

Original article

Prevalence of Magnesium Deficiency and Its Association with Age and Sex Among Individuals Attending Al-Baraa Medical Laboratory in Derna, Libya

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Abstract

Serum magnesium plays a crucial role in various physiological functions, and its deficiency is associated with multiple health complications. This study aimed to evaluate the prevalence of magnesium deficiency and assess its association with demographic factors (age and gender) among the study population at Al-Baraa Medical Laboratory in Derna. A descriptive cross-sectional study was conducted during spring 2026 among 300 individuals attending Al-Bara Medical Laboratory in Derna, Libya. Venous blood samples were collected, and serum magnesium was measured using the colorimetric Calmagite method with a BioLabo Magnesium reagent kit and Photometer 4040. Magnesium deficiency was defined as a serum magnesium concentration <1.7 mg/dL. Data on age, sex, serum magnesium concentration, and magnesium status were collected and analyzed statistically. The study included 300 participants with a mean age of 38.97 ± 18.45 years. Females constituted the majority of participants (244, 81.3%). Magnesium deficiency was observed in 199 (66.3%) participants, whereas 101 (33.7%) had normal magnesium status. A statistically significant association was found between age and magnesium status ($\chi^2 = 11.29$, $p = 0.046$), while no significant association was observed between sex and magnesium status ($\chi^2 = 0.80$, $p = 0.371$). Pearson correlation analysis demonstrated a weak negative correlation between age and serum magnesium concentration ($r = -0.121$, $p = 0.037$). Magnesium deficiency was common among participants. Age was significantly associated with magnesium status and showed a weak inverse correlation with serum magnesium, while no significant association was found with sex. Further population-based studies are recommended to confirm these findings.

Keywords. Magnesium Deficiency, Serum Magnesium, Prevalence, Correlation, Derna, Libya.

Introduction

Magnesium (Mg) is an essential mineral that plays a fundamental role in maintaining normal physiological and biochemical functions in the human body. It acts as a cofactor in more than 300 enzymatic reactions involved in energy production, protein synthesis, nucleic acid synthesis, glucose metabolism, DNA and RNA stability, neuromuscular function, electrolyte balance, and maintenance of cellular integrity. Magnesium is also important for normal muscle contraction, nerve transmission, and cardiovascular function. Approximately 50–60% of total body magnesium is stored in bone, while most of the remaining magnesium is located within soft tissues and muscles. Less than 1% of total body magnesium is present in the circulating blood, making the assessment of magnesium status challenging [1].

Magnesium deficiency is an important nutritional and clinical concern that may occur as a result of inadequate dietary intake, impaired gastrointestinal absorption, increased gastrointestinal losses, excessive renal excretion, certain medications, or chronic diseases. The clinical manifestations of magnesium deficiency depend on its severity and duration. Mild deficiency may remain clinically unrecognized, whereas more pronounced deficiency can be associated with fatigue, weakness, muscle cramps, tremor, nausea, and neuromuscular disturbances. Severe hypomagnesemia may contribute to electrolyte abnormalities, particularly hypokalemia and hypocalcemia, and may increase the risk of cardiac arrhythmias and neurological complications [2]. The clinical importance of magnesium deficiency highlights the need for adequate assessment of magnesium status, particularly among individuals at risk of inadequate intake or increased magnesium loss. Assessment of magnesium status is challenging because the majority of body magnesium is stored in bone and intracellular compartments rather than in the circulation. Several methods have been investigated for evaluating magnesium status, including serum and plasma magnesium, erythrocyte magnesium, urinary magnesium excretion, magnesium tolerance testing, and intracellular measurements. However, serum magnesium remains the most commonly used laboratory measure because it is relatively simple, inexpensive, widely available, and suitable for routine clinical and laboratory investigations. Despite these advantages, serum magnesium represents only a small proportion of total body magnesium and may not always reflect intracellular or total-body magnesium stores. Consequently, individuals with reduced tissue magnesium reserves may sometimes have serum concentrations within conventional laboratory reference ranges [1].

The interpretation of serum magnesium concentrations is further complicated by differences in reference intervals and cutoff values used among laboratories and studies. Traditional reference ranges may not necessarily correspond to optimal magnesium status, and differences in analytical methods, populations, and laboratory procedures can contribute to variation in reported concentrations [1]. emphasized the importance of establishing evidence-based reference intervals for serum magnesium and improving the interpretation of magnesium measurements. Therefore, studies investigating magnesium deficiency should clearly define the laboratory cutoff used to classify participants and should recognize that

serum magnesium is an accessible indicator of magnesium status rather than a perfect measure of total-body magnesium stores.

Magnesium status has also been associated with several important metabolic and chronic health conditions. Magnesium is involved in glucose metabolism and insulin signaling, and inadequate magnesium status has been reported in individuals with obesity, metabolic syndrome, insulin resistance, and type 2 diabetes mellitus. Several studies have suggested that lower magnesium concentrations may be more common among individuals with metabolic disorders, although the magnitude of these associations varies across populations [3,4]. A systematic review and meta-analysis also reported a considerable prevalence of hypomagnesemia among individuals with type 2 diabetes mellitus, further emphasizing the clinical relevance of magnesium assessment in populations with metabolic disease [5].

Magnesium status may also be influenced by a range of demographic and physiological characteristics. In particular, age and gender may contribute to differences in magnesium concentrations through variations in dietary intake, body composition, physiological requirements, hormonal factors, renal handling, and the prevalence of chronic diseases and medication use. Nutritional requirements and dietary patterns may change across different stages of life, while physiological and hormonal differences between males and females may also influence magnesium metabolism. Consequently, examining magnesium status according to age and gender may provide useful information about demographic patterns of magnesium deficiency [4,1].

The relationship between magnesium status and age is particularly relevant because changes in nutritional intake, gastrointestinal absorption, renal function, body composition, and the occurrence of chronic diseases may accompany increasing age. Older individuals may therefore be more susceptible to inadequate magnesium status because of multiple interacting factors, including reduced dietary intake, altered absorption, increased medication use, and changes in renal handling of magnesium. However, magnesium status is not necessarily determined by age alone, and differences between age groups may vary according to the characteristics of the population studied [2].

Gender may also be associated with differences in magnesium status. Men and women may differ in dietary patterns, body composition, hormonal characteristics, and metabolic requirements, all of which may contribute to variation in serum magnesium concentrations. Previous population studies have reported differences in serum magnesium concentrations and reference intervals according to sex and age, although the direction and magnitude of these differences have not been consistent across all populations. These findings support the importance of examining demographic characteristics when investigating magnesium status rather than assuming that the prevalence of magnesium deficiency is uniform across population groups [4].

The prevalence of magnesium deficiency varies considerably between studies and populations. Differences in the prevalence reported in the literature may reflect variations in dietary habits, age distribution, health status, geographical location, sample characteristics, laboratory methods, and the cutoff values used to define deficiency. In addition, studies conducted in hospital or laboratory populations may produce prevalence estimates that differ from those obtained from community-based samples because individuals attending healthcare facilities may have different underlying health characteristics. Therefore, local studies are important for establishing the frequency of low serum magnesium concentrations within specific populations and for identifying demographic patterns that may warrant further investigation [1].

Although magnesium deficiency has been investigated internationally, information regarding serum magnesium status in Libya remains limited, particularly in the eastern region of the country and in Derna. Local data are important because dietary practices, demographic characteristics, healthcare utilization, and the prevalence of chronic diseases may differ between populations and geographical settings. In the absence of sufficient local evidence, it is difficult to determine the magnitude of magnesium deficiency among individuals undergoing laboratory investigations or to establish whether particular demographic groups are more frequently affected [2].

Al-Baraa Medical Laboratory in Derna provides an appropriate setting for investigating serum magnesium status among individuals undergoing laboratory testing. Examining magnesium concentrations in this setting can provide useful baseline information regarding the frequency of low serum magnesium concentrations and their distribution according to age and gender. Such information may contribute to the local evidence base and provide a foundation for future research investigating nutritional, clinical, and metabolic factors associated with magnesium status in the Libyan population.

Therefore, the present study was conducted to estimate the prevalence of magnesium deficiency among individuals attending Al-Baraa Medical Laboratory in Derna, Libya, and to evaluate the relationship and statistical association between magnesium status and demographic variables, specifically age and gender. The findings are expected to provide baseline epidemiological information on magnesium status within the study population and to improve understanding of demographic variations in magnesium deficiency in the local setting.

Methods

Study Design and Study Area

A descriptive cross-sectional study was conducted during the spring season of 2026.

Study Population and Sample Size

The study population consisted of individuals who attended Al-Bara Medical Laboratory in Derna City, Libya, during the study period and provided blood samples for serum magnesium determination. A total of 300 participants were included in the study.

Participants were eligible for inclusion if they attended the laboratory during the study period, provided a venous blood sample suitable for serum magnesium analysis, had sufficient serum available for laboratory testing, and had complete age and sex information. Samples were excluded if they were hemolyzed or otherwise unsuitable for analysis, insufficient in volume for magnesium determination, or had incomplete or unavailable demographic information required for the study analysis. Samples that did not meet the laboratory requirements for reliable serum magnesium measurement were also excluded.

Sample Collection and Preparation

Venous blood samples were collected by qualified laboratory personnel using standard phlebotomy procedures. Blood was collected into appropriate plain blood collection tubes and allowed to clot. The samples were subsequently centrifuged to separate the serum from the cellular components.

The separated serum was carefully transferred into appropriate containers and prepared for magnesium analysis. Samples were handled according to standard laboratory procedures. Particular attention was given to the identification and exclusion of hemolyzed specimens because hemolysis may interfere with the determination of serum magnesium concentration.

Laboratory Procedure

Serum magnesium concentration was measured using the BioLabo Magnesium CALMAGITE reagent kit (BioLabo S.A.S., France; Ref. K1212/K2212) according to the manufacturer's instructions. The analysis was performed using a Photometer 4040, with calibrated micropipettes and appropriate pipette tips used for sample and reagent preparation. A laboratory centrifuge was used for serum separation, and standard plain blood collection tubes and laboratory consumables were used throughout the procedure.

The assay was based on the colorimetric Calmagite method, according to the principle described by Gindler and Heth. In this method, magnesium ions in the serum react with Calmagite to form a colored magnesium–Calmagite complex. The intensity of the color produced is directly proportional to the concentration of magnesium in the sample. The absorbance of the reaction mixture was measured spectrophotometrically at the manufacturer's specified wavelength, with 546 nm used for the assay.

The reagent system contained Calmagite and other components, including EGTA, which helps reduce calcium interference, as well as components intended to minimize interference from other substances.

For each analysis, the required volumes of serum and reagent were accurately pipetted using calibrated micropipettes. The reaction mixture was prepared according to the manufacturer's recommended procedure and allowed to react under the specified conditions. The absorbance was then measured using the Photometer 4040 at 546 nm. Serum magnesium concentration was calculated according to the manufacturer's instructions using the appropriate calibrator.

The same analytical method, reagent system, and measurement conditions were maintained throughout the study to ensure consistency of the laboratory measurements.

Calibration

The Photometer 4040 was calibrated using the appropriate magnesium calibrator according to the manufacturer's instructions. The calibrator was traceable to an appropriate reference material where applicable.

Recalibration was performed when required, particularly following changes in reagent batches or when indicated by internal quality-control procedures.

Quality Control

Internal quality-control procedures were applied throughout the analytical process to ensure the reliability and consistency of serum magnesium measurements. Appropriate control materials representing relevant concentration levels were analyzed according to the manufacturer's recommendations and the laboratory's quality-control procedures.

Quality-control results were reviewed before accepting analytical runs. When control results were outside the acceptable range, the analytical procedure was reviewed and appropriate corrective measures were taken before patient results were accepted.

Definition of Magnesium Deficiency

Serum magnesium concentration was used to determine magnesium status.

For the purpose of this study, magnesium deficiency was defined as a serum magnesium concentration <1.7 mg/dL, while participants with serum magnesium concentrations ≥ 1.7 mg/dL were classified as having normal magnesium status.

The cutoff of 1.7 mg/dL was applied uniformly to all participants regardless of age or sex.

Analytical Performance

According to the manufacturer's information, the analytical measurement range of the magnesium assay was approximately 0.70–9.00 mg/dL, with a detection limit of approximately 0.13 mg/dL.

The assay was performed under standardized laboratory conditions. Potential analytical interference from factors such as significant hemolysis, turbidity, or other interfering substances was considered during sample processing and interpretation.

Data Collection

Data were collected using a structured data-recording form. The variables recorded for each participant included age in years, sex (male or female), serum magnesium concentration measured in mg/dL, and magnesium status. Magnesium status was categorized as deficient or normal based on the study-defined cutoff of <1.7 mg/dL; participants with serum magnesium concentrations <1.7 mg/dL were classified as magnesium deficient, while those with concentrations ≥1.7 mg/dL were classified as having normal magnesium status.

Statistical Analysis

Data were entered, coded, and analyzed using the Statistical Package for the Social Sciences (SPSS), version 26.0. Descriptive statistics were used to summarize the study variables. Continuous variables, including age and serum magnesium concentration, were summarized using the mean and standard deviation (SD), with the range reported where appropriate. Categorical variables, including sex, age group, and magnesium status, were presented as frequencies and percentages. The prevalence of magnesium deficiency was calculated as the proportion of participants with serum magnesium concentrations <1.7 mg/dL. The Chi-square test (χ^2) was used to assess the association between magnesium status and categorical demographic variables, including age group and sex. Where the assumptions of the Chi-square test were not met, Fisher's exact test was considered appropriate. The relationship between age and serum magnesium concentration was assessed using Pearson's correlation coefficient (r). This analysis was used to determine the direction and strength of the linear relationship between age and serum magnesium concentration. A p -value <0.05 was considered statistically significant.

Ethical Considerations

The study was conducted in accordance with accepted principles of research ethics and confidentiality. Participant information was kept confidential and used solely for research purposes. Personal identifiers were not included in the analysis or presentation of the findings. Blood samples were collected and analyzed using standard laboratory procedures, with appropriate precautions taken to protect participants and laboratory personnel.

Results

The study included a total of 300 participants. The mean age of the participants was 38.97 ± 18.45 years, with an age range of 1–98 years. The largest proportion of participants was in the 31–45 years age group, comprising 97 (32.3%) participants, followed by the 16–30 years group with 65 (21.7%) participants and the 51–65 years group with 54 (18.0%). Participants aged ≤15 years accounted for 35 (11.7%), while 28 (9.3%) participants were aged 46–50 years. The smallest age group was participants aged ≥66 years, comprising 21 (7.0%) of the study population. Females constituted the majority of the study population, with 244 (81.3%) participants, whereas males accounted for 56 (18.7%) participants (Table 1).

Table 1. Demographic Characteristics of the Study Population

Characteristic	No	%
Age group (years)		
≤15	35	11.7
16–30	65	21.7
31–45	97	32.3
46–50	28	9.3
51–65	54	18.0
≥66	21	7.0
Sex		
Female	244	81.3
Male	56	18.7

Prevalence of Magnesium Deficiency

Among the 300 participants, 199 (66.3%) were classified as magnesium deficient, while 101 (33.7%) had normal magnesium status according to the applicable age-specific reference intervals provided by the manufacturer (Figure 1).

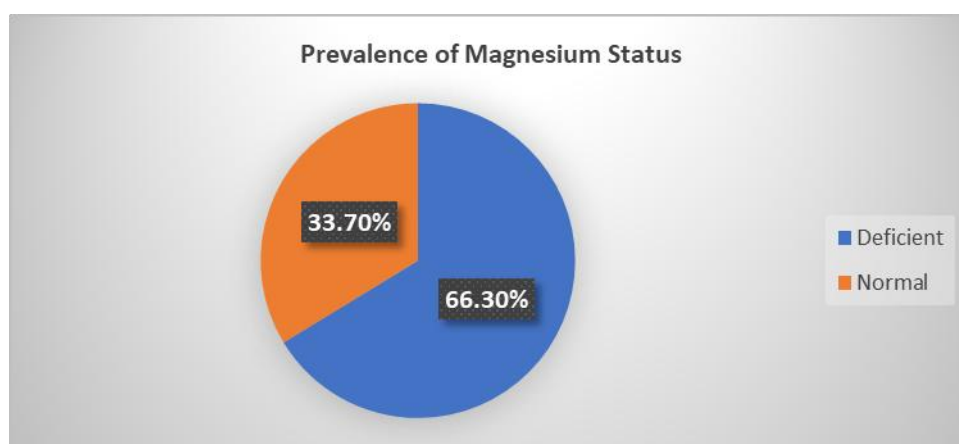


Figure 1. Prevalence of Magnesium Status Among Study Participants

Association Between Age Group and Magnesium Status

Magnesium deficiency was observed across all age groups, with the proportion of deficient participants ranging from 42.9% to 74.3%. The highest proportion of magnesium deficiency was observed among participants aged ≤ 15 years, at 26 (74.3%), followed closely by those aged 51–65 years, at 40 (74.1%). The lowest proportion was observed among participants aged ≥ 66 years, at 9 (42.9%). The Chi-square test demonstrated a statistically significant association between age group and magnesium status ($\chi^2 = 11.29$, $p = 0.046$), indicating that the distribution of magnesium status differed significantly across the age groups (Table 2).

Table 2. Association Between Age Group and Magnesium Status

Age group (years)	Magnesium deficient No (%)	Normal magnesium No (%)	χ^2	p-value
≤ 15	26 (74.3)	9 (25.7)	11.29	0.046
16–30	43 (66.2)	22 (33.8)		
31–45	67 (69.1)	30 (30.9)		
46–50	14 (50.0)	14 (50.0)		
51–65	40 (74.1)	14 (25.9)		
≥ 66	9 (42.9)	12 (57.1)		

Association Between Sex and Magnesium Status

Magnesium deficiency was observed in 40 (71.4%) males and 159 (65.2%) females. Although the proportion of deficiency was higher among males than females, the difference was not statistically significant. The Chi-square test showed no statistically significant association between sex and magnesium status ($\chi^2 = 0.80$, $p = 0.371$) (Table 3).

Table 3. Association Between Sex and Magnesium Status

Sex	Magnesium deficient No (%)	Normal magnesium No (%)	χ^2	p-value
Female	159 (65.2)	85 (34.8)	0.80	0.371
Male	40 (71.4)	16 (28.6)		

Correlation Between Age and Serum Magnesium Concentration

Pearson correlation analysis demonstrated a weak negative correlation between age and serum magnesium concentration ($r = -0.121$, $p = 0.037$). This correlation was statistically significant, indicating that higher age was associated with slightly lower serum magnesium concentrations in the study population (Table 4).

Table 4. Pearson Correlation Between Age and Serum Magnesium Concentration

Variable	Age (r)	p-value	Magnesium level (r)	p-value
Age	1	—	-0.121*	0.037
Magnesium level	-0.121*	0.037	1	—

*Correlation is significant at the 0.05 level (two-tailed).

Discussion

The present cross-sectional study investigated the prevalence of magnesium deficiency and its association with age and sex among 300 individuals attending Al-Bara Medical Laboratory in Derna, Libya. Using a serum magnesium concentration of <1.7 mg/dL as the study-defined cutoff, magnesium deficiency was identified in 199 participants (66.3%), while 101 (33.7%) had magnesium concentrations $\geq$ 1.7 mg/dL. This finding indicates that a substantial proportion of the individuals included in this laboratory-based sample had serum magnesium concentrations below the predefined cutoff. However, because the study population consisted of laboratory attendees rather than a randomly selected community sample, the observed prevalence should be interpreted as the prevalence within the study sample and should not be generalized directly to the wider population of Derna.

The prevalence of magnesium deficiency observed in the present study was relatively high, with approximately two-thirds of participants classified as deficient. Differences in the reported prevalence of magnesium deficiency across studies may be related to differences in study populations, clinical characteristics, dietary patterns, laboratory methods, and, importantly, the cutoff values used to define deficiency. Serum magnesium is widely used in clinical practice, but it represents only a small proportion of total body magnesium and may not fully reflect total body magnesium stores. Therefore, serum magnesium concentration should be interpreted within the clinical and laboratory context [2].

The present finding should also be distinguished from estimates of dietary magnesium inadequacy. A large global modelling analysis estimated that approximately 15% of the global population had inadequate intake of one or more micronutrients, with magnesium among the nutrients for which inadequacy was widespread; however, dietary inadequacy cannot be directly equated with biochemical magnesium deficiency (6). Therefore, the 66.3% observed in the present study should be interpreted specifically as the proportion of laboratory participants with serum magnesium concentrations below the study-defined cutoff.

The choice of cutoff is also important when interpreting the prevalence. There is currently no universally standardized evidence-based lower reference limit for serum magnesium. Different laboratories and studies have used different lower limits, which can substantially influence the estimated prevalence of hypomagnesemia [1,7]. The 1.7 mg/dL cutoff used in the present study was applied uniformly to all participants and should therefore be considered a study-defined classification criterion. More recent literature has proposed higher thresholds for identifying possible chronic or subclinical magnesium deficiency, further demonstrating that prevalence estimates depend strongly on the selected definition [7].

Females constituted the majority of the study population, accounting for 244 (81.3%), compared with 56 males (18.7%). Magnesium deficiency was observed in 71.4% of males and 65.2% of females. Although the proportion of deficiency was numerically higher among males, the Chi-square analysis demonstrated no statistically significant association between sex and magnesium status ($\chi^2=0.80$, $p=0.371$). This finding indicates that, within the present sample, magnesium status did not differ significantly according to sex. Population-based research has demonstrated that serum magnesium concentrations can vary according to both age and sex, although the magnitude and direction of these differences are not necessarily consistent across populations (8). More recent population-based data have also identified sex-related differences in serum magnesium concentrations, particularly among children and adults with different metabolic health characteristics (9). These findings highlight the importance of considering the demographic composition of individual study populations when interpreting sex-related differences.

The absence of a statistically significant association in the present study should not be interpreted as evidence that sex has no biological relationship with magnesium metabolism. Rather, it indicates that a statistically significant difference was not demonstrated in this particular sample. Furthermore, the substantial imbalance between female and male participants, particularly the relatively small number of males, should be considered when interpreting the finding.

Age and Magnesium Status

Age showed a statistically significant association with magnesium status when participants were categorized into six age groups ($\chi^2=11.29$, $p=0.046$). The proportion of magnesium deficiency ranged from 42.9% among participants aged $\geq$ 66 years to 74.3% among those aged $\leq$ 15 years. The highest observed proportions were therefore found among participants aged $\leq$ 15 years (74.3%) and 51–65 years (74.1%), whereas the lowest proportion was observed among those aged $\geq$ 66 years (42.9%).

The statistically significant result indicates that the distribution of magnesium deficiency differed across the age categories. However, the pattern was not consistently progressive with increasing age. In particular, the $\geq$ 66-year group had a lower proportion of deficiency than several younger age groups. Therefore, the results do not demonstrate a simple linear increase in magnesium deficiency with age.

This interpretation is further supported by the Pearson correlation analysis. A weak negative correlation was observed between age and serum magnesium concentration ($r=-0.121$, $p=0.037$), indicating that serum magnesium tended to decrease slightly as age increased. Although statistically significant, the correlation was weak, suggesting that age explains only a small proportion of the variation in serum magnesium concentration.

The relationship between magnesium status and aging is biologically plausible. Previous reviews have described several age-related changes that may influence magnesium homeostasis, including reduced dietary intake, impaired intestinal absorption, and increased renal magnesium loss [4]. Magnesium homeostasis is maintained through coordinated intestinal absorption and renal reabsorption, and the kidney plays a central role in regulating serum magnesium concentrations [10]. Consequently, physiological changes associated with aging may contribute to alterations in magnesium status.

However, these mechanisms were not directly assessed in the present study. Information regarding dietary magnesium intake, renal function, gastrointestinal losses, medication use, diabetes, and other chronic conditions was not collected. Therefore, these factors should be considered possible explanations for the observed age-related pattern rather than established causes.

The relatively low proportion of deficiency among participants aged ≥ 66 years is also noteworthy. This finding may reflect characteristics specific to the individuals who attended the laboratory, differences in clinical or nutritional status, or the relatively small number of participants in this age category ($n=21$). It should therefore be interpreted cautiously and should not be assumed to represent magnesium status among the general older population.

Conclusion

In conclusion, the findings indicate that magnesium deficiency, as defined by a serum magnesium concentration <1.7 mg/dL, was frequent among individuals included in this laboratory-based sample. Age group was significantly associated with magnesium status, and age also demonstrated a weak inverse correlation with serum magnesium concentration. In contrast, no statistically significant association was observed between sex and magnesium status.

The findings provide preliminary information regarding serum magnesium status among individuals attending a medical laboratory in Derna. However, several limitations should be considered when interpreting the results. First, the cross-sectional design prevents conclusions about temporal or causal relationships. Second, the study population was laboratory-based and may not be representative of the general population of Derna. Third, the study relied on a single serum magnesium measurement. Serum magnesium is widely used because it is accessible and practical, but it has recognized limitations as a marker of total body magnesium status because most magnesium is stored outside the serum compartment [2]. Finally, the study did not evaluate dietary intake, renal function, medication use, chronic diseases, or other potential determinants of magnesium status.

Despite these limitations, the present study provides useful baseline data on serum magnesium status in this local laboratory population. Future studies involving larger and more representative community-based samples should investigate dietary magnesium intake, nutritional status, renal function, chronic diseases, medication use, and other potential determinants of low serum magnesium. Such studies would help determine whether the high frequency observed in the present sample reflects a broader population pattern and would provide a better understanding of the factors associated with magnesium status in the Libyan population.

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Conflicts of Interest

The authors declare no conflicts of interest related to this study.

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