INTERNATIONAL JOURNAL OF MULTIDISCIPLINARY RESEARCH AND ANALYSIS

ISSN(print): 2643-9840, ISSN(online): 2643-9875

Volume 07 Issue 10 October 2024

DOI: 10.47191/ijmra/v7-i10-15, Impact Factor: 8.22

Page No. 4701-4707

Glomerular Filtration Rate and Blood Urea Nitrogen Levels between Coastal and Desert Regions within Libya

Moath F. Alsarah[1], Mohammed A. Elgadra[1], Ali Alhamali[1], Gamal W. Maree[2], Basma F. Idris[2], Abeer H. A. Amer[1,3*]

[1]Faculty of Applied Medical Sciences, Libyan International Medical University, Benghazi, Libya

[2]Department of Physiology, Faculty of Medicine, University of Benghazi, Benghazi- Libya.

[3]Department of Histology, Faculty of Medicine, University of Benghazi, Benghazi- Libya

ABSTRACT

Background: Limited research exists on how geographic location and environmental factors influence kidney function. This study investigates potential variations in Glomerular Filtration Rate (GFR) and Blood Urea Nitrogen (BUN) levels between individuals residing in the coastal and desert regions of Libya.

Methods: An observational, retrospective analysis was conducted using medical records. Participants (n=260) were recruited from Benghazi (coastal) and Jalu/Samnu/Sabha (desert) regions. Inclusion criteria included age range (18-90 years) and residency in the designated location. Exclusion criteria focused on factors affecting GFR (e.g., pre-existing kidney disease). GFR was estimated using the CKD-EPI formula. BUN levels were obtained from medical records. T-tests and Mann-Whitney U tests were used for statistical analysis.

Results: The final sample size (after exclusions) and participant demographics was 134 participants. The study found no statistically significant difference in GFR between the coastal and desert groups (p-value = 0.238). However, BUN levels were significantly higher in the desert group (mean = 28.2 SD = 30.5) compared to the coastal group (mean = 15.5, SD = 10.5) with a p-value of (p-value = 0.026).

Conclusion: This study did not identify a significant association between GFR and geographic location (coastal vs. desert) within Libya. However, BUN levels were significantly higher in the desert population, suggesting potential differences in kidney function or contributing factors that warrant further investigation.

KEYWORDS: Kidney Function, Glomerular Filtration Rate (GFR), Blood Urea Nitrogen (BUN), Libya, Geographic Variation.

INTRODUCTION

The kidneys are vital organs responsible for maintaining blood volume and composition, filtering waste products, and regulating blood pressure. Few studies highlight the early abnormalities of the kidneys function as kidney diseases have few signs and symptoms early in the disease progression, and the only way to assess the kidneys function is by laboratory tests. Tests should detect abnormalities early enough to allow corrective treatment [1]. With renal Function tests, namely the concentrations of urea and creatinine in the serum could certainly detect the glomerular filtration rate (GFR) of the kidneys depending on the age, sex and ethnicity could affect the function. Also, other health issues as Diabetes, hypertension and even the lifestyle of the household has an effect on the renal function [2]. Age-related changes in intrarenal vascular structure coincide with a reduction in renal volume and size. Both the bulk of the juxtamedullary nephrons and the number of glomeruli decrease. As a result, the glomerular basement membrane's filtration area and permeability both decrease. As people age, their glomerular filtration rate (GFR) decreases [3].

Persistent kidney damage is known as chronic kidney disease (CKD), which has a significant financial and social cost to both the patient and his family [3]. It would be crucial to identify the illness in advance while examining the population's glomerular filtration rate (GFR), particularly in those with coexisting conditions. Researchers have demonstrated that a community's and an individual's lifestyle is one of the primary variables influencing glomerular filtration rate (GFR) [4,5]. Both high-income industrialized nations like the United States and developing nations like China and Libya face significant challenges and public health issues as a result of the global pandemic of chronic kidney disease (CKD) [6–12]. The population of Libya is diverse in terms of lifestyle, geography, demographically and environmental factors, while the Studies in Libya are scarce [13]. The high prevalence and low awareness of impaired renal function and urinary abnormalities in the population illustrates the urgent need to implement a CKD prevention program in the different areas of Libya.

Glomerular filtration rate (GFR) is a key measure of kidney function, reflecting the rate at which blood plasma is filtered by the kidneys [14]. It is estimated using various formulas, with the CKD-EPI formula being a commonly employed method [15]. GFR declines naturally with age, but various factors can accelerate this decline and contribute to kidney disease [16].

Blood urea nitrogen (BUN) is a waste product generated from protein breakdown in the body. Healthy kidneys efficiently filter BUN, maintaining its blood concentration within a specific range. Elevated BUN levels can indicate reduced kidney function or dehydration [17]. Environmental factors, including climate and geographic location, have been hypothesized to influence kidney health. Studies suggest that hot climates and dehydration can increase BUN levels, potentially impacting GFR [18,19]. However, research on the association between geographic location (e.g., coastal vs. desert) and GFR variations remains limited.

Understanding the potential impact of environmental factors on kidney function is crucial for several reasons. Socially, a significant portion of the global population resides in arid or desert regions. If geographic location is linked to increased risk of kidney disease, identifying these populations becomes crucial for preventive healthcare measures and resource allocation. Medically, early detection of kidney dysfunction allows for timely intervention and management, potentially delaying or preventing progression to chronic kidney disease (CKD) and its associated complications [14].

This study investigates potential variations in GFR and BUN levels between individuals residing in the coastal and desert regions of Libya. By exploring the association between geographic location and these kidney function markers, this research contributes to a better understanding of environmental influences on kidney health and informs public health strategies in arid regions.

Aim:

To investigate the association between geographic location (coastal vs desert) and kidney function in Libya as measured by Glomerular Filtration Rate (GFR) and Blood Urea Nitrogen (BUN) levels.

METHODOLOGY

GFR Estimation:

The CKD-EPI formula was used to estimate GFR [14]. This widely accepted and validated method utilizes readily available clinical data (serum creatinine, age, gender,) to estimate GFR. The formula was applied to participants' documented serum creatinine levels in their medical records.

Sample Selection:

A convenience sample of 260 participants was determined using the Epi-info software they were recruited by reviewing medical records at Al Akeed Labs in Benghazi (coastal region) and General hospitals in Jalu/Samnu/Sabha (desert region) within the time period 01/11/2023 – 01/04/2024. The final sample size was determined after applying the following inclusion and exclusion criteria.

CKD-EPI

$$GFR = 141 \times \min(S_{cr}/\kappa, 1)^{\alpha} \times \max(S_{cr}/\kappa, 1)^{-1.209} \times 0.993^{Age} \times (1.018 \text{ if female}) \times (1.159 \text{ if African American})$$

[14]

*S_{cr} is serum creatinine in mg/dL
κ is 0.7 for females and 0.9 for males
α is -0.329 for females and -0.411 for males
min indicates the minimum of S_{cr}/κ or 1
max indicates the maximum of S_{cr}/κ or 1

Inclusion Criteria:

- Age range: 18-90 years.
- Complete medical records with documented:
  - Creatinine levels
  - BUN levels

Exclusion Criteria:

- Pre-existing chronic kidney disease (CKD).
- GFR estimated to be lower than 90 mL/min/1.73m².[14]

Data Collection:

Medical records of participants meeting the inclusion criteria were reviewed to collect the following data:

- Demographic information (age, gender).
- Geographic location (coastal or desert).
- Estimated GFR (calculated using the CKD-EPI formula).[14]
- BUN level.

Statistical Analysis:

SPSS version 26 was used, Descriptive statistics (mean, standard deviation) were used to summarize participant demographics, GFR, and BUN levels for the coastal and desert groups. Independent-samples t-tests were used to compare GFR and normally distributed continuous variables (e.g., age) between the two regions. Mann-Whitney U tests were used to compare BUN levels, a non-normally distributed variable, between the coastal and desert groups.

The level of statistical significance was set at $\alpha = 0.05$. All statistical analyses were performed using appropriate statistical software.

RESULTS

This section presents the findings of the analysis investigating potential associations between GFR and BUN levels, stratified by geographic location (coastal vs. desert) within Libya.

Overall Population Characteristics

A total of 134 participants were included in the final analysis after applying the inclusion and exclusion criteria.

Gender: The overall sample included 65 males and 69 females. (Figure 1)

Age: The participants' ages ranged from 18 to 90 years old, with a mean age of 46.46 (SD = 16). (Figure 2).

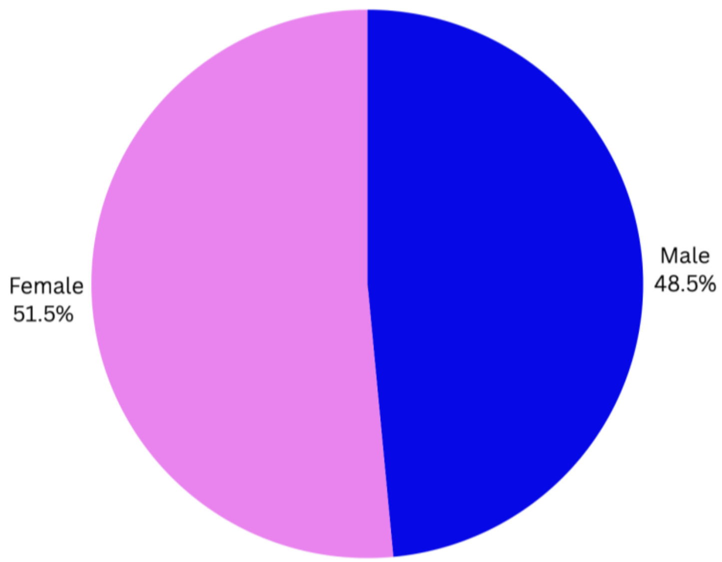

Figure 1: Percentage of males to females

Figure 3 and Figure 4, show the eGFR levels and he BUN levels in the different age groups and the highest number was at the years between 18 – 37 years of age for the eGFR with no significant differences between the groups, while the ages between 38 -57 years old were the highest group for the BUN groups, whereas, the older group was significantly lower than the other groups, could be because of the limited number or other medical causes.

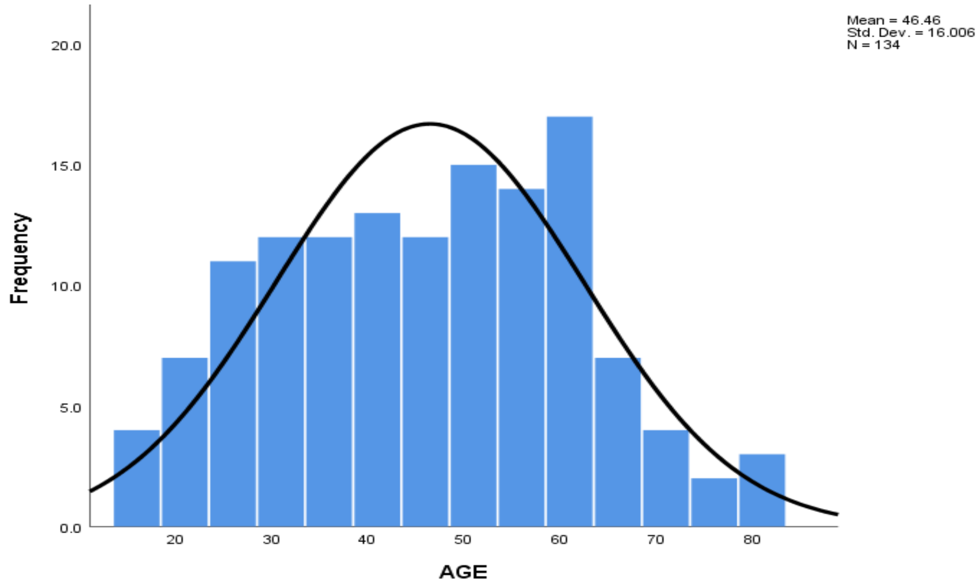

Figure 2: Frequency of individuals across different ages

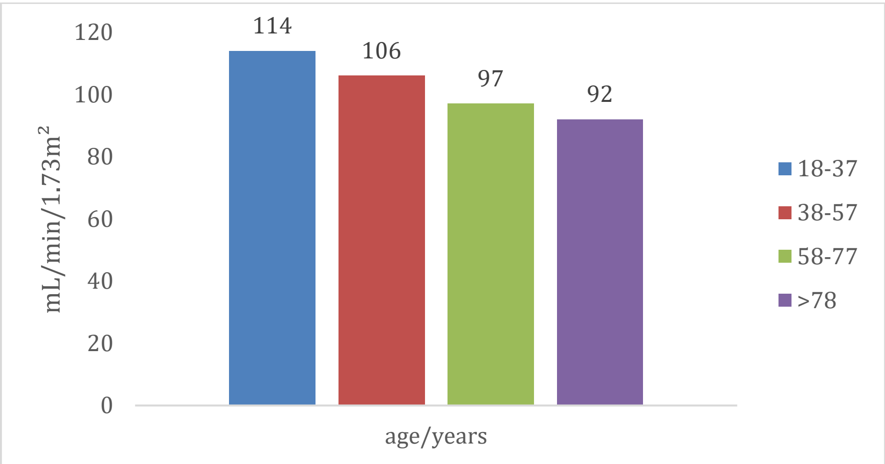

Figure 3: The eGFR levels in the different age groups

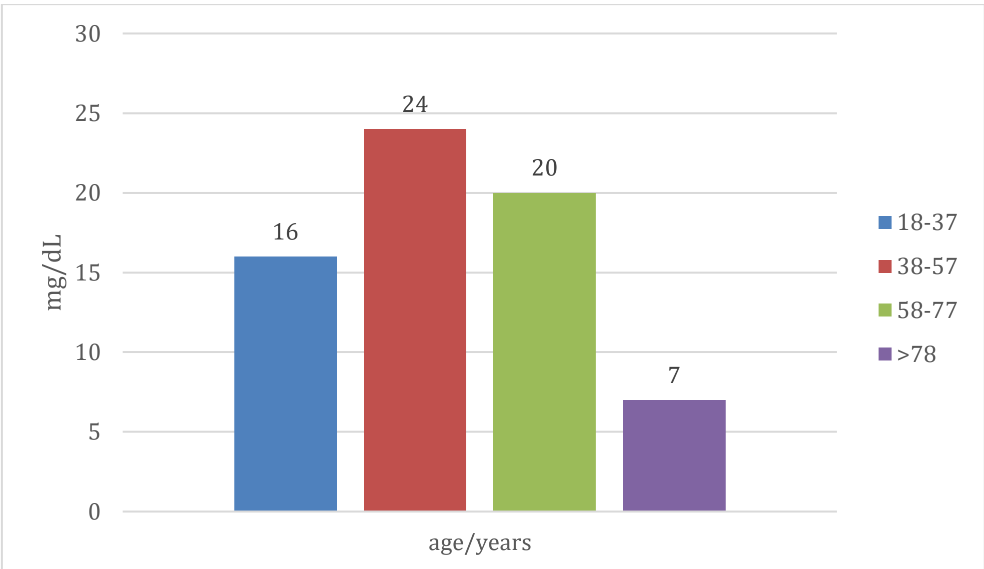

Figure 4: The BUN levels in the different age groups

Glomerular Filtration Rate and Blood Urea Nitrogen Levels between Coastal and Desert Regions within Libya

GFR Findings:

The analysis included data from 134 participants after applying the inclusion and exclusion criteria. As shown in (table 1), no statistically significant difference was found in GFR between the coastal and desert groups based on the independent-samples t-test (p-value = 0.283). The mean GFR for the coastal group was 108 (SD =21.2), while the mean GFR for the desert group was 104 (SD =21.6).

Table 1: Results of Independent-Samples t-test

	Levene's test for equality of variances			T-test for equality of Means		
eGFR	Equal variances assumed	F	Sig.	Sig.(2-tailed)	Mean Difference	Std.Error Difference
		0.093	0.760	0.283	4.11	3.82

Table 2 and 3 show the difference in means between coastal and desert regions within each gender. As is clear in table 2, males do not have significantly different GFR results between the two regions. Similarly, the results for GFR within females also did not show any significant difference between the regions.

Table 2: Results of Independent-Samples t-test for Males only

	Levene's test for equality of variances			T-test for equality of Means		
eGFR	Equal variances assumed	F	Sig.	Sig.(2-tailed)	Mean Difference	Std.Error Difference
		0.002	0.963	0.643	-2.514	5.401

Table 3: Results of Independent-Samples t-test for Females only

	Levene's test for equality of variances			T-test for equality of Means		
eGFR	Equal variances assumed	F	Sig.	Sig.(2-tailed)	Mean Difference	Std.Error Difference
		0.890	0.349	0.071	9.859	5.367

BUN Findings

As shown by (table 4), the Mann-Whitney U test revealed a statistically significant difference in BUN levels between the coastal and desert groups (p-value = 0.026). Participants residing in the desert region had significantly higher BUN levels compared to those in the coastal region. The mean BUN level for the desert group was 28.2 (SD =30.5), while the coastal group had a mean BUN level of 15.5 (SD = 10.5). The 95% confidence interval for the mean difference in BUN levels ranged from 13.2 to 36.8.

Table 4: Result of Mann-Whitney U test for BUN

	coastal	Desert	p-value
N	84	50	0.026
Mean +/- Sd	15.5 +/- 10.5	28.2 +/- 30.5	

DISCUSSION

This study investigated potential associations between GFR and BUN levels, stratified by geographic location (coastal vs. desert) within Libya. While we did not observe a significant difference in GFR between the two regions (p-value = 0.283), BUN levels were significantly higher in the desert group compared to the coastal group (p-value = 0.026).

Glomerular Filtration Rate and Blood Urea Nitrogen Levels between Coastal and Desert Regions within Libya

Limited research exists on the association between geographic location and GFR. Some studies suggest that hot climates and dehydration can increase BUN levels, potentially impacting GFR [20]. However, our results do not fully support this notion. Several factors might explain this discrepancy. First, our study relied on a convenience sample from medical records, potentially introducing selection bias. Second, while we categorized participants by coastal or desert residence, factors like variations in water intake or air conditioning use within these regions might have influenced GFR [21] but weren't captured in this study design. Finally, dietary habits could also play a role in both GFR and BUN levels [22], and future studies could explore potential dietary variations between the coastal and desert regions.

The significantly higher BUN levels in the desert group (p-value = 0.026) require further exploration. Dehydration is a potential explanation, as dehydration can lead to increased BUN concentration in the blood. However, other factors like dietary protein intake or even undiagnosed chronic conditions could also contribute [23]. Future research could investigate these possibilities.

These elevated BUN levels in the desert population warrant attention, even though we did not observe a significant GFR difference. While a single elevated BUN level might not be indicative of kidney dysfunction, chronically high levels can be a sign of underlying issues. Identifying populations at risk for elevated BUN levels allows for targeted public health interventions, such as educational campaigns on hydration and healthy eating habits.

Study Limitations:

The retrospective design relies on existing medical records, potentially introducing bias based on documentation practices. Additionally, the reliance on a convenience sample might not fully represent the target population. Future research could benefit from a prospective cohort study design with a more rigorously selected sample and detailed data collection on environmental factors and dietary habits. Furthermore, including additional kidney function markers beyond BUN could provide a more comprehensive picture.

CONCLUSION

This study provided insights into potential geographic variations in GFR and BUN levels. The higher BUN levels observed in the desert population highlight the need for further investigation into environmental and lifestyle factors that might influence kidney function in arid regions. Future studies with more robust methodologies can build upon these findings to inform public health strategies for promoting kidney health in diverse geographic settings.

REFERENCES

1) Mitchell H. Rosner, and W. Kline Bolton (2006) Renal Function Testing. American Journal of Kidney Diseases, 47(1):174-183.
2) Nakanga WP, Prynn JE, Banda L et al. (2019) Prevalence of impaired renal function among rural and urban populations: findings of a cross-sectional study in Malawi. Wellcome Open Research, 4:92 https://doi.org/10.12688/wellcomeopenres.15255.1
3) Liu Q, Li Z, Wang H, Chen X, Dong X, et al. (2012) High Prevalence and Associated Risk Factors for Impaired Renal Function and Urinary Abnormalities in a Rural Adult Population from Southern China. PLoS ONE 7(10): e47100. doi:10.1371/journal.pone.0047100
4) Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, et al. (2007) Prevalence of chronic kidney disease in the United States. JAMA 298: 2038–2047.
5) Zhang L, Zhang P, Wang F, Zuo L, Zhou Y, et al. (2008) Prevalence and factors associated with CKD: a population study from Beijing. Am J Kidney Dis 51: 373–384.
6) Bello AK, Nwankwo E, El Nahas AM (2005) Prevention of chronic kidney disease: a global challenge. Kidney Int Suppl 98: S11–S17.
7) Levey AS, Atkins R, Coresh J, Cohen EP, Collins AJ, et al. (2007) Chronic kidney disease as a global public health problem: approaches and initiatives - a position statement from Kidney Disease Improving Global Outcomes. Kidney Int 72: 247–259.
8) Coresh J, Astor BC, Greene T, Eknoyan G, Levey AS (2003) Prevalence of chronic kidney disease and decreased kidney function in the adult US population: Third National Health and Nutrition Examination Survey. Am J Kidney Dis 41: 1–12.
9) Coresh J, Selvin E, Stevens LA, Manzi J, Kusek JW, et al. (2007) Prevalence of chronic kidney disease in the United States. JAMA 298: 2038–2047.

10) Zhang L, Zhang P, Wang F, Zuo L, Zhou Y, et al. (2008) Prevalence and factors associated with CKD: a population study from Beijing. Am J Kidney Dis 51: 373–384.
11) Chadban SJ, Briganti EM, Kerr PG, Dunstan DW, Welborn TA, et al. (2003) Prevalence of kidney damage in Australian adults: The AusDiab kidney study. J Am Soc Nephrol 14 (7 Suppl 2): S131–138.
12) Wei X, Li Z, Chen W, Mao H, Li Z, et al. (2012) Prevalence and Risk Factors of Chronic Kidney Disease in First-Degree Relatives of CKD Patients in Southern China. Nephrology (Carlton) 17: 123–130.
13) Altaworghei, A. Al-saqer,E. Erhoma, E. Sabei, T. and Abukres, S. (2019) Chronic Kidney disease among a sample of Libyan population: What are the leading risk factors? Lebda Medical Journal, 6; p.221-224
14) National Kidney Foundation. GFR (Glomerular Filtration Rate). Available at: https://www.kidney.org/professionals/KDOQI/gfr Accessed April 22, 2024.
15) National Kidney Foundation. CKD-EPI Equation. Available at: https://www.kidney.org/professionals/kdoqi/gfr_calculator/formula Accessed April 22, 2024.
16) Kovesdy CP. Epidemiology of chronic kidney disease: an update 2022. Kidney international supplements. 2022 Apr 1;12(1):7-11.
17) Mayo Clinic. Blood urea nitrogen (BUN) test. Available at: https://www.mayoclinic.org/tests-procedures/blood-urea-nitrogen/about/pac-20384821?links=false&_escaped_fragment_=&p=1 Accessed April 22, 2024.
18) Sellami M, Cheikh MB, Najjar MF, Impact of hot climate on renal function in healthy young adults. Int Urol Nephrol. 2012;44(2):392-397. doi:10.1007/s11255-011-0012-0
19) Khan NU, Pervez S, Nawaz S, Dehydration and variations in serum electrolytes and kidney function tests. Cureus. 2020;12(10):e10829. doi:10.7759/cureus.10829
20) Ephraim RK, Asamoah CA, Abaka-Yawson A, Kwadzokpui PK, Adusei S. Climate change causes changes in biochemical markers of kidney disease. BMC nephrology. 2020 Dec;21:1-8.
21) Nakamura Y, Watanabe H, Tanaka A, Yasui M, Nishihira J, Murayama N. Effect of increased daily water intake and hydration on health in Japanese adults. Nutrients. 2020 Apr 23;12(4):1191.
22) Eimery S, Tangestani H, Mansouri S, Kordvarkaneh H, Rahimi-Foroushani A, Shab-Bidar S. Association between dietary patterns with kidney function and serum highly sensitive C-reactive protein in Tehranian elderly: An observational study. Journal of Research in Medical Sciences. 2020 Jan 1;25(1):19.
23) Urea Nitrogen Blood Level. In: Nursing and Health Professions. ScienceDirect. Available at: https://www.sciencedirect.com/topics/nursing-and-health-professions/urea-nitrogen-blood-level. Accessed April 22, 2024.

There is an Open Access article, distributed under the term of the Creative Commons Attribution – Non Commercial 4.0 International (CC BY-NC 4.0) (https://creativecommons.org/licenses/by-nc/4.0/), which permits remixing, adapting and building upon the work for non-commercial use, provided the original work is properly cited.