household size (Table 2).

The health system variables associated with weight gain in low-birth-weight newborns at the 10% threshold were, wearing of the Bempu bracelet to the newborn and home visit by methodology completely, including sample collection, processing, lab analysis, statistical tests used for data analysis etc.

Use section headings or subheadings in a logical order to entitle each category of the community relays shows in Table 3.

Among neonatal factors, birth weight, occurrence of hypothermia and number of KMCs performed were associated with weight gain. The mean birth weight of newborns with adequate weight gain was statistically higher (2172.41±164.76 g) than that of newborns with low weight gain (1793.75±217.46 g), and this difference was statistically significant (p=0.00).

Mean number of KMCs performed in newborns with adequate weight gain (33.01±25.58 times) was statistically higher than in newborns with low weight gain (19.04±6.59 times), and this difference was statistically significant (p=0.007).

Newborns who had a hypothermic episode reported by the bracelet were less likely to have a low weight gain than those who had no hypothermic episode (OR=0.15 with CI95%: [0.05-0.44]).

Mother-related variables associated with weight gain in low-weight newborns at the 10% threshold were: traditional practices, early breastfeeding, newborn's consumption of hind milk, feeding method, frequency of suckling, newborn's consumption of herbal tea, mothers' knowledge of the importance of colostrum, mothers' knowledge of early breastfeeding, presence of garbage in homes, distance between latrines and water sources, dietary diversity, frequency of mother's water consumption, mother's alcohol consumption and quantity of alcohol consumed (Table 4).

Multivariate analysis

The final logistic regression model shows that household size, home visits by community relays, feeding method and consumption of hindmilk were statistically associated with weight gain (Table 5).

Table 1: Distribution of surveyed mothers of low-birth-weight newborns according to mother-related factors, Bohicon heath district, Benin (n=101).

Mother-related factors	Headcounts	Percentage (%)
Parity		
1	54	53.47
2-4	44	43.56
≥5	3	2.97
Inter-gestational interval		
NA	54	53.47
1 to 24 months	37	36.63
≥24 months	10	9.90
Experience of LBW		
Slaughtered	15	14.85
Afraid	78	77.23
Neutral	8	7.92
Previous n-born LBW		
No	96	95.05
Yes	5	4.95
Newborn feeding practices		
Early breastfeeding		
No	30	29,70
Yes	71	70,30
Newborn hindmilk consumption		
No	33	32.67
Yes	68	67.33
Feeding methods		
Sucking by the baby	87	86.14
Milk expressed directly from the breast into baby's mouth	14	13.86
Daily suckling frequency		
≥12	80	79.21
<12	21	20.79
Drinking water intake by newborns		
No	39	38.61
Yes	62	61.39
Herbal tea consumption by newborns		
No	92	91.09
Yes	9	8.91
Mothers' knowledge of newborn feeding		
Importance of colostrum for newborns		
Good knowledge	83	82.18
Don't know	18	17.82
Knowledge of early breastfeeding		
Good	80	79.21
Inadequate	21	20.79
Knowledge of exclusive breastfeeding		
Good	96	94.00
Inadequate	6	6.00
Hygiene		
Hand washing with soap and water		
No	100	100.00
Yes	0	0.00
Garbage in the house		
No	66	65.35
Yes	35	34.65
Dirty water in the house		
No	46	45.54
Yes	55	54.46

Continued.

Mother-related factors	Headcounts	Percentage (%)
Distance between latrines and kitchen		
≥10 meters	87	86.14
<10 meters	14	13.86
Drinking water		
Drilling	46	45.54
Tap water	55	54.46
Distance between latrine and water supply		
Far (≥15 m)	90	89.11
Close (<15 m)	11	10.89
Mother's diet		
Dietary diversity		
Moderately acceptable food consumption	21	20.79
Acceptable food consumption	80	79.21
Frequency of water consumption		
Spontaneous	59	59.00
Feeling of thirst	41	41.00
Water consumption		
1.5 to 3 liters/day	85	84.16
<1.5 liters/day	16	15.84
Alcohol consumption		
No	55	54.46
Yes	46	45.54
Quantity of alcohol consumed		
None	55	54.46
≤330 ml beer/day	37	36.63
≤45 ml sodabi	9	8.91
Beer and sodabi	0	0.00
Coffee consumption		
No	93	92.08
Yes	8	7.92

Table 2: Relationship between socio-demographic and economic factors and weight gain among low-birthweight newborns in Bohicon heath district, Bénin.

Socio-demographic and economic factors	Low weight gain		P value
	OR	(CI 95%)	
Marital status			
Married/ living with child's father	1	-	0.003
Single/ living with parents	6.68	(1.87-23.89)	
Level of education			
Secondary	1	-	
Primary	0.92	(0.30-2.84)	0.893
Not in school	ND	-	
Occupation			
Housekeeper	1	-	
Shopkeeper/saleswoman	ND	-	0.637
Craftswoman	1.33	(0.40-4.43)	
Civil servant	ND	-	
Income-generating activities			
Yes	1	-	0.151
No	4.61	(0.57-37.14)	
Father's profession			
Vehicle driver	1	-	
Retailer	1.43	(0.27-7.56)	0.673
Farmer	2.62	(0.18-36.33)	0.472
Craftsman	3.93	(0.87-17.72)	0.074
None	1.75	(0.25-11.99)	0.569

Continued.

Socio-demographic and economic factors	Low weight gain		P value
	OR	(CI 95%)	
Household size			
≤4	1		0.011
>4	4.47	(1.41-14.14)	

Table 3: Relationship between health system factors and weight gain in low-birthweight newborns in Bohicon heath district, Benin.

Health system factors	Low weight gain		P value
	OR	(CI 95%)	
Bempu Harbor to N-born LBW			
Yes	1	-	
No	4.47	(1.41-14.14)	0.011
Home visits by relays			
Yes	1		
No	5.62	(1.49-21.18)	0.011

Table 4: Relationship between maternal factors and weight gain in low-birthweight newborns in Bohicon heath district, Benin.

Maternal factors	Low weight gain		P value
	OR	(CI 95%)	
Parity			
≥2*	1		0.762
1	0.84	(0.29-2.46)	
Inter-gestational interval			
0-24 months*	1		0.209
>24 months	0.38	(0.89-1.69)	
Mothers experience of LBW			
Afraid*	1	-	0.165
Neutral	3	(0.63-14.13)	
Slaughtered	ND	-	
Newborn feeding practices			
Early breastfeeding			
Yes*	1		0.000
No	11.16	(3.21-38.79)	
Newborn hindmilk consumption			
Yes*	1		0.000
No	9.14	(2.66-31.41)	
Newborn diet			
Feeding method			
Sucking by the baby	1		0.000
Milk expressed directly from breast into baby's mouth	33.75	(8.11-140.40)	
Frequency of suckling			
≥12*	1		0.000
<12	11.21	(3.39-37.00)	
Herbal tea consumption by newborns			
No*	1		0.000
Yes	32.27	(5.80-179.43)	
Mothers' knowledge of newborn feeding			
Importance of colostrum for newborns			
Good knowledge*	1		0.001
Don't know	7.5	(2.30-24.44)	
Early breastfeeding knowledge			
Good*	1		0.081
Inadequate	2.8	(0.88-8.89)	

Continued.

Maternal factors	Low weight gain		P value
	OR	(CI 95%)	
Garbage in the house			
No*	1		0.004
Yes	5.59	(1.75-17.79)	
Distance between latrine and water source			
Far (≥15 m)	1		0.000
Far (≥15 m)	27.33	(6.02-124.04)	
Mother's diet			
Food diversity			
Acceptable	1		0.000
Moderately acceptable	16.5	(4.74-57.36)	
Frequency of water consumption			
Spontaneous*	1		0.063
Feeling of thirst	2.84	(0.94-8.60)	
Alcohol consumption			
No*	1		0.049
Yes	3.14	(1.00-9.84)	
Quantity of alcohol			
None	1		
≤330 ml beer/day	4.23	(1.32-13.47)	0.015
≤ 45 ml sodabi/day	ND	-	

*Reference modality for comparison; ND: number of modalities too small for comparison.

Table 5: Final model of factors associated with weight gain in low-birth-weight newborns in Bohicon HZ, Bénin.

Factors	Low weight gain		
	OR	(CI 95%)	P value
Household size			
≤4	1	-	0.045
>4	5.65	(1.04-30.71)	
Home visits by community relays			
Yes	1		0.016
No	10.93	(1.54-77.14)	
Feeding methods			
Sucking by the baby	1		0.002
Milk expressed directly from the breast into baby's mouth	13.90	(2.57-74.97)	
Newborn hindmilk consumption			
Yes	1		0.009
No	9.01	(1.72-47.08)	

DISCUSSION

A This study examined the factors associated with weight gain in low-weight newborns followed by the model within Bohicon health district. Adequate weight gain was 83.06% and low weight gain was 16.94%. Household size, occurrence of hypothermia, number of "kangaroo mother" care sessions, home visits by community relays, feeding method and consumption of hind milk by newborns were the factors associated with weight gain in the present study.

Weight gain determinants

Household size

Newborns living in households with a size greater than 4 were more likely to have the low weight gain after four weeks of follow-up compared to those living in households with a size less than or equal to 4. A study carried out in Indonesia by Mahmudiono et al found evidence that children living in larger households would be at greater risk of stunting and food insecurity.[7] Another study in Ivory Coast by Kinimo et al reported similar results.[8]

Hypothermia onset and "kangaroo mother" care

Newborns experiencing hypothermia episodes reported by the bracelet were less likely to have low weight gain than others without hypothermia episodes. This could be explained by the fact that hypothermia episodes were not followed up in newborns not wearing the Bempu bracelet. However, each time a hypothermia signal is given, mothers perform KMCs, which implies breastfeeding. The average number of KMCs performed in newborns

with adequate weight gain was statistically higher than in newborns with low weight gain. These findings support the observed relationship between the occurrence of hypothermia and low weight gain. The relationship between the number of KMCs and weight gain is consistent with the results of other studies carried out in Nigeria, Benin, Ethiopia and Nepal, which showed that adequate weight was achieved more quickly in newborns who received KMCs.[9-12]

Home visits by community relays

Newborns not reached by community health promoters' home visits were more likely to have a low weight gain at the end of four weeks' follow-up than those who did. This association supports the strategy of using community relays to bring health promotion issues closer to vulnerable populations.[13] It is attributable to the importance of the parameters (the baby's actual wearing of the bracelet, the mothers' performance of KMC, the types of difficulties encountered by the mothers in performing KMC and using the bracelet, the mothers' actual practice of exclusive breastfeeding, the baby's state of health) monitored by the community relays during their home visits and their psychological support for the mothers. Home visits by community relays would therefore enable mothers to take better care of their children, to practice KMC as much as necessary, and to breastfeed them regularly so that the right weight is reached at the end of the follow-up.

Feeding methods

During follow-up, newborns whose mothers were forced to express milk directly from the breast into the infant's mouth were more likely to have low weight gain after four weeks' follow-up than those who were able to suck breast milk on their own throughout the follow-up period. A study by Emond and al. in the UK also concluded that the sucking ability of newborns was related to their growth.[14] The amount of milk sucked voluntarily by the newborn would be better adapted to his or her needs than the quantity expressed by the mother.

Consumption of hindmilk

Newborns who did not consume hind milk were more likely to have low weight gain after four weeks' follow-up than those who did. As this milk has a higher fat content and average caloric density than the first milk, it would promote faster weight growth in the newborn.[15]

CONCLUSION

More than half of the newborns followed by the "optimized mother-newborn care model" were able to reach the weight threshold of 2,500 grams after four weeks. Low weight gain was associated with socio-demographic, health system and maternal factors. Addressing these factors could improve the effectiveness of the "optimized mother-newborn care model" within the health district.

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