

Comparison of blood glucose levels in breastfed vs. formula-fed low birth weight infants

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Abstract

Background Low birth weight infants are defined as babies with birth weight less than 2500 grams. Low birth weight infants tend to suffer from hypoglycemia compared to full term infants. The incidence of hypoglycemia in newborns varies between 1.3 and 3 per 1000 live births. Blood glucose levels in formula-fed infants are lower than those in breastfed infants.

Objective To compare blood glucose levels in breastfed and formula-fed low birth weight infants.

Methods A cross sectional study was conducted between February 2007 and June 2007 at Pirngadi and H. Adam Malik General Hospital in Medan, North Sumatra, Indonesia. All low birth weight babies were classified into two groups: the breastfed and formula-fed. Each group consisted of 32 infants. Capillary blood was collected using heel pricks at 1, 48, and 72 hours after birth, and plasma glucose was evaluated using the Glucotrend2 blood glucose test.

Results The breastfed low birth weight infants had significantly higher blood glucose levels ($P=0.002$) than formula-fed low birth weight infants. Mode of delivery was related to blood glucose level. Infant delivered by caesarean section had significantly different blood glucose levels at 1 hour ($P=0.005$) and 72 hours after birth ($P=0.027$). The full-term infants had significantly higher blood glucose level ($P=0.007$) than the small for gestational age infants.

Conclusions Generally, low birth weight infants have hypoglycemia after first hour of delivery. Breastfed low birth weight infants have higher blood glucose levels than formula-fed low birth weight infants. [Paediatr Indones. 2009;49:15-9].

Keywords: low birth weight, hypoglycemia, full-term, breastfeeding, formula-feeding

Pretermaturity has historically been defined as an infant born with birth weight ≤ 2500 grams.¹ In 1961, a low birth weight infant was defined by the World Health Organization (WHO) as weight at birth of less than 2500 grams.^{1,2} Low birth weight (LBW) infants remain a significant public issue as this is the leading cause of neonatal death, also a long-term cause of neurodevelopmental disturbances and health problems including low blood glucose.²

Low blood glucose (hypoglycemia) is common in newborn infants.³⁻⁷ Affected infants usually have no symptoms, therefore this condition is easily missed. Prolonged hypoglycemia may result in long-term adverse neurodevelopmental outcomes.³ Preterm babies are more likely to develop hypoglycemia than full-term babies.^{6,7} The incidence of hypoglycemia in neonates varies between 1.3 and 3 per 1000 live births. Hypoglycemia is common to premature babies and small for gestational age (SGA) babies.⁸ Hypoglycemia is not a common condition in normal newborn babies and early breastfeeding will prevent it.¹¹

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Blood glucose level tests should be routinely performed on LBW newborns who fall below the tenth percentile of gestational age, and is suggested for all babies who fall below the fiftieth percentile.⁹ Unfortunately, the exact parameters of normal blood glucose level in the neonates remain controversial.^{4,5,9,10} Although neonates have a lower normal blood glucose range than older infants, blood glucose level that requires intervention in every newborn has not been defined as it appears to be dependent on a number of interacting factors such as birth weight, gestational age, feeding method, and postnatal periods.⁴

In past studies of blood glucose levels in breastfed and formula-fed neonates, there were some conflicting results. Some found lower blood glucose concentrations in formula-fed infants than in breastfed infants, while according to others the reverse was true.⁸ In this study, we wanted to compare blood glucose levels of breastfed and formula-fed LBW infants.

Methods

A cross sectional study was conducted from February 2007 to June 2007 at H. Adam Malik and Pirngadi General Hospital, Medan. All LBW babies were classified into two groups: the breastfed or formula-fed. There were 32 infants in each group. Capillary blood was collected using heel pricks at 1, 48, and 72 hours after birth, and plasma glucose was evaluated using the Glucotrend2 blood glucose test.

All LBW infants without signs of asphyxia who were born to mothers without diabetes mellitus (DM), and whose parents agreed to sign the informed consent were enrolled in this study. Asphyxia in newborn babies was defined as failure of spontaneous regular breathing during the first minute after birth.¹² Hypoglycemia was defined as a blood glucose level of 40-45 mg/dl.¹³

Statistical analysis was performed using SPSS version 12 (SPSS Inc., Chicago). The mean difference between the two groups was analyzed using an independent sample t-test or a Mann-Whitney U Test; proportion between the two groups was analyzed using χ^2 where $P < 0.05$ was determined as statistically significant.

Results

Among 64 LBW infants, there were 35 (55%) girls and 29 (45%) boys, and there were more SGA infants (39 infants, 60.9%) compared to appropriate for gestational age (AGA) infants (25 infants, 39.1%). The age of mother had no significant effect if they were breastfeeding. There were more breastfed infants compared to formula-fed infants although no statistically significant result was found.

There were no significant differences ($P > 0.05$) in the infants' body length and body weight in both groups. There were significant differences ($P < 0.05$) in the blood glucose level at one hour after birth between the gestational age groups (AGA and SGA).

Table 1. Subjects' characteristics

Characteristic	Groups		Total
	Formula Feeding	Breast-feeding	
Gender			
Boy	15 (47%)	14 (44%)	29 (45%)
Girl	17 (53%)	18 (56%)	35 (55%)
Maternal age at - delivery (years)			
≤ 20	1 (3%)	5 (16%)	6 (9%)
21 - 30	17 (53%)	11 (34%)	28 (44%)
31 - 40	14 (44%)	16 (50%)	30 (47%)
Mode of delivery			
Vaginally -			
(Spontaneously + EV)	21 (66%)	23 (72%)	44 (69%)
Cesarean Section	11 (34%)	9 (28%)	20 (31%)
Gestational of age			
Appropriate for - gestational age (AGA)	13 (41%)	12 (38%)	25 (39%)
Small for gestational - age (SGA)	19 (59%)	20 (63%)	39 (61%)
Birth body weight (g)			
1500-2000	15 (47%)	7 (22%)	22 (34%)
2001-2500	17 (53%)	25 (78%)	42 (66%)
Birth body length (cm)			
40-45	21 (66%)	22 (69%)	43 (67%)
46-50	11 (34%)	10 (31%)	21 (33%)

Table 2. Comparison between birth body weight and birth body length between breastfed and formula fed infants.

Variable	Groups	Mean (SD)	P
Birth body weight (g)	Formula feeding	2061.9 (334.22)	0.163
	Breastfeeding	2207.2 (190.89)	
Birth body length (cm)	Formula feeding	44.3 (2.84)	0.452
	Breastfeeding	44.9 (2.35)	

In addition, the blood glucose level of the AGA group was consistently higher than that of SGA group.

Significant differences ($P < 0.05$) were observed in increase of blood glucose level between breastfed and formula-fed groups at 48 and 72 hours after birth (Table 4), in blood glucose levels between infants born by caesarean section and born vaginally at 1 and 72 hours after birth (Table 5), and in blood glucose level in both body weight groups of the LBW infants (Table 6).

Table 3. Correlation between gestational age and blood glucose level

Time (hour)	Blood glucose - Mean (SD) mg/dL		P
	Gestational age		
	SGA (< 37 weeks)	AGA (37- 42 weeks)	
1	26.1 (4.79)	29.0 (3.66)	0.007
48	57.7 (7.38)	59.5 (9.26)	0.177
72	64.1 (7.71)	65.8 (7.98)	0.223

Table 4. Blood glucose levels (BGL) in breastfed and formula-fed infants

Time (hour)	BGL - Mean (SD) mg/dl		P
	Formula Feeding	Breastfeeding	
1	27.8 (4.24)	27.8 (4.57)	0.972
48	55.3 (6.60)	62.3 (8.91)	0.002
72	65.0 (7.50)	68.2 (7.02)	0.002

Table 5. Correlation between mode of delivery and blood glucose levels

Time (hour)	Blood glucose - Mean (SD) mg/dl		P
	Mode of delivery		
	Vaginal (Spontaneous + EV)	Cesarean section	
1	26.6 (3.86)	31.1 (3.75)	0.005
48	54.3 (7.41)	56.6 (4.30)	0.259
72	60.1 (7.24)	65.6 (6.50)	0.027

Table 6. Correlation between birth body weight and blood glucose level

Time (hour)	Blood glucose levels - Mean (SD) mg/dl		P
	mg/dl		
	1500 – 2000 grams	2001 – 2500 grams	
1	25.2 (3.46)	29.2 (4.20)	<0.0001
48	55.6 (4.17)	60.4 (9.75)	0.011
72	61.2 (5.84)	67.2 (8.05)	<0.0001

Discussion

The neonatal period represents a time of transition from the constant supply of glucose provided by maternal circulation during fetal life to the development of independent carbohydrate homeostasis. Problems with hypoglycemia are common during this transition.¹⁴ At birth, the transplacental supply of nutrients, especially glucose, to the newborn is interrupted abruptly. This sets into motion a complex cascade of metabolic and endocrine processes. This cascade is triggered by a surge in the concentrations of glucagons and catecholamine, and cessation of insulin secretion. Glucagons and catecholamine increase glycogenolysis, gluconeogenesis, lipolysis, and ketogenesis.^{7,15}

The complex enzyme machinery responsible for these processes is mature in healthy newborns born at term. The metabolic and endocrine process allowing the transition to the extrauterine environment are not fully developed in preterm infants or those who have suffered IUGR, placing these newborns at significant risk of hypoglycemia.¹⁵ IUGR infants have reduced glucose stores in the form of glycogen and body fat, and are therefore prone to hypoglycemia despite appropriate endocrine adjustments at birth.^{16,17} Bazaes *et al*¹⁸ investigated glucose and lipid metabolism in SGA infants at 48 hours of age and found that these SGA infants had lower glucose levels than full term infants.

Among LBW infants, SGA infants had lower blood glucose than AGA infants (Table 3). By the first hour after birth, glucose levels in AGA infants were significantly higher than the SGA infants. These infants experienced hypoglycemia with mean blood glucose levels of 26.08 mg/dL in SGA group, and 29.03 mg/dL in AGA group. After 48 and 72 hours, AGA infants had higher blood glucose levels than SGA infants but the difference was not significant. This research had similar conclusions to the study of Bazaes *et al*.¹⁸

Many studies on breastfed AGA infants show that plasma glucose level will decrease soon after birth and then will increase until 72 hours after birth. It is very important that 12-14% of preterm infant who was breastfed had glucose level < 2.6 mmol/L in three days after birth.¹⁹

At the first hour of birth (Table 4), LBW infants had lower blood glucose levels compared to 48 and 72 hours after birth. Blood glucose level will increase

as soon as the feeding is started. LBW infants who were breastfed had significantly higher blood glucose level ($P=0.002$); 62.25 mg/dL and 68.22 mg/dL, than LBW infants who had formula feeding (55.25 mg/dL) and (65 mg/dL) at 48 and 72 hours after birth. This study was in agreement with the study by Heck and Erenberg which found that lower blood glucose levels in formula-fed newborns compared to breastfed newborns.^{20,21} The results of this study were in contrast to the study of Hawdon *et al*⁸ which observed that breastfed babies had lower blood glucose levels until one week after birth.

Much research on premature and SGA babies has shown correlations between hypoglycemia of less than 2.6 mmol/L and long and short-term neurodevelopment disturbances.¹⁹ In this study we found a correlation between blood glucose level and gestational of age.

The mode of delivery also affected blood glucose levels. The difference in blood glucose level was significantly different at one hour ($P=0.005$) and 72 hours after birth ($P=0.027$) when the mode of delivery was by caesarean section (Table 5). Mode of delivery is also a stress factor that has been shown to cause the hypoglycemia, six hours after birth.²² In our study, the blood glucose level of infants born by vaginal birth at one hour after birth was 26.55 mg/dL, while for infants delivered by caesarean sections was 31 mg/dL. From all LBW infants who were breastfed, 71.88% were delivered vaginally and 28.12% were delivered by caesarean section caused by the medicine or anesthetic drug which was given to the mother when she was on delivery. Several studies also found that caesarean section delivery can inhibit the production of breast milk.²³ After 48 hours, the effect of anesthetic drug was considerably decreased and allowing the production of breast milk at normal levels, allowing the infant to gain adequate nutrition, and increase their blood glucose level. LBW infants born by caesarean section constantly had higher blood glucose levels than infants born vaginally. This study showed statistically significant different of blood glucose levels depending on the mode of delivery after 1 and 72 hours. This could be caused by anesthetic drugs that were used in the delivery procedure and affected the babies' blood glucose level. Further study of the effect of mode of delivery on the infants' blood glucose level is required.

Hypoglycemia was found in LBW infants at 1 hour after birth, with mean blood glucose levels of 25.2 mg/dL for the group of 1500-2000 g birth weight and 29.2 mg/dL for the group of 2001-2500 g birth weight. There was also an increase in blood glucose level at 48 and 72 hours after birth in both groups. This study concluded that birth weight has a statistically significant effect on the blood glucose level of LBW infants. A study by Wight²⁴ indicated that early breastfeeding can increase the blood glucose level in newborn babies. Wight and Marinelli⁷ reported that LBW infants tended to experiencing hypoglycemia. Hypoglycemia in LBW infants and preterm babies was caused by decreased glycogen reserves in the liver and body fat, glycogenolysis disturbances, and abnormality of insulin responses.^{21,25} In the birth weight group of 1500-2000 grams, blood glucose levels were lower compared to the birth weight group of 2001-2500 grams. In this group, we found higher blood glucose level in the formula fed babies. It is because the LBW infants could not catch up so the formula feeding should be given to fulfill his nutrition requirements.²³

To conclude, in general low birth weight infants have hypoglycemia after first hour of delivery. Breastfed low birth weight infants have higher blood glucose levels than formula-fed low birth weight infants. Further study is needed to establish other factors related to blood glucose level in newborn infant. Many factors in LBW infants can cause hypoglycemia, e.g. hypothermia, breastfed or formula-fed, type of maternal drugs received during the delivery, and the duration of delivery time.

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