



Comparison of Hypocalcemia in Geriatric Pregnant Women with and without Preeclampsia

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ABSTRACT

Introduction: Preeclampsia remains a major cause of maternal and fetal morbidity, particularly in geriatric pregnancies. Hypocalcemia has been identified as a potential risk factor for preeclampsia due to its role in vascular regulation and endothelial function. **Objective:** To compare the incidence of hypocalcemia between geriatric pregnant women who had and had not preeclampsia. **Materials and Method:** This is a cross-sectional analytical study that was undertaken at PNS Hafeez, Islamabad from 13th March, 2025 to 15th June, 2025. Eighty pregnant women aged >35 years were grouped into two categories, namely preeclamptic (Group A) and normotensive (Group B). Data of serum calcium levels were analyzed after measurement with SPSS version 23. **Results:** Hypocalcemia was significantly more common in the preeclamptic group (72.5%) compared to the normotensive group (32.5%) ($p < 0.001$). **Conclusion:** Preeclampsia associated with hypocalcemia is observed in geriatric pregnancies. Regular screening and calcium supplementation could lead to less terrible maternal outcomes.

INTRODUCTION

Preeclampsia is a hypertensive condition that involves multiple systems and is highly dangerous to the health of a mother and a child. It continues to be among the major maternal mortalities and morbidities in the world, especially in developing nations (1). This is defined by the development of induced hypertension and proteinuria occurring after 20 weeks of gestation and is usually associated with a variety of biochemical and physiological abnormalities, one of which is hypocalcemia. New findings have found a close association between low levels of serum calcium and the occurrence of preeclampsia, and this has offered prophylactic and management directions (2). The current definition of hypocalcemic states as levels lower than 8.5 mg/dL of total serum calcium is commonly present among pregnant women in low- and middle-income states where calcium intake remains poor (3). Disruption of calcium homeostasis affects not just the development of the fetal skeleton and the health of the maternal muscles but also vascular tone and endothelial functioning (4). During pregnancy, to accommodate the growth of the fetus, the body of a pregnant woman is able to adjust to a higher calcium load. Nevertheless, hypocalcemia frequently develops when there are low

levels of calcium intake in the body, which is compensated by the process of bone resorption and calcium loss, leading to hypocalcemia. This physiological stress is compounded during geriatric pregnancy, where the maternal reserve and capacity of calcium absorption are already weakened (5). The association of hypocalcemia and hypertensive disorders of pregnancy, such as preeclampsia, was noted in different regional and international research. According to Mlay et al., the serum calcium shortage was significantly interconnected with preeclampsia prevalence of Tanzanian women, and calcium supplementation may be a cost-efficient measure (1). A similar cross-sectional study conducted in the same hospital found maternal undernutrition, low body mass index, and little antenatal care as risk factors for hypocalcemia (2). The same pattern was revealed in Upper Egypt, where reverse predisposition to hypocalcemia was found even in asymptomatic pregnant women, indicating its prevalence (3). Hypocalcemia (electrolyte disturbances) has also been postulated to affect vascular resistance and collaborate with endothelial dysfunction, which is a main characteristic in the pathophysiology of preeclampsia (4). A study in Lagos, Nigeria, between normotensive and preeclamptic women who had serum calcium and

magnesium levels significantly lower than the preeclamptic group established the security function of calcium in the cardiovascular system of the pregnant woman (4). Moreover, Onovughakpo-Sakpa and Atoe demonstrated the results that were quite the same concerning hypertensive pregnant women with heart disorders, which also proves the clinical significance of calcium status in maternal cardiovascular regulation (5). Dietary change and supplementation are involved in the management of hypocalcemia during pregnancy. Circuit training was also considered as one of the possible non-pharmacologic measures on how to correct calcium status and general fitness in hypocalcemic pregnant ladies, and the results were encouraging with elevated serum calcium achieved (6). A prevalence survey on ionized and total hypocalcemia in pregnant women has also been carried out in Cameroon, where weak dietary calcium intake and low levels of vitamin D were some of the risk factors that could be changed (7). The findings are important since they help guide prevention measures in low-income worlds. Additional complications of calcium homeostasis are usually caused by comorbidities like COVID-19, chronic hypertension, and endocrine diseases, which can impair the course of pregnancy (8,9).

These changes in electrolyte levels have been reported to vary throughout pregnancy and across trimesters, as well as in different conditions of pregnancy, indicating alterations in the complexities of metabolism during pregnancy (10). Calcium supplementation is not only an important intervention in the management and prevention of preeclampsia, but this is restricted by socio-economics and awareness (11). Another issue that is to be considered is the body mass index (BMI), which also affects calcium metabolism. According to Sudarma et al., the relationship between BMI and vitamin levels in pregnant women has been strongly evidenced as an indication that nutritional supplementations must be adjusted based on anthropometrical data on the mother (12). Likewise, maternal impairment can simulate glucose metabolism, and homeostatic calcium homeostasis that are characteristic of gestational diabetes may negatively impact fetal outcome and complicate hypertensive disorders (13).

A systematic review by da Silveira et al. supported findings of vitamin D and calcium deficiencies being a common problem in women of reproductive age that confers increased risks of complications in pregnancy and preeclampsia in particular (14). Late preterm births to preeclamptic mothers are at increased risk of morbidity and fatalities, which further underscores the value of timely diagnosing and correcting any modifiable maternal deficiencies (15). There is an indication that levels of calcium and magnesium before fertility procedures have been linked to the same procedure due to its importance even before conception (16). Further, animal models have revealed that dietary deficiency of magnesium and calcium is capable of causing salt-sensitive hypertension, which is similar to human gestational hypertension pathogenesis (17).

Maternal-fetal health is hugely dependent on vitamin D status, which is closely related to calcium intake. Luo et al. discovered that vitamin D deficiency had significant

correlations with gestational diabetes and additional metabolism irregularities during pregnancy early (18). Dietary interventions like the DASH diet and carbohydrate counting proved to have positive effects on pregnancy outcomes among women with gestational diabetes, and there may be more to the overall production of dietary intervention in high-risk pregnancies (19). Although the connection between calcium status and preeclampsia is established, there is a lack of local data specifically assessing geriatric pregnant women (a group that is prone to higher risks by virtue of age-related physiological changes). Since sociocultural issues like late childbirth are on the rise, geriatric pregnancies, generally considered to be globally those that happen at 35 years and older, are on the rise as well.

Nonetheless, such pregnancies are linked to an increase in the rates of hypertension, gestational diabetes as well as nutritional deficiencies, such as hypocalcemia. Considering this risk, early predictors like the level of calcium, which could be useful in reducing maternal and fetal complications, need to be identified. The current research setting is designed to fill this gap by comparing the rate of geriatric pregnant women with hypocalcemia with and without preeclampsia. The study aims to enlighten methods of screening, preventative nutritional interventions, and the general management of at-risk births with regard to preeclampsia in the identified population and its relationship to hypocalcemia in the resource-poor environment.

Objective

To evaluate the rate of hypocalcemia among geriatric pregnant women diagnosed with preeclampsia and normotensive to establish the possible relations and design the preventive measure.

MATERIAL AND METHODS

Design: Cross-sectional Validative Study.

Study setting: The study was carried out at the Department of Gynecology and Obstetrics, PNS Hafeez, Islamabad.

Duration: The study was conducted over a period of three months, from 13th March, 2025 to 15th June, 2025.

Inclusion Criteria

Pregnant women aged more than 35 years of singleton pregnancies were to take part. Group A consisted of individuals who were diagnosed with preeclampsia within a period of 20 weeks of gestation, characterized by blood pressure 140/90 mmHg or higher and proteinuria of 300 mg/d. The second group (group B) was made of normotensive pregnant women who did not show proteinuria beyond 20 weeks of gestation.

Exclusion Criteria

The patients with concomitant systemic diseases, including renal failure, diabetes mellitus, gestational diabetes, endocrine illnesses, or chronic hypertension, were not selected. The study did not include the immunocompromised expectant women either.

Methods

The study used a non-probability consecutive sampling technique after the hospital review committee approved it

ethically. Subjects were categorized into two groups, with group A consisting of geriatric pregnant women with preeclampsia, whereas group B consisted of normotensive geriatric pregnant women. All the participants signed an informed consent. Each participant donated 5 mL of venous blood between 0900-1000 hours using an antecubital vein. A plain bottle containing three milliliters was used to store the serum, and a 2 mL EDTA tube was used in packed cell volume (PCV) analysis. The samples were centrifuged, and serum was separated and aliquoted at -20°C until analysis. Atomic Absorption Spectrophotometry was used in measuring the Serum calcium levels. Age, BMI, gestational age, and parity were captured in a predesigned proforma. Analyses of data were conducted with the help of IBM SPSS 23. Hypocalcemia comparison between the two groups was done using chi-square, having a p-value of 0.05 as a statistically significant value.

RESULTS

The study involved a sample population of 80 geriatric pregnant women (40 per group). Group A was composed of preeclamptic women compared with Group B, consisting of normotensive pregnant women. Group A had an average age of participants of 37.9 ± 2.1 years, and Group B was 37.6 ± 1.9 years old. Group A's Mean gestational age was 32.4 ± 2.5 weeks, and Group B's mean gestational age was 33.1 ± 2.2 weeks. The baseline characteristics like BMI and parity were similar in the two groups ($p > 0.05$).

Table 1

Demographic Characteristics of Study Participants

Variable	Group A (Preeclamptic)	Group B (Normotensive)	p-value
Mean Age (years)	37.9 ± 2.1	37.6 ± 1.9	0.423
BMI (kg/m^2)	27.4 ± 3.2	26.9 ± 3.0	0.312
Gestational Age (weeks)	32.4 ± 2.5	33.1 ± 2.2	0.158
Parity (Median)	2	2	0.679

In terms of biochemical findings, the frequency of hypocalcemia was significantly higher in the preeclamptic group. Hypocalcemia was present in 29 (72.5%) women in Group A compared to 13 (32.5%) women in Group B ($p < 0.001$). The mean serum calcium level in the preeclamptic group was 7.82 ± 0.41 mg/dL, while it was 8.61 ± 0.46 mg/dL in the normotensive group, showing a statistically significant difference ($p < 0.001$).

Table 2

Comparison of Hypocalcemia Between Groups

Hypocalcemia Status	Group A (n=40)	Group B (n=40)	Total (n=80)	p-value
Present	29 (72.5%)	13 (32.5%)	42 (52.5%)	<0.001
Absent	11 (27.5%)	27 (67.5%)	38 (47.5%)	

The stratification was performed to estimate the impact of parity, gestational age, and BMI on hypocalcemia. The findings demonstrated that the prevalence of hypocalcemic was higher among women who were more parous and had lesser gestational ages, although not all influence was statistically significant.

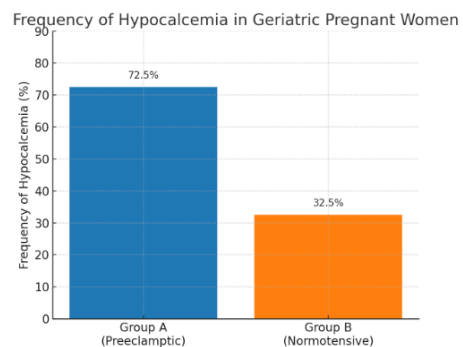
Table 3

Stratification of Hypocalcemia by Clinical Parameters

Variable	Subgroup	Hypocalcemia Present	Hypocalcemia Absent	p-value
Parity	≤ 2 (n=45)	20 (44.4%)	25 (55.6%)	0.034
	> 2 (n=35)	22 (62.9%)	13 (37.1%)	
Gestational Age	≤ 32 weeks (n=38)	24 (63.2%)	14 (36.8%)	0.067
	> 32 weeks (n=42)	18 (42.9%)	24 (57.1%)	
BMI	< 28 kg/m^2 (n=43)	20 (46.5%)	23 (53.5%)	0.198
	≥ 28 kg/m^2 (n=37)	22 (59.5%)	15 (40.5%)	

Graph 1

Frequency of Hypocalcemia in Both Groups



The above graph shows that the prevalence of hypocalcemia was significantly higher in the preeclampsia group as compared to the normotensive group of women. This confirms the hypothesis that provides a strong correlation between low calcium levels and preeclampsia in geriatric pregnancies. In general, the results of the study clearly indicate that the existence of preeclampsia in geriatric women is by far a very high-risk factor in cases of hypocalcemia. These findings support the significance of calcium surveillance and may supplementation in antenatal care, mostly in high-risk pregnancies.

DISCUSSION

This study was carried out to evaluate and contrast the prevalence of hypocalcemia in a period of geriatric pregnant women with and without preeclampsia. The results also indicated a considerable difference in the occurrence of hypocalcemia between preeclamptic (72.5 percent) and normotensive (32.5 percent) hospital groups and thus point towards a well-documented volume of evidence that supports the formulation of a great relationship between calcium deficiency and preeclampsia pathogenesis. The findings are consistent with the past literature where calcium intake in resource-limited and developing regions tends to be poor, particularly in cases of women who are older pregnant people. Mlay et al. have shown that there exists a close connection between hypocalcemia and preeclampsia, thus suggesting that the problem of calcium deficiency is highly related to the development of healthcare disorders during pregnancy (1). In a subsequent study by the same authors, maternal undernutrition and inferior antenatal care coverage were noted to be strong predictors of hypocalcemia, indicating the influence of socioeconomics on the health of a mother

(2).

The high incidence of hypocalcemia in a normotensive group of the present study (32.5%) is in line with the report by Abdel Aty et al., who reported hypocalcemia in asymptomatic pregnant women in upper Egypt, despite not having overt preeclampsia (3). This shows how rampant calcium deficiency during pregnancy is, both in clinically suspected and unsuspected cases, and how screening and early intervention should be instituted as a routine tool. The very low average mean serum calcium levels in the preeclamptic group of the study (7.82 0.41 mg/dL) also concur with the levels observed in the earlier African and South Asian groups where calcium insufficiency was strikingly high among the hypertensive pregnant women (4, 5).

Moreover, calcium modulates vascular tone and endothelial function, which are the focus of the preeclampsia pathophysiology. Extracellular calcium levels affect vascular smooth muscle contraction, nitric oxide synthesis and regulation of blood pressure (4). Hypocalcemia thus may cause high vascular resistance and endothelial dysfunction, which adds to the hypertensive expressions of preeclampsia. Nigerian and Cameroon studies also supported the fact that low calcium and magnesium are related to the elevated risk of preeclampsia, proving the mechanistic connection (4, 7). Besides mineral deficiency, several prospective interventions have been suggested to combat lifestyle and dietary influences. Research by Wahb et al. aimed at how circuit training could be given in promoting calcium levels improvement in pregnant women with hypocalcemia and the outcome was positive with evidence pointing towards the support of physical exercise on the subject of improving the mineral metabolism of pregnant females (6).

Furthermore, calcium supplements have been recommended as an inexpensive intervention to curtail the cases of preeclampsia in populations with poor dietary intake. Ajong et al. have pointed out the necessity of expanded standard supplementation protocol in under-resourced environments where compliance and availability are crucial factors (11). There is the role of comorbid diseases during pregnancy impacting calcium metabolism, i.e., gestational diabetes mellitus, obesity, and vitamin D deficiency. Sudarma et al. established a strong relationship between increased BMI and decreased plasma vitamin D in women during pregnancy, which is a deficiency that interferes directly with calcium intake (12). On the same note, the reciprocal relationships between gestational diabetes and disturbed mineral homeostasis have been established in several reports with a connection to compromised maternal and fetal outcomes (13). Conclusions of the meta-analysis of Da Silveira et al. indicated that insufficiencies of calcium and vitamin D are predominantly evident amongst women of reproductive age in low-income countries. The fact that their research highlighted the relationship between such shortcomings and poor pregnancy outcomes, such as preeclampsia, further confirms the results of the current study (14). Amazingly, in a systematic review, Saccone et al. found hypocalcemia and hypertensive disorders to be risk factors associated with maternal age, in that maternal

outcomes like preeclampsia, placental abruption, and preterm birth were more prevalent in women 35 years and older (8). Special care should be provided to the geriatric obstetric population because they are more prone to both nutritional deficiencies and hypertensive disorders. Stratification by parity and gestational age in this study indicated a tendency in which more women of high parity and lower gestational age had hypocalcemia.

These findings are clinically important because they can inform risk-based screening plans. This was similarly found in a Nigerian study that showed calcium was reduced in severe preeclampsia in women and related to the severity of the disease (9). Although the present results confirm those in the literature, certain limitations are present. The study was conducted in one tertiary care center, and the sample size was comparatively small, which does not allow for generalizing the results. Additionally, there was no determination of dietary calcium intake, vitamin D status, or adherence to supplementation, which would have altered the serum calcium levels. Nevertheless, the external validity of the observed relationship between hypocalcemia and preeclampsia is given by the consistency of the findings with numerous international studies.

Further studies need to consider the longitudinal studies rather large and most diverse population to identify the causal relationships and the effectiveness of supplementation programs. Expanding the dietary assessment and investigating the other micronutrients, such as magnesium and vitamin D, would provide more detailed insight into how maternal nutrition can affect hypertensive disorders. Moreover, the inclusion of calcium-rich and prenatal supplementation education into the antenatal care service can be of great help to maternal and fetal outcomes as well. Finally, this paper shows that hypocalcemia is far more prevalent among geriatric pregnant women in preeclampsia than in normotensive patients. The results support that periodic calcium screening and supplementation of the antenatal treatment should be included in the formula, especially in pregnant women who are already old.

CONCLUSION

This study has underscored the important relationship between hypocalcemia and preeclampsia in geriatric pregnant women. Hypocalcemia was significantly more prevalent in preeclamptic than in normotensive women, pointing out the possible contributory role of low calcium in the pathogenesis of hypertensive disorders in pregnancy. The risk factor of calcium deficiency is a crucial but changeable parameter because of the physiological requirements of the pregnant state and the age-related reduced level of nutrient uptake in older women. Hypocalcemia should be identified and corrected as early as possible through an understanding of routine screening and supplementation, which may help in the reduction of incidence and severity of preeclampsia, particularly in resource-limiting environments. These results advocate the inclusion of surveillance of calcium status in the standard antenatal care among high-risk pregnancies, especially those occurring among the geriatric population. Larger groups of populations and other biochemical

markers like vitamin D and magnesium could be investigated further to shed more light on the contribution

of mineral deficiencies to maternal outcomes and the preventive measures in this respect.

REFERENCES

- Mlay GH, Shayo PA, Kiritta RF, Matovelo DK, Kidenya BR. Strong association between hypocalcemia and preeclampsia-eclampsia among pregnant women attending at a tertiary referral hospital in Northwestern Tanzania. *Scientific Reports*. 2025 May 31;15(1):1-8. <https://doi.org/10.1038/s41598-025-03580-w>
- Mlay GH, Shayo PA, Kiritta RF, Matovelo DK, Kidenya BR. Predictors of maternal hypocalcemia among pregnant women attending at a tertiary referral hospital in Tanzania: a cross-sectional study. *BMC Pregnancy and Childbirth*. 2025 Apr 23;25(1):481. <https://doi.org/10.1186/s12884-025-07536-w>
- Abdel Aty AH, Youssef MA, Mohamed YK. Prevalence of hypocalcemia in asymptomatic pregnant females in Upper Egypt. *Egyptian Journal of Medical Research*. 2022 Jul 1;3(3):28-40. <https://doi.org/10.21608/ejmr.2022.251656>
- Kuye-Kuku TO, Ajayi G, Adegbola O. Serum and Red Cell Magnesium and Calcium Concentrations in Normotensive and Pre-Eclamptic Pregnant Women in Lagos, Nigeria. *Annals of Health Research (The Journal of the Medical and Dental Consultants Association of Nigeria, OOUTH, Sagamu, Nigeria)*. 2023 Mar 26;9(1):12-22. <https://doi.org/10.30442/ahr.0901-02-186>
- Onovughakpo-Sakpa EO, Atoe K. Plasma Electrolyte Patterns among Pregnant Women with Hypertensive Heart Disorder in Benin City, Nigeria. *Journal of Applied Sciences and Environmental Management*. 2024 Jul 7;28(7):2233-9. <https://doi.org/10.4314/jasem.v28i7.38>
- Wahb S, ElDeeb A, Kamel H, El-Shafei M. Effect of Circuit Training on Calcium Level and Physical Fitness in Pregnant Women with Hypocalcemia: A randomized controlled trial. *Physical Activity Review*. 2024 Jan 1;12(1). <https://doi.org/10.16926/par.2024.12.03>
- Ajong AB, Kenfack B, Ali IM, Yakum MN, Onyidinma UP, Mangala FN, Aljerf L, Telefo PB. Ionised and total hypocalcaemia in pregnancy: An analysis of prevalence and risk factors in a resource-limited setting, Cameroon. *PLoS One*. 2022 May 18;17(5):e0268643. <https://doi.org/10.1371/journal.pone.0268643>
- Raoufi M, Hojabri M, Samiei Nasr D, Najafiarab H, Salahi-Niri A, Ebrahimi N, Ariana S, Khodabandeh H, Salarian S, Looha MA, Pourhoseingholi MA. Comparative analysis of COVID-19 pneumonia in pregnant versus matched non-pregnant women: radiologic, laboratory, and clinical perspectives. *Scientific Reports*. 2024 Sep 30;14(1):22609. <https://doi.org/10.1038/s41598-024-73699-9>
- Yamashita K, Morimoto S, Inoue Y, Hirata K, Kimura S, Seki Y, Bokuda K, Watanabe D, Ichihara A. A case of a pregnant woman with primary aldosteronism and superimposed preeclampsia treated with esaxerenone. *Journal of the Endocrine Society*. 2022 Aug 1;6(8):bvac085. <https://doi.org/10.1210/jendso/bvac085>
- Otoikhila OC, Seriki SA. A Comparative Study of Serum Sodium and Potassium Levels across the Three Trimesters of Pregnancy. *Clinical Journal of Obstetrics and Gynecology*. 2023;6:108-16. <https://doi.org/10.29328/journal.cjog.1001137>
- Ajong AB, Kenfack B, Ali IM, Yakum MN, Ukaogo PO, Mangala FN, Aljerf L, Telefo PB. Calcium supplementation in pregnancy: An analysis of potential determinants in an under-resourced setting. *PLoS One*. 2023 Oct 5;18(10):e0292303. <https://doi.org/10.1371/journal.pone.0292303>
- Sudarma V, Liman PB, Istriana E, Mohamed HJ, Mediana A. Correlation between body mass index and 25 (OH) D levels in pregnant women. *World Nutrition Journal*. 2025 Feb 28;8(i2):63-8. <https://doi.org/10.25220/wjn.v08.i2.0008>
- Vashum M, Devi NM, Shakti LC, Yambem TD. Hba1c In Abnormal Gct In First And Second Trimester Of Pregnancy And Its Correlation With Ultrasound Findings And Fetal Outcome. *Int J Acad Med Pharm*. 2022;4(5):696-701.
- Da Silveira EA, Moura LD, Castro MC, Kac G, Hadler MC, Noll PR, Noll M, Rezende AT, Delpino FM, Oliveira CD. Prevalence of vitamin D and calcium deficiency and insufficiency in women of childbearing age and associated risk factors: a systematic review and meta-analysis. *Nutrients*. 2022 Oct 17;14(20):4351. <https://doi.org/10.3390/nu14204351>
- Saji PN, Deka A. Morbidity and mortality profile of late preterm neonates as compared to term neonates from a tertiary care centre in Silchar. *J Evolution Med Dent Sci*. 2021 Jul 26;10(30):2239-43. <https://doi.org/10.14260/jemds/2021/458>
- Polzikov M, Blinov D, Barakhoeva Z, Vovk L, Fetisova Y, Ovchinnikova M, Tischenko M, Zorina I, Yurasov V, Ushakova T, Sergeyev O. Association of the serum folate and total calcium and magnesium levels before ovarian stimulation with outcomes of fresh in vitro fertilization cycles in normogonadotropic women. *Frontiers in Endocrinology*. 2022 Feb 11;13:732731. <https://doi.org/10.3389/fendo.2022.732731>
- Kumagai A, Takeda S, Sohara E, Uchida S, Iijima H, Itakura A, Koya D, Kanasaki K. Dietary magnesium insufficiency induces salt-sensitive hypertension in mice associated with reduced kidney catechol-o-methyl transferase activity. *Hypertension*. 2021 Jul;78(1):138-50. <https://doi.org/10.1161/hypertensionaha.120.16377>
- Luo C, Li Z, Lu Y, Wei F, Suo D, Lan S, Ren Z, Jiang R, Huang F, Chen A, Jiang L. Association of serum vitamin D status with gestational diabetes mellitus and other laboratory parameters in early pregnant women. *BMC Pregnancy and Childbirth*. 2022 May 11;22(1):400. <https://doi.org/10.1186/s12884-022-04725-9>
- Allehdan S, Basha A, Hyassat D, Nabhan M, Qasrawi H, Tayyem R. Effectiveness of carbohydrate counting and Dietary Approach to Stop Hypertension dietary intervention on managing Gestational Diabetes Mellitus among pregnant women who used metformin: A randomized controlled clinical trial. *Clinical Nutrition*. 2022 Feb 1;41(2):384-95. <https://doi.org/10.1016/j.clnu.2021.11.039>