



(RESEARCH ARTICLE)



EVALUATION OF ENDOTHELIN-1 AND SOME BIOCHEMICAL VARIABLES IN PATIENTS WITH BENIGN PROSTATITIS

Mohammed Asker Mohammed *

Department of Biochemistry, College of Science, Tikrit University, IRAQ.

* Corresponding Author

International Journal of Biological and Pharmaceutical Sciences Archive, 2026, 12(02), 064–073

Publication history: Received on 12 September 2026; revised on 19 October 2026; accepted on 21 October 2026

Article DOI: <https://doi.org/10.53771/ijbpsa.2026.12.2.0103>

Copyright © 2026 Author(s) retain the copyright of this article. This article is published under the terms of the Creative Commons Attribution License 4.0

ABSTRACT

Prostate enlargement is generally a slow-growing disease, with the majority of men living for many years without symptoms. However, it is a life-threatening condition, and early treatment can control its progression. It is one of the most common diseases after the age of fifty, affecting males and impacting the prostate gland, which is important for maintaining sperm due to its contribution to seminal fluid production. This study was conducted from September 5, 2025, to December 5, 2025, to evaluate the levels of certain biochemical variables in the blood serum of 80 men aged 45-80 years. Blood samples were collected from Oncology Hospital in Medical City. Forty blood samples were collected from the patient group and forty from the healthy control group. Then, several biochemical variables were measured (prostate-specific antigen, C-reactive protein, fibrinogen-gamma, glucose, C-reactive protein 1-endothelin, ferritin, zinc, and SOD). The results showed significant differences between the two groups at a probability level of $P \leq 0.05$.

Keywords: Benign Prostatic Cancer, CRP, PSA, Fibrinogen-gamma, 1-Endothelin.

1 INTRODUCTION

Prostate diseases are among the most common diseases after the age of fifty, affecting males and impacting the prostate gland, whose importance lies in preserving sperm due to its contribution to the production of seminal fluid (1). Benign prostatic hyperplasia (BPH) is a histological disease characterized by excessive growth of epithelial and stromal cells in the transitional zone of the prostate gland (2,3). It is a common disease that affects the lifestyle of men as they age (4). The disease is one of the diseases that cause symptoms in the lower urinary tract, which may be accompanied by symptoms of non-prostate diseases such as bladder weakness (6,5).

Prostate enlargement is diagnosed by measuring the level of prostate-specific antigen (PSA), which is a significant diagnostic indicator, in addition to monitoring the progression of the disease, which is one of the oldest diagnostic indicators of the disease. (8,7). While measuring prostate-specific antigen levels is primarily used to diagnose prostate cancer, its levels can also be elevated in some non-cancerous conditions, such as prostatitis and benign prostatic hyperplasia (BPH). It is an indicator of the development of 25% of prostate cancer cases if the level of prostate-specific antigen is between 4-10 ng/cm³ (9).

C-reactive protein (CRP) is one of the acute inflammatory proteins that rise during inflammatory infections (10). CRP levels may also rise in several conditions, including obesity (11), atherosclerosis (12), heart disease (13), and types -2 diabetes (14-15).

Fibrinogen is one of the most abundant plasma proteins, and it is present at a rate of 2-4 mg/ml under normal physiological conditions, but its concentration can double in some pathological conditions. Qualitative and quantitative changes in the protein play an important role in pathological coagulation and bleeding disorders, making fibrinogen a focus of research studies (16,17).

Endothelin-11 is one of the most important biological peptides in the human body. It plays a key role in vasoconstriction and has broad effects on many physiological and pathological systems in the body. Endothelin-1 is mainly produced by endothelial cells, which are the cells that line the inner surface of blood vessels. This puts it in an ideal position to influence the dilation and constriction of blood vessels. Although its primary function is to constrict blood vessels, research has revealed its role in a variety of physiological processes and pathological pathways, including the regulation of blood pressure and inflammation, the development of some cardiovascular diseases, and even its role in some types of cancer (18).

Ferritin is one of the most important proteins involved in iron metabolism, as it stores iron and plays a key role in its metabolism. There are two types of ferritin: cytoplasmic ferritin and mitochondrial ferritin (FTMT). Cytoplasmic ferritin stores excess iron in the mitochondrion and releases it when needed through its breakdown. The regulation of Mitochondrial ferritin is classified as a metal-binding protein and is found in mitochondria. Once the mitochondria absorb the protein, it can be processed into a mature protein, and functional ferritin sheaths are built (19). Low ferritin levels are associated with several diseases, including anemia. (20).

Zinc is a trace mineral essential for many cellular processes, crucial for growth, and may play a significant role in cancer development and outcomes. Nutrition plays a profound and increasingly recognized role in mitigating risk factors for chronic diseases. In addition, zinc's immune function is linked to cellular signaling pathways, providing multiple mechanisms for zinc's role in cancer. Zinc has direct effects on cancer cells, influencing immune function and tumor suppression. (21). Low zinc levels are linked to several diseases, including cancer and multiple sclerosis (22).

Superoxide dismutase (SOD) is an antioxidant enzyme found primarily in mitochondria. Among SOD enzymes, manganese superoxide dismutase is the predominant mitochondrial enzyme. In 2005, it was shown that elevated MnSOD levels in various tissues inhibit the growth of cancer cells (23). Low levels of superoxide dismutase are linked to several factors that lead to cancer, including smoking (24).

2 MATERIAL AND METHODS

2.1 Collection of specimens

This study was conducted from 5/9/2025 to 5/12/2025 to evaluate the levels of some biochemical variables in the blood serum of 80 blood samples from men aged between (45-80) years. The blood samples were collected from Oncology Hospital in Medical City. The samples were divided into two groups:

Patient group: (40) blood samples were collected from patients with benign prostatic hyperplasia (BPH).

Healthy control group: (40) blood samples were collected from the control group (healthy individuals) without any disease.

Subsequently, several biochemical variables were measured (prostate-specific antigen, C-reactive protein, fibrinogen, gamma, glucose, C-reactive protein 1-endothelin, ferritin, zinc, and SOD).

2.2 Estimating the level of biochemical variables in the samples under study

Biochemical variables, including PSA, CRP, FGG, 1-endothelin, ferritin, zinc, and SOD, were measured using enzyme-linked immunosorbent assay (ELISA) on serum from both patients and healthy individuals. The plate contained 96 antibody-coated wells, after which antibodies against all the biochemical variables were captured. The enzyme-labeled antibody and serum antigens are used. The reaction between the antigens and antibodies is non-competitive and results in a sandwich-like complex. During incubation, the immune complex aggregates in the titration tubes due to the high-affinity reaction between streptavidin and biotinylated antibody. After equilibrium is reached, the bound antibody fragments separate from the unbound antigens in the washing process. The enzyme's activity in the bound antibody fragments is directly proportional to the antigen concentration. It is stimulated by HRP, and upon addition, the pits

appear blue. Then, the stop solution is applied to each pit, and the color changes from blue to yellow. The optical density is measured at a wavelength of 450 nm.

2.3 Statistical analysis

The Statistical Package of Social Sciences (SPSS) was used with a completely randomized design (CRD) to analyze the data using statistical methods for the study samples, through a t-test to determine the significant differences between the two groups at a probability level of ($P \leq 0.05$).

3 RESULT AND DESICCATION

3.1 Analysis of immunological and biochemical variables in both groups

The levels of certain biochemical variables were assessed in the blood serum of men with benign prostatic hyperplasia (BPH). The results, as shown in Table (1), indicate a significant increase in the levels of the studied variables (PSA, Glucose, CRP, FGG) in the blood serum of patients compared to healthy individuals, as illustrated in the figures(1,2,3,4).

Table 1: The mean $\pm$ S.D of the parameters in the two groups

Parameter	Mean $\pm$ SD	
	Control n=40	BPH n=40
PSA (ng/ml)	0.41 $\pm$ 1.17	0.62 $\pm$ 2.01
Glucose (mg/ml)	7.52 $\pm$ 92.04	11.12 $\pm$ 169.84
CRP (ng/ml)	0.31 $\pm$ 1.32	1.91 $\pm$ 0.37
FGG (ng/ml)	796.61 $\pm$ 403.84	1201.61 $\pm$ 254.24

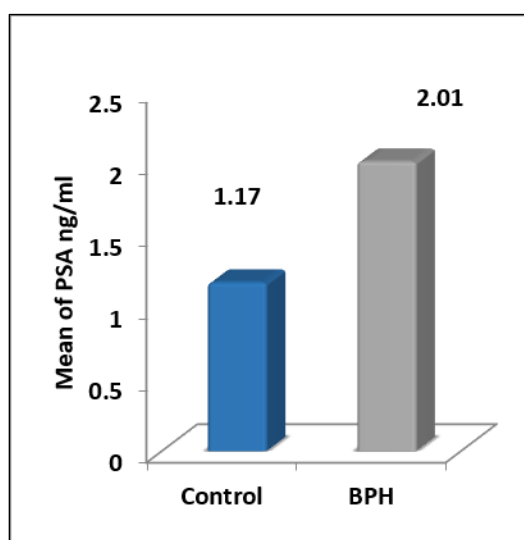


Figure 1: PSA in the serum of the blood samples under study

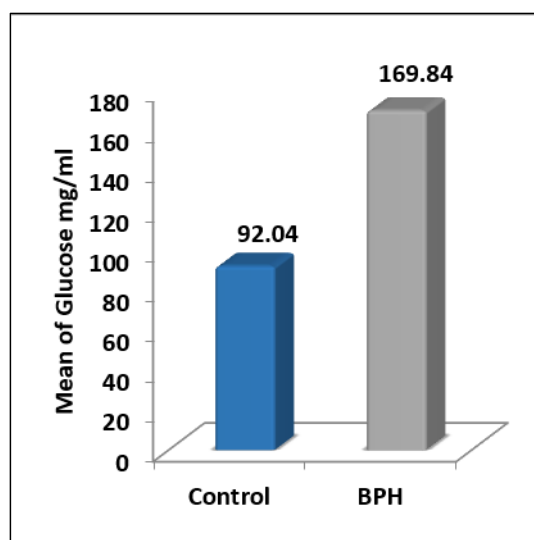


Figure 2: FGG in the serum of the blood samples under study

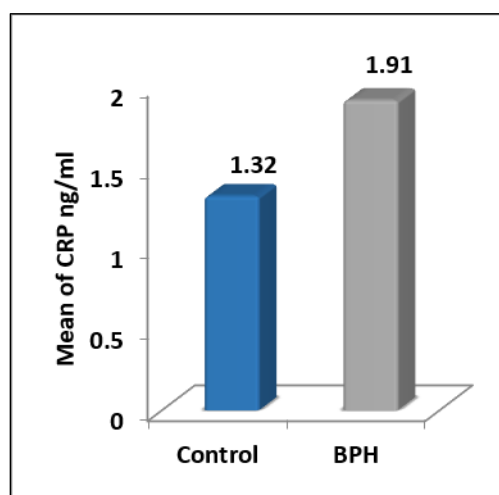


Figure 3: CRP in the serum of the blood samples under

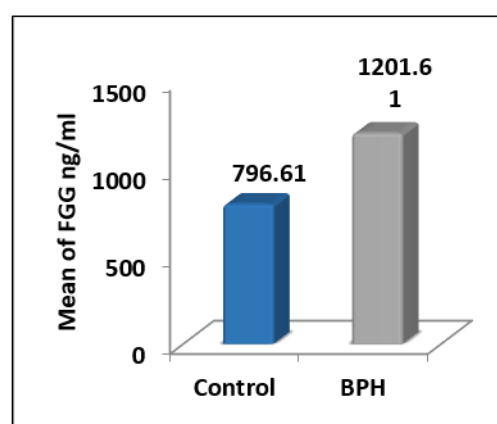
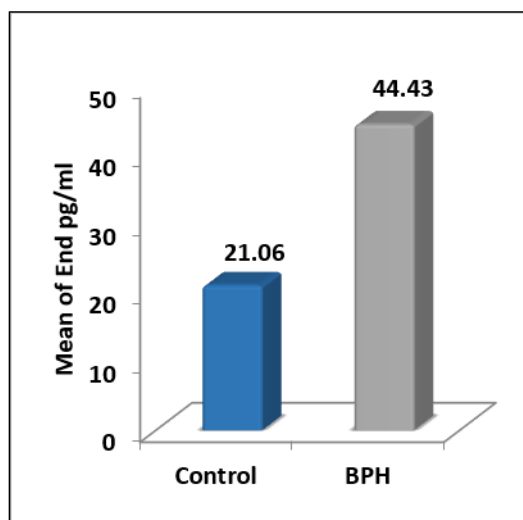
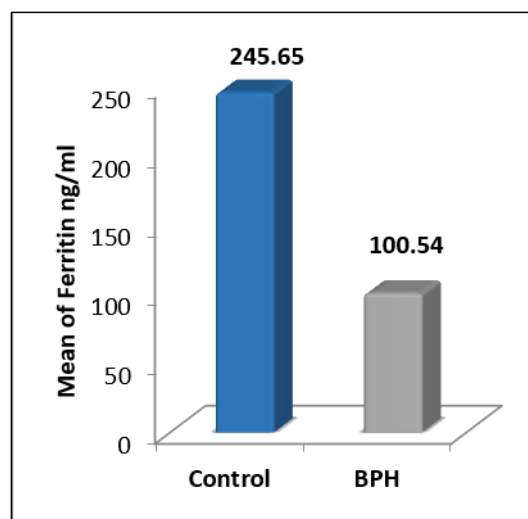


Figure 4: FGG in the serum of the blood samples under study

On the other hand, the results, as shown in Table (2), indicated a significant increase in the levels of the studied variables (Endothelin-1) in the blood serum of patients compared to healthy individuals. In contrast, the variables (ferritin, Zinc, SOD) showed a significant decrease in the blood serum of patients compared to healthy individuals, as shown in the figures(5,6,7,8).

Table 2: The mean $\pm$ S.D of the Endothelin-1 and ferritin parameters in the two groups

Parameter	Mean $\pm$ SD	
	Control n=40	BPH n=40
Endothelin-1 (pg/ml)	5.08 $\pm$ 21.06	5.23 $\pm$ 44.43
Ferritin (ng/ml)	245.65 $\pm$ 20.32	100.54 $\pm$ 17.66
Zinc (ng/ml)	100.65 $\pm$ 4.67	3.75 $\pm$ 65.67
SOD (U/ml)	0.54 $\pm$ 2.5	0.89 $\pm$ 0.124

**Figure 5: Endothelin-1 in the serum of the blood samples under study****Figure 6: Ferritin in the serum of the blood samples under study**

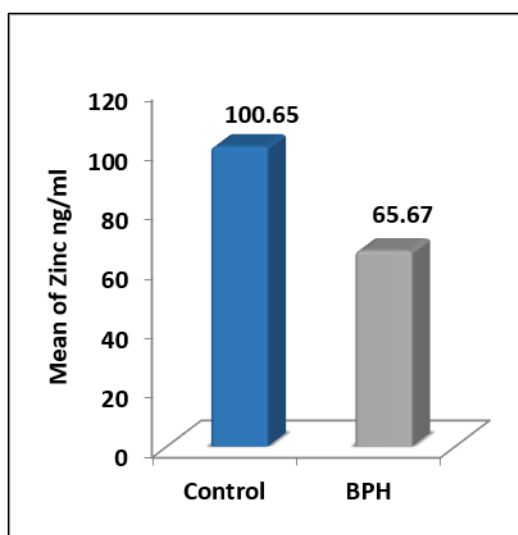


Figure 7: Zinc in the serum of the blood samples under study

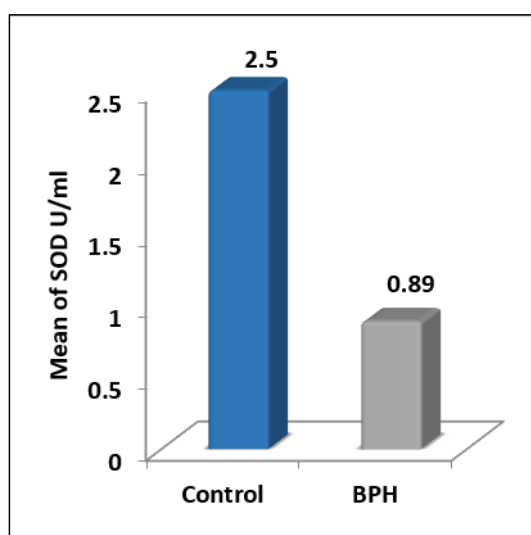


Figure 8: SOD in the serum of the blood samples under study

Table 3: The mean $\pm$ S.D of the parameters in the two groups according to age

Age group	Age (45-55) Mean $\pm$ SD	Age (56-65) Mean $\pm$ SD	Age (66-80) Mean $\pm$ SD
PSA (ng/ml)	0.62 a $\pm$ 2.01	0.58 a $\pm$ 1.97	0.59 a $\pm$ 1.99
Glucose (mg/ml)	11.12 a $\pm$ 170.04	12.02 a $\pm$ 170.84	10.12 a $\pm$ 169.14
CRP (ng/ml)	0.37 a $\pm$ 1.97	0.37 a $\pm$ 2.01	0.37 a $\pm$ 1.99
FGG (ng/ml)	264.24 a $\pm$ 1221.61	254.24 a $\pm$ 1211.61	264.14 b $\pm$ 1261.61
Endothelin-1 (pg/ml)	5.83 a $\pm$ 47.13	5.33 a $\pm$ 45.93	6.13 b $\pm$ 64.17
Ferritin (ng/ml)	100.14 $\pm$ 17.16a	99.94 $\pm$ 18.96a	117.24 $\pm$ 18.06b
Zinc (ng/ml)	65.17 $\pm$ 3.55 a	66.07 $\pm$ 3.61 a	85.17 $\pm$ 3.95 b
SOD (U/ml)	0.90 $\pm$ 0.144 a	0.91 $\pm$ 0.151 a	0.89 $\pm$ 0.134 a

While the biochemical variables were studied according to age groups (45-55) , (56-65) , (66-80) years respectively, and shown in Table (3), it was found that there were no significant differences for the variables (PSA, Glucose, CRP,

SOD) for all age groups. However, the variables (FCG, Endothelin-1, ferritin, Zinc, SOD) showed a significant decrease in the age group (66-80) years compared to the other groups.

4 DISCUSSION

Elevated blood levels of PSA may be associated with an increase in prostate gland size and tissue damage caused by prostate diseases such as prostate cancer, benign prostatic hyperplasia, and prostatitis (26). The results above show that the PSA level is significantly elevated at a probability level ($p \leq 0.05$) in the blood serum of men with prostate compared to the control group, and that the results of this study were consistent with the results of (27), who indicated in their results that the concentration of cancer antigen was higher in the group of patients compared to the control group, and that the reason for this increase is due to the structural and functional changes that occur in the prostate gland. Because the PSA test is used in all stages of prostate diseases, this explains the wide range of values for the indicator in patients, as the PSA value depends on the stage and progression of the disease (28). Prostate-specific antigen (PSA) is one of the diagnostic indicators that plays an important role in the diagnosis of prostate cancer(29, 30).

The (CRP) result was consistent with the findings of Shun-Fa Hung et al. (31) and Sauver et al. (32). It is believed that the elevation is due to chronic inflammation, which may contribute to prostate enlargement; therefore, treating chronic inflammation is essential to prevent disease progression (33). Furthermore, the results of McArdle and colleagues (34) indicated that patients with metastatic prostate have high levels of C-reactive protein and that this measurement may predict poor outcomes if the patient's condition progresses, regardless of the level of prostate-specific antigen. However, the result of the elevated glucose was consistent with the findings of the study by Xiong et al. (35) and the study by Nugroho (36). Since they found that high blood glucose and prostate size were strongly associated in patients with benign prostatic hyperplasia (BPH), high blood glucose became an important risk factor for BPH in patients with BPH. Since diabetes is a common disease in middle-aged and elderly patients, studies have indicated a possible link between diabetes and benign prostatic hyperplasia (BPH) for many years. (37).

However, the elevated fibrinogen gamma result was consistent with that of Ma et al. (38), who reported that patients with benign prostatic hyperplasia showed a significant increase in fibrinogen concentration, especially those with high PSA levels. Therefore, the study recommended monitoring patients with elevated FGG levels. Additionally, Gerner et al. (39) reported fibrin deposition in various types of cancerous tumors, with high concentrations of fibrin G in the blood plasma of cancer patients, which explains the high level of fibrin G in prostate cancer patients in the current study. Elevated levels of fibrinogen gamma may promote the development and progression of cancer cells, and this may explain why some cases of prostatitis progress to prostate cancer in some patients (40).

The result of elevated endothelin-1 hormone was consistent with the findings of Dadali et al. (41) and Torres et al. (42), who found elevated levels of endothelin-10 hormone in patients with benign prostatic hyperplasia and prostate cancer compared to control groups. The reason for the increase in endothelin-1-ET in benign prostatic hyperplasia is attributed to the important role that this hormone plays in a variety of pathophysiological processes, including growth, tissue differentiation, vascular tone, hormone production, pulmonary diseases, cardiovascular disorders, kidney diseases, wound healing, nerve transmission, and cancer (43).

Low ferritin levels in patients with benign prostatic hyperplasia can be explained by a disturbance in iron metabolism compared to normal cases, as studies have shown that prostate diseases are associated with changes in iron-regulating proteins such as hepcidin and ferritin (44). On the other hand, comparative studies have shown that ferritin levels are lower in some prostate diseases compared to healthy individuals, indicating a problem with iron stores or consumption(45). Prostate patients (in general) also have a difference in the distribution of iron within the body, as iron may be present in tissues in an abnormal way while it is low in the serum, leading to a decrease in ferritin measured in the blood (46).

Zinc may play a role in cancer development, so high zinc concentration may have a protective role in prostate cancer and could be used as a therapeutic or preventive intervention (47). The prostate gland contains one of the highest concentrations of zinc in the body. Studies have shown that patients with prostatitis, (BPH), or prostate cancer often have abnormal zinc levels. This leads to changes in zinc levels throughout the body and an imbalance in its distribution within tissues. Zinc prevents the malignant transformation of normal prostate tissue by inhibiting citric acid oxidation, inducing apoptosis, and exhibiting antioxidant activity(48).

Superoxide dismutase (SOD) is a group of antioxidant enzymes that play a crucial role in combating oxidative stress in cells. It is particularly important in the detoxification of reactive oxygen species. A study indicated that administering superoxide dismutase leads to increased apoptosis in prostate cancer cell lines (PC-3) by increasing caspase-3 expression. (49) Superoxide dismutase could be considered a treatment for advanced-stage prostate cancer. This has become hormone-resistant and spread to other organs, where it induces programmed cell death in prostate cells. The

superoxide dismutase family of enzymes removes reactive oxygen species derived from oxygen, and high activity of these enzymes is often protective against prostate cancer (50).

5 CONCLUSION

This study shows that the level of serum PSA, CRP, FGG, glucose and Endothelin-1 has significant correlation with benign prostatic hyperplasia, while the plasma antioxidant defenses and trace elements such as SOD, zinc and ferritin are significantly decreased, especially in elderly age group. These pathophysiological changes underscore the importance of chronic inflammation, oxidative stress and endothelial dysfunction in the initiation and development of the disease. In summary, keeping track of these biochemical indicators can significantly contribute to the precision of early diagnosis and the management of the disease in aging male populations and, thus, public health outcomes, providing valuable information to guide future clinical strategies.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

Disclosure of conflict of interest

The author declares no conflicts of interest regarding this manuscript.

Statement of ethical approval

The study protocol was approved by the Institutional Ethics Committee and all procedures were carried out following the ethical standards of the institutional and/or national research committee.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

REFERENCES

- [1] Miyahira AK, Sharp A, Ellis L et al. Prostate cancer research: the next generation; report from the 2019 Coffey - Holden Prostate Cancer Academy Meeting. *The Prostate*. 2020;80(2):113-32.
- [2] Foo KT. Pathophysiology of clinical benign prostatic hyperplasia. *A j of u*. 2017 ; 1:4(3):152-157.
- [3] Lepor H. Pathophysiology of benign prostatic hyperplasia in the aging male population. *Reviews in urology*. 2005;7(Suppl 4):S3.
- [4] Gravas SC, Cornu JN, Gacci M, et al. Management of non-neurogenic male lower urinary tract symptoms (LUTS), incl. benign prostatic obstruction (BPO)2019.
- [5] Capogrosso P and Salonia A, Montorsi F. Evaluation and nonsurgical management of benign prostatic hyperplasia. *Campbell-Walsh-Wein Urology*. 12th ed. Philadelphia, PA: Elsevier. 2021.
- [6] ROEHRBORN, Claus G. Male lower urinary tract symptoms (LUTS) and benign prostatic hyperplasia (BPH). *Medical Clinics*, 2011; 95(1): 87-100.
- [7] Alarcón-Zendejas AP, Scavuzzo A, Jiménez-Ríos MA et al, Arriaga-Canon C. The promising role of new molecular biomarkers in prostate cancer: from coding and non-coding genes to artificial intelligence approaches. *Prostate Cancer and Prostatic Diseases*. 2022 ; 14:1-3.
- [8] Bazzichetto C, Conciatori F, Pallocca M et al. PTEN as a prognostic/predictive biomarker in cancer: an unfulfilled promise?. *Cancers*. 2019 ; 28:11(4):435.
- [9] Wang JW and Man LB. Transurethral resection of the prostate stricture management. *A J of A*. 2020;22(2):140.
- [10] Coghe F, Orrù G, Ferraguti P et al. C-reactive protein levels in the first days of life: a systematic statistical approach. *The J of Mat-F & Neo Med*. 2012 ; 1:25(sup5):47-50.
- [11] Pavela G, Kim YI and Salvy SJ. Additive effects of obesity and loneliness on C-reactive protein. *PloS one*. 2018 ; 15:13(11):e0206092.
- [12] Quispe R, Michos ED, Martin SS et al. High - Sensitivity C - Reactive Protein Discordance With Atherogenic Lipid Measures and Incidence of Atherosclerotic Cardiovascular Disease in Primary Prevention: The ARIC Study. *J of the Ame H Asso*. 2020 ; 4:9(3):e013600.

- [13] 13- Kumar N, Singh VB, Meena BL et al. Mild cognitive impairment in young type 1 diabetes mellitus patients and correlation with diabetes control, lipid profile, and high-sensitivity C-reactive protein. *Ind J of Endo and Meta.* 2018;22(6):780.
- [14] 14- Esraa Ali Abdul Karim Al-Samarra and Rafah Razooq Hameed Al-Samarrai. Evaluation of the correlation between D dimer and total L-fucose, fucose binding protein and fucose binding lipids in type 2 diabetes patients infected with COVID-19. *AIP Conference Proceedings* 2450, 020038 (2022).
- [15] 15-Esraa Ali Abdul Karim Al-Samarra and Rafah Razooq Hameed Al-Samarrai. Evaluation of the antioxidant state in type 2 diabetes mellitus patients with COVID-19. *AIP Conference Proceedings* 2394, 040047 (2022).
- [16] Kattula S, Byrnes JR and Wolberg AS. Fibrinogen and fibrin in hemostasis and thrombosis. *Arteriosclerosis, thrombosis, and vascular biology.* 2017;37(3):e13-21.
- [17] Gaule TG and Ajjan RA. Fibrin (ogen) as a Therapeutic Target: Opportunities and Challenges. *International Journal of Molecular Sciences.* 2021;22(13):6916.
- [18] Samuel, V. T., and Shulman, G. I. (2012). Mechanisms for insulin resistance: common threads and missing links. *Cell*, 148(5): 852-871.
- [19] Yanatori, I.; Nishina, S.; Kishi, F.; Hino, K. Newly uncovered biochemical and functional aspects of ferritin. *FASEB J.* 2023, 37, e23095.
- [20] AL-SAMARAI, E.A.A. EVALUATION OF LACTOFERRIN AND TUMOR NECROSIS FACTOR IN PREGNANT WOMEN WITH IRON DEFICIENCY ANEMIA IN SAMARRA CITY. *Oxidation Communications* 48, No 2, 540–547 (2025)
- [21] Galior, K., Grebe, S., & Singh, R. (2018). Development of vitamin D toxicity from overcorrection of vitamin D deficiency: a review of case reports. *Nutrients*, 10(8), 953.
- [22] I. A. A. K. Al-Samarai, H. N. Mohammed, S. S. M. Al-Samarrai, A. J. Al Samer. Evaluation of the levels of vimentin, neural cell adhesion molecule, C-X-C motif chemokine ligand 10, toll-like receptor 4, and some minerals in patients with multiple sclerosis. *Regulatory Mechanisms in Biosystems*, 2025, 16(3), e25130.
- [23] Venkataraman S, Xiaohong J, Christine W, et al. Manganese superoxide dismutase overexpression inhibits the growth of cancer cells. *Nat Publ Group.* 2005;24:77–89.
- [24] I. A. A. K. Al-Samarai, A. J. Al Samer¹, H. N. Moha mmed. Angiotensin, vascular endothelial growth factor and caspase-3 levels in blood serum of smoking students. *ISSN 2409-4943. Ukr. Biochem. J., 2025, Vol. 97, N 6 Pathophysiological Aspects of Proteases.* 2017;617-34.
- [25] Hong D, Min JY, Min KB. Association between pyrethroids and prostate endpoints; stratified according to renal function. *Environment International.* 2021 ; 153:106489.
- [26] Cosma G, McArdle SE, Reeder S et al. Identifying the presence of prostate cancer in individuals with PSA levels < 20 ng mL⁻¹ using computational data extraction analysis of high dimensional peripheral blood flow cytometric phenotyping data. *Frontiers in Immunology.* 2017 ; 18:8:1771.
- [27] Ilic D, Djulbegovic M, Jung JH, et al. Prostate cancer screening with prostate-specific antigen (PSA) test: a systematic review and meta-analysis. *bmj.* 2018 Sep 5;362.
- [28] Verma AK, Chandra S, Singh RG, Singh TB, Srivastava S and Srivastava R. Serum prolidase activity and oxidative stress in diabetic nephropathy and end stage renal disease: a correlative study with glucose and creatinine. *Bio R Int.* 2014 ; 1:2014.
- [29] Pinsky PF, Prorok PC and Kramer BS. Prostate Cancer Screening-A Perspective on the Current State of the Evidence. *The New Engl j of med.* 2017 ; 1:376(13):1285-9.
- [30] Shun-Fa Hung, Shiu-Dong Chung, Hann-Chorng Kuo. Increased Serum C-Reactive Protein Level Is Associated with Increased Storage Lower Urinary Tract Symptoms in Men with Benign Prostatic Hyperplasia. *Division of Urology, Department of Surgery, Far Eastern Memorial Hospital, New Taipei City, Taiwan.* 2014.
- [31] Jennifer L. St. Sauver, Aruna V. Sarma, Debra J. Jacobson, Michaela E. McGree, et al. Associations between C-reactive protein and benign prostatic hyperplasia/lower urinary tract symptom outcomes in a population-based cohort. *Quantitative Health Sciences . Research output: Contribution to journal › Article › peer-review.* 2009.
- [32] Lehrer S, Diamond EJ, Mamkine B, Droller MJ, Stone NN and Stock RG. C - reactive protein is significantly associated with prostate - specific antigen and metastatic disease in prostate cancer. *BJU international.* 2005;95(7):961-2.

- [33] McArdle PA, Mir K, Almushatat AS, Wallace AM, Underwood MA and McMillan DC. Systemic inflammatory response, prostate-specific antigen and survival in patients with metastatic prostate cancer. *Urologia internationalis*. 2006;77(2):127-9.
- [34] Xiong, Y., Zhang, Y., Tan, J., Qin, F., and Yuan, J. The association between metabolic syndrome and lower urinary tract symptoms suggestive of benign prostatic hyperplasia in aging males: evidence based on propensity score matching. *Translational andrology and urology*, 2021. 10(1): 384.
- [35] Nugroho, E. A., and Kurniawan, R. Association between hyperglycemia and prostate volume in patients with Benign Prostate enlargement: A Hospital case-control study. *Journal of Biomedicine and Translational Research*, 2017. 3(2): 46-49.
- [36] Ozcan, L., Besiroglu, H., Dursun, M., Polat, E. C., Otunctemur, A., and Ozbek, E. Comparison of the clinical parameters of benign prostate hyperplasia in diabetic and non diabetic patients. *Archivio Italiano di Urologia e Andrologia*, 2017. 89(1): 26-30.
- [37] Ma XK, Wen JY, Chen ZH et al. Clinical significance of plasma fibrinogen level in patients with prostate cancer. 2013.
- [38] Gerner C, Steinkellner W, Holzmann K et al. Elevated plasma levels of crosslinked fibrinogen gamma-chain dimer indicate cancer-related fibrin deposition and fibrinolysis. *Thrombosis and haemostasis*. 2001;85(03):494-501.
- [39] Peng HH, Wang JN, Xiao LF et al. Elevated Serum FGG Levels Prognosticate and Promote the Disease Progression in Prostate Cancer. *Frontiers in Genetics*. 2021 ;29:12:651647.
- [40] Dadali, M., Tad, M., and Bagbanci, M. S. Expression of Endocan in Tissue Samples from Prostate Adenocarcinoma and Prostate Hyperplasia: A Comparative Retrospective Study. *Urology Journal*, 2021. 18(5).
- [41] Torres, M. J., López-Moncada, F., Herrera, D., Indo, S., Lefian, A., Llanos, P., ... and Contreras, H. R. Endothelin-1 induces changes in the expression levels of steroidogenic enzymes and increases androgen receptor and testosterone production in the PC3 prostate cancer cell line. *Oncology reports*, 2021. 46(2): 1-11.
- [42] Kawanabe, Y., and Nauli, S. M. Endothelin. *Cellular and Molecular Life Sciences*, 2011. 68: 195-203.
- [43] Tian, Z., Li, Y. G., Li, G. Z., Huang, Z. H., Dai, W. H., Wei, X. D., ... & Huang, Y. H. (2022). A correlative study of iron metabolism based on q-Dixon MRI in benign prostatic hyperplasia and prostate cancer. *Asian Journal of Andrology*, 24(6), 671-674.
- [44] Kuvibidila, S. R., Gauthier, T., & Rayford, W. (2004). Serum ferritin levels and transferrin saturation in men with prostate cancer. *Journal of the National Medical Association*, 96(5), 641.
- [45] Tian, Z., Li, Y. G., Li, G. Z., Huang, Z. H., Dai, W. H., Wei, X. D., ... & Huang, Y. H. (2022). A correlative study of iron metabolism based on q-Dixon MRI in benign prostatic hyperplasia and prostate cancer. *Asian Journal of Andrology*, 24(6), 671-674.
- [46] Ziqi Chen , Junsheng Liu ,Jing Ma ,Xiuqiao Yu ,Role of zinc homeostasis in the prevention of prostate diseases, *Journal of Trace Elements in Medicine and Biology*. Volume 88, April 2025, 127605. Martin Igbokwe, Ayo Salako, Tajudeen Badmus, Eusebius Obiajunwa,
- [47] Olalekan Olasehinde, Chiamaka Igbokwe, Rotimi David. Tissue Zinc Concentration in Prostate Cancer: Relationship with Prostate Specific Antigen and Gleason Score in a Cohort of Nigerian Men . *Asian Pac J Cancer Biol*, 6 (2), 147-153. 2021.
- [48] Jufriady Ismy , Suwandi Sugandi , Dedi Rachmadi , Sunaryo Hardjowijoto , Akhmad Mustafa. The Effect of Exogenous Superoxide Dismutase (SOD) on Caspase-3 Activation and Apoptosis Induction in Pc-3 Prostate Cancer Cells. *Res Rep Urol*. 2020 Oct 27;12:503–508. doi: 10.2147/RRU.S271203.
- [49] Sameera Kumar , and Daret St. Clair .Radioresistance in Prostate Cancer: Focus on the Interplay between NF-κB and SOD. *Antioxidants* 2021, 10, 1925. <https://doi.org/10.3390/antiox10121925>.