PREVALENCE OF HYPOGLYCEMIA IN NEWBORN AT KENYATTA NATIONAL HOSPITAL AND THE RESPONSE TO GLUCOSE SUPPLEMENTATION IN LOW BIRTH WEIGHT

BY

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A thesis submitted in partial fulfillment of the requirement for the award of the degree of Masters of Science in Medical Biochemistry in the school of Pure and Applied Sciences of Kenyatta University.

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DECLARATION

I, Mary Mmbone Masakha, duly declare that this thesis is my original work and has not been presented for a degree in any other university or for any other award.

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DEDICATION

To my family and Christian friends who prayed and encouraged me.
Thank you and May God bless you all.
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LIST OF ABBREVIATIONS

LBW – Low birth weight
KNH – Kenyatta National Hospital
WHO – World Health Organization
NBU – New Born Unit
BMI – Body Mass Index
HIV – Human Immunodeficiency Virus
SGA – Small for gestational age
AGA – Appropriate weight for gestational age
G 6 P- Glucose – 6 Phosphate
PEPCK – Phosphoenol Pyruvate Carboxylase Kinase
ACTH – Adrenocorticotropic hormone
ATP – Adenine triphosphate
NAD – Nicotamine adenine dinucleotide
NADH – Nicotinamide adenine dinucleotide hydrogen
NADPH – Nicotinamide adenine dinucleotide phosphate hydrogen
I.V. - Intravenous
M mol/L - Millimole per litre
KJ – Kilo joules
KCAL – Kilo calorie
Kg - Kilo gram
g - Gram
M – Metre
ABSTRACT

Hypoglycaemia in neonates is defined as blood glucose concentration below 1.1mmol/l for term neonates. A common abnormality in neonates, it is associated, with neurological damage and death when it occurs in the first few days of life. This is more pronounced in rural set-ups without the knowledge, detection and management facilities. When promptly diagnosed and managed, its effects can be prevented or minimized. Studies at Kenyatta National Hospital (KNH) show that 59.8% of all neonates born at the facility have low birth weight (LBW ≤2500 gms) and end up in newborn unit. It has also been noted that the LBW neonates mostly suffer hypoglycaemia and hence need for this study. Four populations of neonates and one population of mothers of the neonates were used in the study. The neonates’ blood glucose was determined using the precision QID sensor. The neonates were weighed in grams (gms) using a top loading balance. The mother’s height, weight and HIV status were determined during the last trimester of pregnancy. The neonates’ populations excluded neonates with congenital or physical abnormalities and those from diabetic mothers. The first population of neonates (for blood glucose reference range) had 117 neonates after removal of the outliers and were physically healthy weighing > 2500 gms. The second (Population A) had 348 neonates of all neonates born during the study. Their blood glucose and weight were taken at birth. The third, LBW neonates (Population B) had 336 neonates whose weight and blood glucose were taken at birth. The fourth of 54 neonates (Population C) consisted of LBW with blood glucose <1.7mmol. This group was supplemented with 10% dextrose and feeds per kilogram body weight (i.e. 120 -125 Kcal/Kg/day of the oral feed) and followed for five days. The blood glucose was taken in the morning and afternoon each day and their weight taken on alternate days. The fifth population was the neonates’ mothers (Population D). Their nutritional status was taken from the Basal Metabolic Index (BMI) and a questionnaire on their feeding habits and income. The normal blood glucose reference range of neonates in this study at birth was 1.7 to 4.0mmol/l. On the nutritional status of the mothers, 15.8% were obese, 33.3% were over-weight, 30.7% had normal good nutrition, 10.3% had chronic malnutrition, 3.4% had severe malnutrition and 6.3% were malnourished. From the study, 43.6% of the neonates had low birth weight. The prevalence of hypoglycaemia in the neonates at KNH during the study period was 19.5%, while the prevalence of hypoglycaemia in the LBW neonates was 30.4%. The prevalence of HIV in the neonates’ mothers during the study period at the same facility was 7.8%, while the prevalence of HIV in the LBW neonates’ mothers during the same period was 8.9%. Hypoglycaemia was highest in neonates of teenage mothers, 15-19 years, while no hypoglycaemia was noted in neonates of mothers 40-44 years of age ( P=0.398). In the LBW neonates hypoglycaemia was high in neonates of mothers 15-19 years and 35-39 years (P=0.188). The lower the birth weight of the neonate, the more the neonate was prone to hypoglycaemia (P=0.004). Hypoglycaemia was higher in the neonates of the most malnourished and HIV positive mothers (P=0.017, P=0.004). In the LBW neonates there was a higher tendency to hypoglycaemia regardless of mothers’nutritional status (P=0.659). Most LBW neonates came from malnourished mothers (P=0.010). In the follow-up group (Population C) the mean blood glucose levels per day increased from 1.3mmol/l on day one to 6.1mmol/l on day five. In conclusion, there is a high prevalence of hypoglycaemia at 19.5% in neonates and 30.4% in LBW neonates. Poor nutrition in mothers leads to a higher percentage of both LBW neonates and also hypoglycaemia. The study recommends correction of nutritional status of mothers to forestall LBW and hypoglycaemia in neonates. Mandatory screening of blood sugar in neonates is also recommended.
CHAPTER ONE
INTRODUCTION AND LITERATURE REVIEW

1.1 Background

Hypoglycaemia is the most common metabolic abnormality in neonates and is associated, with neurological damage and death especially when it occurs during the first few days of life. This is more pronounced in rural set ups that do not have the knowledge and facilities for the detection and management of the condition. However, when promptly diagnosed and supplemented these conditions can be prevented or minimized. Studies have shown that hypoglycaemia is common in pre-term neonates (about 60%). Studies done at Kenyatta National Hospital (KNH) show that about 59.8% of all babies born at the facility have low birth weight (LBW) and end up in New Born Unit (NBU). It has also been noted that the LBW neonates are affected more by hypoglycaemia and hence their choice for this study. Studies have shown that severe hypoglycaemia (Plasma glucose <1.6 mmol/L) occurs in 28% of LBW neonates. Mortality rates of upto 51.3% have been reported in LBW neonates less than 1500g; and hypoglycaemia has been reported to account for up to 32% in the neonates with glucose 0.9 mmol/L, and 15% for those with glucose 1.0 – 1.9 mmol/L.

Peripheral blood glucose forms the main substrate for brain metabolism and is essential for normal neurological function. At birth glucose levels fall in neonates who are not fed immediately after birth, but neonates of appropriate birth weight will mobilize alternative metabolic substrates (free fatty acids and ketone bodies) in response. This is not seen in neonates with LBW, due to the reduced energy reserve at birth (both liver glycogen and fat and less developed glycogenic pathway (Cowett and Schwartz, 1979). These defects lead to persistent or prolonged hypoglycaemia if not corrected through feeding or glucose
supplementation (Miller and Ross, 1940). Studies have shown that hypoglycaemia occurring in
the first few days of life causes neurodevelopmental impairment (Lucas et al., 1987). Other
incidences of hypoglycaemia other than LBW (preterm neonates and small for gestational age
(SGA) neonates) occur in: 1. perinatal asphyxia in which possible underlying mechanisms
include high fuel requirement of anaerobic metabolism, the utilization of stores during the
asphyxial episode, and a delay in the normal pattern of metabolic adaptation, so that hepatic fuel
production is impaired; 2. neonatal hyperinsulinism which occurs in infants of diabetic mothers,
but hypoglycaemia is rarely of concern except in the infants of the poorly controlled diabetic
mothers (Landon et al., 1987). Other conditions resulting in hyperinsulinism are; the islet cell
dysregulation syndrome (nesidioblastosis), Beckwith Weidemann syndrome, and insulin
secreting adenoma (Anysley and Soltesza, 1987); 3. inborn error of metabolism and congenital
defects. These include glycogen storage diseases, congenital hypopituitarism, defects of amino
cids metabolism (e.g methyl mesnylmalonic aciduria), defects of gluconeogenesis (e.g fructose
1-6-diphosphate deficiency) and defects of β-oxidation of fatty acids (Saudubray et al., 1986).
These other causes of hypoglycaemia should be investigated if hypoglycaemia persists after the
first three days of birth. Complications resulting from hypoglycaemia can be prevented by
prompt detection and treatment when it occurs.

In addition to its high prevalence in the neonatal period, hypoglycaemia is of particular
importance to the paediatrician since it is, when prolonged or recurrent, a preventable cause of
mental retardation and permanent neurological damage (Anysley, 1991). Hypoglycaemia in
neonates is described usually as blood glucose concentration below 1.1 mmol/L for term babies
(WHO, 1997). Other investigators have reported levels below 1.7 mmol/L (Cornblath and
Schwartz, 1976., Kohl et al., 1988) for term babies and an average of below 2.2 mmol/L (Anysley, 1991).

The low-birth weight (LBW) at Kenyatta National Hospital (KNH) are below 2.5 kg (2500 g), and are further grouped based on their weight at birth thus: 1.5 kg – 2.5 – low birth weight, 1.0 kg – 1.49 kg – very low birth weight and less than1.0 kg – extremely low birth weight. This study focused on all the above groups for the follow-up of glucose response and management. Studies on the prevalence of hypoglycaemia in low birth weight have not been done in less developed countries (WHO, 1997).

1.2 Literature review
Hypoglycaemia was first described in children a century ago and in newborns and older infants about fifty years ago (Hartmann and Jandon, 1937). The vulnerability of premature infants and those of diabetic mothers to hypoglycaemia was recognized early in the history of neonatal medicine (Miller and Ross, 1940; Norval, 1950; Quarrie, 1954; Farguhar, 1954; Ginsburg et al., 1985). The Nature of hypoglycemia and apparent infrequency of clinical manifestations led many to assume that low blood glucose concentrations among these groups were innocuous and physiological, in contrast to hypoglycaemia caused by metabolic and endocrine disease. However, Cornblath et al. (1959) described eight day old infants born to mothers with pre-eclamptic toxaemia in whom symptoms (apnoea, cyanosis, coma and convulsions) were associated with reduced blood glucose concentrations (0.056 – 1.33 Mmol/L) (Conblath et al., 1990). Concern arose that hypoglycaemia without clinical associated signs (asymptomatic hypoglycaemia) might also lead to neurological sequelae.
This led to an attempt to define hypoglycaemia statistically as blood glucose concentration more than two standard deviations below the mean for populations of well full-term and low-birth weight infants (LBW). This and the introduction in the early 1970’s of reagent strip glucose assays (e.g Dextrostix) for cotside screening of new born at risk, led to clinical classifications of neonatal hypoglycemia (Griffiths and Bryant, 1971; Fluge, 1974). Gutberlet and Cornblath (1975) estimated the prevalence of hypoglycaemia (defined as glucose <1.7 Mmol/L) as 4.4 per 1000 total newborn live births and 15.5 per 1000 low birth weight infants (Lubchenco and Bard, 1971). Lubchenco and Bard (1971) arrived at much higher estimates: 11.4% of all nursery admissions and 20.3% of those premature or low birth weights who had blood sugar less than 1.7 Mmol/L, if screened before feeding at 6 hours of age.

Anderson et al. (1993) observed that 38% of uncomplicated term infants born in Kathmandu, Nepal showed a blood glucose concentration of less than 2.6 Mmol/L during the first 50 hours of life. An approach aimed first at the prevention of hypoglycemia, second at its’ reliable detection in newborns at risk and third at appropriate treatment which will not be deleterious to breastfeeding is thus of global importance.

Long-term neurological sequelae were identified in up to 35% of those with symptomatic hypoglycaemia and 20% of those with asymptomatic hypoglycaemia (Harworth and McRae, 1965; Harwoth and Vindyasagar, 1971), although others could find no relationship (Griffiths and Bryant, 1971). Controversy persists about the significance of asymptomatic hypoglycaemia in healthy term infants capable of mounting a counter regulatory response to neurodevelopment sequelae if symptomatic.
A corollary is that preterm infants and infants that are small for gestational age (SGA) may be at a greater risk of sequelae (Lucas et al., 1988) because of metabolic immaturity. Second it seems likely that infants who develop symptomatic hypoglycaemia were hypoglycaemic but asymptomatic at an earlier stage of their clinical course.

1.2.1 Gluconeogenesis

Gluconeogenesis is the process by which glucose is synthesized from lactate or pyruvate essentially by the reversal of the glycolytic pathway. Certain regulatory steps are subject to substrate and/or endocrine activation and inhibition. They are: Pyruvate dehydrogenase, Pyruvate carboxylase, phosphoenol pyruvate carboxykinase (PEPCK), pyruvate kinase and fructose – 1, 6 – biophosphatase. The overall effect of insulin is to inhibit gluconeogenesis, whilst glucagon directly activates it. Apart from insulin/glucagon ratio, intracellular accumulation of precursors such as pyruvate, acetyl coA concentration and NADH/NAD⁺ ratio are regulatory influences. Adrenaline indirectly stimulates gluconeogenesis by stimulating peripheral mobilization of non esterified fatty acids from adipose tissues and their subsequent oxidation in the liver. Thus provision of fat both reduces glucose uptake into cells and favours gluconeogenesis in the liver.

Moment to moment endocrine control of blood glucose concentration is achieved through the opposing actions of insulin and glucagon. Adrenaline boosts the counter reglulatory response during stress. Other hormones act permissively, cortisol has little, and short term, effect on blood glucose concentrations but the effect of glucagons is reduced in cortisol deficiency. Substrate concentrations directly affect the rate at which gluconeogenesis proceeds. Administration of glucose suppresses gluconeogenesis where as it is activated by lactate,
pyruvate and glucogenic amino acids, increased oxidation of non-esterified fatty acids facilitates gluconeogenesis indirectly in the liver by increasing acetyl coA and NADH concentrations. It also reduces peripheral glucose requirements. The reasons for the preterm infants’ propensity to hypoglycaemia are: energy reserves at birth, both as liver glycogen and fat, are greatly reduced. Differences in fat content are particularly important, fat accounts for only 2% of body weight at 28 weeks of gestation but about 16% at term. Although fat is not itself convertible to glucose, mobilization and oxidation of fat reduces glucose uptake and oxidation. Recent evidence indicates that preterm infants show plasma insulin concentrations greater than those of term infants when related to plasma glucose concentration. It appears that the elevated insulin: glucose ratio and relative immaturity of ketogenesis persists for some months after birth (Deshpande et al., 1994). The greater protein intake of preterm infants appears necessary to match their faster growth potential, and is an insulinogenic stimulus. It has been known for some years that insulin secretion in term infants (as reflected by C-peptide excretion) is modified by dietary protein intake and related to plasma valine: glycine ratio (Ginsburg et al., 1985); it’s likely the gluconeogenic pathways are less mature than in term infants. For example, the expression of microsomal G-6-P was reduced in liver necropsy samples obtained from preterm neonates of 24 to 36 weeks of gestation at birth in infants up to one year of age. This enzyme catalyses the final step of both glycogenolysis and gluconeogenesis (Hume and Burchell 1993). Small for gestational age (SGA) infants have increased risk to hypoglycemia (Cornblath et al., 1959). A factor which may account for these includes a high brain: body mass ratio, reduced fat stores, failure of counter regulation and hyperinsulinism. Kalhan et al. (1986) noted SGA infants in the basal (fasting) state on the first day of life to have significantly higher
rates of endogenous glucose production than appropriate weight for gestation age (AGA) infants. This reflected the greater brain weight of SGA infants relative to AGA infants.

Several studies have shown that SGA infants, when compared to AGA infants, have increased plasma concentrations of glucogenic substrate(s) (Lindblad et al., 1970; Haymond et al., 1974; Mestyan et al., 1975). In a longitudinal study of 33 SGA infants throughout the 1st postnatal week, it was found that increased blood levels of lactate and other total gluconeogenic substrates persisted until the 4th postnatal day in preterm SGA infants, but fell within the 1st 24 hrs in term of SGA infants, thereafter being lower than those of AGA infants. This is consistent with the hypothesis that elevated concentrations of gluconeogenic substrates reflect delayed maturation of gluconeogenic pathways in SGA infants, particularly those born preterm (Hawdon and Ward, 1993).

At birth ketone body concentrations of SGA & AGA infants do not appear to differ, though they differ by 24 hours of age (Haymond et al., 1974) and throughout the postnatal 1st week (Hartmann and Jandon, 1937). Ketone body levels both term and preterm SGA infants remain low relative to those seen in AGA infants. This shows an inability of the SGA to mount a ketogenic response, or just more aggressive attention to nutritional management and prevention of hypoglycaemia among the infants studied. Some infants also show low plasma glucagon concentrations, raising the possibility that failure of the glucagon surge after birth plays a great part in aetiology of hypoglycaemia in SGA infants as does hyperinsulinism (Mehta, 1954).
SGA infants have both high plasma insulin concentrations and glucose requirements, consistent with hyperinsulinism (Le dune, 1972; Collins et al., 1990). Hypoglycaemia may be present in several stress neonatal conditions, such as sepsis, perinatal asphyxia, congenital heart disease and neonatal cold injury with fat necrosis. Hypoglycaemia associated with transient hyperinsulinism is seen most commonly among infants born to diabetic mothers.

Hypoglycaemia which persist or recurs after the first few days of life should raise diagnostic possibility of an endocrine disorder or inborn error of metabolism. These include hypopituitarism, Growth hormone deficiency, glucagon deficiency or ACTH unresponsiveness, hyperinsulinism (Beckwith-Weidman syndrome, β-cell dysregulation syndrome), glycogen storage disease type 1, fructose intolerance, galactosaemia, glycogen synthase deficiency, Fructose – 1, 6 –diphosphate deficiency, maple syrup urine disease, propionic acidaemia, tyrosinaemia, 3-hydroxy-3-methylglutaryl coA lyase deficiency, medium chain acetyl coA dehydrogenase deficiency and long chain acyl coA dehydrogenase deficiency. Lucas et al. (1988) showed a prevalence of 28% hypoglycaemia (< 1.6 mmol/L) in infants whose birth weight was under 1850 g.

1.2.2 Importance of glucose in the body

Glucose, amino acids and lactate are the principle energy substrates during fetal life, glucose alone providing about half the total energy requirement. Glucose is the main product of dietary carbohydrate metabolism and excess glucose is stored as glycogen in liver and muscles, or converted to fat and stored in adipose tissues, processes stimulated by insulin hormone.
During fasting, glycogen is broken down in the liver and to a lesser extent, the kidney releases glucose into plasma. Triglyceride breakdown in adipose tissue releases glycerol, which can be converted to glucose, and fatty acids which can be metabolized by most tissues other than the brain. The liver converts excess fatty acids to ketone which can be used as an energy source by the brain and other tissues.

Brain cells are very dependent on the extracellular glucose concentration for their energy supply; and hypoglycaemia is likely to impair cerebral function. This is because they cannot store glucose in significant amounts; synthesize glucose; metabolize substrates other than glucose and ketones; and plasma ketone concentrations are usually very low and are of little importance as an energy source under such physiological conditions. Brain cells cannot extract enough glucose from extracellular fluid at low concentrations of glucose for their metabolic needs. This is because entry of glucose into brain cells is not facilitated by insulin. Normal glucose levels are necessary for proper cerebral function.

When one mole of glucose is combusted in a colorimeter to carbon dioxide and water, approximately 2870 KJ are liberated as heat. When oxidation of glucose occurs in the tissues some of this energy is not lost immediately as heat but is “captured” in high-energy phosphate bonds. In total thirty eight high energy phosphate bonds are generated per molecule of glucose oxidized to carbon dioxide and water. Assuming each high-energy phosphate (ATP) is equivalent to 36.8 KJ, the total energy captured in ATP per mole of glucose oxidized is 1398 KJ. A continual supply of glucose is necessary as a source of energy, especially for the nervous system and erythrocytes.
Glucose is also required in adipose tissue as a source of glyceride-glycerol, and it probably plays a role in maintaining the level of intermediates of the citric acid cycle in many tissues. It’s clear that even under conditions where fat may be supplying most of the caloric requirement of the organism; there is always a certain basal requirement for glucose. In addition glucose is the only fuel that will supply energy to skeletal muscle under anaerobic conditions. It is the precursor of milk sugar (Lactose) in the mammary gland and it is taken up actively by the fetus. It is not surprising therefore, to find that enzymatic pathways have been developed in certain specialized tissues for the conversion of non-carbohydrates to glucose i.e glucogenesis. In addition, these gluconeogenic mechanisms are used to clear the products of metabolism of other tissues from the blood, e.g, lactate, produced by muscle and erythrocytes, and glycerol, which is continuously produced by adipose tissues.

1.2.3 Metabolism of glucose by neonates

At birth the newborn must switch abruptly from a state of net glucose uptake and glycogen synthesis to one independent glucose production. The maintenance of normoglycaemia depends upon adequacy of glycogen stores, maturation of glycogenolytic and gluconeogenic pathways, and an integrated endocrine response. The endocrine events believed to trigger the release of glucose and the mobilization of fat from peripheral stores are an increase in adrenaline secretion and a rapid fall in the insulin: glucagon ratio during the first few hours of life, attributed to both a fall in the plasma insulin concentration and a surge in glucose concentration (Yeung, 2003). Hawdon and Ward (1993) were able to confirm the fall of insulin concentration in a cross sectional study of healthy term and preterm neonates of appropriate weight for gestation. Moment-to-moment endocrine control of blood glucose concentration is achieved through the
opposing actions of insulin and glucagon. Adrenaline “boosts” the counter-regulatory response during stress. Other hormones (cortisol, growth hormone) act permissively; cortisol has little, short term, direct effect on blood glucose concentration, but the effect of glucagon is reduced in cortisol deficiency. Substrate concentrations directly affect the rate at which gluconeogenesis proceeds. Administration of glucose suppresses gluconeogenesis whereas it is activated by lactate, pyruvate and glucogenic aminoacids. Increased oxidation of non-esterified fats facilitates gluconeogenesis indirectly in the liver by increasing acetyl CoA and NADH concentrations. It also reduces peripheral glucose requirements. Blood glucose levels for preterm and small for gestational age (SGA) infants tend to be lower, and the reasons for their propensity to hypoglycemia are that energy reserves at birth both as liver glycogen and fat, are greatly reduced. It is possible that the greater protein intake of preterm infants, necessary to match their faster growth potential, is an insulinomic stimulus.

Other reasons for SGA infants having an increasing risk to hypoglycaemia include a high brain; body mass ratio (with corresponding increase in glucose consumption), failure of counter-regulation and hyperinsulinism. Within the cell, glucose is rapidly converted to glucose –6-phosphate (G6P), a major intermediate in glucose metabolism. The enzyme catalyzing the phosphorylation of glucose by ATP is hexokinase (or glucokinase in the liver and the beta cells of the pancreas). Glucokinase may play a key role in the regulation of glucose homeostasis by maintaining a gradient for glucose transport in hepatocytes. Glucose –6- phosphate serves as a starting point for five metabolic pathways. The G6P is converted by glycolysis to pyruvate, a substance that further metabolized by tricarboxylic acid pathway to carbodioxide and water. It is also oxidized by hexose monophosphate shunt to ribose and carbondioxide, converted by uronic
acid pathway to glucuronic acid, and incorporated into glycogen by glycogenesis. Further G6P is metabolized by the glycolytic pathway, producing pyruvic acid and two moles of ATP per glucose molecule. Pyruvic acid is further metabolized in the tricarboxylic acid cycle and oxidative phosphorylation to produce 36 moles of ATP.

1.2.4 Disorders of glucose metabolism in the newborn babies

Disorders of glucose metabolism can be classified as hyper and hypoglycaemia. Hypoglycaemia may be caused by: endocrine deficiency, which may include hypopituitarism, growth hormone deficiency, glucagon deficiency and cortisol deficiency/ACTH unresponsiveness. These hormones are counter regulatory to insulin; Hyperinsulinism as seen in: Beck with-Weidman syndrome and β-cell dysregulation syndrome. Insulin being a hypoglycaemic agent will cause low blood glucose; disorders of carbohydrate metabolism, largely due to deficiency of gluconeogenic enzymes such as glycogen storage disease type I, fructose intolerance, galactosaemia, glycogen synthase deficiency, fructose-1, 6 – phosphate dehydrogenase deficiency; disorders of aminoacid metabolism: maple syrup urine disease, propionic acidaemia, methylmalonic acidaemia, tyrosinaemia and 3 – hydroxy 3-methyl glutaryl co-A lyase deficiency; disorders of fatty acid metabolism e.g in medium chain acyl co-A dehydrogenase deficiency and Long chain acyl-co-A dehydrogenase deficiency. Hyperglycaemia is caused by diabetic type 1 syndrome, a deficiency of insulin from the B-cells of islets of Langerhan of pancreas.

1.2.5 Hypoglycaemia and low birth weight (LBW) neonates

The LBW included because both the preterm infants and the SGA infants. This group is prone to hypoglycaemia due to: energy reserves at birth (both liver glycogen and fat) are greatly
reduced. Differences in fat content are particularly important; fat accounts for only 2% of body weight at 28 weeks of gestation but about 16% at term. Although fat is not itself convertible to glucose, mobilization and oxidation of fat reduces glucose uptake and oxidation; recent evidence indicates that preterm infants show plasma (insulin) greater than those of term infants when related to plasma (glucose).

1.2.6 Pathology of hypoglycemia

Evidence from animal studies and post mortem studies of human infants indicate that severe and prolonged hypoglycaemia can be co-related with particular neuroanatomical patterns of brain damage. In recent years much has also been learnt about the excitotoxic mechanisms which lead to injury in hypoglycaemia. Pathology of brain damage associated with hypoglycaemia include, cerebral cortex, hippocampus and caudate nucleus. These are the regions principally affected by experimentally induced hypoglycaemia and also dentate gyrus damage. In both cases the damage may lead to neuronal death. The LBW infants are at a greater risk, because of their inability to mount a ketogenic response in cases of hypoglycemia at birth owing to the fact that: Their glycogen stores are reduced, their gluconeogenic pathways are immature, their high brain: body mass ratio (with corresponding increase in glucose consumption) and their (esp. SGA) being prone to hyperinsulinism (Norbert and Nancy, 1986). Their low fat content compared to the term and AGA infants although fat itself is not convertible to glucose. Mobilization and oxidation of fat reduces glucose uptake and oxidation.

1.2.7 Nutritional status of the mothers

Nutritional status is generally determined by the following methods; anthropometric, clinical, biochemical or dietary. Women of child bearing age (15-44 years old), those from poor
families, those with more children, less education and with limited access to information are at highest risk of malnutrition. The malnutrition in this group is as a result of various factors among them, living in areas with seasonal food shortages and disease, working for long hours, their increased nutritional needs due to; menstration, pregnancy and lactation.

This more often results in nutritional anaemia in this group due to dietary deficiencies of iron or B vitamins, increased iron requirements due to pregnancy and lactation and iron losses due to bleeding (menstruation) or parasites- worms, malaria and schistosomiasis and low food intake. Studies have shown that a mothers’ nutritional status affects her infants’ birth weight, it’s survival in the first month of life and possibly, the quality of her breast milk.

Low birth weight infants, who have a higher frequency of death, are twenty times more frequent in developing countries (Hamilton et al., 1981). Maternal underweight is a key risk factor in LBW. This in turn is a risk factor for child stunting and underweight as well as for some types of chronic disease during adulthood (Barker, 1993). Low birthweight (defined as birthweight below 2500 grams) specifically due to intrauterine growth retardation (IUGR) is the perinatal condition most strongly linked to undernutrition (Fishman et al., 2003). The latest estimates from UNICEF indicate that 30% of all babies born at term in South Asia have low birthweights, with 14% in Sub-Saharan Africa, 15% in the Middle East and North Africa, 10% in Latin America and the Caribbean, and 8% in East Asia and the Pacific. Occurrence of LBW may be due to IUGR, Preterm birth, or both (Kramer, 1987). Fishman et al. (2003) recently showed that the attributable fraction of neonatal death due to IUGR-LBW was considerable in some parts of
the world, and highest (53.2 %) in South Asian countries. In the UNICEF fifth report on the 
world nutritional status of 1998-2002 the LBW in Kenya was 11%.
1.2.8 Laboratory methods used to diagnose hypoglycaemia

Previously blood glucose was determined using non-enzymatic methods such as the copper reduction method. The currently used methods include glucose oxidase method, in which glucose is oxidised in the presence of glucose oxidase enzyme to yield glucuronic acid and hydrogen peroxide. The concentration of hydrogen peroxide liberated is measured using a peroxidase step coupled to a coloured oxygen acceptor or an electrode (Bergmeyer, 1974). These reactions form the basis of both reagent strips and bench top glucose electrode methods. Hexokinase method is also used in which hexokinase enzyme catalyses the phosphorylation of glucose by ATP to Glucose – 6 – phosphate (G-6-P). The G-6-P is then reduced by glucose-6-phosphate dehydrogenase enzyme; yielding NADPH/H⁺ which can be measured using a suitable spectrophotometric indicator system (Bergmeyer, 1984).

This is commonly used with most chemistry auto-analyzers; and the glucose electrode methods. These encompass both glucose oxidase and potentiometric determination of blood glucose. This glucose electrode method is suitable for both cotside and benchtop glucose determinations. This is because it is more accurate than the reagent strips. It also uses a drop of blood and gives results immediately. Plasma glucose is usually higher than in whole blood (by about 18%) and is usually used for blood glucose determination due to variation in the haematocrit. In neonatal samples the haematocrit may vary from below 40% to below 70% (Anysley, 1991). Thus reagent strip tests are unsuitable for diagnosing neonatal hypoglycaemia. Less frequent but more accurate laboratory or ward based glucose electrode measurements among babies at risk are preferable (WHO, 1997).
A study done by Yeung et al. (2003) on evaluation of “Point of care” devices in the measurement of low blood glucose involving five glucometers showed that Glucotrend and Precision Glucometers had the greatest sensitivity and Negative predictive value when diagnosing hypoglycaemia in neonates.

1.2.9 HIV/AIDS in Pregnant women in Kenya

Kenya faces a severe, generalized HIV/AIDS epidemic that continues to have a devastating impact on all sectors of society. National estimates indicate that the adult HIV prevalence rate in 2005 was 6.7%. In 1999, Kenya declared HIV/AIDS a national disaster and public health emergency. An estimated 1.2 million people are living with HIV/AIDS in Kenya. An estimated 1.5 million people have died from AIDS since 1984. More than 1.6 million children younger than 15 years (3.7% of the total population) have been orphaned through the death of their mother. At least 180,000 people die from AIDS annually. The prevalence is still high but appears to be decreasing. The Ministry of Health reported an adult prevalence of 13.5% in 2001, and surveillance figures suggested that the prevalence had declined to 10.2% in 2002.

Vulnerable groups include AIDS orphans, pregnant women and rural populations living in areas with a high burden of disease. Girls and young women are particularly vulnerable to infection. Women 15-24 years of age are more than twice as likely to be infected as men this age. The prevalence of HIV is higher in urban areas: about 10% among pregnant women. (Ministry of Health Kenya in collaboration with WHO, 2005).
1.2.10 Problem statement
The normal reference range for blood glucose for the neonates in Kenya is not determined and categorizations as normal or hypoglycaemia state is based on values from the American and/ or European populations. Whereas low birth weight (LBW) babies who are almost always hypoglycaemic is a common encounter at Kenyatta National Hospital and are always supplemented with glucose, the outcome of such supplementation has never been closely monitored. The relationship between maternal factors, LBW and hypoglycaemia in babies has also never been determined in Kenya. This study therefore endeavored to establish the reference values for blood glucose at Kenya’s referral, Kenyatta National Hospital (KNH), monitor the outcome of glucose supplementation of LBW and establish relationship if any between maternal factors and LBW and hypoglycaemia in new born babies at KNH.

1.2.11 Hypotheses
1. Hypoglycaemia is common in the low birth weight babies.
2. There is a relationship between maternal factors and LBW and hypoglycemia in new borns

1.2.12 Objectives of the study
1.2.12.1 General objective
The objective of this study was to establish the prevalence of hypoglycaemia in low birth weight (LBW) babies at KNH, relate the neonates’ blood glucose levels and weight to their mother’s nutritional status and determine the response to glucose supplementation in the LBW for the maintenance of normoglycaemia during the first five days of life.
1.2.12.2 Specific objectives

- To establish the normal ranges for blood glucose levels in normal neonates at KNH.
- To determine the prevalence of hypoglycaemia in neonates at KNH.
- To determine the prevalence of hypoglycaemia in low birth weight neonates.
- To determine the blood glucose after glucose supplementation in the low birth weight during the 1st five days of their life and relate it to their weight.
- To relate the mothers nutritional status to the birth weight of their neonates.

1.2.13 Justification and expected output

This was a cross sectional study to establish the normal ranges of blood glucose and the prevalence of hypoglycaemia in the newborn and further in the low birth weight newborns.

The study further sought, (in a five day-study) to monitor the effect of glucose supplementation in the LBW and also relate the effect of this supplementation in neonates born to HIV positive and negative mothers. The nutritional status of the mothers will be related to the low birth weight of their neonates. The study excluded all neonates born to diabetic mothers, mothers with unknown HIV status and those with established congenital problems and those without their mother’s consent.
CHAPTER TWO
MATERIALS AND METHODS

2.1 Study area

The study was undertaken at Kenyatta National Hospital, Labour ward and newborn unit.

2.2 Study population, sample size and inclusion/exclusion criteria

There were four study populations; Population A consisted of normal neonates, Population B consisted of low birth weight neonates, while population C consisted of LBW width while population c consisted of LBW neonates with glucose levels of less than 1.7 mmo/l and Population C consisted of mothers of LBW neonates.

2.2.1 Population A (normal neonates)

Normal neonates as described in the, “Nelson textbook of Paediatrics” were selected for this population. The Central Theorem (Marasinghe et al., 1994) which uses population equal to or greater than 30 subjects was used to determine the sample size. Only the normal neonates were included while those outside the description of normal were excluded. Neonates from diabetic mothers and those whose HIV status was not known were also excluded. A total of 117 infants were recruited for the study.
2.2.2 Population B (LBW neonates) and C (LBW and glucose 1.7 mmo/l)

In those populations only neonates weighing less than 2500gm and whose mothers’ HIV status was known were included.

The sample size was determined using the formula by Fisher et al. (1983). The formula below applies in this case;

\[ N = Z^2 \frac{P (1 - P)}{d^2} \]

Where \( N \) = minimum sample score; \( Z \) = Standard normal deviate value corresponding to 95% confidence interval (= 1.96); \( P \) = Estimated prevalence of (28% prevalence will be used) (Fisher et al., 1983); \( d \) = degree of precision (set = 5%); Therefore \( n = 1.96^2 \times 0.28 (1 - 0.28)/0.0025 = 310 \)

2.2.3 Population D (Mothers of LBW neonates)

This population consisted all the mothers whose babies were recruited in population B.

Their weight, height and HIV status was determined on inclusion to the study.

2.3 Ethical consideration

Consent was sort from the Kenyatta National Hospital Ethical Committee where the study was carried out. Permission was sought from them to carry out this study and to obtain data from the patients’ files with the help of the clinicians in the areas where the study was done. Also permission to take blood for glucose estimation from the neonates was obtained from the mothers.
2.4 Specimen collection and analysis

The sampling and analysis of glucose was done immediately at the cotside.

The first blood 50μL for glucose determination was collected by a heel-prick after swabbing with methylated spirit before the first feed was given to the infants. Analysis was carried out using a Q.I.D. Precision Sensor glucose meter by applying 50μ and reading after 20 seconds. The subsequent samples were collected twice every day one hour after feeding in the morning and afternoon for the next 5 days. The neonates were fed every three hours with the feed calculated per body weight (i.e 120 – 125) Kcal/Kg/day of the oral feed). The neonates whose blood glucose did not rise above 1.7 mmol/L were given 10% dextrose intravenously (IV) calculated based on the body weight (i.e 100 ml/Kg body weight) apart from the normal prescribed oral feed. The blood glucose was monitored at the end of the infusion, and twice a day, i.e. in the morning and afternoon by the principle investigator or the trained matrons or paediatricians at night when the investigator was not available.

The blood was analysed for blood glucose by applying the drop or 50 microlitres to the precision QID Sensor and allowing it to read within 20 seconds. This was done after calibrating the machine with a supplied calibrator in the packet of the glucose strips. The results were read on the screen in mmol/L. The results were interpreted based on the reference ranges that were obtained from the reference range study. The weights were based on those used in the NBU i.e less than 2500g for low birth weight. The BMI ranges were interpreted from those given under nutritional status of mothers in this study.
2.5 Weighing of the neonates

The neonates were weighed using a top loading balance weighing a minimum of 0.1 grams and maximum of 5000 grams. The weight of each neonate was taken at birth and on alternate days for five days. The matrons in charge of labour ward and NBU were requested to assist in taking the weight when the investigator was not available at night.

2.6 Nutritional status of the mothers

This was obtained through the calculation of Body Mass Index (BMI) by using their weight and height (Anthropometrical method); Using the formula:

\[
BMI = \frac{\text{Weight (Kg)}}{\text{Height (M}^2)}
\]

The matron in the ANC was requested to assist in taking of the height and weight of the mothers during their last trimester. The mothers’ nutritional status assessment was done from the BMI and the questionnaire with the help of the medical statistician;

(Ranges for Pregnant women)

BMI < 19.8 = underweight  \hspace{1cm} BMI 19.8 - 26.0 = Normal weight
BMI 26.0 - 29.0 = Over weight  \hspace{1cm} BMI > 29 = Obesity
BMI 18.5 = Malnutrition Chronic  \hspace{1cm} BMI 16.0 = Severe Malnutrition.

Further assessment of the nutritional status was captured through interviewing them using the questionnaire provided (Appendix V11). This was done at the ANC by the investigator and those assisting her, i.e the matrons at the ANC and those technologists recruited to help her. This was in the last trimester of the mothers.
2.7 Data analysis

Data was collected by the principal investigator. Computer entry was done with assistance from a biostatistician using EPI Info which has a facility for double entry to avoid errors. This took care of the cleaning which involves correction of errors and quality control was ensured by the double entry. The data entered was analysed using SPSS (Statistical Package for Social Sciences). Analysis involved descriptive statistics and frequency distribution. The significance of the result was be tested using Chi Square. Glucose was determined and correlated with weight, HIV status, and nutritional status. Response to glucose supplementation was also assessed.
CHAPTER THREE

RESULTS

3.1 Normal reference range of neonates

The mean (SD) and median blood glucose levels for 117 normal neonates observed at Kenyatta National Hospital was 2.81 (0.58) mmol/L and 2.80 mmol/L, respectively. The normal reference range developed using these normal neonates is therefore (Mean ± 1.96SD) 1.67 mmol/L (Lower Limit) to 3.95 mmol/L (Upper Limit). These values rounded to one decimal place become 1.7 mmol/L to 4.0 mmol/L. The lower limit of the developed normal reference range of neonates was used to assess the prevalence of hypoglycemia.

3.2 Relationship between the neonate’s birth weight and the prevalence of hypoglycemia

As depicted in Table 1, the prevalence of hypoglycemia in low birth weight neonates was 14.7% while that in the normal weight neonates was 8.6%. The overall prevalence of hypoglycemia in the 348 neonates was 23.2%. Results show that there was a relationship between the neonate’s birth weight and the prevalence of hypoglycemia ($X^2 = 16.56; df = 1; p=0.000$). The prevalence of low birth weight neonates at KNH was 43.4%.

Table 1: Relationship between neonate’s birth weight and the prevalence of hypoglycemia

<table>
<thead>
<tr>
<th>Neonate’s birth weight</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Low Birth weight</td>
<td>51 (14.7)</td>
<td>100 (28.7)</td>
</tr>
<tr>
<td>Normal Birth weight</td>
<td>30 (8.6)</td>
<td>167 (48.0)</td>
</tr>
<tr>
<td>Total</td>
<td>81 (23.2)</td>
<td>267 (76.7)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 16.56; df=1; p<0.001$
3.3 Effects of HIV status of the mother’s on the blood glucose levels of neonates

As depicted in Table 2, blood glucose concentration in neonates from HIV negative mothers was not significantly higher than that of neonates from HIV positive mothers (p=0.054).

Table 2: Blood glucose concentration (mmol/L) in neonates from HIV negative and HIV positive mothers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Mother’s HIV status</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Negative (n=320)</td>
<td></td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>2.88 ± 0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Positive (n=27)</td>
<td></td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>2.35 ± 0.25</td>
<td></td>
</tr>
</tbody>
</table>

Results are expressed as mean ± SEM. Differences in blood glucose levels in neonates from HIV negative and HIV positive mothers compared by t-test.
3.3.1 Effects of neonate weight from HIV negative and HIV positive Mother’s on the Blood glucose levels of neonates

As depicted in Table 3, blood glucose levels in low birth weight neonates from HIV negative and HIV positive mothers were insignificantly different (p=0.059) while that in normal birth weight neonates were similar (p=0.584).

Table 3: Blood glucose level (mmol/L) of low birth weight and normal birth weight neonates from in HIV negative and HIV positive mothers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Neonate weight status</th>
<th>Low birth weight</th>
<th>Normal birth weight</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HIV negative mothers (n=130)</td>
<td>2.98 ± 0.19</td>
<td>2.27 ± 0.31</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>HIV positive mothers (n=20)</td>
<td>2.27 ± 0.31</td>
<td>2.82 ± 0.09</td>
</tr>
<tr>
<td></td>
<td>HIV negative mother (n=190)</td>
<td></td>
<td>2.60 ± 0.37</td>
</tr>
<tr>
<td></td>
<td>HIV positive mother (n=7)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Results are expressed as mean ± SEM. Differences in blood glucose levels in low birth weight and normal birth weight neonates from HIV negative and HIV positive mothers compared by t-test.

3.3.2 Relationship between the mother’s HIV status and the prevalence of hypoglycemia in the 347 neonates

As depicted in Table 4, the prevalence of hypoglycemia in neonates from HIV negative mothers was 19.6% while that from HIV positive mothers was 3.7%. Overall the prevalence of hypoglycemia in the 347 neonates studied was 23.3% while that of HIV was 7.8%. Results show that there is a significant association between the HIV status of the mother and the prevalence of hypoglycemia in the neonates ($X^2 =10.07$; df =1; p=0.002).
Table 4: Relationship between the HIV status of the mother and the prevalence of hypoglycemia in the 347 neonates

<table>
<thead>
<tr>
<th>Mothers HIV status</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>HIV negative</td>
<td>68 (19.6)</td>
<td>252 (72.6)</td>
</tr>
<tr>
<td>HIV positive</td>
<td>13 (3.7)</td>
<td>14 (4.0)</td>
</tr>
<tr>
<td>Total</td>
<td>81 (23.3)</td>
<td>266 (76.7)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 10.07; df = 1; p=0.002$

3.3.3 Relationship between the mothers HIV status and the prevalence of hypoglycemia in the low and normal birth weight of neonates

As depicted in Table 5, the prevalence of hypoglycemia in low birth weight neonates from HIV negative mother was 26.7% while that in low birth weight neonates from HIV positive mothers was 7.3%. The overall prevalence of hypoglycemia in the 150 low birth weight neonates studied was 34.0% while the prevalence of low birth weight neonates in HIV positive mothers was 13.3%. Results show that there was a significant association between the HIV status of the mother and the hypoglycemic state of the low birth weight neonates ($X^2 = 4.54; df =1; p=0.033$).
Table 5: Relationship between mothers HIV status and the prevalence of hypoglycemia in the 150 low birth weight neonates

<table>
<thead>
<tr>
<th>Mothers HIV status</th>
<th>Blood glucose status (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemic (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>HIV negative</td>
<td>40 (26.7)</td>
<td>90 (60.0)</td>
</tr>
<tr>
<td>HIV positive</td>
<td>11(7.3)</td>
<td>9(6.0)</td>
</tr>
<tr>
<td>Total</td>
<td>51 (34.0)</td>
<td>99(66.0)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 4.54; df = 1; p=0.033$

3.3.4 Relationship between mothers HIV status and the prevalence of hypoglycemia in the 197 normal birth weight neonates

As depicted in Table 6, the prevalence of hypoglycemia in normal birth weight neonates from HIV negative mothers is 14.2% while that in normal birth weight neonates from HIV positive mothers were 1.0%. The overall prevalence of hypoglycemia in the 197 normal birth weight neonates studied was 15.2% while the prevalence of normal birth weight neonates in HIV positive mothers was. Results show that there was no association between the HIV status of the mother and the hypoglycemic state of the normal birth weight neonates ($X^2 =1.00; df =1; p=0.317$)

Table 6: Relationship between mothers HIV status and the prevalence of hypoglycemia in the 197 normal birth weight neonates

<table>
<thead>
<tr>
<th>Mothers HIV status</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia</td>
<td>Normal</td>
</tr>
<tr>
<td>HIV negative</td>
<td>28 (14.2%)</td>
<td>162 (82.2%)</td>
</tr>
<tr>
<td>HIV positive</td>
<td>2 (1.0%)</td>
<td>5 (2.5%)</td>
</tr>
<tr>
<td>Total</td>
<td>30 (15.2%)</td>
<td>167 (84.8%)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7 mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 1.00; df =1; p=0.317$
3.3.5 Effects of the mother’s age and HIV status on the blood glucose levels in low birth weight and normal birth weight neonates

As depicted in Table 7, blood glucose levels of neonates in the low birth weight category from HIV negative and HIV positive adolescent mother’s were similar (p=0.409) while blood glucose levels of neonates in the normal birth weight category from HIV negative and HIV positive adolescent mother’s were also similar (p=0.543). Blood glucose levels of neonates in the low birth weight category from HIV negative and HIV positive adult mother’s were similar (p=0.121) while blood glucose levels of neonates in the normal birth weight category from HIV negative and HIV positive adult mother’s were also similar (p=0.714) (Table 7).

Table 7: Blood glucose levels (mmol/L) of low birth weight and normal birth weight neonates from HIV negative and HIV positive adolescent and adult mothers

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Adolescent</th>
<th></th>
<th></th>
<th>Adult</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low birth weight</td>
<td>Normal birth weight</td>
<td></td>
<td>Low birth weight</td>
<td>Normal birth weight</td>
<td></td>
</tr>
<tr>
<td></td>
<td>HIV -ve (n=84)</td>
<td>HIV+ve (n=7)</td>
<td>HIV -ve (n=66)</td>
<td>HIV +ve (n=3)</td>
<td>HIV -ve (n=46)</td>
<td>HIV +ve (n=13)</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>2.99±0.24</td>
<td>2.46±0.57</td>
<td>2.80±0.13</td>
<td>2.67±0.17</td>
<td>2.95±0.31</td>
<td>2.16±0.39</td>
</tr>
</tbody>
</table>

Results are expressed as Mean ± SEM. Differences in blood glucose levels in neonates from HIV negative and HIV positive mothers compared by T-test

3.3.6 Relationship between mother’s age and the prevalence of hypoglycemia in the low and normal birth weight neonates

As depicted in Table 8, the prevalence of hypoglycemia in low birth weight neonates from adolescent mothers is 19.2% while that in low birth weight neonates from adult mothers was 14.6%. The overall prevalence of hypoglycemia in the 151 low birth weight neonates studied was 33.8%. Results show that there was no relationship between the mother’s age and the hypoglycemic state of the low birth weight neonates ($X^2=0.534; df=1; p=0.465$).
Table 8: Relationship between mother’s age and the prevalence of hypoglycemia in the low birth weight neonates

<table>
<thead>
<tr>
<th>Mothers age</th>
<th>Blood glucose level (mmol/L)</th>
<th>Totals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Adolescent</td>
<td>29 (19.2)</td>
<td>63 (41.7)</td>
</tr>
<tr>
<td>Adult</td>
<td>22 (14.6)</td>
<td>37 (24.5)</td>
</tr>
<tr>
<td>Totals</td>
<td>51 (33.8)</td>
<td>100 (66.2)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=0.534; \text{df}=1; p=0.465$

3.3.7 Relationship between mother’s age and the prevalence of hypoglycemia in the normal birth weight neonates

As depicted in Table 9, the prevalence of hypoglycemia in normal birth weight neonates from adolescent mothers is 4.0% while that in normal birth weight neonates from adult mothers was 11.2%. The overall prevalence of hypoglycemia in the 197 low birth weight neonates studied was 15.2%. Results show that there was no relationship between the mother’s age and the hypoglycemic state of the normal birth weight neonates ($X^2=1.086; \text{df}=1; p=0.297$).

Table 9: Relationship between mother’s age and the prevalence of hypoglycemia in the normal birth weight neonates

<table>
<thead>
<tr>
<th>Mothers age</th>
<th>Blood glucose level (mmol/L)</th>
<th>Totals (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Adolescent</td>
<td>8 (4.0)</td>
<td>61 (31.0)</td>
</tr>
<tr>
<td>Adult</td>
<td>22 (11.2)</td>
<td>106 (53.8)</td>
</tr>
<tr>
<td>Totals</td>
<td>30 (15.2)</td>
<td>167 (84.8)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=1.086; \text{df}=1; p=0.297$. 

31
3.3.8 Relationship between mother’s nutritional status and the prevalence of hypoglycemia in neonates

As depicted in Table 10, the prevalence of hypoglycemia in neonates born of malnourished mothers was 5.2%, that born of normal mothers was 1.7% and those born of over weight mothers was 8.7%. Overall the prevalence of hypoglycemia in neonates born of all the mothers was 15.6%. Results show that there was a relationship between the nutritional status of the mother and the prevalence of hypoglycemia in the neonates ($X^2 = 15.329$; df=2; p=0.000).

Table 10: Relationship between mother’s nutritional status and the prevalence of hypoglycemia in the neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>9 (5.2)</td>
<td>11 (6.4)</td>
</tr>
<tr>
<td>Normal</td>
<td>3 (1.7)</td>
<td>34 (19.6)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>15 (8.7)</td>
<td>101 (58.4)</td>
</tr>
<tr>
<td>Total</td>
<td>27 (15.6)</td>
<td>146 (84.4)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 15.329$; df=2; p=0.000

3.3.9 Relationship between mother’s nutritional status and the prevalence of hypoglycemia in the low birth weight neonates

As depicted in Table 11, the prevalence of hypoglycemia in low birth weight neonates born of malnourished mothers was 15.4%, and those born of over weight mothers was 15.4%. Overall the prevalence of hypoglycemia in neonates born of all the mothers was 30.8%. Results show that there was a relationship between the nutritional status of the mother and the prevalence of hypoglycemia in the low birth weight neonates ($X^2 = 6.179$; df=2; p=0.046).

Table 11: Relationship between mother’s nutritional status and the prevalence of hypoglycemia in the low birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>4 (15.4)</td>
<td>4 (15.4)</td>
</tr>
<tr>
<td>Normal</td>
<td>0 (0.0)</td>
<td>9 (34.6)</td>
</tr>
</tbody>
</table>
Over Weight | 4 (15.4) | 5 (19.2) | 9 (34.6) \\
Total | 8 (30.8) | 18 (69.2) | 26 (100.0) \\

3.3.10 Relationship between mother’s nutritional status and the prevalence of hypoglycemia in the normal birth weight neonates

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 6.179; df = 2; p = 0.046$

As depicted in Table 12, the prevalence of hypoglycemia in normal birth weight neonates born of malnourished mothers was 3.4%, those born of normal mothers was 2.0% and those born of over weight mothers was 7.5%. Overall the prevalence of hypoglycemia in neonates born of all the mothers was 12.9%. Results show that there is a relationship between the nutritional status of the mother and the prevalence of hypoglycemia in the normal birth weight neonates ($X^2 = 9.595; df = 2; p = 0.008$).

Table 12: Relationship between mother’s nutritional status and the prevalence of hypoglycemia in the normal birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>5 (3.4)</td>
<td>7(4.8)</td>
</tr>
<tr>
<td>Normal</td>
<td>3(2.0)</td>
<td>25(17.0)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>11(7.5)</td>
<td>96(65.3)</td>
</tr>
<tr>
<td>Total</td>
<td>19(12.9)</td>
<td>128(87.1)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2 = 9.595; df = 2; p = 0.008$

3.3.11 Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in the neonates

As depicted in Table 13, the prevalence of hypoglycemia in neonates born of malnourished adolescent mothers was 5.9%, those born of normal adolescent mothers was 12.7% and those born of over weight adolescent mothers was 12.7%. Overall the prevalence of hypoglycemia in neonates born of adolescent mothers was 31.4%. Results show that there is a relationship
between the nutritional status of the adolescent mother and the prevalence of hypoglycemia in neonates ($X^2 = 6.214; df = 2; p=0.045$).
Table 13: Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>7 (5.9)</td>
<td>7 (5.9)</td>
</tr>
<tr>
<td>Normal</td>
<td>15 (12.7)</td>
<td>22 (18.6)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>15 (12.7)</td>
<td>52 (44.1)</td>
</tr>
<tr>
<td>Total</td>
<td>37 (31.4)</td>
<td>81 (68.6)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); \(X^2=6.214; \text{df}=2; p=0.045\)

3.3.12 Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in low birth weight neonates

As depicted in Table 14, the prevalence of hypoglycemia in low birth weight neonates born of malnourished adolescent mothers were 5.4%, those born of normal adolescent mothers was 20.3% and those born of over weight adolescent mothers was 17.6%. Overall the prevalence of hypoglycemia in neonates born of adolescent mothers was 43.2%. Results show that there was no relationship between the nutritional status of the adolescent mother and the prevalence of hypoglycemia in the low birth weight neonates \(X^2=1.014; \text{df}=2; p=0.602\).

Table 14: Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in low birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>4 (5.4)</td>
<td>4 (5.4)</td>
</tr>
<tr>
<td>Normal</td>
<td>15 (20.3)</td>
<td>16 (21.6)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>13 (17.6)</td>
<td>22 (29.7)</td>
</tr>
<tr>
<td>Total</td>
<td>32 (43.2)</td>
<td>42 (56.8)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); \(X^2=1.014; \text{df}=2; p=0.602\)

3.3.13 Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in normal birth weight neonates
As depicted in Table 15, the prevalence of hypoglycemia in normal birth weight neonates born of malnourished adolescent mothers was 6.8% and those born of over weight adolescent mothers were 4.5%. Overall the prevalence of hypoglycemia in neonates born of adolescent mothers was 11.4%. Results show that there was a relationship between the nutritional status of the adolescent mother and the prevalence of hypoglycemia in normal birth weight neonates ($X^2=10.492; \, df=2; \, p=0.005$).

Table 15: Relationship between adolescent mother’s nutritional status and the prevalence of hypoglycemia in normal birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>3 (6.8)</td>
<td>3 (6.8)</td>
</tr>
<tr>
<td>Normal</td>
<td>0 (0.0)</td>
<td>6 (13.6)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>2 (4.5)</td>
<td>30 (68.2)</td>
</tr>
<tr>
<td>Total</td>
<td>5 (11.4)</td>
<td>39 (88.6)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=10.492; \, df=2; \, p=0.005$

3.3.14 Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in the neonates

As depicted in Table 16, the prevalence of hypoglycemia in neonates born of malnourished adult mothers was 3.2%, those born of normal adult mothers was 5.9% and those born of over weight adult mothers was 14.5%. Overall the prevalence of hypoglycemia in neonates born of adult mothers was 23.7%. Results show that there is no relationship between the nutritional status of the adult mother and the prevalence of hypoglycemia in the neonates ($X^2=1.412; \, df=2; \, p=0.492$).
Table 16: Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose level (mmol/L)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>6 (3.2)</td>
<td>11 (5.9)</td>
</tr>
<tr>
<td>Normal</td>
<td>11 (5.9)</td>
<td>39 (21.0)</td>
</tr>
<tr>
<td>Over weight</td>
<td>27 (14.5)</td>
<td>92 (49.5)</td>
</tr>
<tr>
<td>Total</td>
<td>44 (23.7)</td>
<td>142 (76.3)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=1.412; \ df=2; p=0.492$

3.3.15 Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in the low birth weight neonates

As depicted in Table 17, the prevalence of hypoglycemia in low birth weight neonates born of malnourished adult mothers was 4.8%, those born of normal adult mothers was 19.6% and those born of overweight adult mothers was 21.7%. Overall the prevalence of hypoglycemia in neonates born of adult mothers was 36.1%. Results show that there was no relationship between the nutritional status of the adult mother and the prevalence of hypoglycemia in the low birth weight neonates ($X^2=1.129; \ df=2; p=0.569$).

Table 17: Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in the low birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>4 (4.8)</td>
<td>7 (8.4)</td>
</tr>
<tr>
<td>Normal</td>
<td>8 (19.6)</td>
<td>20 (24.1)</td>
</tr>
<tr>
<td>Over weight</td>
<td>18 (21.7)</td>
<td>26 (31.3)</td>
</tr>
<tr>
<td>Total</td>
<td>30 (36.1)</td>
<td>53 (63.9)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=1.129; \ df=2; p=0.569$
3.3.16 Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in the normal birth weight neonates

As depicted in Table 18, the prevalence of hypoglycemia in normal birth weight neonates born of malnourished adult mothers was 1.9%, those born of normal adult mothers was 2.9% and those born of overweight adult mothers was 8.7%. Overall the prevalence of hypoglycemia in neonates born of adult mothers was 13.6%. Results show that there was no relationship between the nutritional status of the adult mother and the prevalence of hypoglycemia in the normal birth weight neonates ($X^2=2.153; \text{df}=2; \text{p}=0.341$).

Table 18: Relationship between adult mother’s nutritional status and the prevalence of hypoglycemia in the normal birth weight neonates

<table>
<thead>
<tr>
<th>Mother’s nutritional status</th>
<th>Blood glucose status</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hypoglycemia (%)</td>
<td>Normal (%)</td>
</tr>
<tr>
<td>Malnourished</td>
<td>2 (1.9)</td>
<td>4 (3.9)</td>
</tr>
<tr>
<td>Normal</td>
<td>3 (2.9)</td>
<td>19 (18.4)</td>
</tr>
<tr>
<td>Over Weight</td>
<td>9 (8.7)</td>
<td>66 (64.1)</td>
</tr>
<tr>
<td>Total</td>
<td>14 (13.6)</td>
<td>89 (86.4)</td>
</tr>
</tbody>
</table>

Hypoglycemic (<1.7mmol/L); Normal (≥1.7 to ≤4.0 mmol/L); $X^2=2.153; \text{df}=2; \text{p}=0.341$

3.3.17 Effect of 10% dextrose supplementation on low birth weight neonates with hypoglycaemia

As depicted by table 19, the results show that blood glucose levels increased from a mean glucose level of 1.3 mmol/L on day one to a mean glucose level of 4.4 mmol/L on day two and 6.1mmol/L on the 5th day.
Table 19: Effect of 10% dextrose supplementation on low birth weight neonates, on the mean daily blood glucose levels.

<table>
<thead>
<tr>
<th>Day</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n=54</td>
<td>n=54</td>
<td>n=54</td>
<td>n=52</td>
<td>N=47</td>
</tr>
<tr>
<td>Glucose (mmol/L)</td>
<td>1.3</td>
<td>4.4</td>
<td>5.3</td>
<td>5.2</td>
<td>6.1</td>
</tr>
</tbody>
</table>

Hypoglycaemic (< 1.7 mmol/L), Normal (1.7 to 4.0 mmol/L).
CHAPTER FOUR
DISCUSSION, CONCLUSION AND RECOMMENDATIONS

4.1 Discussion
The fasting normal reference range of full term neonates born at Kenyatta National Referral Hospital at birth of 1.7 to 4.0 mmol/L is different from the normal reference range of 1.5 to 6.0 mmol/L reported by others (Nicholl., 2003; Hawdon et al., 1992; Hoseth et al., 2000; Diwakar and Sasidhar, 2002). These normal neonatal blood glucose levels also differed from 2.5 mmol/L reported by Barnes-Powell (2007), 2.8-6.1 mmol/L reported by Karlsen (2006), 2.2 mmol/L reported by Verklan and Walden (2004), 1.1 mmol/L for preterm and 1.7 mmol/L for term reported by Kenner and Lott (2004). The difference could be attributed to differences in neonate population, if the sample taken was before any feeds or after, assay method used: whole blood glucose-microenzymatic and glucose dehydrogenase photometric method; plasma glucose-glucose oxidase method; use of reagent strips wrongly diagnose hypoglycemia in one out of four neonates who are normoglycemic, and type of feed: breast fed full term neonates have lower blood glucose concentration in the first week of life than formula fed neonates (Nicholl, 2003). The lower limit observed in this study is in line with the value of 1.8 mmol/L reported by Tanzer et al. (1997). However, this lower limit of fasting normal neonatal blood glucose at birth is lower than the commonly used fasting normal lower limit of 2.0 mmol/L in Kenyan Hospitals, who should use 1.7mmol/L as the research results indicate.
The 43.4% prevalence of low birth weight (LBW) neonates at KNH could be due to intrauterine growth restriction (IUGR) or prematurity factors which were not investigated in this study. LBW in neonates contributes to neonatal morbidity mortality and. LBW neonates have a higher risk of asphyxia, sepsis, hypothermia, feeding problems; have more severe and longer lasting common illnesses, are prone to long term disorders such as infections, malnutrition, and neurodevelopment disabilities; and have a higher risk of developing coronary heart disease, non-insulin dependent diabetes mellitus, stroke, and hypertension during adult life (Gupte et al., 2004; Gupta, 2008; Stoll and Chapman, 2008). The causes of LBW in neonates are maternal malnutrition and anemia, young age at conception, multiple pregnancies, and pregnancy induced hypertension, infection, substance abuse, etc and genetic factors (Gupta 2008). This LBW prevalence of 43.4% compares with the 30% reported for Indian neonates (Gupte et al., 2004; UNICEF, 2004; Gupta et al., 2007; Stoll and Chapman, 2008; Gupta, 2008).

The 23.3% prevalence of hypoglycemia observed in this study for full term neonates at Kenyatta National Hospital was higher than 11.5% reported by Lubchenco and Bard (1971) for full term neonates within three hours of life after the first oral feeding. The higher prevalence of hypoglycemia observed in low birth neonates relative to normal birth weight neonates (14.7% versus 8.6%) could be attributed to lower energy reserves in hepatic and muscle glycogen and fats (Deshpande et al., 1994), higher insulin levels which matches the higher protein intake which is an insulinomic stimulus (Ginsburg et al., 1985), less developed gluconeogenic pathways to synthesize glucose from glucogenic amino acids (Hume et al., 2003), high brain to body mass ratio in small for gestational age neonates resulting in high glucose consumption,
reduced fat stores and failure of counter regulatory hormones in low birth weight neonates (Hume et al., 2003; Gupta, 2008).

The 14.7% prevalence of hypoglycemia observed in LBW neonates is higher than the 6.2% reported by Lubchenco and Bard (1971) for low birth weight neonates within three hours of life after the first oral feeding. The 8.6% prevalence of hypoglycemia observed in normal birth weight neonates in this study is the same as the 8.6% reported by Lubchenco and Bard (1971) for full term neonates within three hours of life after the first oral feeding. The reported prevalences would have been higher if the neonates had not been orally fed within the three hours of life.

The low non-significant levels of blood glucose in neonates born of HIV positive mothers (2.35 mmol/L) compared to neonates born of HIV negative mothers (2.88 mmol/L) could be attributed to the LBW of the neonates. This is supported by the observation that the LBW neonates from HIV positive mothers (2.27 mmol/L) had a lower non-significant blood glucose level compared to that in LBW neonates from HIV negative mothers (2.98 mmol/L); the blood glucose levels in the normal birth weight neonates born of HIV positive (2.60 mmol/L) and HIV negative mothers (2.82 mmol/L) were in the same range.

The 7.8% prevalence of HIV in the neonate’s mothers was lower than the 34.7% reported by Malaba et al. (2005) for Zimbabwean neonate’s mothers. This could be attributed to changes in behavior toward fewer partners, less commercial sex, greater condom use and late age at first sex (KDHS, 2003; NACC, 2005) in Kenya than in the rest of Africa.
4.2 Conclusion

The normal blood glucose reference range for neonates observed at Kenyatta National Hospital using normal neonates is 1.67 mmol/L (lower limit) to 3.95 mmol/L (upper limit). The cut off for hypoglycaemia in neonates is therefore 1.7 mmol/L and not 2.0 mmol/L as currently used in Kenyan hospitals.

The prevalence of hypoglycaemia in low birth weight neonates at Kenyatta National Hospital is 14.7% while that in the normal weight neonates is 8.6%. The overall prevalence of hypoglycaemia in neonates at Kenyatta National Hospital in the study period was 23.2% a percentage much higher than what has been reported elsewhere and should be urgently addressed.

There was no statistically significant difference between the HIV status of the mothers and hypoglycaemia in both the low and normal birth weight neonates as depicted in the results. There was also no statistically significant difference between the mother’s age and hypoglycaemia in both the low and normal birth weight neonates as depicted by the results.

There was a statistically significant difference between the mother’s nutritional status and the prevalence of hypoglycaemia in both the low and normal birth weight neonates with an overall prevalence of 8.6% in over-weight mothers, 5.2% in malnourished mothers and only 1.7% in normal weight mothers.

Supplementation of the hypoglycaemic neonates with 10% dextrose given (100mls. per kilogram body weight) restored blood sugar to normal levels within a week.
4.3 Recommendations

1. The findings of this study have shown that there should be a mandatory screening of blood glucose and weight of all neonates at birth, and their blood glucose screened daily in the first week of birth to reduce complications of hypoglycaemia and neonatal deaths countrywide.

2. Appropriate formulations of supplements for neonates and 10% dextrose should be made available at all health facilities in the country.

3. Nutritional status of mothers should be taken seriously and addressed during the antenatal period as it affects both the birth weight and blood sugar state of their neonates.

4. Good quality screening equipments and their reagents, controls and standards for the methods should be made readily available by the government in all health facilities, to enhance quality results.
REFERENCES


APPENDICES

APPENDIX I

Hypoglycaemia in the Newborn at KNH and the response to glucose suplimentation in the LBW

CONSENT FORM: FOR NEONATES BY THEIR MOTHERS

Hypoglycaemia is a condition that occurs in some children who are born with low birth weight. The condition can cause problems in the development of the child’s brain if not detected and corrected during the first few days of life. This study therefore intends to assist the researcher formulate glucose reference ranges for future neonates proper glucose management. The study will involve taking some little blood from the infant’s heel, (which maybe a little bit uncomfortable to the infant) as the doctors manages him/her. The infant is not put at any risk during the study.

Your consent to this study is voluntary.

I have been explained to, allowed to ask questions on this study, understood and Consented.

Mother’s signature ………………………………………

Date ………………………………………

I have clearly explained the above study to subject and they have understood and Consented.

Researcher’s Name ………………………………………

Researcher’s signature ……………………..Date…………………..

Contact. (Tel.) ……………………………………………..
APPENDIX II

Hypoglycaemia in the Newborn at KNH and the response to glucose supplementation in the LBW

CONSENT FORM: BY MOTHERS FOR LBW NEONATES

Hypoglycaemia is a condition that occurs in some children who are born with LBW. The condition can cause problems in the development of the child’s brain if not detected and corrected during the first few days of life. This study therefore intends to assist the health worker in the management of such infants now and in future. The study will involve taking some little blood from the infant’s heel, (which may be a little bit uncomfortable to the infant) as the doctors manage him / her.

The infant is not put to any risk during the study. Your consent to this study is voluntary.

I have been explained to, allowed to ask questions on this study, understood and consented.

Mother’s signature………………………………………………

Date…………………………

I have clearly explained the above study to the subject and they have understood and consented.

Resercher’s Name ………………………signature………………………………………..

Date…………………………

Contact (Tel.)……………………………………
APPENDIX III

Hypoglycaemia in the Newborn at KNH and the response to glucose suplimentation in the LBW

CONSENT FORM: FOR LBW WITH HYPOGLYCAEMIA BY MOTHERS

Hypoglycaemia is a condition that occurs in some children who are born with LBW. The condition can cause some problems in the development of the child’s brain if not detected and corrected in the first few days of life. The study therefore intends to assist the health workers in the management of such infants now and in future.

The study will involve pricking the infant once daily for seven days. This will assist the doctor to manage the low blood sugar of the neonate until it’s normalised. In case your neonate needs additional glucose other than the prescribed feed, then the doctor will prick the neonate after giving the glucose again until the blood sugar normalises. This will be a little uncomfortable to the neonate, but it will not put the neonate at any risk. Your consent to this study is voluntary.

I have been explained to, allowed to ask questions on this study, understood and consented.

Mother’s signature………………………………………………

Date……………………

I have clearly explained the above study to the subject and they have understood and consented.

Researcher’s Name……………… signature……………………………

Contact (Tel)…………………………………………………………

Date……………………
APPENDIX IV

Hypoglycaenia in the Newborn at KNH and the response to glucose Supplimentation in the LBW.

CONSENT FORM: FOR MOTHERS

The nutritional status of the mother has an effect on their unborn neonate. The Researcher intends to assess the nutritional status of the mother by taking your weight and height, and also asking you a few questions on your health status and dietary habits. This will assist the health workers in future to advice the mothers on nutrition, for the purpose of enabling them to give birth to healthy normal neonates with normal weight. The exercise will not cause any risk to the mother.

Your consent to this study is voluntary.

I have been explained to, allowed to ask questions on this study, understood and consented.

Mother’s signature ……………………………………………………..

Date ‘…………………………………’

I have clearly explained the above study to the subject and they have understood and consented.

Researcher’s Name…………………………… signature …………………………………………………

Contact (Tel.)…………………………………………………………

Date ……………………..
APPENDIX V

Hypoglycaemia in the Newborn at KNH and the response to glucose supplimentation in Low Birth Weight

LABORATORY RESULTS PROFORMA

Study case Number of neonate ........................................

IP. Number .........................................................

Mother’s study number ...........................................

Neonate’s status (Tick where applicable)
Asymptomatic Seizures Irritability Lethargic

<table>
<thead>
<tr>
<th></th>
<th>Weight (g)</th>
<th>Blood glucose (mmol/L)</th>
<th>Blood glucose after IV dextrose infusion (mmol/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Day 1</td>
<td>At birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 hour after 1st feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 2</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 3</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 4</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 5</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 6</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Day 7</td>
<td>1 hour after feed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The day of dextrose supplementation must be shown on the results sheet.
APPENDIX VI

LABORATORY RESULTS PROFORMA FOR NORMAL NEONATES

<table>
<thead>
<tr>
<th>Study case Number</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IP. Number</td>
<td></td>
</tr>
<tr>
<td>Mother’s study number</td>
<td></td>
</tr>
</tbody>
</table>

Neonate’s status (Tick where applicable)

- Healthy looking
- Sickly looking

Weight (g) Blood glucose (mmol/L)
APPENDIX VII
NUTRITIONAL STATUS OF THE MOTHER’S QUESTIONAIRE

MOTHERS’ STUDY NO. □□□□□□

NEONATES’ STUDY NO. □□□□□□

WEIGHT □□□□□□ g HEIGHT □□□□□□ M AGE □□□□□□ Years

1) RESIDENCE □□□□□□ TYPE OF RESIDENCE □□□□□□

1) Residence: Mathare/Kibera/ Kawangware/Kangemi .......... 01
City center/Ngara/Eastleigh/Eastlands .................02
Muthaiga/Lavington/SouthB/South
C/Parklands/Southlands/Highview/Karen/Westlands ... 03
Kikuyu/Kabete/Uthiru/Kinoo/Waithaka ................. 04
Others within Nairobi province ............................... 05

Type of residence: Rental- (a) Owner occupier … (b)

HOME DISTRICT □□□□□□

NUMBER OF HOUSEHOLD MEMBERS □□□□□□

NUMBER OF CHILDREN □□□□□□

DEAD □□□□□□ ALIVE □□□□□□

2) EDUCATION LEVEL □□□□□□

Education:
- None .......................................... 01
- Primary ..................................... 02
- Technical Training after primary …. 03
- Secondary................................. 04
- Post secondary Training .............. 05
- University/Professional .............. 06
- Unknown .................................. 07

3) MARITAL STATUS □□□□□□
3) Marital Status:
- Single ..................... 01
- Married ..................... 02
- Divorced/Separated .... 03
- Widowed ..................... 04

4) FAMILY INCOME ASSESSMENT
Family Income assessment

i. School fees expenditure
   Number of children in schools and colleges:
   - None ...................... (01)
   - 1 – 3 ...................... (2)
   - 4 above .................. (03)

ii. Daily food expenditure
- Upto KShs. 200 ............. 01
- Upto KShs. 500 ............. 02
- Above 500 .................. 03

5) SEROLOGICAL STATUS
- Positive
- Negative

6) GENERAL HEALTH STATUS
- Visibly malnourished and weak subjects ..... (0)
- Well looking and healthy subjects ............ (3)

General Health status: Will be rated from 0 – 3

7) MEDICAL HISTORY

Has the mother been admitted during pregnancy  YES/NO?

Does the mother suffer from any chronic ailment?  YES/NO