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Research Article

Evaluation of Serum Calcium and Alkaline Phosphatase Levels Among Sudanese Women Using Hormonal Contraceptives in Shendi Town, Sudan

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ISSN: 2637-8019

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Submission: September 01, 2025
Published: September 23, 2025

Volume 3 - Issue 5

How to cite this article: IMohammed Salih MA, Hussien AM, Abdien Saeed A, Almajed Altaher TA, Mahjaf GM and Mohammed Hamad MN*. Evaluation of Serum Calcium and Alkaline Phosphatase Levels Among Sudanese Women Using Hormonal Contraceptives in Shendi Town, Sudan. Glob J Endocrinol Metab 3(5). GJEM. 000575. 2025. DOI: 10.31031/GJEM.2025.03.000575

Abstract

Background: Contraceptives are methods used to prevent pregnancy. In recent years, attention has grown regarding the potential alterations in metabolic processes and trace elements associated with contraceptive use.

Objective: This study aimed to evaluate the serum calcium and Alka Line Phosphatase (ALP) levels among Sudanese women using hormonal contraceptives.

Methodology: A case-control study was conducted in Shendi, Sudan (Feb 2023-Mar 2024). Eighty women were enrolled (40 contraceptive users and 40 controls). Blood samples were analyzed for calcium and ALP using the Mindray BA88A spectrophotometer. Data were analyzed using SPSS version 28.

Result: A significantly higher mean serum calcium level was observed in users (9.4mg/dl) than in non-users (8.2mg/dl, p=0.000). No significant difference was found in ALP levels (p=0.101). A weak positive correlation was found between ALP and duration of use (r=0.335, p=0.034).

Conclusion: Hormonal contraceptive use appears to significantly increase serum calcium levels, with a modest impact on ALP activity.

Keywords: Serum calcium; ALP; Contraceptives; Sudanese women; Metabolic impact

Introduction

Devices or methods that allow sexual union without resulting in pregnancy are known as contraceptives. Changes in several metabolic pathways and trace element profiles linked to the usage of contraceptives have drawn attention in recent years [1]. Oral contraceptives provide two hormones. The estrogens in birth control pills inhibit ovulation via the effect on the hypothalamus and the subsequent suppression of pituitary FSH and LH; inhibit implantation of the fertilized egg; Accelerate ovum transport and cause luteolysis or degeneration of the corpus luteum, thereby causing the fall of serum progesterone levels, which prevents normal implantation and placental attachment. The progestins in birth control Pills create thick cervical mucus that hampers the transport of sperm; inhibit capacitation required for sperm to penetrate the cells and macromolecular investments surrounding the ovum; inhibit implantation; and inhibit ovulation by a subtle disturbance in the hypothalamic-pituitary ovarian functions and by modification of the midcycle surge of FSH and LH [2]. Calcium, the second most predominant intracellular cation, is the most important inorganic messenger in the cell. It also exists in protein-bound and non-protein-bound states. Calcium in the non-protein-bound form is either ionized and physiologically active or not ionized and complexes with small, diffusible ions, such as phosphate and bicarbonate [3].

The ionized form is freely filtered by the glomerulus and reabsorbed in the tubules under the control of PTH. However, renal control of calcium concentration is not the major means of regulation. PTH and calcitonin-controlled regulation of calcium absorption from the gut and bone stores is more important than renal secretion or reabsorption [4]. Calcium is very essential in muscle contraction, oocyte activation, building strong bones and teeth, blood clotting, nerve impulse transmission, regulating heartbeat and fluid balance within cells [4]. Alka Line Phosphatase (ALP) belongs to a group of enzymes that catalyze the hydrolysis of various phosphor-monoesters at an alkaline pH. Consequently, ALP is a nonspecific enzyme capable of reacting with many different substrates. Specifically, ALP functions to liberate inorganic phosphate from an organic phosphate with the concomitant production of an alcohol [5]. It is present on cell surfaces in most human tissues. The highest concentrations are found in the intestine, liver, bone, spleen, placenta and kidney. Elevations of ALP are of most diagnostic significance in the evaluation of hepatobiliary and bone disorders [5]. Contraceptives are devices or techniques that permit sexual union without resultant pregnancy. Nowadays, the use of contraceptives has increased due to various factors. In recent years researches show that contraceptive may play a role in alterations of various metabolic processes in human body that due to hormonal change that it produced, which may result in disturbance in many parameters and metabolites within human body, so that this study was conducted to assess Calcium and ALP among Sudanese female used contraceptives.

Materials and Methods

Study design

This is a case-control study.

Study area

The study was conducted in Shendi town, located in the River Nile State, Sudan. Shendi is a town in northern Sudan situated on the east bank of the Nile, approximately 150km northeast of Khartoum and about 45km southwest of the ancient city of Meroe. It serves as the center of the Jaaliin tribe and is considered an important historic trading hub. Its principal suburb on the west bank is Al-Matamma. A traditional trade route across the Bayuda Desert connects Al-Matamma to Marawi and Napata, approximately 250km to the northwest.

Study population

The study population included women who use contraceptives.

Inclusion criteria

Women using contraceptives were enrolled as the case group, while healthy women not using contraceptives were enrolled as the control group.

Exclusion criteria

Women with known liver or renal diseases were excluded from the study.

Sample collection

A total of 80 women of childbearing age were enrolled in the study. Forty blood samples were collected from women using various types of contraceptives (case group), and another 40 samples were collected from healthy women not using contraceptives (control group). From each participant, 5ml of venous blood was collected using standard phlebotomy procedures. The blood was used to measure serum calcium and AlkaLine Phosphatase (ALP) levels. Participants were asked to complete a structured questionnaire before sample collection to obtain basic demographic and health-related information. The study variables, serum calcium and ALP, were treated as interval scale measurements for statistical analysis.

Laboratory method

Five milliliters (5ml) of venous blood were collected into plain containers using disposable syringes. To ensure accuracy, the use of a tourniquet, prolonged standing and recumbency were avoided. The puncture site was cleaned with alcohol before collection. The blood samples were then centrifuged at 4000 Revolutions Per Minute (rpm) to separate the serum. The biochemical analysis was performed at the university laboratory using a Mindray BA-88 spectrophotometer. The principle of this instrument is based on the interaction of light with a solution containing an absorbing substance (chromogen). When light passes through such a solution, part of the light is absorbed, resulting in a decrease in the intensity of transmitted light. The absorbed fraction is detected and measured, allowing the determination of the analyte concentration. The relationship between transmittance, absorbance and concentration is explained by Beer-Lambert's law.

Ethical consideration

The study was approved by the Department of Clinical Chemistry in Medical Laboratory Sciences at SHENDI UNIVERSITY. The study was submitted to the ethical review committee board. The data collection was conducted with volunteers' permission, and all participants were informed about the study.

Data analysis and presentation

Data was entered, checked and analyzed using SPSS version 28.0 (Statistical Package for the Social Sciences).

Result

This study included a total of 80 Sudanese women, evenly divided into two groups: 40 women who used contraceptives and 40 who did not. The analysis revealed that the mean serum calcium level was significantly higher among contraceptive users (9.4±1.4mg/dl) compared to non-users (8.2±2.71mg/dl), with a highly significant P-value of 0.000. However, no statistically significant difference was observed in AlkaLine Phosphatase (ALP) levels between the two groups, with users showing a mean of 69.7±18.8U/L and non-users 63.0±17.2U/L (P=0.101). When examining the impact of different types of contraceptives-oral pills, injectables, and Implanon-no significant variations were found in either calcium or ALP levels. Calcium levels were 9.2±1.36mg/dl, 9.5±1.47mg/dl and 9.9±1.71mg/dl, respectively,

across the three types (P=0.526), while ALP levels measured 70.2±20.7U/L, 66.4±11.4U/L and 71.4±19.3U/L, respectively (P=0.873). Correlation analysis revealed a weak but statistically significant positive association between ALP levels and duration of contraceptive use (R=0.335, P=0.034), as well as between calcium levels and age of the users (R=0.337, P=0.034). No significant correlations were found between calcium levels and duration of use (R=0.227, P=0.158), nor between ALP levels and age (R=0.182, P=0.261). These findings suggest that while contraceptive use may elevate serum calcium levels, particularly with increasing age, ALP levels may be modestly affected by the duration of use (Table 1 & 2).

Table 1: Mean serum calcium and alkaline phosphatase levels among study.

Parameter	Oral (n=26)	Injectable (n=7)	Implanon (n=7)	P-value
ALP (U/L)	70.2±20.7	66.4±11.4	71.4±19.3	0.873
Calcium (mg/dl)	9.2±1.36	9.5±1.47	9.9±1.71	0.526

Table 2: Correlation with age and duration of use (contraceptive users only).

Variable	R-Value	P-Value
ALP vs. Age	0.182	0.261
ALP vs. Duration of Use	0.335	0.034
Calcium vs. Age	0.337	0.034
Calcium vs. Duration of Use	0.227	0.158

Discussion

The current study aimed to evaluate the serum levels of calcium and AlkaLine Phosphatase (ALP) among Sudanese women using contraceptives in Shendi city. The results demonstrated a statistically significant increase in the mean serum calcium level among contraceptive users compared to non-users (P=0.000), which suggests that hormonal contraceptive use may influence calcium homeostasis. This finding is consistent with the study conducted by Akinloye et al. who reported higher calcium levels in women using contraceptives compared to controls [6]. However, it contradicts the findings of Raad et al. who observed no significant difference in serum calcium levels between users and non-users of hormonal contraceptives [7]. Such discrepancies might be attributed to variations in dietary habits, sample size, or geographical and lifestyle factors. In contrast, the study revealed no statistically significant difference in serum ALP levels between the two groups (P=0.101), aligning with the findings of Panel et al. who also found no significant alterations in ALP levels among women on long-term oral contraceptive therapy [8]. This indicates that while calcium levels may be affected by contraceptive use, ALP levels appear to remain stable in most cases. When examining different types of contraceptives (oral, injectable and Implanon), the current study showed no significant differences in serum calcium or ALP levels between the subgroups. This is in agreement with Raad et al. who reported no substantial variations in biochemical bone markers across different types of hormonal contraceptives [7].

However, this contrasts with findings by Abdul Hameed et al. who observed significant differences between users of oral and injectable contraceptives regarding calcium and magnesium levels [9]. These opposing results might be due to differences in hormonal formulations, study duration, or underlying health conditions among participants. Furthermore, a weak but statistically significant positive correlation was found between serum calcium and age (R=0.337, P=0.034), and between ALP and duration of contraceptive use (R=0.335, P=0.034), suggesting that age and duration may have modest effects on these biochemical markers. These results partially agree with Akinloye et al. who found significant associations between some trace elements and the duration of contraceptive use [6]. Conversely, Raad et al. reported no correlation between age or duration of use and biochemical parameters [7]. Overall, the study supports the hypothesis that contraceptive use can influence certain biochemical markers, particularly serum calcium, while ALP remains largely unaffected. Further research with larger sample sizes and extended monitoring is recommended to validate these findings and explore the underlying mechanisms involved. Furthermore, previous studies have indicated that hormonal contraceptives may affect additional biochemical parameters beyond calcium and ALP, including glucose metabolism, renal function markers (urea and electrolytes) and liver function tests. These changes are believed to result from the systemic hormonal shifts caused by contraceptive use. Additionally, recent advances emphasize the importance of key regulatory genes like Sirtuin 1 (SIRT1) in bone metabolism and mineral balance. Although these parameters were not assessed in the current study, future research examining plasma SIRT1 levels and a wider range of biochemical markers could offer more detailed insights into the metabolic effects of hormonal contraceptives.

Conclusion

This study concluded that the use of hormonal contraceptives is associated with a statistically significant increase in serum calcium levels among Sudanese women. However, no significant effect was observed on serum AlkaLine Phosphatase (ALP) levels. Furthermore, while the type of contraceptive used did not significantly influence either parameter, a weak positive correlation was found between ALP and the duration of contraceptive use and between calcium and age. These findings suggest that hormonal contraceptives may influence calcium metabolism but have a limited impact on ALP activity.

Recommendations

a. Further large-scale, multicenter studies are recommended to confirm these findings and to investigate the long-term effects of contraceptive use on mineral metabolism, particularly calcium and bone-related markers.

b. Healthcare providers should consider routine monitoring of serum calcium in long-term users of hormonal contraceptives, especially in women at risk of bone metabolic disorders.

c. Awareness campaigns should be implemented to educate women about the possible metabolic effects of contraceptives and the importance of nutritional and hormonal balance.

d. It is advised to encourage the use of contraceptives under medical supervision and to promote individualized contraceptive counseling based on age, health status and risk factors.

e. Future studies should not only focus on mineral metabolism but also include the assessment of glucose, urea, electrolytes and liver function tests in contraceptive users. Additionally, measuring plasma levels of regulatory genes like Sirtuin 1, which has a crucial role in bone metabolism, is highly recommended to better understand the molecular mechanisms behind the observed changes.

Acknowledgment

We acknowledge the support of the Faculty of Medical Laboratory Sciences at Shendi University to help complete this study.

Consent

The patient's written consent has been collected.

Sources of Funding

There was no specific grant for this research from any funding organization in the public, private, or nonprofit sectors.

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