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Mob: +92 300 3008585, Fax: +92 41 8815544

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Levels of Some Essential Elements in Pregnant Women and Association with Low Birth Weight of Babies in Benin City

Osaretin James Agbonlahor[1] and Mathias Abiodun Emokpae[2]
[1]Department of Medical Laboratory Services, Stella Obasanjo Hospital, Benin City, Nigeria
[2]Department of Medical Laboratory Science, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria

Abstract: Poor foetal growth and development has been associated with maternal inadequate or under-nutrition. There is no agreement as to whether dietary macro and micro-nutrient supplementation in pregnancy enhance neonatal birth weight. This study evaluates the levels of magnesium, calcium, albumin and phosphorus in pregnant women at delivery, the proportion of the neonates with low birth weight and the relationship between these essential elements and neonatal birth weight. A total of 300 subjects were enrolled, which included 200 healthy pregnant women and 100 age-matched non-pregnant women (controls). The concentrations of essential elements in maternal blood were measured using Atomic Absorption Spectrophotometry and colorimetric methods. The concentrations of magnesium and albumin were significantly ($p<0.001$) higher in women who had babies with low birth weight than those had normal birth weight. Conversely, calcium ($p = 0.002$) and phosphorus ($p<0.001$) levels were significantly lower in women who had babies with low birth weight compared with those that had babies with normal birth weight. The levels of measured variables in the pregnant women at delivery were significantly lower ($p<0.001$) compared with controls. Supplementation of some of these essential elements may help to prevent the delivery of infants with low birth weight. Therefore measurement of these essential elements may be considered important as part of the routine antenatal investigations.

Key words: Pregnant women, essential elements, infants and low birth weight

INTRODUCTION

It is universally accepted that adequate nutrition before and during pregnancy could greatly affect the health of both mother and infants (Singh *et al*., 2009). A well nourished women before conception begins her pregnancy with reserved of essential nutrients such that the growth and well being of the growing foetus and good health of the women is achieved. A neonate who was well nourished in the womb stands a better chance of becoming healthy after birth than that who was malnourished. Poor foetal growth and development has been associated with maternal inadequate or under-nutrition (Khoushabi and Saraswathi, 2010). There is no agreement as to whether dietary macro and micro-nutrient supplementation in pregnancy enhance neonatal birth weight (Muthayya, 2009). However, it was suggested that nutritional deficiency may be responsible for up to 60% of the reported variations in birth weight. It also observed that high intake of calcium, magnesium, iron and zinc significantly affect the birth weight of infants (Khoushabi and Saraswathi, 2010). The prevalence of low birth weight (LBW) varies from one region to another and the estimated prevalence is particularly high in developing countries. The prevalence of 15-30% was reported in India (Kapil, 2009), Sri Lanka, Nepal and UNICEF/WHO estimated figure for Sub-Sahara Africa (Mavalankar *et al*., 1992; UNICEF and WHO, 2004). The Nigerian Demographic Health Survey put the incidence of LBW as 14% (655 per 1000) (NPC and ORC Macro, 2009).

Magnesium, calcium, phosphorus and albumin are essential elements of nutrition required for cell multiplication in a growing fetus, proper soft tissue functioning during muscle contraction, bone formation in fetus, hormone release and other physiological actions (Mariko *et al*., 2011). The demand for these essential elements is higher during pregnancy. Therefore, a pregnant woman requires more of these nutrients (calcium, magnesium, phosphorus and albumin) than a non-pregnant woman (Baig *et al*., 2003). Previous studies on the association of these essential elements with neonatal birth weight and thus the need for supplementation during pregnancy had yielded inconsistent results. Some of them reported that LBW was associated with low levels of calcium, magnesium, phosphorus and albumin in maternal blood (Baba *et al*., 2012; Mariko *et al*., 2011; Merialdi *et al*., 2003; Baig *et al*., 2003; Stephenson and Symonds, 2002). Others did not find any association of these elements with infant birth weight (Pourarian *et al*., 2014; Pathak and Kapil, 2004). In Nigeria, Baba *et al*. (2012) examined the correlation of

Corresponding Author: M.A. Emokpae, Department of Medical Laboratory Science, School of Basic Medical Sciences, University of Benin, Benin City, Nigeria

maternal albumin and birth weight of babies in a Nigerian Teaching Hospital and observed that there was a positive correlation between maternal albumin and mean birth weight of babies. But studies on the association of these essential elements with birth weight of babies in our setting are few. Therefore, this study was designed to determine the level of calcium, albumin, magnesium and phosphorus amongst pregnant women at delivery, the prevalence of LBW and examine the relationship between these essential elements and neonatal birth weight in Benin City, Nigeria.

MATERIALS AND METHODS

Subjects: Two hundred healthy pregnant women visiting antenatal clinic were consecutively enrolled for the study between January and November 2015 at the Department of Obstetrics and Gynecology, Stella Obasanjo Hospital, Benin City and 100 age-matched non-pregnant women were also recruited as controls.

Institutional Ethical approval was obtained from Ethics Committee of the Edo State Hospitals Management Board and individual inform consent was obtained before the commencement of study. Demographic and clinical information were obtained using structured questionnaires.

Inclusion criteria: All healthy pregnant women of 18 years and above expecting singleton, who attended antenatal clinic throughout the pregnancy and reported for delivery were included. Pregnant women who carried their pregnancy to full term and delivered either by vaginal and caesarean were also included.

Exclusion criteria: Pregnant women with complications such as diabetes mellitus, cardiovascular diseases and those who had parity more than 4 were excluded. Obstetrical conditions that could cause small for dates babies like preterm deliveries, abruption placenta previa, intrauterine death, bad obstetric history, intrauterine rupture and congenital anomalies of the baby, pregnancy induced hypertension, polyhydramnios, clinical signs of infection and benign tumors or malignancies were also excluded.

Sample preparation: Five milliliters of venous blood was collected from the antecubital vein of the mother at the onset of labour into anticoagulated container and labeled. Two milliliters of the blood was kept refrigerated prior to analysis for magnesium while the other 3 ml was spun at 3000 rpm for 10 min to obtain the plasma. The plasma was stored at -20°C prior to analysis for calcium, albumin and phosphorus.

Birth weight of the infant was measured by beam scale designed for infants.

Magnesium analysis

Reagent and sample preparation for magnesium analysis:

1: 100 µL of mg Standard was diluted with 5 ml of HNO_3 and 1.7 mL of deionized water and mixed thoroughly with 200 µL internal standard
2: 100 uL of whole blood was diluted with 5 ml of HNO_3 and 1.7 mL of deionized water and mixed thoroughly with 200 µL internal standard and 100 µL of Gold

Procedure for magnesium analysis: Magnesium was determined by Inductively Coupled Plasma Mass Spectrometer (Agilent 7500, Norwalk, U.S.A) by adopting the methods of Fong *et al.* (2007) as below. The instrument was standardized and calibrated with standard blank and magnesium standards. Aliquot of 20uL of the prepared sample was aspirated into the quartz spray chamber. The result data was displayed on the screen after the run and later downloaded to Microsoft excel sheet.

Determination of magnesium was done at the analytical services laboratory, International Institute for Tropical Agriculture, Ibadan.

Plasma albumin, calcium and phosphorus were determined by colorimetric method using reagents supplied by Randox Laboratories, UK. Quality control sera were included in the assay in order to ensure accuracy and precision of determinations.

Statistical analysis: The data obtained were analyzed using statistical package for Social Science Program (SPSS) Version 16.0 (Chicago, IL, USA).The values obtained in this study are presented as Mean±Standard Error of Mean. Student's t-test and Analysis of Variance (ANOVA) were used to compare means. A $p<0.05$ was considered as statistically significant.

RESULTS

The results of the investigations are presented on the Table 1 and 2. The values of the measured elements were stratified according to the birth weight of infants. The babies with birth weight less than 2500 g were classified as LBW while those above 2500 g were considered as normal birth weight (UNICEF and WHO, 2004). Table 1 shows the comparison of measured parameters in maternal blood according to the birth weight of the babies. Maternal blood levels of magnesium and albumin were significantly higher ($p<0.001$) in women who had babies with LBW compared to those who had babies of normal birth weight. Conversely, calcium ($p<0.002$) and phosphorus ($p<0.001$) levels in women who had babies with LBW were significantly lower compared to those who had babies of normal birth weight.

Table 1: Comparison of measured parameters in the blood of women who gave birth to babies with low and normal birth weight (mean±SEM)

	Birth weight of babies		
Measured parameters	Low birth weight <2.5 kg n = 24	Normal birth weight >2.5 kg n = 176	p-value
Magnesium (mg/L)	2.78±0.153	2.29±0.089	0.000
Calcium (mg/dL)	6.86±0.311	7.04±0.103	0.002
Albumin (g/dL)	3.88±0.053	3.69±0.037	0.000
Phosphorus (mg/dL)	3.11±0.059	3.55±0.042	0.000

Table 2: Comparison of the levels of measured essential elements in pregnant women at delivery and non-pregnant women (control) (mean±SEM)

	Magnesium (mg/l)	Calcium (mg/dl)	Albumin (g/dl)	Phosphorus (mg/dl)
Maternal cases n = 200	2.41±0.05	7.21±0.071	3.69±0.002	3.36±0.03
Control groups n = 100	3.33±0.04	8.76±0.06	4.12±0.03	3.79±0.04
p-value	0.000	0.000	0.000	0.000

Table 2 shows the mean concentrations of the measured parameters in pregnant women at delivery compared to non-pregnant women (controls). Magnesium, calcium, albumin and phosphorus levels in the pregnant women at delivery were significantly lower (p<0.001) compared with controls.

DISCUSSION

This study evaluated the levels of essential elements (magnesium, calcium, phosphorus) and albumin in the blood of pregnant women at delivery. The measured parameters were compared in pregnant women that had babies with LBW and those that had babies with normal birth weight. Also the levels in non-pregnant women (controls) were compared with those of pregnant women at delivery. The levels of magnesium and albumin were significantly higher (p<0.001) in women that had babies with LBW when compared with those that had normal birth weight. While calcium (p = 0.002) and phosphorus (p<0.001) levels were significantly lower in women that had babies with low birth weight than those with normal birth weight. We also observed that the levels of magnesium, calcium, albumin and phosphorus in the pregnant women at delivery were significantly lower (p<0.001) compared with the non-pregnant women (controls).

To our knowledge, few studies have evaluated the levels of multiple essential elements (magnesium, calcium and phosphorus) and albumin in pregnant women at delivery and their possible association with birth weight in Nigeria. In this study, the magnesium levels in the pregnant women were significantly (p<0.001) lower than in non-pregnant women. This is consistent with previous study (Husain and Sibby, 1993). Who observed that there was hypomagnesaemia during pregnancy, relative to the non-pregnant women. It was suggested that the hypomagnesaemia observed could be due to haemodilution and high estrogen levels during pregnancy.

The magnesium levels in the blood of pregnant women who delivered babies with LBW were significantly (p<0.001) higher than those that had normal birth weight babies. This was consistent with that of other authors (Sherwani *et al.*, 1998). But the observation, did not agree with that of Takaya and Kaneko (2011), who found an association between magnesium deficiency and small for dates babies. However, there are inconsistencies in reports regarding association of magnesium with low birth weight babies. While some authors recommended magnesium supplement in pregnancy to prevent LBW babies (Watson and Mc Donald, 2010; Merialdi *et al.*, 2003) others observed no significant association between maternal magnesium and birth weight of babies (Pourarian *et al.*, 2014; Pathak and Kapil, 2004). Therefore, this study shows that there was an adequate magnesium levels amongst our study group and that the LBW of the infants may be due other factors.

The calcium levels in pregnant women were significantly (p<0.001) lower than the non-pregnant control groups. This observation is consistent with an other study (Baig *et al.*, 2003). They evaluated calcium levels in maternal blood and observed that maternal calcium levels were significantly lower than the non-pregnant women. These findings may be due to the high foetal demand for calcium during pregnancy which tend to exhaust the calcium resources of the body, coupled with the evidence of active placenta transport of calcium beginning from the 12th week of gestation to week 36 (Kronenderg and Kowacs, 1997). The placental calcium transport is dependent upon transport proteins (TRPV6) expressed on the apical membrane of the trophoblast, intracellular calcium-binding proteins (primarily Calbindin-DK9) and active transport into the fetal circulation at the basolateral membrane through the calcium pump $PMCA_3$ (Kronenderg and Kowacs, 1997). The blood Calcium levels of pregnant women who had babies with LBW were significantly lower (p = 0.002) than those with normal birth weight babies. This is in agreement with other authors (Mariko *et al.*, 2011; Baig *et al.*, 2003; Bogden *et al.*, 1978), who reported lower levels of maternal blood calcium in small for dates babies than normal birth weight babies.

The effect of maternal calcium intake on infant growth remains unclear. But since calcium is a primary component of bone and Bone Mineral Content (BMC), it is thought to be related with birth weight (Hernandez-Avila *et al.*, 2000). A positive relationship between maternal calcium intake and infant length or mid-upper circumference has been shown (Mariko *et al.*, 2011; Elizabeth *et al.*, 2008). The result of the effect of calcium supplementation on fetal growth conducted by Purwar *et al.* (1996) for pregnant women shows that larger birth weights were associated with supplementation. The result of our study supported this suggestion.

Conversely, some other researchers reported inconsistent findings of positive relationships between maternal calcium intake and weight of infants (Namgung *et al.*, 1994). However, the hypocalcaemia observed in our study may be contributing factor to the small for dates babies observed in this current study.

In this study, we also compare maternal blood albumin levels according to birth weight and observed a significantly lower levels ($p<0.001$) in women who had small for dates babies than normal birth weight. The observation was consistent with that reported elsewhere in Nigeria (Baba *et al.*, 2012), who observed that maternal albumin was directly proportional to birth weight of babies. But the report from previous studies had it that albumin level was closely related to maternal nutritional status as malnourished women have increased tendencies of having poor albumin status (Eltahir and Gerd, 2008). And that these women could have an increased risk of adverse reproductive outcomes including low birth weight and preterm birth. But it was however argued that the possible effect of maternal albumin deficiency on birth weight of babies may depend on the stage of gestation and that small for dates babies face increased risk of dying since low birth weight is the main contributor to neonatal and under five mortality in Sub-Saharan Africa (Eltahir and Gerd, 2008). It was reported that poor maternal nutrition, which may give rise to low maternal albumin in late gestation was associated with reduced birth weight in babies (Stephenson and Symonds, 2002). But in another study, it was reported that birth weight of babies was normal in mothers who suffered from malnutrition that could lead to low levels of maternal albumin during the first trimester of pregnancy (Lumey, 1998).

However the maternal nutritional status of these women were not taken into account in this present study, but from the demographic information obtained, they were from average Socio-economic class.

The findings from this study show that there was a possible association of maternal albumin levels with small for dates babies but evidence of maternal nutritional status should be addressed in future studies. This however, does not undermine the clinical and public Health significance of our observation.

The mean phosphorus values for pregnant women at the time of delivery was significantly ($p<0.001$) lower than the non-pregnant control groups. This observation was inconsistent with other studies (Baig *et al.*, 2003; Olatunbosun *et al.*, 1976), They reported in their separate studies that phosphorus levels checked at the time of delivery were found similar to non-pregnant levels. But our observation confirms the belief that the demands of pregnancy exhaust the phosphorus resources of the body and that the net absorption of phosphorus was higher in pregnant women compared to non-pregnant women (Fenton *et al.*, 2011). The phosphorus levels were significantly lower ($p<0.001$) in women who had small for dates babies than that with normal birth weight babies. This observation is a reflection of the requirement of phosphorus in fetal bone formation (Fenton *et al.*, 2011).

The proportion of infants with LBW in this study was 12% and is similar to that observed elsewhere in Nigeria (NPC and Macro, 2009) but lower than 15-30% reported from India, Sri Lanka and Nepal (Kapil, 2009; Mavalankar *et al.*, 1992). The birth weight of neonates is a reflection of the health and nutritional status of the mothers as well as an important determinant and likelihood of the infants survival, healthy growth and development.

Conclusion: It was observed that magnesium and albumin levels were significantly higher ($p<0.001$) while calcium ($p = 0.002$) and phosphorus ($p<0.001$) were lower in the blood of pregnant women who gave birth to small for dates babies when compared with those who had babies with normal birth weight. Calcium, magnesium, phosphorus and albumin were associated with small for dates babies. Supplementation of some of these essential elements may help to prevent the delivery of infants with LBW. Therefore measurement of these essential elements may be considered important as part of the routine antenatal investigations especially in patients with previous clinical history of having small for dates babies.

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REFERENCES

Hernandez-Avila, M., K.E. Peterson, T. Gonzalez-Cossio, L.H. Sanin, A. Aro, L. Schnaas and H. Hu, 2000. Effect of maternal bone lead on length and head circumference of new born and 1-month old infants. Arch. Environ. Health, 57: 482-488.

Baba, U.A., A.A. Adebayo, N. Haruna, J. Usman and S.M. Kyari, 2012. Correlation of maternal albumin and birth weight of babies in a Nigerian Teaching Hospital. Int. J. Pub. Health and Epidemiol., 1: 10-13.

Baig, S., N.U. Hasnain and Q. Ud-Din, 2003. Studies on Zn, Cu, Mg, Ca and Phosphorus in maternal and cord blood. J. Pak. Med. Assoc., 53: 417-422.

Bogden, J.D., S.T. Inderjit, B.L. Donald and C. Herik, 1978. Maternal and cord blood metal concentrations and low birth weight- a case-control study. Am. J. Clin. Nutr., 31: 1181-1187.

Elizabeth, K.E., V. Krishnan and T. Vijaykumar, 2008. Umbilical cord blood nutrients in low birth weight babies in relation to birth weight and gestational age. Ind. J. Med. Res., 128: 128-33.

Eltahir, M.E. and S. Gerd, 2008. The effect of maternal antropometric characteristics and social factors on gestational age and birth weight in sudanese newborn infants. BMC. Pub. Health, 8: 244-251.

Fenton, T.R., W.L. Andrew and R. Sarah, 2011. Cord blood Calcium, phosphate, magnesium and alkaline phosphatase gestational age-specific reference intervals for preterm infants. BMC Pediatr., 11: 76.

Fong, B.M.W., T.S. Siu, J.S.K. Lee and S. Tam, 2007. Determination of Mercury in whole blood and urine by Inductively Coupled Plasma Mass Spectrometry. J. Analytic Toxicol., 31: 281-287.

Husain, S.M. and L.P. Sibby, 1993. Magnesium and pregnancy. Miner Electrolytr Metals, 19: 295-307.

Kapil, U., 2009. Multiple micronutrient supplements will not reduce incidence of low birth weight. Ind. J. Com. Med., 34: 85-86.

Khoushabi, F. and G. Saraswathi, 2010. Association between nutrition status and birth weight of neonates in selected hospitals in Mysore city, India. Pak. J. Nutr., 9: 1124-1130.

Kronenderg, F.N. and Kowacs, 1997. Magnesium chemistry and biochemistry. Biometals, 15: 203-210.

Lumey, L.H., 1998. Reproductive outcomes in women prenatally exposed to undernutrition: a review of findings from the Dutch famine birth cohort. Proceed Nutr. Soc., 57: 129-135.

Mariko, E.A., A. Keshavarzian and G.M. Mutlu, 2011. Hyperalbuminaemia and elevated transaminases associated with high protein diet. Scand J. Gastroenterol., 41: 750-760.

Mavalankar, D.V., R.H. Gray and C.R. Trivedi, 1992. Risk factors for preterm and term low birth weight in Ahmedabad, India. Int. J. Epidemiol., 21: 263-272.

Merialdi, M., G. Carroli, J. Villar, E. Abalos, A.M. Gulmezoglu and R. Kulier *et al*., 2003. Nutritional interventions during pregnancy for the prevention or treatment of impaired fetal growth: An overview of randomized controlled trials. J. Nutr., 133: 1626-1631.

Muthayya, S., 2009. Maternal nutrition and low birth weight- what is really important? Ind. J. Med. Res., 130: 600-608.

Namgung, R., R.C. Tsang, B.L. Specker, R.I. Sierra and M.L. Ho, 1994. Low bone mineral content and high serum osteocalcin and 1,25-dihydroxy vitamin D in summer- versus winter-born newborn infants: an early fetal effect? J. Pediatr. Gastroenter. Nutr., 19: 220-227.

National Population Commission (NPC) (Nigeria) and ORC Macro, 2009. Demographic and Health Survey, 2008, Calverton, Maryland: National Population Commission and ORC Macro.

Olatunbosun, D.A., J.O. Bolodeoku, T.O. Cole and B.K. Adadevoh, 1976. Relationship of serum copper and zinc to human hypertension in Nigerians. Bull. World Health Org., 53: 34-35.

Pathak, P. and U. Kapil, 2004. Role of trace elements zinc, copper and magnesium during pregnancy and its outcome. Ind. J. Pediatr., 71: 1003-1005.

Pourarian, S.H., N.Z. Bahia and T. Faranak, 2014. The Relationship between Maternal Serum Magnesium Level and Infant Low Birth Weight in Iran. Iranian J. Neonatol., 5: 5.

Purwar, M., H. Kulkarni, V. Motghare and S. Dhole, 1996. Calcium supplementation and prevention of pregnancy induced hypertension. J. Obstet. Gynaecol. Res., 22: 425-430.

Sherwani, S., N. Hasnain and S. Qadiruddin, 1998. Magnesium status in maternal and cord blood. J. Pak. Med. Assoc., 48: 32-33.

Singh, M., S. Jain and M. Choudhary, 2009. Dietary adequacy of pregnant women of four district of Rajasthan. J. Hum. Ecol., 25: 161-165.

Stephenson, T. and M.E. Symonds, 2002. Maternal nutrition as a determinant of birth weight. Arch. Dis. Child Fetal Neonatal, 86: 4-6.

Takaya, J. and K. Kaneko, 2011. Small for gestational age and magnesium in cord blood platelets: Intrauterine Magnesium deficiency may induce metabolic syndrome in later life. J. Pregnancy, Article ID 270474.

UNICEF and WHO, 2004. State of World Children, UNICEF-2004, available at http://www.unicef.org/publications/index.html.

Watson, P.E. and B.W. McDonald, 2010. The association of maternal diet and dietary supplement intake in pregnant New Zealand women with infant birth weight. Eur. J. Clin. Nutr., 64: 184-193.