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Correlation of Maternal Serum ionic calcium and Magnesium Levels with Foetal Outcome

[1]Dr Premlata Mital, [2]Dr Saloni Sethi, [3]Dr Ankita Chaudhary, [4]Dr Nupur Hooja* [5]Dr Aditi Arora, [6]Dr Vikas Kumar Kasana
[1,4]Senior Professor, [2, 3, 5, 6]PG Student
Department of Obstetrics and Gynaecology, S.M.S. Medical College, Jaipur 302004

***Corresponding Author:**
Dr Nupur Hooja
Department of Obstetrics and Gynaecology, S.M.S. Medical College, Jaipur 302004

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ABSTRACT

Introduction: Pregnancy is associated with increased demand of all the nutrients like calcium, iron, zinc, copper, and other micronutrients. Low levels of calcium and magnesium can lead to preeclampsia, low birth weight, preterm delivery, foetal low bone mineral density and caesarean section. The main objective of the present study was to measure serum ionic calcium and magnesium in women in their third trimester and to assess the relationship between maternal serum ionic calcium and magnesium and birth weight.

Material and Methods: 100 women with live singleton pregnancy with gestational age between 28 to 36 weeks and willing to participate in the study were included in the study. Serum ionic calcium and magnesium were measured foetal outcome was noted. Results were analysed.

Results: Birth weight was significantly more in women with normal serum ionic calcium levels than in women with below normal levels (2.63±0.51 vs 2.37±0.62; p=0.02). There was no significant difference in mean APGAR score, NICU admission and perinatal mortality. Birth weight was significantly more in women with normal magnesium levels than in women with below normal magnesium levels (2.58±0.52 vs 2.33±0.5 kg; p=0.04). NICU admission of the babies (33.3% vs 6.8%; p=0.000) and perinatal mortality (25.9% vs 535%; p=0.003) was significantly more in women having below normal magnesium levels than in women with normal magnesium levels.

Conclusion: Low serum ionic calcium and magnesium are associated with low birth weight. Counselling of each women attending antenatal clinic regarding consumption of food rich in calcium and magnesium should be done. Calcium and magnesium should be supplemented if needed.

Keywords: S. Calcium, S. Magnesium, Birth Weight, Perinatal Mortality.

INTRODUCTION

Nutrition is an important health determinant that can affect the course of pregnancy and its outcomes. Foetal development depends mainly on genetic makeup, maternal nutrition and fetoplacental circulation[1]. This development is especially susceptible to the effects of environmental risk factors that disrupt the processes during a critical window of vulnerability [2,3]. Maternal diets during pregnancy need to provide energy and nutrients for the mother as well as for foetal growth [4]. Poor maternal nutrition during pregnancy, particularly during the third trimester, is a major cause of low birth weight in developing countries [5]. Pregnancy is associated with increased demand of all the nutrients like calcium, iron, zinc, copper, and other micronutrients. Many minerals are transferred to the foetus for foetal stores in the latter part of the pregnancy, although they may play important developmental role throughout pregnancy. Mineral deficiencies are also considered to be contributing factors in premature birth, miscarriage, intrauterine growth restriction, birth defects, and immune system impairment. [6]

Calcium, iron, zinc, copper and magnesium are essential elements required for the normal growth and development of the foetus [7]. Calcium is the most abundant mineral in our body [8]. Bones contain 99% of total body $Ca^{2+}$and about 1% is freely available in the extracellular fluid. The recommended daily calcium is 1000 mg/day (>18yrs). The maternal demand for calcium during pregnancy is elevated by 300mg/day. Pregnancy causes a tremendous shift in maternal calcium metabolism as calcium becomes important for the foetal bone mineralization. Calcium is transported from the mother to the foetus throughout pregnancy through the placenta in large amounts mainly during the third trimester. This active transport of calcium occurs by a magnesium adenosine triphosphatase -dependent Ca^{2+} pump. It transfers nearly 150 mg of Ca/kg of foetal weight/day (approximately 80%) in the third trimester. Various calcium binding proteins play a role in this transport. Vitamin D helps in the synthesis of these calcium binding proteins.[9] Pregnancy is a period of high calcium demand because of foetal requirement. The plasma total calcium concentration is in the range of 2.2-2.6 mmol/L (9-10.5 mg/dL), and the normal ionized calcium is 1.3-1.5 mmol/L (4.5-5.6 mg/dL). Pregnancy entails number of physiological events with implications regarding calcium metabolism: the extracellular fluid expands, the albumin level decreases, the glomerular filtration rate increases causing increase in calciuria and calcium is also removed from the maternal system by transfer to foetus. These mechanisms all tend to promote lowering of maternal calcium concentration and present pregnant women for maintaining the levels within the narrow range necessary to preserve homeostasis.[10] Lowering of maternal calcium levels can lead to preeclampsia, low birth weight, preterm delivery, fetal low bone mineral density and caesarean section.[11]

Magnesium (Mg) is the second most abundant intracellular cation and is vital for a multitude of cellular functions and enzymes. Magnesium is a cofactor for more than 300 enzymes in the body. It is required for enzyme substrate formation (Mg+2ATP). It acts as a catalytic co-factor for numerous biochemical reactions in the body, as a regulator of ion channels by stabilisation of cellular membranes, and is essential for various metabolic pathways such as glycolysis, oxidative phosphorylation, including protein and nucleic acid synthesis.[11] The normal plasma magnesium concentration is 1.7-2.4 mg/dl. Generally hypomagnesaemia in most of pregnant women is associated with haemodilution, renal clearance, consumption of minerals by the growing foetus. There is decrease in ionized and total magnesium levels with increasing gestational age during normal pregnancy.[12] Magnesium supplementation during pregnancy was associated with significantly fewer maternal hospitalizations, a reduction in preterm delivery, and less frequent referral of the newborn to the neonatal intensive care unit and increase birth weight. [13,14]

The micronutrient profile in maternal body will influence the normal growth and development of the foetus in the womb. The main objective of the present study was to measure serum ionic calcium and magnesium in women in their third trimester and to assess the relationship between maternal serum ionic calcium and magnesium and birth weight.

MATERIAL AND METHODS

This was a hospital based observational study done in the department of Obstetrics and Gynaecology, S M S Medical College, Jaipur. 100 women with live singleton pregnancy with gestational age between 28 to 36 weeks and willing to participate in the study were included in the study after taking informed consent. Women with medical disorders, congenital malformation of foetus, PROM were excluded. Detailed history and physical examination including blood pressure and urine for protein and other baseline investigations were done. Serum ionic calcium and magnesium were measured. Women were followed till delivery and foetal outcome was noted, Data were entered in MS excel sheet and statistically analysed.

The following values were taken to be as the reference range for calcium & magnesium

Serum ionic Calcium: 4.2 - 5.5 mg/dL

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Serum Magnesium: 1.6 – 2.3 mg/dL

RESULTS

Table 1 shows mean serum ionic calcium and magnesium levels with age and gravidity of the women. Majority of the women were above 25 years (67%) and multigravida (61%). There was no significant difference in serum ionic calcium and magnesium levels in terms of age. Serum ionic calcium and magnesium levels were significantly more in primigravida (p=0.03 and 0.04 respectively).

Table 2 shows serum ionic calcium and magnesium levels with foetal outcome. 64% women had normal serum ionic calcium (4.2 -5.5 mg/dl) while 78% women had normal serum magnesium (1.6 – 2.3 mg/dl). Gestational age was significantly more in women with normal serum ionic calcium levels than in women with below normal levels (35.4±1.9 vs 34.2±3.02; p=0.005). Birth weight was significantly more in women with normal serum ionic calcium levels than in women with below normal levels (2.63±0.51 vs 2.37±0.62; p=0.02). There was no significant difference in mean APGAR score, NICU admission and perinatal mortality in women with normal serum ionic calcium levels than in women with below normal levels. There was no significant difference in mean gestational age and mean APGAR score in women with normal magnesium levels than in women with below normal magnesium levels. Birth weight was significantly more in women with normal magnesium levels than in women with below normal magnesium levels (2.58±0.52 vs 2.33±0.5 kg; p=0.04). NICU admission of the babies (33.3% vs 6.8%; p=0.000) and perinatal mortality (25.9% vs 535%; p=0.003) was significantly more in women having below normal magnesium levels than in women with normal magnesium levels.

A positive correlation was observed between birth weight and serum ionic calcium levels though the relation between the variables was very weak. The R^2 is 0.1051, it means 10% of the total variation in birth weight is explained by the linear relation with serum ionic calcium. A positive correlation was observed between birth weight and serum magnesium levels though the relation between the variables was very weak. (Table 3; Graph 1&2))

A positive correlation was observed between APGAR score and serum ionic calcium levels though the relation between the variables was very weak. The R^2 is 0.0623, it means 6% of the total variation in APGAR score is explained by the linear relation with serum ionic calcium. A positive correlation was observed between APGAR score and serum magnesium levels though the relation between the variables was very weak. (Table 4; Graph 3&4))

DISCUSSION

Hypomagnesaemia was seen in 22% of the pregnant women in our study which was in contrast to that observed by Pathak P et al [15] and S Mangalesh et al [16]. In their study hypomagnesaemis was prevalent in 43.6% and 40% women respectively. Inadequate intake of magnesium, increased metabolic demand of pregnancy and physiological hemodilution in pregnancy were suggested as the main reasons for low levels of magnesium in pregnancy.[17] Hypocalcemia was seen in 36% women in our study. According to Malas NO and Shurideh ZM during pregnancy due to the increase in glomerular filtration rate, calciuria increases along with removal of more calcium by transfer it to the foetus so maternal calcium levels down.[18] Calcium requirement increase in pregnancy and this increase reached at peak in third trimester which may cause the hypocalcaemia.[19]

Mean serum ionic calcium was significantly more in primigravida than in multi gravida (p=0.03) which is in agreement with the study done by Deepika Chandrasekaran et al.[8] Mean Magnesium levels in our study was 1.81±0.42 mg/dl which was consistent with findings of Pathak et al[15], Aziz R, Mahboob T[20], Indumati et al[21] and Fahimeh Khoushabi et al[22] while the mean serum magnesium levels in normal pregnant women was higher in the studies done by Punthumapol and Kittichotpanich[23] and Rajendra Kumar Chaudhari et al[24] but lower in the study done by Deepa V Kanagal et al.[25] Mean ionic calcium levels in our study was 3.94±1.15 mg/dl which was lower than that observed by Indumati et al[21].

In present study, pregnant women who gave birth to low birth weight babies had low levels of calcium and magnesium levels than the pregnant women who gave birth to normal neonates. Similar results have been reported in Turkey[26] and Iran[27] and Fahimeh Khoushabi et al[22]

In our study there was a weak positive correlation between serum ionic calcium and birth weight, our finding are in close agreement with studies done in California[28], UK[29], Korea[30] and Iran[31]which reported there were significant association between maternal calcium, iron and zinc with birth weight of neonates. Maternal serum magnesium levels were positively correlated with birth weight (r = 0.0057, p=0.4) which was statistically not significant. Our results are in agreement with study of S Mangalesh et al[16], they observed maternal serum Mg levels were positively correlated with birth weight (r- value =0.205, p-value <0.05)

Limited data is available on the role of calcium and magnesium from Rajasthan where the diet is deficient of the necessary elements. High risk women with low calcium and magnesium intake will be benefited with supplementation. The recommended dietary allowance in the USA recommends that pregnant women should take 1 to 1.5 gms of calcium daily for pre-eclamptic complication prevention[32]. Milk, soy milk, yogurt, cheese and vegetables like cabbage, broccoli, almonds, sardine and salmon with bones and calcium fortified orange juice are good sources of calcium. The daily requirement of magnesium is about 350mg/day.[33] Foods rich in magnesium include whole grains, nuts and green vegetables. Green leafy vegetables are particularly good sources of magnesium. Counselling of each women attending ante natal clinic regarding consumption of food rich in calcium and magnesium should be done.

CONCLUSION

In present study serum ionic calcium and magnesium are positively associated with birth weight so serum calcium and magnesium should be measured in all pregnant women attending antenatal clinic. Every woman should be counselled regarding consumption of food rich in calcium and magnesium.

REFERENCES

1. Kontic-Vucinic O, Sulovic N, Radunovic N. Micronutrients in women's reproductive health: II. Minerals and trace elements. Int J Fertil Womens Med. 2006;51:116–24.
2. Grandjean P, Bellinger D, Bergman A, Cordier S, Davey-Smith G, Eskenazi B, Gee D, Gray K, Hanson M, van den Hazel P, Heindel JJ, Heinzow B, Hertz-Picciotto I, Hu H, Huang TT, Jensen TK, Landrigan PJ, McMillen IC, Murata K, Ritz B, Schoeters G, Skakkebaek NE, Skerfving S, Weihe P. The faroes statement: human health effects of developmental exposure to chemicals in our environment. Basic Clin Pharmacol Toxicol. 2008 Feb;102(2):73-5. doi: 10.1111/j.1742-7843.2007.00114.x. PMID: 18226057.
3. Vrijheid M, Casas M, Bergström A, Carmichael A, Cordier S, Eggesbø M, Eller E, Fantini MP, Fernández MF, Fernández-Somoano A, Gehring U, Grazuleviciene R, Hohmann C, Karvonen AM, Keil T, Kogevinas M, Koppen G, Krämer U, Kuehni CE, Magnus P, Majewska R, Andersen AM, Patelarou E, Petersen MS, Pierik FH, Polanska K, Porta D, Richiardi L, Santos AC, Slama R, Sram RJ, Thijs C, Tischer C, Toft G, Trnovec T, Vandentorren S, Vrijkotte TG, Wilhelm M, Wright J, Nieuwenhuijsen M. European birth cohorts for environmental health research. Environ Health Perspect. 2012 Jan;120(1):29-37. doi: 10.1289/ehp.1103823. Epub 2011 Aug 29. PMID: 21878421; PMCID: PMC3261945.
4. King, J.C. Physiology of pregnancy and nutrient metabolism. Am J Clin Nutr 2000. 71: p. 1218S–25S.
5. Ladipo, O. Nutrition in pregnancy: mineral and vitamin supplements. Am J Clin Nutr 2000. 72: p. 280S–90S.
6. Kocyłowski R, Lewicka I, Grzesiak M, Gaj Z, Oszukowski P, von Kaisenberg C, Suliburska J. Evaluation of Mineral Concentrations in Maternal Serum Before and After Birth and in Newborn Cord Blood Postpartum-Preliminary Study. Biol Trace Elem Res. 2018 Apr;182(2):217-223. doi: 10.1007/s12011-017-1109-9. Epub 2017 Aug 1. PMID: 28762093; PMCID: PMC5838124.
7. Moghaddam Tabrizi F, Saraswathi G. Maternal Nutrient Intake and Maternal Serum Micronutrients and Their Relation to Birth

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Weight-A longitudinal study. International Journal of Collaborative Research on Internal Medicine & Public Health. 2011; 3(8):617-632.

8. Deepika Chandrasekaran, SheelaRavinder S, Padmavathi R and Jaya Vijayaraghavan. Effect of Maternal Serum ionic calcium on Fetal Birth Weight. IOSR Journal of Nursing and Health Science. Volume 4, Issue 5 Ver. II (Sep. - Oct. 2015), PP 20-23
9. Dawodu A, Tsang RC. Maternal vitamin D status: effect on milk vitamin D content and vitamin D status of breastfeeding infants. Adv Nutr. 2012 May 1;3(3):353-61. doi: 10.3945/an.111.000950. PMID: 22585912; PMCID: PMC3649470.
10. Grandjean P, Bellinger D, Bergman A, Cordier S, Davey-Smith G, Eskenazi B, et al. The faroes statement: human health effects of developmental exposure to chemicals in our environment. Basic Clin Pharmacol Toxicol. 2008;102:73–5.
11. Romani AM. Cellular magnesium homeostasis. Arch Biochem Biophys. 2011;512(1):01-23.
12. Tong GM, Rude RK. Magnesium deficiency in critical illness. J Intensive Care Med. 2005;20:3-17.
13. Seyed Mohammadreza Parizadeh, Ashraf Mohammadzadeh, Ahmadshah Farhat, Laya Valaee, Mohammad Khajedaluee, and Gholamreza Faal. Maternal Serum Magnesium Level and Low Birth Weight Neonate. Int J Prev Med. 2013 Dec; 4(12): 1476–1479
14. Makrides M, Crowther CA. Magnesium supplementation in pregnancy (Review) Cochrane Database Syst Rev. 2012;10:CD000937.
15. Pathak P, Kapil U, Kapoor SK, Saxena R, Kumar A, Gupta N, et al. Prevalence of multiple micronutrient deficiencies amongst pregnant women in a rural area of Haryana. Indian J Pediatr. 2004;71(11):1007-14.
16. S Mangalesh, Kanchan Kulhari, Bhasker Mukherjee, KS Rajmohan, BD Toora. The Magnesium Story in Pregnancy-Levels in Maternal and Cord Blood-Correlation with Pregnancy Outcome. Journal of Clinical and Diagnostic Research. 2019 Oct, Vol-13(10): BC01-BC05
17. Touy ZRM. Role of magnesium deficiency in pathogenesis of hypertension. Mol Aspects Med. 2003;24:107-36.
18. Chaurasia PP, Jadav PA, Jasani JH. Changed in Serum ionic calcium and Serum Magnesium Level In Pre-eclamptic VS Normal Pregnancy. *IJBAR*. 2012;3(6):511–3.
19. Kim J, Kim YJ, Lee R, Moon JH, Jo I. Serum levels of zinc, calcium, and iron are associated with the risk of preeclampsia in pregnant women. Nutr Res. 2012; 32: 764-769.
20. Aziz R, Mahboob T Serum ionic calcium, Magnesium and Parathyroid Hormone in Normal Pregnant and Pre-eclamptic Women in Karachi, Pakistan. J Hypertens. 2014. 3: 143. doi:10.4172/2167-1095.1000143
21. Indumati V, Kodiwadmath M.V. and Sharma M.K. The role of serum electrolyte in pregnancy induced hypertension. Journal of clinical and diagnostic Research, Feb 2011; 5(1): 66-69.
22. Fahimeh Khoushabi, Mohammad Reza Shadan, Ali Miri, and Javad Sharifi-Rad. Determination of maternal serum zinc, iron, calcium and magnesium during pregnancy in pregnant women and umbilical cord blood and their association with outcome of pregnancy. Mater Sociomed. 2016 Apr; 28(2): 104-107
23. Punthumapol C, Kittichotpanich B. Serum ionic calcium, magnesium and uric acid in Preeclampsia and normal pregnancy. J Med Assoc Thai. 2008; 91(7): 968-73.
24. Rajendra Kumar Chaudhari, Apeksha Niraula, Mahima Bataju, Jouslin Kishore Baranwal, Seraj Ahmed Khan, Rabindra Dev Bhatt, Shailaja Chettri, madhab Lamsal. Serum ionic calcium and Magnesium levels in Pre-

eclampsia. National Journal of Laboratory Medicine. 2018, Oct, Vol-7(4):BO01-BO06

25. Kanagal DV, Rajesh A, Rao K, et al. Levels of Serum ionic calcium and Magnesium in Pre-eclamptic and Normal Pregnancy: A Study from Coastal India. J Clin Diagn Res. 2014;8(7):OC01-OC4. doi:10.7860/JCDR/2014/8872.4537
26. MaraI, I, Baykan Z, Savcak B, Aksakal FN. Unal A, Kayikcioglu F, Bumin MA. The Relationship Between Maternal Zinc Level and Infant Birth Weight. Gazi Medical Journal, 2001. 12: p. 179-182.
27. Farhat, A., et al., Relationship between low birth weight neonate and maternal serum copper level. Journal of Chinese Clinical Medicine. 2008. 3(12): p. 658-64.
28. Allen, L.H. Anemia and iron deficiency: effects on pregnancy outcome. Am J Clin Nutr, 2000. 71: p. 1280S–4S.
29. Baker PN, Wheeler SJ, Sanders TA, Thomas JE, Hutchinson CJ, Clarke K, Berry JL, Jones RL, Seed PT, Poston L. A prospective study of micronutrient status in adolescent pregnancy. Am J Clin Nutr. 2009 Apr;89(4):1114-24. doi: 10.3945/ajcn.2008.27097. Epub 2009 Feb 25. PMID: 19244368.
30. Lee, H., Kim, M., Kim, M. *et al.* Iron status and its association with pregnancy outcome in Korean pregnant women. *Eur J Clin Nutr* **60,** 1130–1135 (2006). https://doi.org/10.1038/sj.ejcn.1602429
31. Hadipour, R, Norimah AK, Poh B, Fproozehchain F. Haemoglobin and Serum Ferritin Levels in Newborn Babies Born to Anaemic Iranian Women: a Cross-Sectional Study in an Iranian Hospital. Pakistan Journal of Nutrition 2010. 9(6): p. 562-566.
32. Sukonpan K, Phupong V. Serum ionic calcium and serum magnesium in normal and pre-eclamptic pregnancy. Arch Gynecol Obstet. 2005;273: 12–6
33. Oladapo A Ladipo. Nutrition in pregnancy: mineral and vitamin supplements. Am J Clin Nutr. 2000; 72:280S–90S

Table 1: S. calcium and magnesium levels with age and gravidity

Variables	Groups	S Calcium	P value	S. Magnesium	P value
Age (years)	<25 (33)	4.0±0.98	0.3	1.86±0.4	0.3
	≥25 (67)	3.78±1.3		1.78±0.45	
Gravida	Primi (39)	4.21±0.79	0.03	1.87±0.35	0.04
	Multi (61)	3.69±1.17		1.71±0.41	

Table 2: S. calcium and magnesium levels and foetal outcome

Variables	S. Calcium		P value	S. Magnesium		P value
	Normal (n=64)	Below normal (n=36)		Normal (n=78)	Below normal (n=22)	
Gestational Age (Weeks)	35.4±1.9	34.2±3.02	0.005	34.6±2.68	33.8±1.91	0.1
Birth Weight (Kg)	2.63±0.51	2.37±0.62	0.02	2.58±0.52	2.33±0.5	0.04
APGAR Score	7.94±1.16	7.5±1.46	0.1	7.9±1.08	7.4±1.05	0.05
NICU admission present	6 (13%)	8 (14.8%)	0.7	5 (6.8%)	9 (33.3%)	0.000
Perinatal Mortality present	5 (10.8%)	6 (11.1%)	0.9	4 (5.5%)	7 (25.9%)	0.003

Table 3: Pearson Correlation of baby weight with S. Calcium and S. Magnesium

n = 100	Mean ± SD	R	R Square	Equation	P-value
Birth Weight	2.54±0.56				
S. Calcium	3.94±1.15	0.3242	0.1051	Y = 0.1526*X + 1.951	0.001
S. Magnesium	1.81±0.42	0.0752	0.0057	Y = 0.0972*X + 2.363	0.4

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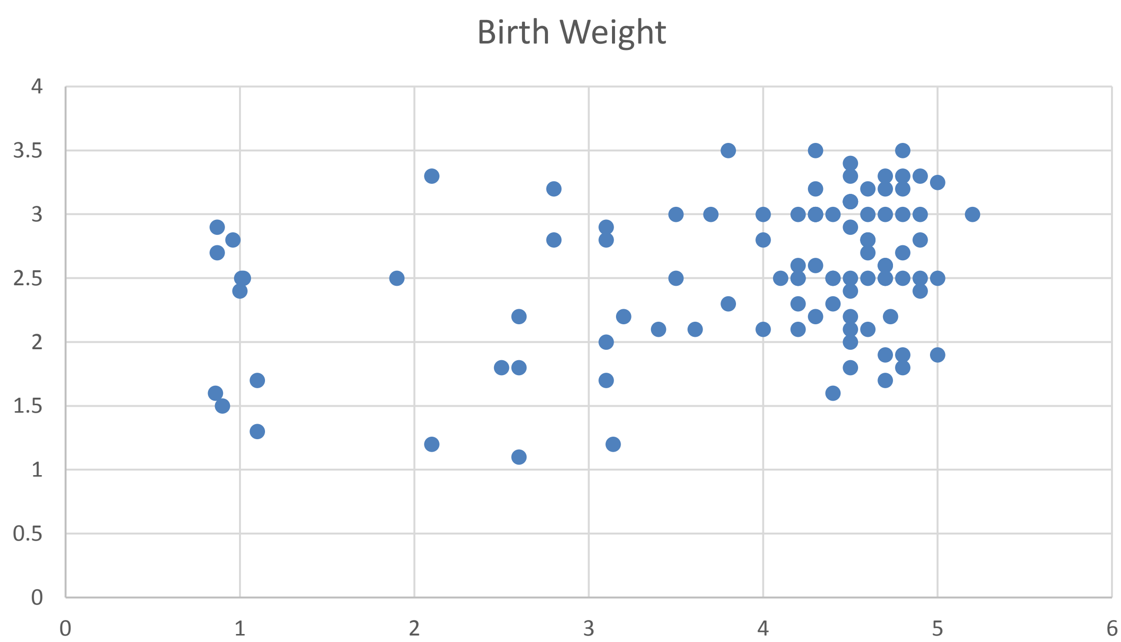
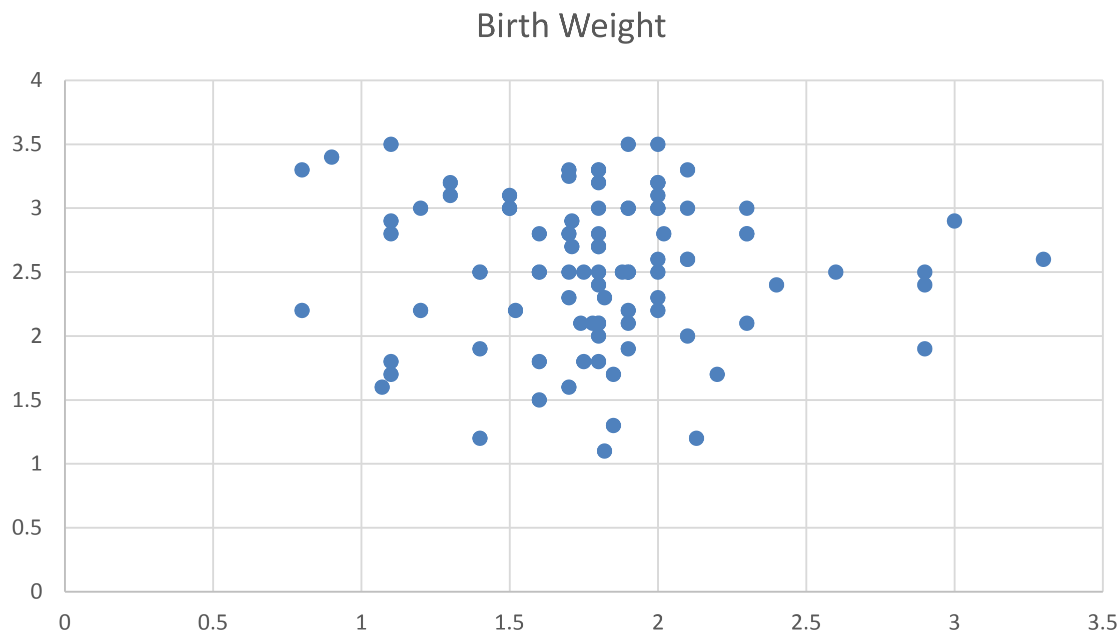
Table 4: Pearson Correlation of APGAR with S. Calcium and S. Magnesium

n = 100	Mean ± SD	R	R Square	Equation	P-value
APGAR Score	7.1±1.46				
S. Calcium	3.94±1.15	0.2496	0.0623	Y = 0.2673*X +6.750	0.01
S. Magnesium	1.81±0.42	0.1493	0.0223	Y = 0.4395*X +6.983	0.1

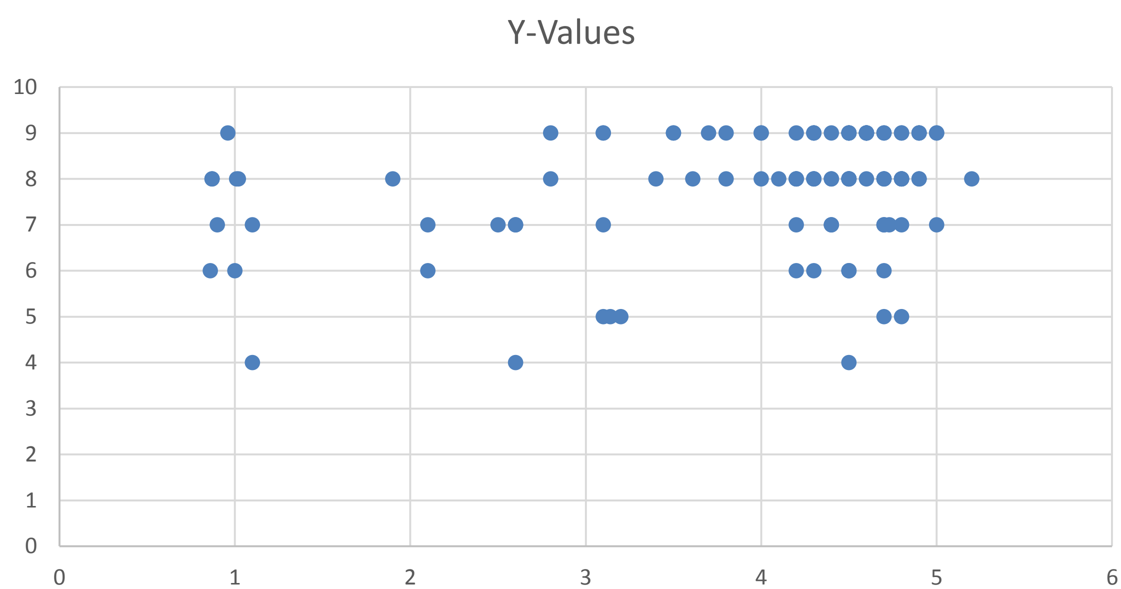


Graph 1: Correlation of serum ionic calcium and birth weight" X axis: S Calcium (mg/dl); Y axis: Birth Weight (Kg)



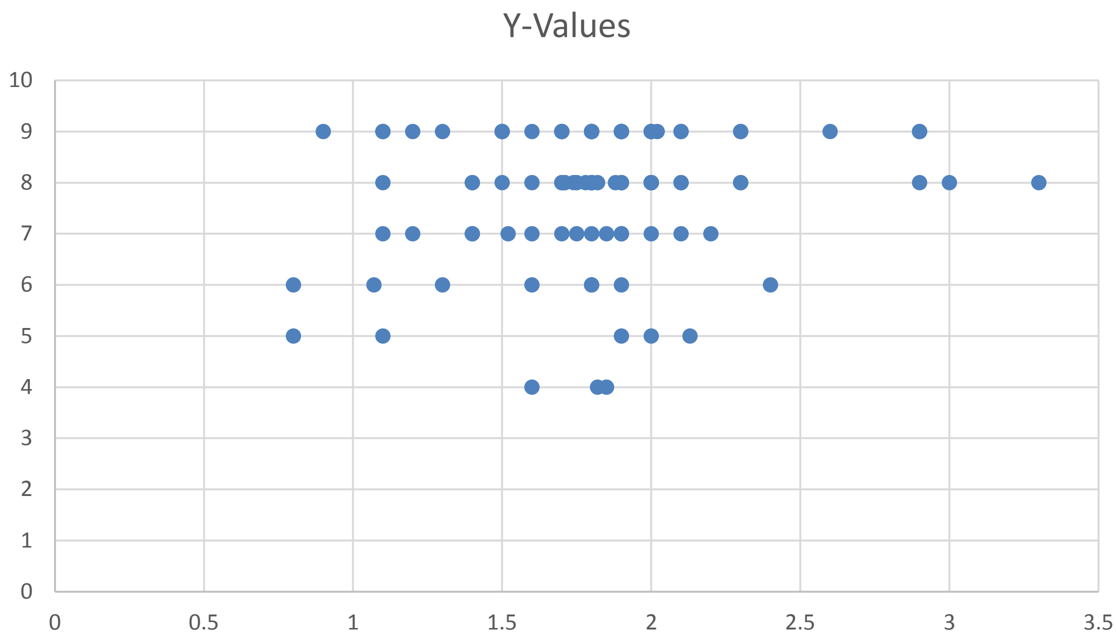
Graph 2: Correlation of serum magnesium and birth weight

X axis: S. Magnesium (mg/dl); Y axis: Birth weight (Kg)



Graph 3: Correlation of serum ionic calcium and APGAR Score

X axis: S Calcium (mg/dl); Y axis: APGAR Score



Graph 4: Correlation of serum magnesium and APGAR score

X axis: S Magnesium (Mg/dl); Y axis: APGAR Score