Research Article

The Effect of Serum Magnesium, Calcium, and Potassium Levels on the Event of Calf Muscle Cramps, According to the Perspective of Pregnant Women in the Third-Trimester of Pregnancy

Pengaruh Kadar Magnesium, Kalsium, dan Kalium Serum Terhadap Terjadinya Kram Otot Betis, Menurut Perspektif Ibu Hamil di Trimester Ketiga Kehamilan

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Abstract

Objective: To determine the effect of magnesium, calcium, and potassium levels on calf muscle cramps in third-trimester pregnant women at Dr. Zainoel Abidin Banda Aceh.

Methods: This research is an observational analytic study with a case-control method by taking samples using a total sampling technique. The research sample was third-trimester pregnant women (28-40 weeks of gestation) who were treated in the maternity ward for the period September to December 2020.

Results: A total of 263 samples were involved in this study where 105 patients (40%) were obese, 229 patients (87%) were housewives, 161 patients (61%) did not experience muscle cramps and samples had magnesium levels below normal as much as 82 people, calcium levels below normal as many as 127 people and potassium levels below normal as many as 2 people. The mean levels of magnesium, calcium, and potassium were 1.8 mg/dL, 8.69 mg/dL, and 4.25 mmol/L, respectively. The results of this study are magnesium levels affect muscle cramps in pregnant women (p-value=0.000), while calcium levels (p-value=0.373) and potassium (p-value=0.062) do not affect muscle cramps in pregnant women.

Conclusion: There is a significant effect between magnesium levels on the incidence of calf muscle cramps in third-trimester pregnant women, while calcium and potassium levels do not affect them.

Keywords: calcium, magnesium, muscle cramps, potassium.

Abstrak

Tujuan: *Untuk mengetahui pengaruh kadar magnesium, kalsium dan kalium terhadap kram otot betis pada ibu hamil trimester III di RSUD Dr. Zainoel Abidin Banda Aceh.*

Metode: *Penelitian ini merupakan penelitian analitik observasional dengan metode case control dengan cara pengambilan sampel menggunakan teknik total sampling. Sampel penelitian ialah ibu hamil trimester III (usia kandungan 28-40 minggu) yang di rawat di kamar Bersalin periode September hingga Desember 2020.*

Hasil: *Sebanyak 263 sampel terlibat dalam penelitian ini di mana 105 pasien (40%) mengalami obesitas, 229 pasien (87%) adalah seorang ibu rumah tangga, 161 pasien (61%) tidak mengalami kram otot dan sampel yang memiliki kadar magnesium di bawah normal sebanyak 82 orang, kadar kalsium di bawah normal sebanyak 127 orang dan kadar kalium di bawah normal sebanyak 2 orang. Kadar rerata magnesium, kalsium, dan kalium masing-masing adalah 1,8 mg/dL, 8,69 mg/dL dan 4,25 mmol/L. Hasil dari penelitian ini adalah kadar magnesium berpengaruh terhadap kram otot pada ibu hamil (p-value=0,000), sedangkan kadar kalsium (p-value=0,373) dan kalium (p-value=0,062) tidak berpengaruh terhadap kram otot pada ibu hamil.*

Kesimpulan: *Terdapat pengaruh signifikan antara kadar magnesium terhadap kejadian kram otot betis pada ibu hamil trimester III, sedangkan kadar kalsium dan kalium tidak memiliki pengaruh.*

Kata kunci: *kalium, kalsium, kram otot, magnesium.*

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INTRODUCTION

Muscle cramps are sudden muscle contractions due to an increase in the frequency of motor action potentials that are painful, continuous, unconscious, and localized to certain muscle fibers. In general, cramps can last from a few seconds to several minutes[1,2]. The prevalence of cramps in pregnant women in China was 32.9% during the first trimester, the percentage was 11.6%, the second trimester, 28.2%, and the last trimester, 50.2%[3]. Pregnant women in India experience third-trimester muscle cramps with a percentage of 64.6%[4].

Electrolyte imbalances such as potassium, magnesium, and calcium deficiency can worsen the condition of muscle cramps[4,5]. Pregnancy is closely related to hypomagnesemia. Based on several previous studies, it has been known that serum magnesium levels decrease during the pregnancy period [6]. The need for calcium to strengthen the skeletal structure of the fetus during pregnancy also increases, especially during the third-trimester, which is around 25-30 g[7–9]. potassium functions to regulate electrolyte balance, maintain blood pressure regulation, reduce rest-leg muscle contraction syndrome, and even transmit nerve impulses[10]. There are no related studies that examine the effect of magnesium, calcium, and potassium levels on the incidence of calf muscle cramps in third-trimester pregnant women at the Regional General Hospital (RSUD) Dr. Zainoel Abidin Banda Aceh so that researchers are interested in researching this.

METHODS

This research is an observational analytic study with a case-control method. The sampling technique used in this study is non-probability sampling using a total sampling technique. The purpose of this study was to determine the effect of magnesium, calcium, and potassium levels on calf muscle cramps in third-trimester pregnant women at RSUD Dr. Zainoel Abidin Banda Aceh. This research was conducted in the Obstetrics and Gynecology Maternity Room at Dr. Zainoel Abidin Banda Aceh from September to December 2020.

The inclusion criteria in this study were mothers in the third trimester of pregnancy (28-40 weeks). As for pregnant women who take magnesium, calcium, and potassium supplements, mothers who smoke and consume alcohol, mothers who use a diuretic or nephrotoxic treatment therapy, mothers who experience medical diseases such as diabetes mellitus, acute pancreatitis, kidney disease, hypothyroidism, and cystic fibrosis (as stated in the investigations, and mothers with gastrointestinal disorders such as chronic diarrhea, vomiting, and gastrointestinal fistulas were excluded from this study.

Data collection was carried out directly by researchers through questionnaires to obtain information about the incidence of calf muscle cramps in pregnant women through respondents' answers. Data on serum magnesium, calcium, and potassium levels in pregnant women were obtained through laboratory tests. Blood sampling was conducted by health workers at RSUD Dr. Zainoel Abidin Banda Aceh on the subject and blood samples were taken from the median cubital vein by antiseptic treatment with 70% alcohol and allowed to dry, then 3 ccs of blood were taken, put into a yellow-top vacutainer blood tube for examination of blood chemistry (magnesium, potassium, and calcium).

RESULTS

During the period September to December 2020, a total of 263 research samples met the inclusion criteria. The general characteristics of respondents in this study are presented in table 1 below.

Table 1. General Characteristics of Respondents

General characteristics	Amount (n=84)	(%)
Body Mass Index (BMI)		
Status	8	3
Underweight	54	20
Normal	55	21
Overweight	105	40
Obesitas I	41	16
Obesitas II		
Occupations	229	87
Housewife	9	Non-Housewife
Civil servant	8	(13)
Teacher	4	
Private	3	
Honorary	3	
Contract employees	7	
Others		
Cramp Status Percentage	102	39
Yes	161	61
No		
Levels of Magnesium, Calcium, and Potassium (Below Normal Values)		
Magnesium	82	31
Kalsium	127	49
Kalium	2	0.7

Based on table 1, the study sample was dominated by pregnant women with BMI obesity I status of 105 people (40%) and housewives as many as 229 people (87%). A total of 161 people (61%) did not experience muscle cramps in this study. The values of magnesium, calcium, and potassium levels below normal were 82 people (31%), 127 people (49%), and 2 people (0.7%).

Binary Logistic Regression Analysis to See the Effect of Magnesium, Calcium, and Potassium Levels on the Perspective of the Incidence of Muscle Cramps in Pregnant Women

The initial stage in binary logistic regression analysis is looking for parameter estimates. Based on the results of data processing with software R version 3.6.3, the following information was obtained:

Table 2. The Estimated Value of the Parameter

Variables	The estimated value of the parameter
(Intercept)	15,902
Magnesium levels	-19,775
Calcium levels	1,002
Potassium levels	2,108

Based on the values presented in table 2, the logit conjecture model is obtained as follows:

$$g(x) = In\left[\frac{\pi}{1 - \pi}\right]$$

=15,902 - 19,775 Magnesium + 1,002 Kalsium + 2,108 Kalium

The logistic equations are

$$\pi(x_i) = \frac{e\ (15{,}902 - 19{,}775\ \text{Magnesium} + 1{,}002\ \text{Kalsium} + 2{,}108\ \text{Kalium})}{1 + e\ (15{,}902 - 19{,}775\ \text{Magnesium} + 1{,}002\ \text{Kalsium} + 2{,}108\ \text{Kalium})}$$

After estimating the parameters, the next step that must be done is to test the significance of these parameters. The parameter significance test was carried out in 2 ways, namely the simultaneous and partial parameter significance test. A simultaneous parameter significance test was conducted to see the effect of independent variables, namely levels of magnesium, calcium, and potassium on the occurrence of muscle cramps in pregnant women simultaneously. The test used to test the significance of the parameters simultaneously is the likelihood ratio chi-square test. The hypothesis for the simultaneous parameter significance test is as follows.

H_0: $\beta_1=\beta_2=\beta_i=0$ (Levels of magnesium, calcium, and potassium together do not affect the incidence of muscle cramps in pregnant women)

H_1: At least one of $\beta i \neq 0$ (at least one of the levels of magnesium, calcium, and potassium affects the incidence of muscle cramps in pregnant women) $\alpha=0.05$.

The test statistic used is the G^2 statistic which follows the chi-square distribution, so that to obtain a decision, it is compared with the chi-square value, a table with degrees of freedom = the number of independent variables. H_0 can be rejected if the test statistic value $G^2>\chi(\upsilon.\alpha)$.

Table 3. G Statistical Test

G^2 statistic	χ(3;0.05)
266.83	7.815

Based on the test results, the G^2 value is 266.83, while the value $\chi(3;0.05)$ is 7.815. The value of G^2 (266.83) > $\chi(3;0.05)$ (7.815) so H0 can be rejected. Thus, it can be concluded that at least one of the levels of magnesium, calcium, and potassium affects the incidence of muscle cramps in pregnant women.

The partial significance test aims to see the effect of each independent variable, namely levels of magnesium, calcium, and potassium on the incidence of muscle cramps in pregnant women. The partial test can be done with the Wald test with the following hypotheses:

H_0: $\beta_j = 0$ (Levels of magnesium, calcium, and potassium do not affect the incidence of muscle cramps in pregnant women)

H_1: $\beta_1 \neq 0$ (Magnesium levels affect the incidence of muscle cramps in pregnant women)

H_2: $\beta_2 \neq 0$ (Calcium levels affect the incidence of muscle cramps in pregnant women)

H_3: $\beta_3 \neq 0$ (Potassium levels affect the incidence of muscle cramps in pregnant women)

The Wald test uses the W^2 test statistic with criteria H_0 is rejected if $W^2>\chi(\upsilon.\alpha)$ or $|W| = {}^{Z\alpha}/_{2}$ with p-value$<\alpha=0.05$.

Table 4. Significance Value

Variables	*P-value*
Magnesium Levels	0.000
Calcium Levels	0.373
Potassium Levels	0.062

Based on the results of data processing, the p-value for the variable levels of magnesium, calcium, and potassium, respectively, is 0.000; 0.373, and 0.062. With a significance level of 0.05, H_0 is rejected if the p-value <0.05. So, the p-value for the variable magnesium content (0.000)<0.05. The p-value for the variable calcium content (0.373)>0.05, and the p-value for the variable potassium content (0.062)>0.05. Thus, H_0 can be rejected for the magnesium variable. It can be concluded that the variable magnesium levels affect muscle cramps in pregnant women, while calcium and potassium levels do not affect muscle cramps in pregnant women.

To test the feasibility of the obtained model, it can be done with a test called the deviance test. The deviance test compares the likelihood of the saturated model, which is a model that has a perfect match with the model obtained. The hypothesis of the model's feasibility test is as follows. H_0: The model is feasible (there is no difference between the observed results and the predicted results). H_1: The model is not feasible (There is a difference between the results of the observations and the predicted results).

The test statistic used is statistic D with rejection criteria H_0 is if $D>\chi(\alpha.n-p)$ which n is the number of observations and p is the number of parameters. Based on the results of data processing, the value of D = 84.42 and the value of $\chi(0,05;263-3)$ of 298,611 so that D (84,42) < $\chi(0,05;263-3)$. Thus, H_0 cannot be rejected. So, at the 0.05 level of significance, this model is feasible to use.

Testing the significance of the parameters partially gave the result that among serum magnesium, calcium, and potassium, only magnesium affected the incidence of muscle cramps in pregnant women. Thus, the previously obtained logistic regression model was revised. Serum calcium and potassium which did not have a significant effect on the incidence of muscle cramps in pregnant women were excluded from the model so that only magnesium remained.

The revised model obtained is

$$g(x) = \log\left\{\frac{\pi}{1-\pi}\right\} = 30{,}780 - 18{,}454\ Magnesium$$

With the following logistic equation

$$\pi(x_i) = \frac{e^{30{,}780 - 18{,}454\ Magnesium}}{1 + e^{30{,}780 - 18{,}454\ Magnesium}}$$

The value of $\pi(\chi_i)$ shows the probability value for muscle cramps in pregnant women. The closer the probability value to the number 1 means that the greater the chance for pregnant women to experience muscle cramps. The opportunity threshold value used in this study to be said to have cramp status is 0.98. It was found that the maximum magnesium level that can make a person experience muscle cramps is 1.457 mg/dL. This means that at least a pregnant woman must have a magnesium level of 1.457 mg/dL to avoid muscle cramps.

DISCUSSIONS

The general characteristics of respondents in this study were body mass index (BMI), cramp status, and patient occupation. In the characteristics of this study (table 1) that the study sample was dominated by pregnant women with BMI in the form of obesity I as much as 40%. This is not in line with the research conducted by Tinius et al. (2020) which states that pregnant women with an average BMI of 26.1 kg/m^2 or overweight will experience musculoskeletal complaints in pregnancy[11].

Furthermore, table 1 shows that 61% of the samples did not experience muscle cramps. Research shows that muscle cramps are the second most common complaint felt by pregnant women, especially in the second and third trimesters. These muscle cramps occur during sleep and are affected by magnesium and calcium deficiency[12]. In addition, stated that muscle cramps in the leg muscles are complaints that are often felt generally in women compared to men[13]. Another study stated that complaints such as low back pain occurred approximately 60% and muscle cramps 42% were the most common complaints experienced by pregnant women[14]. In another study showed that as many as 334 pregnant women who were the research sample experienced muscle cramps during pregnancy[15].

Another characteristic is the occupation of pregnant women, most of the pregnant women who were the sample of this study were dominated by housewives by 87%, while the other 13% worked as teachers, midwives, contract employees, civil servants, honorary, private, and others. Based on research, 50.9% of musculoskeletal disorders in pregnancy such as leg cramps occur in pregnant women whose daily work is other than being a housewife, so

in this study, it was stated that work status was related to musculoskeletal disorders in pregnant women[16]. It is different from the research which showed that 90% of pregnant women with musculoskeletal disorders that occur in pregnant women do not work[12]. The pathophysiology of calf muscle cramps is still not known with certainty. Based on previous research, one of the causes of muscle cramps due to electrolyte imbalance, in the form of magnesium, calcium, and potassium.

The results of this study indicate that based on a partial parameter significance test which aims to assess the effect of each of the independent variables, namely magnesium levels on the incidence of muscle cramps in pregnant women, the results of the test are that the p-value for magnesium levels is 0.000. The results of this statistical test can be interpreted that magnesium levels affect the incidence of muscle cramps in pregnant women. These results which states that if there is a magnesium deficiency in pregnancy it can have outcomes such as premature birth, intrauterine growth restriction (IUGR), uterine hyperexcitability, insulin resistance, and musculoskeletal disorders such as muscle cramps[17]. In another study, it was recommended that magnesium supplementation during pregnancy be the treatment of choice for the management of muscle cramps induced by pregnancy[18]. In addition, another study stated that pregnancy with a magnesium deficiency will cause hypertension in pregnancy, IUGR, and muscle cramps[19]. Oral magnesium supplementation during pregnancy did not reduce the incidence and frequency of episodes of leg cramps in pregnant women[20]. Another study stated that the administration of magnesium during pregnancy did not treat the incidence of muscle cramps in pregnant women, only reduced the incidence of muscle cramps[3].

The results of this study indicate that the p-value of calcium and potassium levels is 0.373 and 0.062, respectively. This means that calcium and potassium levels do not affect the incidence of muscle cramps in pregnant women. This can happen because when viewed from a descriptive analysis of the content of calcium levels in pregnant women are in the range of 8.0-9.5 mg/dL with the average calcium content in pregnant women is 8.689 or 8.7 mg/dL is still within the normal range. normal range (8.5-10.5 mg/dl)[21]. The potassium content in pregnant women is in the range of 3.2-5 mmol/L, the content of potassium levels in pregnant women when viewed on average is 4.25 mmol/L also still within normal limits (3.3-5.1 mmol/L)[21]. The results who stated that there was no significant effect of serum calcium and potassium levels in pregnant women with muscle cramps[22]. A study on the effects of calcium and potassium content on pregnant women showed that calcium and potassium levels cause hypertension in pregnancy such as preeclampsia-eclampsia but do not cause muscle cramps[23], also gave the results that giving calcium and potassium during pregnancy did not treat the incidence of muscle cramps in pregnant women, but only reduced pain when muscle cramps occur[3].

CONCLUSION

This study concludes that there is a significant effect of magnesium levels on the incidence of calf muscle cramps in third-trimester pregnant women. The minimum magnesium threshold value for a pregnant woman during the third trimester is 1.457 mg/dL, to avoid the occurrence of calf muscle cramps during pregnancy with a probability value of 0.98.

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REFERENCES

1. Bordoni B, Sugumar K, Varacallo M. Muscle Cramps. In: StatPearls Treasure Island, Florida. StatPearls Publishing. 2020.
2. Buttaravoli P. Minor Emergencies. Expert Consult. 2021: 465–518.
3. Luo L, Zhou K, Zhang J, Xu L, Yin W. Interventions for leg cramps in pregnancy. The Cochrane database of systematic reviews. 2020;12:CD010655.
4. Katzberg HD. Neurogenic muscle cramps. J Neurol. 2015;262(8):1814–21.
5. Group BP. BMJ Best Practice. BMJ Publishing Group Limited 2020. 2020. https://bestpractice.bmj.com/info/
6. Alalawi Y, M'Hiri I, Alrob HA, Khan A. Hypoparathyroidism in Pregnancy. Springer. 2020.
7. Ramachandra P, Maiya AG, Kumar P, Kamath A. Prevalence of musculoskeletal dysfunctions among Indian pregnant women. J Preg. 2015;2015: 437105. doi: 10.1155/2015/437105.

8. Katzberg HD. Case Studies in Management of Muscle Cramps. Neurol Clin. 2020;38(3):679–96. https://doi.org/10.1016/j.ncl.2020.03.011
9. Meena PK, Maheswari S. Serum Magnesium Level as a Predictive Tool for Preterm Labour. Ind J Obstet Gynecol Res. 2020;7(3):356–36.
10. Spatling L, Classen HG, Kisters K,. et al. Supplementation of Magnesium in Pregnancy. J Preg Child Health. 2017;04:01.
11. Tinius R, Nagpal TS, Edens K, Duchette C, Blankenship M. Exploring Beliefs about Exercise among Pregnant Women in Rural Communities. J Midwifery Women's Health. 2020;65(4):538–45.
12. Bakilan F, Zelveci DD. Musculoskeletal problems during pregnancy. J Clin Med Kazakhstan. 2020;6(60):53–5.
13. Asghar A, Ahmad A, Gillani SA. Leg cramps among older men and women. Rawal Med J. 2020;45(2):396–8.
14. Vyas H, Deviga T. Impact of Musculoskeletal Dysfunctions on Quality of Life of Pregnant Women. Int J Nurs Midwifery Res. 2020;7(2):27–31.
15. Hall H, Lauche R, Adams J, Steel A, Broom A, Sibbritt D. Healthcare utilization of pregnant women who experience sciatica, leg cramps and/or varicose veins: A cross-sectional survey of 1835 pregnant women. Women and Birth. 2016;29(1):35–40. http://dx.doi.org/10.1016/j.wombi.2015.07.184
16. Badri PRA, Novrikasari, Flora R. Analysis of Physical Activity Against Stress Levels in Pregnant Women at Plaju Health Center. Sriwijaya Int Conference of Public Health. 2020;25(Sicph 2019):51–63.
17. Fanni D, Gerosa C, Nurchi VM,. et al. The Role of Magnesium in Pregnancy and in Fetal Programming of Adult Diseases. Biol Trace Elem Res. 2020;199(10):3647-3657.doi: 10.1007/s12011-020-02513-0
18. Gaheen A, Sayed M, Shaban R. Knowledge, Attitude and Practices Regarding Calcium Intake among Pregnant Women in Tanta City. J Nurs Health Sci. 2020;9(1):55–69. http://www.academia.edu/download/62482125/E090108556920200325-86618-d5hffv.pdf
19. Zarean E, Tarjan A. Effect of Magnesium Supplement on Pregnancy Outcomes: A Randomized Control Trial. Advanced Biomed Res.2017;6(109). https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5590399/
20. De Araujo CAL, De Lorena SB, De Sousa Cavalcanti GC, et al. Oral magnesium supplementation for leg cramps in pregnancy-An observational controlled trial. PLoS ONE. 2020;15(1):6–13.
21. Garg A, Parajuli P, Mamillapalli C. Pregnancy Complicated by Hypertension and Hypokalemia. Am J Kidney Dis. 2020;76(4):A21-2.
22. Majidi U, Amerian M, Khosravi F, et al,. The Effect of Gradual Reduction in Sodium Dialysate on Occurrence of Muscular Cramp, and the Serum Level of Calcium and Magnesium in Patients Undergoing Hemodialysis: A Cross-Over Clinical Trial. Int J Health Stud. 2020;6(1):1–5.
23. Brown LL, Cohen BE, Edwards E, Gustin CE, Noreen Z. Physiological Need for Calcium, Iron, and Folic Acid for Women of Various Subpopulations during Pregnancy and Beyond. J Women's Health. 2020;30(2):207–12.