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Evaluation of Serum Calcium Levels and Its Cellular Transport Implications in a Cohort of Healthy Females in Tocra, Libya: Integration with Local Baseline Vitamin D3 and TSH Profiles

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تقييم مستويات الكالسيوم في المصل وتداعياتها على النقل الخلوي لدى مجموعة من النساء السليمات في توكره، ليبيا: الربط مع المؤشرات المرجعية المحلية لفيتامين "د3" والهرمون المنبه للغدة الدرقية

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Abstract:
Calcium ions play essential regulatory roles in controlling neuromuscular response thresholds, signal transduction pathways, and skeletal tissue mineralization. Although the Mediterranean climate supports mineral metabolism, the dynamics of physiological and cellular transport in the city of Tocra, eastern Libya, remain poorly understood. This cross-sectional study aimed to measure calcium concentrations in a precisely defined, independent cohort of healthy women in Tocra, integrate these findings with regional reference data for Vitamin D3 and thyroid-stimulating hormone (TSH), and explore potential bottlenecks in cellular uptake and their associated environmental and genetic implications. Calcium levels were measured in 54 participants selected based on strict exclusion criteria. The results were compared with data from two separate regional reference groups; these groups exhibited high prevalence rates of Vitamin D3 deficiency (79.63%, n=54) and a stable distribution of normal thyroid status (91.43%, n=70). The mean calcium level among participants was 7.58 ± 1.20 mg/dL. Significant calcium deficiency was observed in 43 participants (79.63%), while normal levels were found in only 11 (20.37%); no cases of elevated calcium were detected. Comparison with the corresponding regional reference data revealed a clear association between low calcium levels and Vitamin D3 deficiency, independent of fluctuations in thyroid function. This indicates a systemic absorption dysfunction and regional gene-environment variations, necessitating the adoption of targeted nutritional and genomic strategies.

Keywords: Hypocalcemia; TRPV6; Enterocyte transport; VDR transcriptional regulation; Eco-genetics; Tocra; Libya.

الملخص:
تؤدي أيونات الكالسيوم أدوارًا تنظيمية أساسية في التحكم بعتبات الاستجابة العصبية العضلية، وسلسلة انتقال الإشارات، وتكلس النسيج الهيكلي. ورغم أن مناخ البحر الأبيض المتوسط يوفر ظروفًا داعمة لاستقلاب المعادن، إلا أن ديناميكيات النقل الفسيولوجي والخلوي في مدينة توكره، شرق ليبيا، لا تزال غير مفهومة. هدفت هذه الدراسة المقطعية إلى قياس تركيزات كالسيوم المصل ضمن مجموعة محددة بدقة ومستقلة من النساء السليمات في توكره، ثم دمجت هذه البيانات مع البيانات المرجعية الإقليمية لفيتامين د3 والهرمون المنبه للدرقية لاستكشاف الاختناقات المحتملة في امتصاص الخلايا وآثارها البيئية والوراثية. تم قياس مستويات الكالسيوم لدى 54 مشاركة، تم اختيارهن وفق معايير استبعاد صارمة. جرت مقارنة النتائج مع بيانات مجموعتين مرجعيتين إقليميتين منفصلتين؛ حيث أظهرت نتائج هاتين المجموعتين معدلات انتشار عالية لنقص فيتامين د3 (79.63%، العدد=54) وتوزيعاً مستقراً لحالة الدرقية الطبيعية (91.43%، العدد=70). بلغ متوسط مستوى الكالسيوم للمشاركات 7.58 ± 1.20 ملغ/ديسيلتر. ولوحظ وجود نقص ملحوظ في الكالسيوم لدى 43 مشاركة (79.63%)، في حين اقتصرت حالات الطبيعية على 11 مشاركة (20.37%)، ولم يتم رصد أي ارتفاع للكالسيوم. عند مقارنة هذه النتائج بالبيانات المرجعية الإقليمية الموازية، تبين وجود تلازم واضح بين انخفاض مستويات الكالسيوم ونقص فيتامين د3، بمعزل عن التقلبات في وظائف الدرقية. وهذا يدل على خلل جهازي في عمليات الامتصاص وتباينات إقليمية بيئية-جينية، مما يستدعي تبني استراتيجيات غذائية وجينومية موجهة.

الكلمات المفتاحية: نقص كالسيوم الدم؛ TRPV6؛ النقل عبر الخلايا المعوية؛ التنظيم النسخي بواسطة VDR؛ علم الوراثة البيئي؛ توكره؛ ليبيا.

Introduction:

Calcium ion serves as an indispensable biological regulator, governing skeletal tissue structure, excitation-contraction coupling in muscle fibers, action potential transmission across neural networks, and numerous intracellular enzymatic cascades (Gehlert et al., 2015). Maintaining systemic mineral homeostasis requires a sophisticated hormonal network, comprising parathyroid hormone, active vitamin D metabolites, and calcitonin, that collectively fine-tunes mineral retention in the kidneys, release from the skeleton, and intestinal absorption pathways (Mashadiyeva-Bayramova et al., 2025). Active transcellular absorption (across the intestinal epithelium) relies specifically on the apical entry channel TRPV6 and the cytoplasmic transport protein Calbindin-D9k; the functional expression of both transport components depends heavily on gene transcription mediated by nuclear vitamin D receptors (VDR) (Christakos et al., 2011; Baird, 2011).

Despite the favorable coastal location and abundant UVB exposure characteristic of Mediterranean environments (such as the city of Tocra), mineral metabolism disorders often present an epidemiological paradox (Rizzolo et al., 2022). Previous local baseline studies in Tocra revealed a high prevalence of Vitamin D3 deficiency (79.63%; n=54), alongside normal thyroid function in the vast majority of subjects (91.43%; n=70). However, these markers were measured in separate groups of females, leaving systemic calcium levels unexamined.

Given that metabolic or thyroid-related alterations in calcium clearance rates can be ruled out based on local reference data, assessing total serum calcium levels in a distinct, non-overlapping cohort of healthy women offers crucial insight into local ion transport dynamics. This study aimed to quantify serum calcium levels in an independent group of healthy adult females in Tocra, Libya, and to contextualize these findings within regional reference data for Vitamin D3 and thyroid function, thereby evaluating cellular absorption efficiency and its environmental and genetic implications.

Materials and Methods:

Study Design and Exclusion Criteria:

An observational, cross-sectional study was conducted in the coastal city of Tocra, eastern Libya, involving 54 healthy women (aged 18–50 years) to evaluate total serum calcium concentrations. Strict exclusion criteria were applied to isolate primary ion transport dynamics and minimize metabolic confounding factors; **these included:**

- Renal insufficiency, hepatic disorders, cardiovascular disease, or diabetes mellitus.
- Tobacco use (direct or indirect) or substance abuse.
- Recent use (within the past six months) of nutritional supplements or medications, including calcium preparations, vitamin D analogs, bisphosphonates, corticosteroids, or antiepileptic drugs.

To enhance epidemiological robustness at the regional level, this study examined an independent, non-overlapping cohort, distinct from the local groups analyzed in our previous studies—which established regional reference data for both 25-hydroxyvitamin D3 (n = 54) and thyroid-stimulating hormone (TSH; n = 70).

Sample Collection and Evaluate Calcium Levels:

Venous blood was drawn under aseptic conditions between 08:00 and 10:00 AM following an overnight fast (exceeding 10 hours). Blood samples (5 mL) collected and allowed to clot completely at

room temperature (22–25°C) for 30 minutes. Serum was separated via refrigerated centrifugation at 3,000 rpm (1,500 × g) for 10 minutes at 4°C, and the separated serum aliquots were immediately processed for biochemical analysis. Total serum calcium levels were measured using the colorimetric *o*-cresolphthalein complexone (*o*-CPC) method, utilizing calibrated, automated clinical biochemistry analyzers. Strict internal quality control protocols were implemented using standard reference serum samples. **Diagnostic reference thresholds were classified as follows:**

- **Hypocalcemia:** < 8.50 mg/dL (< 2.12 mmol/L).
- **Normocalcemia:** 8.50 - 10.50 mg/dL (2.12 - 2.62 mmol/L).
- **Hypercalcemia:** > 10.50 mg/dL (> 2.62 mmol/L).

Statistical Analysis:

Biostatistical analysis was performed using SPSS software (IBM Corp., Version 26.0). The normal distribution of continuous data was assessed using the Shapiro-Wilk test, and results were presented as mean ± standard deviation (SD), median, and range (minimum–maximum). Categorical variables and diagnostic frequencies were presented as absolute numbers (n) and percentages (%).

Results:

Biochemical assessment of total serum calcium levels in the participants of this independent group (n = 54) revealed a mean concentration of 7.58 ± 1.20 mg/dL. A median value of 7.60 mg/dL was recorded, within a physiological range extending from a minimum of 5.40 mg/dL to a maximum of 10.00 mg/dL (Table 1).

Upon applying standard clinical diagnostic criteria, hypocalcemia (less than 8.50 mg/dL) was observed in 79.63% (n = 43) of the participants, while only 20.37% (n = 11) maintained normal calcium levels (8.50–10.50 mg/dL). No cases of hypercalcemia (greater than 10.50 mg/dL) were recorded (0.0%) (Table 2).

Table (1): Descriptive Statistics of Serum Total Calcium Levels

Metric / Parameter	Value (mg/dL)	Value (mmol/L)
Mean ± Standard Deviation (Mean ± SD)	7.58 ± 1.20	1.89 ± 0.30
Median	7.60	1.90
Minimum Value (Min)	5.40	1.35
Maximum Value (Max)	10.00	2.50

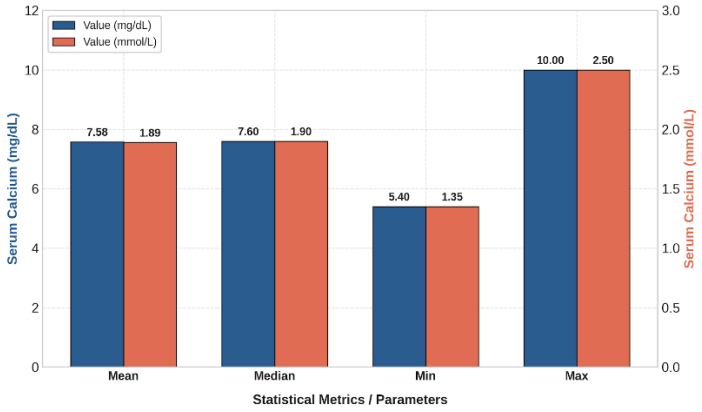

Figure (1): Shows Metrics of Serum Calcium Concentrations: Dual-Unit Analysis (mg/dL vs. mmol/L)

Table (2): Stratification and Prevalence of Serum Calcium Status

Diagnostic Category	Concentration Threshold	Frequency (n)	Relative Percentage (%)
Hypocalcemia	< 8.50 mg/dL (< 2.12 mmol/L)	43	79.63%
Normocalcemia	8.50 - 10.50 mg/dL (2.12 - 2.62 mmol/L)	11	20.37%
Hypercalcemia	> 10.50 mg/dL (> 2.62 mmol/L)	0	0.00%
Total Population	—	54	100.0%

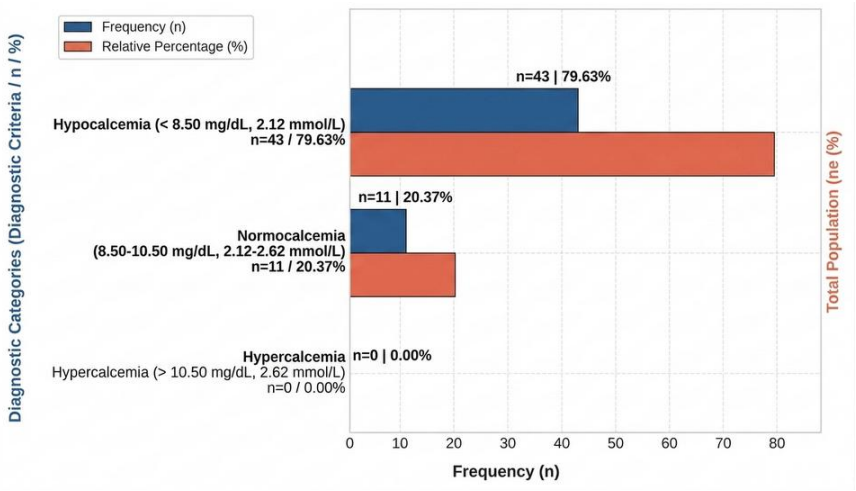

Figure (2): Shows Diagnostic Categorization of Serum Calcium Levels

Discussion:

This study documents a high prevalence of hypocalcemia (79.63%) among healthy women in the city of Tocra. These findings align with regional observational studies conducted across North Africa and the Middle East, where suboptimal extracellular calcium levels in adult women are frequently documented (Fuleihan et al., 2015). Similarly, local epidemiological reports from Benghazi and Tripoli have highlighted significant rates of calcium imbalance, attributing this to dietary deficiencies, low dairy consumption, and limited sun exposure (Baccush & Elofi, 2018; Elhassi & Shareef, 2020).

More importantly, given that this study evaluated an independent cohort, linking these findings with parallel reference data from the Tocra area—where 79.63% of females exhibit severe Vitamin D3 deficiency (n=54), while 91.43% maintain normal, stable thyroid function (n=70)—reveals a striking, **multifactorial phenomenon:**

- **Inhibition of Vitamin D Receptor (VDR) transporters in intestinal cells:** Intestinal calcium absorption relies heavily on the active transcellular pathway, wherein the 1,25-$(OH)_2D_3$ compound binds to nuclear vitamin D receptors (VDR) in intestinal cells to stimulate the expression of both TRPV6 and Calbindin-D9k (Christakos et al., 2016). A severe deficiency in the vitamin D3 precursor in this population limits the availability of the ligand, thereby inhibiting the gene transcription levels of these transporters and leading to reduced systemic blood calcium levels.
- **Ruling out thyroid-mediated clearance pathways:** Given that the predominance of a euthyroid state (91.43%) confirms normal basal metabolic rates, the high prevalence of hypocalcemia cannot attribute to accelerated steroid or mineral clearance driven by thyroid activity; this confirms the presence of a primary defect at the level of absorption.
- **Receptor-related gene-environment variations:** The precise numerical correspondence between the rates of hypocalcemia (79.63%) and Vitamin D3 deficiency (79.63%) in independent groups of females suggests the presence of underlying gene-environment variations. It also may suggest the single nucleotide polymorphisms (SNPs) in the Vitamin D receptor (VDR) gene among the population of Tocra; these factors may alter receptor sensitivity and the efficiency of transport across mucous membranes.

Conclusion & Recommendations:

Conclusion:

Extremely high rates of hypocalcemia (79.63%) were recorded among healthy adult women in the city of Tocra. When compared to the region's prevailing reference rates, these findings indicate a defect in transcellular intestinal absorption, a dysfunction resulting from severe Vitamin D3 deficiency and potential gene-environment variations in receptors, independent of any thyroid-related metabolic factors.

Recommendations:

1. **Genetic and molecular characterization:** Conducting molecular analyses to determine VDR gene polymorphisms (such as FokI, BsmI, and TaqI) and measuring TRPV6 channel expression levels in intestinal cells across regional populations.
2. **Nutrition and public health initiatives:** Implementing national strategies for supplementation and biofortification with calcium and vitamin D.
3. **Routine clinical screening:** Adopting a dual biochemical screening protocol (measuring serum vitamin D and total calcium levels) in primary healthcare facilities throughout eastern Libya.

References:

1. Gehlert, S., Bloch, W., Suhr, F. (2015). Ca^{2+}-Dependent Regulations and Signaling in Skeletal Muscle: From Electro-Mechanical Coupling to Adaptation. Int. Mol. Sci., 5;16(1): 1066-1095. doi: 10.3390/ijms16011066
2. Mashadiyeva-Bayramova, S. A., Aliyeva, D. M., Zulfugarova, P. A., Rustamzada, A. A., Bayramov, A. A. (2025). Calcium Homeostasis: Physiological Regulation by Parathyroid Hormone and Vitamin D. International Journal of Medical Science and Health Research, 9(4): 48-53. doi: 10.51505/ijmshr.2025.9404. http://dx.doi.org/10.51505/ijmshr.2025.9404.
3. Christakos, S., Dhawan, P., Porta, A., Mady, L. J., Seth, T. (2011). Vitamin D and Intestinal Calcium Absorption. Mol. Cell Endocrinol., 5; 347(1-2): 25–29. doi: 10.1016/j.mce.2011.05.038. doi: 10.1016/j.mce.2011.05.038. https://pmc.ncbi.nlm.nih.gov/articles/PMC3405161/
4. Baird, G. S. (2011). Ionized calcium interpretation: What is the right way? Annals of Clinical Biochemistry, 48(6), 508–511. https://doi.org/10.1258/acb.2011.011122
5. Diaz-Rizzolo, D. A., Kostov, B., Gomis, R., Siso-Almirall, A. (2022). Paradoxical suboptimal vitamin D levels in a Mediterranean area: a population-based study. Scientific Reports, 12:19645. https://doi.org/10.1038/s41598-022-23416-1
6. Fuleihan, G. E., Bouillon, R., Clarke, B., Chakhtoura, M., Cooper, C., McClung, M., & Singh, R. J. (2015). Serum 25-hydroxyvitamin D levels: Variability, regional differences, and relationship to bone mineral density. J. Bone Miner. Res., 30(7), 1119–1133. DOI: 10.1002/jbmr.2536 https://doi.org/10.1002/jbmr.2515
7. Baccush, M. M., & Elofi, A. O. (2018). High prevalence of vitamin D deficiency among women of childbearing age in Benghazi, Libya. Libyan Journal of Medical Sciences, 12(2), 45–50. DOI: 10.4103/ljms.ljms_22_18
8. Elhassi, A. M., & Shareef, A. S. (2020). Assessment of vitamin D and mineral status in healthy adult females in Western Libya: A cross-sectional analytical study. Tripoli Medical Journal, 15(1), 88–95.
9. Christakos, S., Dhawan, P., Verstuyf, A., Verlinden, L., & Carmeliet, G. (2016). Vitamin D: Metabolism, molecular mechanism of action, and pleiotropic effects. Physiol. Rev., 96(1), 365–408. DOI: 10.1152/physrev.00014.2015 https://doi.org/10.1152/physrev.00014.2015