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Original Research Article

Estimation of serum levels of magnesium in antenatal women in a tertiary health centre

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ABSTRACT

Context: Magnesium is an important macrominerals required for various functions in our body and also as a cofactor for several enzymes. Magnesium deficiency in pregnancy due to decreased intake or increased demands may lead to complications like eclampsia, pre eclampsia, IUGR, gestational diabetes mellitus, low birth weight etc. Hence we aim to estimate magnesium levels in antenatal women attending a tertiary care centre in North Kerala.

Aim of Study: 1. To estimate the levels of Serum Magnesium in antenatal women. 2. Compare the level of Magnesium with Hb, random blood glucose and Blood Pressure levels. 3. Determine sociodemographic profile of antenatal cases.

Settings and Design: This observational study was conducted in department of Biochemistry, GMC, Kannur from February 2020. All antenatal cases attending OBG OPD, GMC, Kannur, age between 18-35 years were included in the study while women with comorbidities and pregnancy complications were excluded from the study.

Materials and Methods: Biochemical parameters like blood sugar, hemoglobin, HBA1C, were assayed on fully automated analyser, Se. Magnesium was assayed on a semi automated analyser by calmagite kit method. Patient biodata, history, clinical parameters and other relevant details were collected in prestructured formats.

Results: Total 30 patients were selected in this study. The age of patients ranged from 20 to 36 years with mean age 27.83 + 4.53 years. The mean Magnesium level in the study participants was 1 + 0.32 mg/dl. In our study participants reported 0 still birth, and 2 (6.7%) had abortions. Majority of them 90% had oedema of lower limbs. Participants had no history of pre-existing illnesses like hypertension hypercholesterolemia, diabetes mellitus, hypothyroidism, etc. There was a week positive correlation of Magnesium with systolic and diastolic blood pressure, and by comparing the levels of Magnesium with Haemoglobin and Blood pressure, they are not significant.

Conclusion: Determination of Magnesium deficiency in the pregnancy can help in initiating appropriate supplementation and prevention of untoward complications, associated with Magnesium deficiency. Also, such studies, have not been conducted in this part of Kerala and will help to provide more information related to the topic.

1. Introduction

Magnesium (Mg) is a critical mineral in the human body governing the activity of hundreds of enzymes encompassing ~ 80% oh known metabolic function.[1]

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Magnesium helps keep blood pressure normal, bones strong, and the heart rhythm steady. It contributes to bone matrix development and is required for the synthesis of biomacromolecules including DNA, RNA, and protein.[2] Only 1% of magnesium is found in blood, but the body works very hard to keep blood levels of magnesium content. Magnesium is primarily found within the cell,[3] where it acts as a counter ion for the energy rich ATP and nuclear acids. Magnesium is a cofactor in more than 300 enzymatic reactions. Cunnjinghan et al revealed that Magnesium contributes to the regulation of vascular tone, heart rhythm, platelet activated thrombosis and bone formation.[4] Magnesium works with many enzymes to regulate body temperature, synthesis of nucleic acids and proteins as well as role in maintaining nerve and muscle cell electrical potentials.[5]

Spices, nuts, cereals, cocoa, and vegetables are rich source of Magnesium. Magnesium absorption occurs primarily in the ileum and colon. Magnesium intake depends on the Magnesium concentration in drinking water and foods. Intravenous or injected Magnesium is used to treat eclampsia during pregnancy and severe asthma attacks. Magnesium is the main ingredient in many antacids and laxatives. A daily intake (DI) of 300mg for men and 270mg for women, is necessary to maintain Magnesium balance under typical physiological conditions.[6] The normal range for blood Magnesium level is 1.7 to 2.2 mg/dl (0.85 to 1.10 mmol/l).[7] Dietary intake studies during pregnancy consistently demonstrate that many women especially those from disadvantaged backgrounds, have intakes of Magnesium below the recommended levels[8] and in different trimesters the levels of magnesium vary slight different.

Magnesium has established its role in obstetrics with its relationship to both fetal and maternal well-being. Magnesium is one of the important mineral which is required for cell multiplication in a growing fetus and is an essential element of life chemistry, keeping a balanced neuromuscular system.[9]

The maternal serum Magnesium concentration rises slightly in early pregnancy, returning to non-pregnant levels by end of pregnancy.[10] Maternal levels are slightly below and correlated with those of the infant at delivery.[11] Magnesium is probably actively transported to the fetus.[12] The normal fetus contains 1g of Magnesium, which is acquired primarily during the last 2 trimesters at a rate of about 6mg/day.

In pregnancy period Magnesium level declines from a preconception mean of 0.93 mmol/L to 0.63mmol/L, in the third trimester.[13] A study measuring serum Magnesium during low risk pregnancies reported that both ionized and total serum Magnesium were significantly reduced after the 18^{th} week of gestation compared to measurement before this time.[14] Common causes of Magnesium deficiency include inadequate dietary intake or gastrointestinal absorption, increased losses through the gastrointestinal or renal systems, and increased requirement of Magnesium, such as in pregnancy.[15] Pregnant women tend to have low magnesium level than non-pregnant because of increased demand of mother and growing fetus and increased renal excretion of magnesium i.e. 25% more than non-pregnant women due to increase GFR (glomerular filtration rate) in the second and third trimester.[16] Suggested reason for the low levels of Magnesium in pregnancy include inadequate intake, increased metabolic demand of pregnancy, especially as gestation advances, physiological haemodilution in pregnancy, and increasing parity.[10] Therefore the serum levels of total magnesium during normal pregnancy seem inconclusive. Studies from different regions report a decline in Magnesium levels during pregnancy with values reaching their lowest point at the end of the 1^{st} trimester. Seasonal fluctuations (5% lower in summer) in maternal blood levels were reported in some studies,[17] but not in others.[18] In 1977 Reitz et al;[19] observed that the maternal serum Magnesium concentration rises slightly in early pregnancy, returning to non-pregnant levels by late pregnancy.

The low concentration of Magnesium in serum exposes the subject to a risk of pregnancy complications like hypertension, pre-eclampsia, IUGR (intra- uterine- growth retardation), pre-term labour, low birth weight baby, and SIDS (sudden infant death syndrome).[20] Roman et al. showed that maternal oral Magnesium supplementation reduced pregnancy induced IUGR by 64% and suppressed cytokine/chemokine levels in the individual amniotic fluid and placentas.

Various studies have focused on the effect of Magnesium on prevention or treatment of various pregnancy complications or pathological conditions in pregnancy period. Dietary intake studies during pregnancy consistently demonstrate that many women have intake of Magnesium below recommended levels.

It has also been declared that benefit of Magnesium during pregnancy is noticeable, and Magnesium supplementation prevents many ill effects in pregnant women. Duley in 2010[21,22] observed that the beneficial effect of Magnesium in oral Magnesium supplement group included decrease in pre-eclampsia, lower pre-term birth, as well as lower rate of LBW. Likewise, Magnesium compounds like $MgSO_4$ were found to be efficient for pre-eclampsia and eclampsia.

In his observational study, Shaikh et al found that in pregnancy outcomes such as toxaemia of pregnancy, preterm birth, intra Uterine Growth Restriction (IUGR), and leg cramps, pregnant women with hypomagnesemia have more frequent complications than normal groups.[23] Numerous studies assessed the effect of Magnesium supplement in preventing increase of diastolic blood pressure during the last weeks of pregnancy.[24]

Pathak et al.[10] reported that higher parity was associated with higher rates of lack of magnesium among rural Indian women in a community based cross-sectional study. However, Kapil et al[25] studied urban Indian dwellers and reported Magnesium deficiency in only 4.6% of all pregnant women included in the study.

Many studies showing that magnesium levels decline as pregnancy advances have also reported improvements in magnesium status with supplementation leading to significant improvement in maternal and perinatal outcomes.[19,26] In a retrospective study of medical records, Conradt 1984 reported that Magnesium supplementation during pregnancy was associated with a reduced risk of foetal growth retardation and preeclampsia.[27] Magnesium intake plays a crucial role in magnesium status; hence, a positive magnesium balance can be readily achieved through supplementation or consumption of a magnesium-rich diet consisting of green leafy vegetables, legumes and soya milk.[28] Considering the level of poverty and other social deprivations in our environment, it is important to examine the significance of magnesium deficiency in pregnancy vis-a-vis maternal and perinatal health.[26]

2. Materials and Methods

This observational study was conducted in department of Biochemistry, GMC, Kannur from February to May 2020.

2.1. *Type of study*

Hospital based cross sectional study.

2.2. *Place of study*

Department of OBG & Department of Biochemistry, GMC, Kannur.

2.3. *Duration of study*

3 months.

Biochemical parameters like blood sugar, hemoglobin, HBA1C, were assayed on fully automated analyser, Se. Magnesium was assayed on a semi automated analyser by Patient biodata, history, clinical parameters and other relevant details were collected in prestructured formats after obtaining clearance from institutional ethical and scientific committee review board.

2.4. *Inclusion criteria*

1. All antenatal cases attending OBG OPD, GMC Kannur.
2. Age between 18-35 years

2.5. *Exclusion criteria*

1. Women suffering from HIV, TB, twin pregnancies
2. Not willing to participate.
3. Women with complicated pregnancies

3. Result

The present study was a pilot approach to estimate the serum levels of magnesium in antenatal women in a tertiary health center. The questionnaire comprised of sections to elicit information regarding the general biodata of the patients as well as specific information.

Table 1: Age distribution of study participants

	Minimum	Maximum	Mean	Std. Deviation
Age (years)	20	36	27.83	4.530

Total 30 patients were selected in this study. The age of patients ranged from 20 to 36 years with mean age 27.83 ± 4.53 years.

Table 2: Magnesium levels of study participants

	Minimum	Maximum	Mean	Std. Deviation
Mg (mg/dl)	.30	1.60	1.00	0.32

The mean Magnesium level in the study participants was 1 ± 0.32 mg/dl.

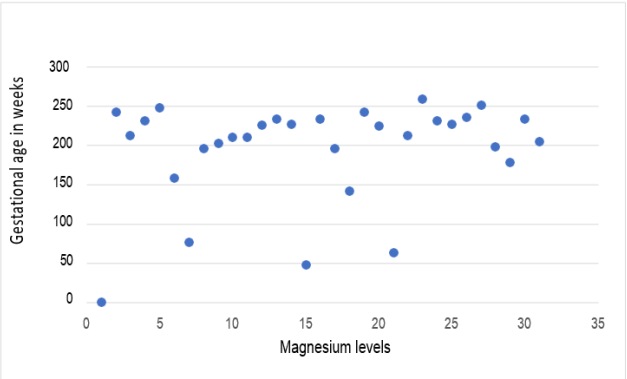

Fig. 1: Magnesium level v/s gestational age

Table 3: Period of gestation of study participants

	Minimum	Maximum	Mean	Std. Deviation
Period of gestation (in weeks)	7	37	29.00	8.000

In our study participants reported 0 still birth, and 2 (6.7%) had abortions.

Table 4: Presenting complaints of study participants

Present complications	Frequency	Percent
Nausea	8	26.7
Dizziness	6	20.0
Oedema	27	90.0
Burning	2	6.7
Micturition	2	6.7

Majority of them 90% had oedema of lower limbs. Participants had no history of pre-existing illnesses like hypertension hypercholesterolemia, diabetes mellitus, hypothyroidism, etc

Table 5: Family history of study participants

Family history	Frequency	Percent
Hypertension	6	20.0
Hypercholestrolemia	0	0
Diabetes mellitus	7	23.3
Others	0	0

Table 6: Clinical variables of study participants

Variables	Minimum	Maximum	Mean	Std. Deviation
Weight (kg)	53.0	80.0	70.15	6.31
Height (cm)	150	165	160.83	3.76
Systolic BP (mmHg)	100	170	113.00	13.68
Diastolic BP (mmHg)	60	100	74.00	8.55
Hb (gm%)	7.4	14.1	11.74	1.68
Blood Sugar (mg%)	82	144	113.00	16.70

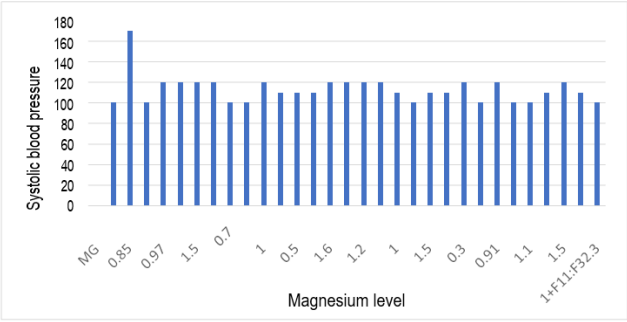

Fig. 2: Magnesium level v/s systolic blood pressure

There was a week positive correlation of Magnesium with systolic and diastolic blood pressure, and by comparing

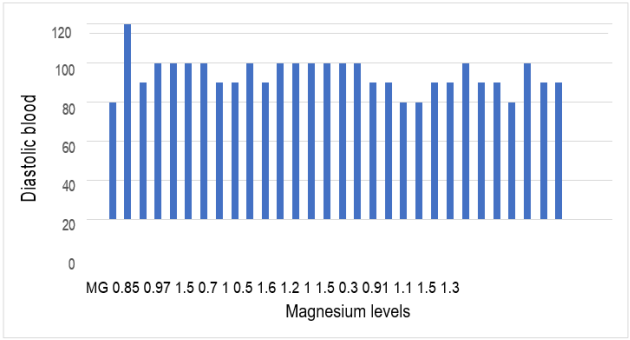

Fig. 3: Magnesium level v/s Diastolic blood pressure

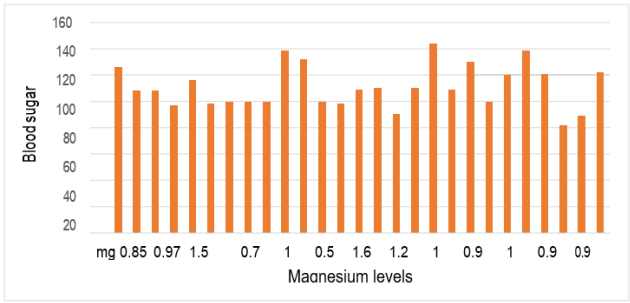

Fig. 4: Magnesium levels v/s blood sugar

Table 7: Correlation of magnesium with various variables

Variable	Correlation coefficient	P value
Haemoglobin	+0.22	0.24
Systolic blood pressure	+0.12	0.52
Diastolic blood pressure	+0.13	0.50
Blood sugar	+0.18	0.35

the levels of Magnesium with Haemoglobin and Blood pressure, they are not significant.

4. Discussion

In pregnancy micronutrients including Magnesium are important for normal growth and development of baby. Deficiency of Magnesium in mothers can impact not only the health of mother but their babies too. The formation of new tissue (maternal and foetal) during pregnancy requires high Magnesium intakes than that of the normal non-pregnant women of comparable age.[29] Magnesium deficiency in pregnant women is an important risk factor for the complications which can be prevented by timely detection and proper management. Dietary deficiencies of Magnesium during pregnancy have been implicated in pre-eclampsia, Eclampsia, pre-term birth, and intrauterine growth retardation.[30] Magnesium supplementation is important for prevention of pregnancy

associated complications.

We conducted this study to find out the serum levels of Magnesium in normal pregnant women's, and we observed a non-significant reduction in serum Magnesium during the progression of normal pregnancy. This observation is supported by Zohrch and Sara[31] and Deeper V Kanag et al.[32]

Sukonpan and Phupong found a decrease in serum Magnesium in pre-eclamptic pregnant women as compared to normal pregnant women in their study.[33] Whereas a research by Glomohammed and Yszdian,[34] did not show significant difference in the level of magnesium in women with pre-eclampsia and normotension. Akinloye et al., in a study from Nigeria reported a decrease in serum Magnesium in pregnant women with pre- eclampsia.[35]

Insufficient Magnesium intake is common, especially in low income regions. Adolescents and women are more prone to Magnesium deficiency. Serum magnesium concentration in mothers ranged from 0.59 mmol/l to 0.95 mmol/L during gestation, from 0.54mmol/L to 0.86mmol/L before and during labour and from 0.54 mmol/L to 0.90 mmol/L at delivery.[14]

Punthunapol and Kittichotpanich showed that there was no difference in serum Magnesium among normal pregnancy and both mild and severe pre-eclampsia.[36] Kumru et al., in their study found that Magnesium concentration showed no significant difference.[36]

A wide range of serum magnesium levels has been reported among non-pregnant women and pregnant women at all trimesters.[37] Some other studies have reported no difference in serum magnesium levels between pregnant and non-pregnant women.[38] And we know that magnesium deficiency in pregnant ladies can lead to life threatening complications for mother as well as their babies, that can be prevented by timely detection and proper management of magnesium deficiency. Pregnant women generally have low plasma levels compared to non-pregnant women. Bardicet in 1995 found that women with GDM had lower levels of plasma Magnesium.[39]

Magnesium is pivotal element for preventing some diseases during whole pregnancy. Magnesium has been established to be used for avoiding some unwanted condition. It could be used by food intake among pregnant women[40] furthermore, Magnesium has various physiological benefits. Numerous studies assessed the effect of Magnesium supplement in prevention of pre-eclampsia in pregnant women. Czeizel et al., showed that Magnesium supplement administered to mother's antenatal leads to a reduction in many bad pregnancy outcomes,[41] Likewise Roman et al., showed that maternal oral Magnesium supplementation reduced pregnancy.[42]

Bullarbo et al., in a clinical trial designed study concluded that Magnesium supplementation prevents increasing of diastolic blood pressure during last weeks of pregnancy.[20] Rudnecki et al., in a double blind randomized controlled study found that using Magnesium chloride until the end of pregnancy has a positive effect on decreasing of blood pressure during pregnancy and delivery time.[43]

Normal pregnancy is associated with a reduction in systemic vascular resistance secondary to vasodilation from reproductive hormones such as oestrogen and progesterone.[44] Both systolic and diastolic blood pressure have been reported to decrease in normal pregnancy. The reduction in diastolic blood pressure is reportedly greater than the reduction in systolic blood pressure.

In this study we observed that there was a week positive correlation of Magnesium with systolic and diastolic blood pressure, both systolic and diastolic blood pressure have been decreases. A study observed that a non-significant reduction in systolic blood pressure but a significant reduction in diastolic blood pressure especially in second and third trimester compared to nonpregnant state, with no significant inter- trimester change in diastolic blood pressure.[44] Many other studies have reported a non-significant change in blood pressure[45] while others have also noted a progressive rise in blood pressure throughout pregnancy.[46]

In our study we also compare the level of Magnesium with blood sugar and haemoglobin, and they are not significant. Simmons et al., reported that hypomagnesemia is associated with known diabetes, but in patients who were newly diagnosed with diabetes, the relationship is not significant.[47]

Magnesium supplementation among women with GDM had beneficial effects on metabolic status and pregnancy outcome in a study by Zatollah Asemi et al.[48] The role of Magnesium lack in preterm birth has been documented previously by Shahid et al.,[49] who conducted that this observation can be useful as an indicator of pre-term delivery.

5. Conclusion

Maternal serum magnesium normally declines during pregnancy. Magnesium deficiency in pregnant women is frequently seen because of inadequate or low intake of magnesium, increased demands, increased renal clearance and physiologal hemodilution. Magnesiium deficiency has been associated with several complications like pre eclempsia, eclampsia IUGR, low birth weight of baby, gestational diabetes mellitus and anemia. Magnesium supplementation has proved beneficial in preventing these complications.

Determination of Magnesium deficiency in the pregnancy can help in initiating appropriate supplementation and prevention of untoward complications, associated with Magnesium deficiency. Also, such studies, have not been conducted in this part of Kerala and will help to provide data related to the topic.

6. Source of Funding

None.

7. Conflict of Interest

The authors declare no conflict of interest.

References

1. Geiger H, Wanner C. Magnesium in disease. *Clin Kidney J*. 2012;5:25–38.
2. Elin RJ. Magnesium metabolism in health and disease. *Dis Mon*. 1988;34(4):161–218. doi:10.1016/0011-5029(88)90013-2.
3. Swaminathan R. Magnesium metabolism and its disorders. *Clin Biochem Rev*. 2003;24(2):47–66.
4. Cunningham J, Rodriguez JM, Messa P. Magnesium in chronic kidney disease Stages 3 and 4 and in dialysis patients. *Clin Kidney J*. 2012;5(Suppl 1):i39–i51. doi:10.1093/ndtplus/sfr166.
5. Newman RL. Serum electrolytes in pregnancy, parturition, and puerperium. *Obstet Gynaecol*. 1957;10(1):51–5.
6. Duncanson GO, Worth HG. Determination of reference intervals for serum magnesium. *Clin Chem*. 1990;36:756–8.
7. Guerrera MP, Volpe SL, Mao JJ. Therapeutic use of Magnesium. *An Fam Physician*. 2009;80:157–62.
8. Kroll MH, Elin RJ. Relationship between Magnesium and protein concentration in serum. *Clin Chem*. 1985;31:244–6.
9. Franz KB. Magnesium intake during pregnancy. *Magnesium*. 1987;6(1):18–27.
10. Pathak P, Kapoor SK, Kapil U, Dwivedi SN. Serum magnesium level among pregnant women in a rural community of Haryana State, India. *Eur J Clin Nutr*. 2003;57:1504–6.
11. Cockburn F, Belton NR, Purvis RJ, Giles M, Brown JK, Turner TL, et al. Maternal vitamin D intake and mineral metabolism in mothers and their new-born infants. *Br Med J*. 1980;281:11–4.
12. Reitz RE, Daane TA, Woods JR, Weinstein RL. Calcium, magnesium, phosphorus, and parathyroid hormone interrelationship in pregnancy and new-born infants. *Obstet Gynecol*. 1997;50:701–5.
13. Fawcett WJ, Haxby EJ, Male DA. Magnesium: physiology and pharmacology. *Br J Anaesth*. 1999;83:302–20.
14. Durlach J. New data on the importance of gestational Mg deficiency. *J Am Coll Nutr*. 2004;23:694–700.
15. Hantoushzadeh S, Jafarabadi M, Khazardoust S. Serum magnesium levels, muscle cramps, and preterm labor. *Int J Gynaecol Obstet*. 2007;98:153–4.
16. Takaya J, Yamato F, Kaneko K. Possible relationship between low birth weight and magnesium status: from the standpoint of "fetal origin" hypothesis. *Magnes Res*. 2006;19:63–9.
17. Arikan GM, Panzitt T, Gucer F, Scholz HS, Reinisch S, Hass J. Course of maternal serum magnesium levels in low risk gestations and in preterm labor and deliverey. *Fetal Diagn Ther*. 1999;14:332–6.
18. Conradt A, Weidinger H, Algayer H. On the role of magnesium in fetal hypotrophy, pregnancy induced hypertension, and pre-eclampsia. *Magnes Bull*. 1984;6:68–76.
19. Ertbeg P, Norgaard P, Bang L, Nyholm H, Rudnicki M. Ionized magnesium in gestational diabetes. *Magnes Res*. 2004;17(1):35–8.
20. Bullardo M, Odman N, Nestler A, Nielsen T, Kolisek M, Vormann J. Magnesium supplementation to prevent high blood pressure in pregnancy: A randomised placebo control trial. *Arch Gynecol Obstet*. 2013;288:1269–74.
21. Duley L, Henderson-Smart DJ, Walker GJA, Chou D. Magnesium sulphate versus diazepam for eclampsia. *Cochrane Database Syst Rev*. 2010;doi:10.1002/14651858.CD000127.pub2.
22. Schoenaker DA, Soedamah-Muthu SS, Mishra GD. The association between dietary factors and gestational hypertension and pre-eclampsia: A systemic review and metanalysis of observational studies. *BMC Med*. 2014;12:157.
23. Sibai BM, Villar MA, Bray E. Magnesium supplementation during pregnancy: A double- blind randomized controlled clinical trial. *Am J Obstet Gynecol*. 1989;161:115–9.
24. Dawson EB, Evans DR, Kelly R, Hook JV. Blood cell lead, calcium, and magnesium levels associated with pregnancy-induced hypertension and pre-eclampsia. *Biol Trace Elem Res*. 2000;74:107–16. doi:10.1385/BTER:74:2:1.
25. Kapil U, Pathak P, Singh C. Zinc and magnesium nutriture amongst pregnant mothers of urban slum communities in Delhi: A pilot study. *Indian pediatr*. 2002;39:365–8.
26. Spatling LU, Spatling GA. Magnesium supplementation in pregnancy. A double-blind study. *Br J Obstet Gynaecol*. 1988;95(2):120–5.
27. Shaik K, Das CM, Baloch GH, Abbas T, Fazlani K, Jaffery MH, et al. Magnesium associated complications in pregnant women. *World Appl Sci J*. 2012;17:1074–8.
28. Franz KB. Magnesium intake during pregnancy. *Magnesium*. 1987;6(1):18–27.
29. Seeling MS. The Role of Magnesium in Normal and Abnormal Pregnancy. In: Magnesium Deficiency with Pathogenesis of Disease. vol. 68. New York; 1980. p. 153–9.
30. Cook LA, Mimouni FB. Whole blood ionized magnesium in the healthy neonate. *J Am Coll Nutr*. 1997;16:181–3.
31. Kanagal DV, Rajesh A, Rao K, Devi UH, Shetty H, Kumari S, et al. Levels of serum calcium and magnesium in preeclamptic and normal pregnancy: A study from Coastal India. *J Clin Diagn Res*. 2014;8(7):OC01–4. doi:10.7860/JCDR/2014/8872.4537.
32. Swiet MD. The respiratory system, in Clinical physiology in obstetrics. Chamberlain G, Pipkin FB, editors. Blackwell Science Ltd; 1998.
33. Sukonpan K, Phupong V. Serum calcium and serum magnesium in normal and preeclamptic pregnancy. *Arch Gynecol Obstet*. 2005;273:12–6.
34. lou SG, Yazdian M, Pashapour N, N. Evaluation of Serum Calcium, Magnesium, Copper, and Zinc Levels in Women with Pre-eclampsia. *Iran J Med Sci*. 2008;33(4):231–4.
35. Akinloye O, Oyewale OJ, Oguntibeju OO. Evaluation of trace elements in pregnant women with pre-eclampsia. *Afr J Biotechnol*. 2010;9(32):5196.
36. Kumru S, Aydin S, Simsek M, Sahin K, Yaman M, Ay G. Comparison of Serum Copper, Zinc, Calcium and Magnesium Levels in Pre-eclamptic and Healthy Pregnant Women. *Biol Trace Elem Res*. 2003;94:105–12.
37. Mahendru AA, Everett TR, Wilkinson IB, Less CC, Mceniery CM. A Longitudinal study of maternal cardiovascular function from preconception to the postpartum period. *J Hypertens*. 2014;32(4):849–56. doi:10.1097/HJH.0000000000000090..
38. Hillman LS, Haddad JG. Perinatal vitamin D metabolism. . Factors influencing late gestational human serum 25-hydroxyvitamin D. *Am J Obstet Gynecol*. 1976;125:196–200.
39. Kuoppala T, Tuimala R, Parviainen M, Koskinen T, Ala-Houhala M. Serum level of vitamin D metabolites, calcium, phosphorus, magnesium and alkaline phosphatase in Finnish women throughout pregnancy and in cord serum at delivery. *Hum Nutr Clin Nutr*. 1986;40:287–93.
40. Schoenaker DA, Soedamah-Muthu SS, Mishra GD. The association between dietary factors and gestational hypertension and pre-eclampsia: A systematic review and meta-analysis of observational studies. *BMC Med*. 2014;12:157. doi:10.1186/s12916-014-0157-7.
41. Czeizel AE, Dudas I, Metneki J. Pregnancy outcomes in a randomised controlled trail of periconceptional multivitamin supplementation. Final report. *Arch Gynecol Obstet*. 1994;255:131–9.
42. Roman A, Desai N, Rochelson B, Gupta M, Solanki M, Xue X. Maternal magnesium supplementation reduces intrauterine growth restriction and suppresses inflammation in a rat model. *Am J Obstet Gynecol*. 2013;208(5):383. doi:10.1016/j.ajog.2013.03.001.
43. Rudnicki M, Frolich A, Rasmussen WF, Mcnair P. The effect of magnesium on maternal blood pressure in pregnancy- induced hypertension. A randomized double-blind placebo- controlled trial. *Acta Obstet Gynecol Scand*. 1991;70:445–50.

44. Gilligan DM, Badar DM, Panza JA, Quyyumi AA, Cannon RO. Effects of oestrogen replacement therapy on peripheral vasomotor function in postmenopausal women. *Am J Cardiol*. 1995;75(4):264–8.
45. Nama V, Antonios TF, Onwude J, Manyonda IT. Mid-trimester blood pressure drop in normal pregnancy: myth or reality? *J Hypertens*. 2011;29(4):763–8.
46. Olatunbosun DA, Adeniyi FA, Adadevoh BK. Serum calcium, phosphorus and magnesium levels in pregnant and non-pregnant Nigerians. *Int J Obstet Gynaecol*. 1975;82(7):568–71.
47. Simmons D, Joshi S, Shaw J. Hypomagnesaemia is associated with diabetes: not pre- diabetes, obesity or the metabolic syndrome. *Diabetes Res Clin Pract*. 2010;87(2):261–6.
48. Enaruna NO, Ande A, Okpere EE. Clinical significance of low serum magnesium in pregnant women attending the University of Benin Teaching Hospital. *Niger J Clin Pract*. 2013;16(4):448–53. doi:10.4103/1119-3077.116887.
49. Durlach J. New data on the importance of gestational Mg deficiency. *J Am Coll Nutr*. 2004;23:694–700.

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