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SU91-MSAHW-S23-188

FAHS

Evaluation of Benign Prostatic Hyperplasia with Ultrasound and its Correlation with Obesity, Hypertension and Diabetes



SUPERIOR UNIVERSITY

Thesis Submitted to

The Superior University Lahore

In Partial Fulfillment of the

Requirement for the Degree of

Master of Science in Allied Health Sciences

By

Siraj Ali

Registration No. SU91-MSAHW-S23-188

Session: 2023-2025

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I hereby state that my MS thesis titled “**Evaluation of Benign Prostatic Hyperplasia with Ultrasound and its correlation with Obesity, Hypertension and Diabetes**” is my work and has not been submitted previously by me for taking any degree from this University.

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Supervisor Name: Madiha Naheed

Designation: Lecturer

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This is to certify that the research work presented in this thesis, titled **“Evaluation of Benign Prostatic Hyperplasia with Ultrasound and its correlation with Obesity, Hypertension and Diabetes”** was conducted by **“Siraj Ali”** under the supervision of **“Madiha Naheed”**

No part of this thesis has been submitted anywhere else for any other degree. This thesis is submitted to the Faculty of Allied Health Sciences, The Superior University Lahore in partial fulfillment of the requirements for the degree of Master of Philosophy in the field of **“Radiology”** in Faculty of Allied Health Sciences at The Superior University, Lahore.

Siraj Ali

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c) Supervisor Name:

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d) PL/HOD: Dr. Hafiz Shehzad

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e) Dean: Prof. Dr. M. Naveed Babur

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f) Controller of Examination: Dr.M. Haris

Signature: _____

DEDICATION

We extend our deepest and heartfelt gratitude to our parents, teachers, supervisor and Co- supervisor, whose unwavering guidance, support, and assistance have been instrumental in our journey throughout the degree program. Their selfless dedication, constant encouragement, and endless patience provided us with the strength and motivation to persevere through challenges and celebrate our successes. Our parents, with their unconditional love and prayers, have been the cornerstone of our achievements, always believing in our potential even when we doubt ourselves. Similarly, our teachers and supervisors, with their expertise and mentoring, have imparted not only knowledge but also values that will guide us throughout our professional lives. All thanks to their support and care to ensure we got to this point. Most of all, we are grateful to Allah Almighty for showering upon us such kind and loving parents and for helping us to complete this work. This testifies that it is by His grace that one has been able to achieve all that one has in one's lifetime.

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LIST OF ABBREVIATIONS

BPH	Benign Prostatic Hyperplasia
USG	Ultrasonography
TRUS	Trans Rectal Ultrasonography
TAS	Trans Abdominal Ultrasound
DRE	Digital Rectal Examination
TURP	Transurethral Resection of the Prostate
TUIP	Transurethral Incision of the Prostate

ABSTRACT

Introduction:

Benign Prostatic Hyperplasia (BPH) is a common condition in older men, often linked to health problems like obesity, high blood pressure, and diabetes. Understanding these connections can improve diagnosis and treatment.

Aim of the Study:

To study BPH using ultrasound and explore its relationship with obesity, high blood pressure, and diabetes to improve diagnosis and care.

Methodology:

The study included 185 men aged 30 and above. Prostate measurements were taken using ultrasound, and information about obesity, blood pressure, and diabetes was collected through tests and medical records.

Results:

The study found clear links between BPH and metabolic conditions. Obesity and high blood pressure were strongly related to larger prostate size, while diabetes affected bladder function. Ultrasound was an effective tool for detecting and understanding these changes.

Conclusion:

This research shows the close relationship between BPH and conditions like obesity, high blood pressure, and diabetes. It highlights the importance of treating these issues together and using ultrasound as a key tool for better diagnosis and management.

Keywords:

BPH, Ultrasound, Obesity, High Blood Pressure, Diabetes, Prostate Health, Metabolic Conditions

Chapter 1

INTRODUCTION

Benign Prostatic Hyperplasia (BPH) is a non-cancerous enlargement of the prostate gland, a condition that significantly impacts the quality of life in aging men. As one of the most prevalent urological disorders globally, BPH often manifests with lower urinary tract symptoms (LUTS) such as increased urinary frequency, nocturnal, weak urine stream, and incomplete bladder emptying. These symptoms, while not life-threatening, can disrupt daily activities and lead to complications like acute urinary retention or urinary tract infections if left untreated[1].

The prostate is a walnut-shaped gland located below the bladder, encircling the urethra. Its enlargement in BPH occurs as a result of hyperplasia of the stromal and epithelial cells. This condition predominantly affects men over the age of 50 and becomes increasingly common with advancing age, with studies indicating a prevalence of up to 80% in men aged 70 and above. Despite its high occurrence, the etiology of BPH remains multifactorial, involving hormonal imbalances, inflammation, and genetic predispositions[2].

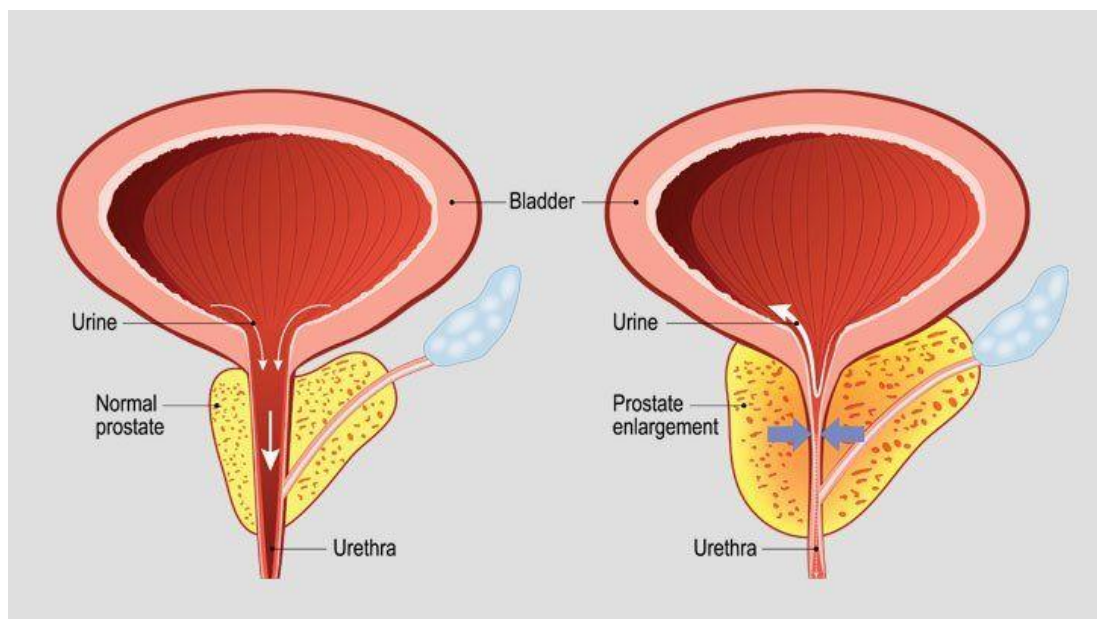


Figure 1: Prostate gland normal vs abnormal

Ultrasound imaging has emerged as a cornerstone in the assessment and management of BPH. This non-invasive diagnostic modality provides crucial insights into prostate anatomy and function, enabling clinicians to determine prostate size, assess bladder wall thickness, and evaluate post-void residual urine volume. Such parameters are essential for diagnosing BPH and guiding appropriate therapeutic interventions[3, 4].

Unlike other imaging techniques, ultrasound is widely accessible, cost-effective, and free from ionizing radiation. Its adaptability, ranging from transabdominal to transrectal approaches, allows detailed visualization of the prostate and surrounding structures. By delivering precise and reliable measurements, ultrasound aids in distinguishing BPH from other conditions with similar presentations, such as prostate cancer or chronic prostatitis[4].

In recent years, researchers have focused on understanding how systemic conditions like obesity, hypertension, and diabetes mellitus influence the development and progression of BPH. These metabolic and cardiovascular disorders share common risk factors, including advanced age and sedentary lifestyles, making their coexistence with BPH a topic of significant clinical interest.

Obesity, characterized by excessive adipose tissue, has been associated with hormonal deregulation, particularly increased estrogen levels and reduced testosterone. These hormonal changes may contribute to prostate growth. Similarly, hypertension and diabetes have been implicated in altering vascular supply and inflammatory pathways within the prostate gland, potentially exacerbating BPH[5].

The interplay between these conditions represents a complex web of biological mechanisms, where metabolic dysfunctions and chronic inflammation create a favorable environment for prostatic hyperplasia. Studying these associations not only enhances our understanding of BPH but also opens new avenues for targeted prevention and management strategies[6].

Ultrasound plays a critical role in assessing BPH, particularly when it is complicated by metabolic disorders such as obesity, hypertension, and diabetes. By using ultrasound imaging to evaluate prostate size, blood flow, and bladder function,

clinicians can gain a better understanding of how these conditions influence the progression of BPH and help guide treatment decisions[7].

Figure 1.3: Color Doppler Ultrasound of Prostate Gland

Hypertension often leads to vascular changes in the prostate, affecting its blood supply. Doppler ultrasound is particularly useful in assessing these changes, as it provides information on the blood flow to the prostate. Hypertensive patients may experience increased vascularity in the prostate, which can worsen BPH symptoms, and Doppler ultrasound can detect these alterations[9].

Benign Prostatic Hyperplasia (BPH) is a condition with significant public health implications, given its widespread prevalence among aging male populations.

Epidemiological studies consistently demonstrate that the risk of BPH increases with advancing age. While only a small percentage of men under the age of 40 experience clinically significant BPH, this figure rises sharply to approximately 50% by the age of 60 and up to 80% by the age of 80[12].

These statistics reflect a pressing need to address BPH as part of broader geriatric healthcare. The economic burden associated with BPH is substantial, encompassing costs related to diagnosis, treatment, and management of complications. Furthermore, the condition profoundly affects quality of life, causing disruptions in sleep, work productivity, and social activities due to its bothersome urinary symptoms[13].

In addition to age-related factors, regional and ethnic variations in BPH prevalence have been observed. For instance, studies suggest that men of African descent may experience more severe LUTS compared to their Asian or Caucasian counterparts. Environmental, dietary, and genetic factors likely play a role in these disparities, further emphasizing the complexity of BPH as a global health issue[14].

Obesity, hypertension, and diabetes are similarly prevalent, particularly in developed and developing nations where sedentary lifestyles and poor dietary habits are becoming increasingly common. These conditions often co-occur in older adults, creating a "syndemic" or intertwined epidemic that compounds healthcare challenges. By investigating the links between these metabolic disorders and BPH, healthcare providers can better address the needs of this vulnerable population[15].

1.1 Epidemiological Insights into Co-Occurring Conditions

The increasing prevalence of Benign Prostatic Hyperplasia (BPH) in aging male populations aligns with a broader rise in metabolic and cardiovascular disorders, including obesity, hypertension, and diabetes. Understanding the intersection of these conditions requires an appreciation of their individual and collective epidemiological trends[16].

BPH remains one of the most common non-cancerous conditions affecting men over 40. By age 60, approximately half of all men exhibit histological evidence of BPH, and by age 80, this figure exceeds 80%. Despite its high prevalence, only a subset of

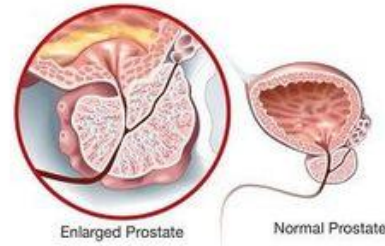
these individuals experience clinically significant symptoms requiring medical attention[17].

Developed countries report higher rates of symptomatic BPH due to extended life expectancies and increased access to healthcare. However, the prevalence of untreated or undiagnosed cases remains substantial in resource-limited settings, where men may not seek medical care until complications arise[18].

Obesity has reached epidemic proportions globally, affecting over 650 million adults, according to the World Health Organization (WHO). Defined by an excessive accumulation of body fat, obesity is commonly measured using the body mass index (BMI), with a BMI of 30 or higher classified as obese[19].

Obesity is strongly linked to BPH due to shared risk factors and overlapping pathophysiological mechanisms. Excessive adipose tissue not only alters hormonal balance but also increases systemic inflammation, both of which are implicated in prostate enlargement. Moreover, obesity exacerbates LUTS by increasing abdominal pressure and impairing bladder function, further complicating BPH management[20].

Risk factors of Enlarged Prostate (BPH)



Although several risk factors are associated with the development of enlarged prostate, not every risk factor may cause the ailment. The common risk factors include:

- Increased age
- Diabetes
- Family history
- Lack of physical exercise
- Obese
- Unhealthy diet



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Figure 1.3: Risk factors of Enlarge Prostate

Hypertension, or persistently elevated blood pressure, affects more than 1.28 billion adults worldwide. It is often referred to as the "silent killer" due to its asymptomatic nature until complications such as stroke or cardiovascular disease arise[21].

In the context of BPH, hypertension contributes to vascular changes in the prostate, leading to hypoxia and subsequent tissue remodeling. Studies suggest that hypertensive men are more likely to experience moderate to severe LUTS, highlighting the importance of addressing blood pressure control in BPH patients[22].

Diabetes mellitus, a chronic condition characterized by elevated blood glucose levels, affects over 460 million people globally. The condition is divided into type 1

(autoimmune) and type 2 (insulin resistance), with the latter being far more prevalent[23].

The relationship between diabetes and BPH is bidirectional, with each condition exacerbating the other. Chronic hyperglycemia leads to vascular and nerve damage, impairing bladder function and worsening LUTS. Additionally, diabetes-related inflammation and oxidative stress accelerate prostatic tissue changes, making it a critical comorbidity to consider in BPH management[24].

Beyond diagnosis, ultrasound plays a crucial role in monitoring treatment outcomes. By tracking changes in prostate volume or residual urine volume over time, clinicians can evaluate the effectiveness of medical or surgical interventions. Ultrasound also aids in identifying complications such as bladder diverticula or stones, which may arise in advanced cases of BPH[25].

Ultrasound has revolutionized the diagnosis and monitoring of BPH due to its precision, accessibility, and non-invasive nature. As a versatile imaging tool, it provides real-time insights into both anatomical and functional aspects of the prostate and bladder [26, 27].

1.2 Key Parameters Evaluated Using Ultrasound

1.2.1 Prostate Volume: Ultrasound allows accurate measurement of prostate size, which is crucial for assessing the severity of BPH and planning interventions.

1.2.2 Bladder Wall Thickness: Increased bladder wall thickness may indicate long-standing obstruction caused by BPH.

1.2.3 Post-Void Residual Volume (PVR): Measuring the amount of urine remaining in the bladder after voiding helps evaluate the functional impact of BPH.

Modern advancements in ultrasound technology have further enhanced its diagnostic capabilities:

- **3D and 4D Imaging:** These techniques provide detailed volumetric assessments, aiding in precise measurement and visualization of prostate anatomy.

- Elastography: By assessing tissue stiffness, elastography helps differentiate BPH from other conditions, such as prostate cancer.
- Doppler Ultrasound: Evaluating blood flow within the prostate offers additional insights into vascular changes associated with hypertension and diabetes.

The findings of this study have implications that extend beyond individual patient care, influencing healthcare systems and policy development.

By addressing metabolic and cardiovascular conditions in conjunction with BPH, healthcare systems can achieve better outcomes at a lower cost. Integrated care pathways that include routine metabolic screening for BPH patients can reduce the burden of complications and hospitalizations.

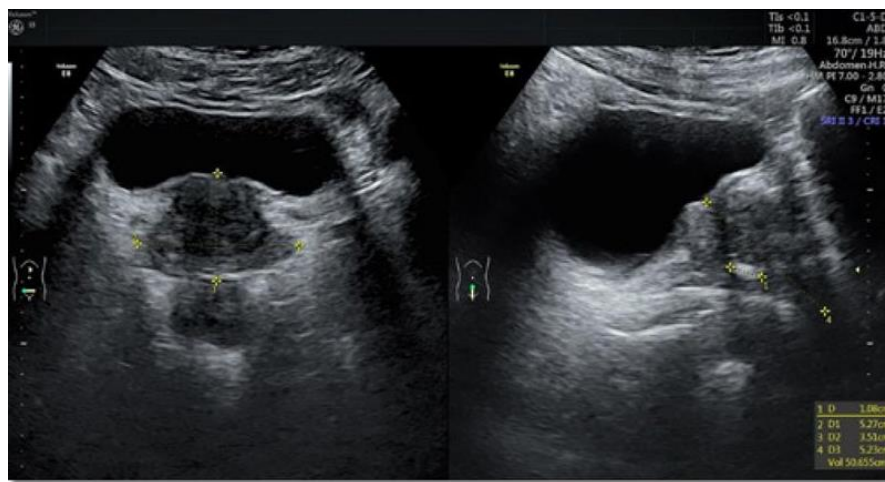


Figure 2: Transabdominal Ultrasound of Prostate Gland

AIM AND OBJECTIVES

The primary aim of this research is to assess the characteristics of Benign Prostatic Hyperplasia (BPH) using ultrasound imaging and to investigate its association with metabolic conditions such as obesity, hypertension, and diabetes. This study seeks to explore how these comorbidities might influence the development, progression, and severity of BPH, with a particular focus on the role of ultrasound as a diagnostic tool. By examining the correlation between prostate enlargement and these prevalent health conditions, the research intends to provide a deeper understanding of their potential impact on prostate health. The ultimate objective is to enhance diagnostic accuracy and contribute valuable insights to the management strategies for patients with BPH, especially those affected by obesity, hypertension, and diabetes.

Chapter 2

LITERATURE REVIEW

Benign Prostatic Hyperplasia (BPH) is one of the most prevalent urological conditions affecting aging men, characterized by the non-cancerous enlargement of the prostate gland. This condition is closely linked with a range of comorbidities, particularly obesity, hypertension, and diabetes, which may influence its development and progression. As the global prevalence of these metabolic disorders continues to rise, understanding their potential role in the pathophysiology of BPH is becoming increasingly important. Ultrasound imaging, with its non-invasive nature and ability to provide real-time visualizations, has emerged as a primary diagnostic tool in evaluating prostate size and structure. This literature review aims to explore the current body of research surrounding the relationship between BPH and these associated conditions, with a focus on the use of ultrasound in assessing the impact of obesity, hypertension, and diabetes on prostate health. The review will also examine how advances in imaging technologies have enhanced our understanding of these interactions and contributed to more effective management strategies for affected individuals.

According to the author Onigbinde et al. (2023), the study investigates the impact of systemic hypertension on prostatic artery resistive indices in patients with benign prostate enlargement (BPE). The research conducted on hypertensive and normotensive groups reveals that hypertensive patients exhibit significantly higher prostatic artery resistive indices compared to their normotensive counterparts. The study reveals that even in patients with controlled hypertension, the resistive indices remain elevated, suggesting a persistent vascular alteration. Additionally, the findings indicate that hypertensive BPE patients have higher transitional zone volumes and quality of life scores, underscoring the influence of hypertension on prostate health. The study concludes that managing hypertension is crucial in mitigating its effects on BPE progression[9].

As highlighted by Mampa et al. (2021), the study explores the correlation between obesity and prostate volume (PV) in patients with benign prostatic hyperplasia (BPH) at Charlotte Maxeke Johannesburg Academic Hospital. The research conducted on

178 men aged 50-75 years reveals that while there is an increase in PV with higher body mass index (BMI) categories, the relationship is not statistically significant. The study also examines other factors such as waist circumference (WC), hypertension, diabetes, and smoking, finding no significant correlation with PV. However, the study reveals a significant relationship between PV and both prostate-specific antigen (PSA) levels and age. The findings suggest that while obesity may influence PV, other factors like PSA levels and age play a more critical role in the progression of BPH[26].

A study conducted by Moudi et al. (2017), the study investigates the relationship between diabetes and benign prostatic hyperplasia (BPH) by comparing resected prostate weights in diabetic and non-diabetic patients. The research conducted on patients who underwent surgery for BPH between 2010 and 2013 reveals that diabetic patients had significantly higher resected prostate weights compared to non-diabetic patients. The study also indicates that body mass index (BMI) and prostate-specific antigen (PSA) levels are higher in diabetic patients, suggesting a link between diabetes and the progression of BPH. Additionally, the findings show that while BMI and PSA levels correlate with resected prostate weight, factors such as age, fasting blood sugar (FBS), and triglyceride levels do not exhibit a significant relationship. The study concludes that diabetes and higher BMI are influential factors in the development and progression of BPH[27].

According to the Besiroglu et al. (2017), the study investigates the association between visceral adiposity index (VAI) and benign prostatic enlargement in non-diabetic patients. The research conducted on 400 patients reveals that higher VAI, which is a measure of visceral fat, correlates positively with increased prostate volume. The study reveals that age, body mass index (BMI), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C) are significant factors influencing prostate volume. Specifically, the findings indicate that older age, higher BMI, elevated TG levels, and lower HDL-C levels are associated with larger prostate volumes. The study concludes that VAI is a reliable indicator of prostate enlargement, suggesting that managing visceral adiposity could be crucial in addressing benign prostatic hyperplasia (BPH) in non-diabetic patients[28].

As highlighted by Chen et al. (2015), the study investigates the impact of obesity and hyperglycemia on benign prostatic hyperplasia (BPH) in elderly patients newly

diagnosed with type 2 diabetes. The research reveals that higher blood glucose levels, increased age, and elevated body mass index (BMI) are significantly associated with the progression of BPH. Specifically, patients aged 70-79 and those over 80 exhibited higher International Prostate Symptom Scores (IPSS) and prostate volumes (PV) compared to those aged 60-69. Additionally, the study found that patients with a BMI of 28 kg/m² or higher, as well as those with HbA1c levels of 6.5% or above, had increased IPSS and PV, alongside a lower maximum urinary flow rate (Q_{max}). The findings suggest that managing body weight and blood glucose levels may help slow the progression of BPH in this patient population[29].

The study conducted by Jung et al. (2016), the study evaluates the relationship between obesity and prostatic enlargement in a Korean cohort. The research conducted on 571 participants reveals that abdominal obesity, measured by waist circumference and body mass index (BMI), is significantly associated with increased prostate volume. The study reveals that higher serum leptin levels correlate positively with prostate growth, while higher adiponectin levels show an inverse relationship. Additionally, the findings indicate that metabolic syndrome components, such as hypertension and hyperglycemia, are linked to the progression of benign prostatic hyperplasia (BPH). The study concludes that managing obesity and metabolic disturbances may help mitigate the risk of BPH in the population studied[30].

Another study conducted by Udoh et al. (2022), the study examines the association between diabetes mellitus (DM) and benign prostatic hyperplasia (BPH). The research conducted on 116 BPH patients reveals that diabetic men tend to have higher prostate volumes, more severe lower urinary tract symptoms (LUTS), and poorer quality of life compared to non-diabetic men. The study reveals that hyperinsulinemia and elevated insulin-like growth factor-1 (IGF-1) levels in diabetic patients contribute to prostatic enlargement and symptom severity. Additionally, the findings indicate that diabetic patients experience both voiding and storage symptoms more intensely, which exacerbates their overall symptom burden. The study concludes that effective management of diabetes may help mitigate the progression and severity of BPH symptoms[31].

According to the Sarma et al. (2019), the study examines the association between metabolic syndrome (MetS) and benign prostatic enlargement (BPE), focusing on

intravesical prostatic protrusion (IPP) and the International Prostatic Symptom Score (IPSS). The research conducted on 114 men over 50 years old reveals that higher IPSS and IPP scores are significantly correlated with components of MetS, including hyperglycemia, hypertriglyceridemia, hypertension, and low HDL cholesterol levels. The study reveals that patients with severe IPSJS and IPP scores exhibit a higher prevalence of MetS, suggesting that metabolic alterations significantly impact prostate enlargement and related symptoms. The findings underscore the importance of managing MetS components to potentially mitigate the severity of BPE symptoms[32].

As highlighted by Ugarte-Carbajal et al. (2023), the study investigates the relationship between metabolic syndrome (MetS) and benign prostatic enlargement (BPE) in men under 60 years old at a Peruvian military hospital. The research conducted on 87 cases and 174 controls reveals that MetS components, such as increased waist circumference, hypertension, and high triglycerides, are significantly associated with BPE. The study reveals that patients with a waist circumference of 102 cm or more, elevated triglycerides, and hypertension have a higher risk of developing BPE. Additionally, high-density lipoprotein cholesterol (HDL-C) levels are found to be a protective factor against BPE. The findings suggest that managing MetS components could be crucial in reducing the risk of BPE in this population[33].

According to Li et al. (2019), the study evaluates the association between body mass index (BMI) and various clinical parameters in Chinese patients with benign prostatic hyperplasia (BPH). The research conducted on 788 newly diagnosed BPH patients reveals that obesity is significantly associated with an increased risk of larger prostate volume (PV) over 80 ml. The study reveals that while obesity presents a significant risk, underweight and overweight categories do not show a similar association. Additionally, the findings indicate no significant effect of BMI on the International Prostate Symptom Score (IPSS), maximum urinary flow rate (Q_{max}), or post-void residual (PVR) urine volume. The study concludes that there is a linear relationship between BMI and the risk of larger PV, suggesting that urologists should consider both BMI and PV when planning surgical treatments for BPH patients[34].

Another author Omran et al. (2021), the study reveals that metabolic syndrome (MetS) is significantly associated with prostate enlargement and exacerbated lower urinary

tract symptoms (LUTS). Research conducted by the authors involved a systematic review and meta-analysis of 70 studies, encompassing over 90,000 patients. The findings indicate that MetS, characterized by factors such as high blood pressure, elevated fasting blood glucose, and increased waist circumference, correlates with moderate to severe LUTS, overactive bladder, and nocturia. The study underscores the importance of addressing MetS to mitigate its impact on prostate health and urinary symptoms[35].

As highlighted by Chung et al. (2020), the study reveals that nonalcoholic fatty liver disease (NAFLD) is significantly linked to benign prostatic hyperplasia (BPH), independent of other risk factors. Research conducted by the authors involved 3,508 subjects who underwent both prostate and hepatic ultrasonography. The findings indicate that the severity of NAFLD correlates with an increased risk of BPH, particularly in non-obese individuals. The study underscores that NAFLD is an independent risk factor for BPH, suggesting that healthcare providers should consider the risk of BPH in patients with NAFLD, regardless of their obesity status[36].

According to Wu et al. (2019), the study reveals that metabolic syndrome (MetS) is significantly associated with benign prostatic hyperplasia (BPH) in men under 60 years old. Research conducted by the authors involved a meta-analysis of six comparative studies, encompassing 61,826 individuals. The findings indicate that MetS is positively correlated with the incidence of BPH, with an odds ratio (OR) of 1.24. However, the study found no significant association between MetS and BPH-related symptoms such as the International Prostate Symptom Score (IPSS) and postvoid residual (PVR). The study underscores the importance of considering MetS as a risk factor for BPH in younger men, while also noting that MetS does not significantly impact BPH-related symptoms[37].

As highlighted by Chia et al. (2024), the study reveals that benign prostatic hypertrophy (BPH) is significantly associated with certain anthropometric measurements in adult Nigerian men. Research conducted by the authors involved a cross-sectional study of 125 men aged 40-80 years, using transabdominal ultrasonography to measure prostate volume (PV) and various anthropometric parameters such as body mass index (BMI), waist circumference (WC), and waist-to-hip ratio (WHR). The findings indicate that while age did not significantly correlate

with PV, there was a notable association between PV and BMI, WC, and WHR. The study underscores the importance of considering obesity, particularly central obesity, as a risk factor for BPH, and suggests that weight management could be an effective strategy for reducing BPH prevalence in the studied population[38].

A study conducted by Zhao et al. (2016), the study reveals that metabolic syndrome (MetS) is significantly associated with predictors for the clinical progression of benign prostatic hyperplasia (BPH) and the severity of lower urinary tract symptoms (LUTS). Research conducted by the authors involved 530 men with moderate to severe LUTS, examining factors such as total prostate volume (TPV), prostate-specific antigen (PSA) levels, and maximal flow rate (Qmax). The findings indicate that the presence of MetS components correlates with increased TPV, higher PSA levels, and reduced Qmax. Additionally, MetS was found to be independently associated with severe LUTS, particularly voiding symptoms. The study underscores the importance of addressing MetS through lifestyle changes to mitigate its impact on prostate health and urinary symptoms[39].

As highlighted by Negi et al. (2024), the study reveals that there is a significant correlation between obesity and prostate volume (PV) in patients with benign prostatic hyperplasia (BPH). Research conducted by the authors involved a prospective cohort study of 560 men aged 50-80 years, where body mass index (BMI) was calculated, and transrectal ultrasonography (TRUS) was used to measure PV. The findings indicate that higher BMI is associated with larger PV, increased prostate-specific antigen (PSA) levels, and more severe lower urinary tract symptoms (LUTS). The study underscores the importance of weight management in reducing prostate volume and alleviating LUTS, thereby improving the quality of life for elderly men with BPH[40].

As highlighted by Privitera et al. (2018), the study reveals that benign prostatic hyperplasia (BPH) and lower urinary tract symptoms (LUTS) are significantly associated with non-alcoholic steatohepatitis (NASH). Research conducted by the authors involved a prospective study of 132 patients who underwent surgery for LUTS due to bladder outlet obstruction. The findings indicate that patients with a higher NASH score had larger prostate volumes, greater waist circumferences, and elevated levels of blood glucose, triglycerides, insulin, and BMI compared to those without

NASH. The study underscores the importance of early identification and management of NASH to prevent complications related to BPH progression, emphasizing the role of inflammation as a common underlying factor[41].

Another study conducted by Wu et al. (2020), the study reveals that glucose homeostasis status significantly impacts prostate size in aging Chinese males with benign prostatic hyperplasia (BPH). Research conducted by the authors involved reviewing 659 medical records of BPH patients undergoing transurethral resection of the prostate (TURP). The findings indicate that abnormal glucose homeostasis, including prediabetes and diabetes, is positively correlated with increased prostate volume and growth rates, particularly in men under 70 years old. The study underscores the importance of managing blood glucose levels to mitigate prostate enlargement and associated urinary symptoms in aging males[42].

A study highlighted by Yelsel et al. (2015), the study reveals that obesity significantly impacts both the International Prostate Symptom Score (IPSS) and prostate volume in patients undergoing prostate biopsies. Research conducted by the authors involved 211 patients, categorized by body mass index (BMI) into underweight, normal, overweight, and obese groups. The findings indicate a positive correlation between BMI and prostate volume, with obese patients exhibiting larger prostate volumes and higher IPSS values compared to their normal-weight counterparts. The study underscores that weight loss can lead to a reduction in prostate volume and urinary symptoms, thereby enhancing the quality of life for patients with benign prostatic hyperplasia (BPH)[43].

As highlighted by Zhao et al. (2016), the study reveals that metabolic syndrome (MetS) significantly increases the risk of developing benign prostatic hyperplasia (BPH) in a northern urban Han Chinese population. Research conducted by the authors involved a prospective cohort study of 1,130 men aged 45-73 years, followed over a median period of 7.7 years. The findings indicate that MetS, particularly central obesity and low high-density lipoprotein cholesterol (HDL-C), is associated with a higher likelihood of BPH. The study underscores the importance of addressing MetS components to prevent BPH, suggesting that interventions targeting central obesity and low HDL-C could be effective in reducing the incidence of BPH. The results

support the notion that MetS is a modifiable risk factor for BPH, with significant public health implications[44].

According to theMoudi et al. (2017), the study reveals that diabetes significantly impacts the weight and volume of the prostate in patients with benign prostatic hyperplasia (BPH). Research conducted by the authors involved 225 patients, including both diabetic and non-diabetic individuals, who underwent prostate surgery. The findings indicate that diabetic patients had a higher mean weight of resected prostate tissue compared to non-diabetic patients. Additionally, the study found significant correlations between resected prostate weight and factors such as body mass index (BMI), prostate-specific antigen (PSA) levels, and ultrasound-estimated prostate volume. However, no significant relationship was observed between resected prostate weight and age, fasting blood sugar (FBS), or triglyceride levels. The study underscores the role of diabetes and obesity in the progression of BPH, suggesting that managing these conditions could help mitigate the severity of BPH symptoms[45].

Aigbe et al. (2022), the study reveals that there is no significant correlation between prostate volume (PV), age, and body mass index (BMI) among patients with benign prostatic hyperplasia (BPH) in the Niger Delta region of Nigeria. Research conducted by the authors involved 80 patients, with PV estimated using transrectal ultrasound scans (TRUS). The findings indicate that the mean age of participants was 68.12 years, with a mean PV of 87.9 ml and a mean BMI of 24.6 kg/m². Despite previous studies suggesting a relationship between these variables, this study found no significant correlation between PV and age ($p = 0.345$) or PV and BMI ($p = 0.410$). The study underscores the need for further research to explore other potential factors influencing PV in this population[46].

According to the author Zeng et al. (2018), the study reveals that there is no significant association between hypertension and prostate volume (PV) in patients with benign prostatic hyperplasia (BPH). Research conducted by the authors involved 350 patients, divided into hypertensive and normotensive groups. The findings indicate that while weight and body mass index (BMI) were significantly different between the two groups, PV did not show a significant correlation with hypertension. However, in the normotensive group, positive correlations were observed between PV and weight, BMI, and age. The study underscores the importance of considering other factors such

as weight and BMI in the management of BPH, rather than focusing solely on hypertension[47].

As highlighted by Wu et al. (2020), the study reveals that there is a complex relationship between body mass index (BMI) and testosterone deficiency (TD) in aging Chinese men with benign prostatic hyperplasia (BPH). Research conducted by the authors involved a retrospective analysis of 795 BPH patients, examining variables such as age, BMI, serum prostate-specific antigen (PSA) levels, and total testosterone (TT) levels. The findings indicate a J-shaped correlation between BMI and TD, with an inflection point at 19.2 kg/m². Below this point, BMI is inversely related to TD, while above it, BMI is positively correlated with TD. The study underscores the importance of considering both low and high BMI as risk factors for TD in BPH patients, suggesting that maintaining a balanced BMI could help manage TD and improve overall health outcomes[48].

Ren et al. (2024), the study reveals that metabolic syndrome (MetS) is significantly correlated with periurethral prostatic fibrosis. Research conducted by the authors involved 108 patients who underwent transurethral resection of the prostate or bipolar plasmakineticenucleation. The findings indicate that patients with MetS exhibited a greater extent of prostatic fibrosis compared to those without MetS. Specifically, central obesity, elevated fasting glucose, reduced HDL cholesterol, and elevated triglycerides were positively associated with the severity of prostatic fibrosis, while elevated blood pressure showed no significant correlation. The study underscores the importance of addressing MetS components to mitigate prostatic fibrosis and its related complications[49].

As highlighted by Daher et al. (2023), the study reveals that metabolic syndrome (MetS) is prevalent among patients with benign prostatic hyperplasia (BPH) in Syria, with a rate of 46.2%. Research conducted by the authors involved 426 men aged 40 and older, using the International Prostate Symptom Score (IPSS) to assess urinary symptoms and the NCEP-ATPIII criteria to define MetS. The findings indicate that patients with MetS had significantly higher IPSS scores, suggesting more severe lower urinary tract symptoms (LUTS). Specifically, components such as waist circumference, diabetes, and triglycerides were positively associated with higher IPSS scores, while blood pressure showed no significant correlation. The study underscores

the importance of addressing MetS to alleviate severe LUTS in BPH patients, proposing lifestyle changes and targeted treatments as potential strategies[50].

Hyun et al. (2021), the study reveals that chronic periodontitis (CP) is significantly associated with lower urinary tract symptoms (LUTS) and benign prostatic hyperplasia (BPH). Research conducted by the authors involved 103 middle-aged men who underwent health checkups, including periodontal examinations and assessments of LUTS/BPH. The findings indicate that patients with CP had higher International Prostate Symptom Scores (IPSS), larger prostate volumes, and lower average flow rates compared to those without CP. After adjusting for confounding factors such as age, testosterone levels, and metabolic conditions, the study found that CP was independently related to more severe LUTS/BPH. The study underscores the importance of considering CP as a potential factor in the management of LUTS/BPH, suggesting that addressing periodontal health could improve urinary symptoms and quality of life in affected individuals[51].

Yue et al. (2020), the study investigates the relationship between body mass index (BMI) and various prostate-related parameters in men aged 40 and older in Zhengzhou. The research reveals that higher BMI is associated with larger prostate volume (PV) and increased International Prostate Symptom Score (IPSS) and quality of life (QoL) scores, while prostate-specific antigen (PSA) levels and age tend to decrease with increasing BMI. The study conducted by Yue et al. (2020) involved 1360 participants and found significant correlations between BMI and these parameters, suggesting that obesity may influence prostate health and related symptoms. The findings underscore the complex interplay between BMI and prostate health, emphasizing the need for further research in this area[52].

Huang et al. (2023), the study explores the link between obstructive sleep apnea (OSA) and benign prostatic hyperplasia (BPH). The research conducted by Huang et al. (2023) involved 467 men, categorized by the severity of their OSA. The study reveals that age is a significant risk factor for BPH across all groups, while the apnea-hypopnea index (AHI) is an independent risk factor for BPH in younger men. The findings suggest that OSA may contribute to the development of BPH in younger individuals, emphasizing the need for targeted interventions and further investigation into the interplay between these conditions[53].

Erbay et al. (2018), the study investigates the association between prostatic volume and carotid intima-media thickness (CIMT) in patients with benign prostatic hyperplasia (BPH). The research conducted by Erbay et al. (2018) involved 123 patients and found that cardiovascular risk factors adjusted CIMT was highest in the severely symptomatic group and lowest in the mildly symptomatic group. The study reveals that there is a significant correlation between prostatic volume and CIMT after adjusting for body mass index and age, suggesting that prostatic tissue may have a notable association with cardiovascular health in BPH patients. The findings underscore the importance of considering cardiovascular risk factors in the management of BPH[54].

Gotera et al. (2017), the study examines the impact of waist circumference (WC), interleukin-6 (IL-6), and insulin resistance (HOMA-IR) on the risk of benign prostatic hyperplasia (BPH) in patients with abdominal obesity (Ab-Ob). The research conducted by Gotera et al. (2017) involved 80 participants and utilized multivariate logistic regression and path analysis to determine the relationships. The study reveals that increased WC significantly raises the risk of BPH through elevated levels of IL-6 and HOMA-IR. The findings suggest that chronic inflammation and insulin resistance, driven by abdominal obesity, play crucial roles in the development of BPH, emphasizing the importance of managing WC to mitigate these risks[55].

Huang et al. (2023), the study compares the predictive value of six anthropometric indicators for benign prostatic hyperplasia (BPH) in men over 50 in southern China. The research conducted by Huang et al. (2023) involved 577 participants and utilized binary logistic regression and receiver operating characteristic (ROC) curves to evaluate the diagnostic capabilities of these indicators. The study reveals that the visceral adiposity index (VAI) had the highest diagnostic value, followed by the cardiometabolic index (CMI), lipid accumulation product (LAP), waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and body mass index (BMI). The findings suggest that CMI is the best predictor of BPH, emphasizing the significant impact of obesity on prostate health in middle-aged and older men[56].

Chapter 3

METHODOLOGY

3.1 Study Design

A prospective observational study was conducted to investigate the association of Benign Prostatic Hyperplasia (BPH) with metabolic conditions, including obesity, hypertension, and diabetes. This design was chosen to systematically assess the relationships among these variables in real-time clinical settings.

3.2 Clinical Settings

The study was carried out in the Radiology Department of Family Hospital, Lahore. This facility was equipped with advanced imaging technology, including ultrasound systems that facilitated precise evaluation of prostate gland characteristics.

3.3 Sample Size

The sample size was calculated using a formula based on a population size of 100,000, a confidence level of 95% ($Z_{\alpha/2} = 1.96$), and a proportion (P) of 14%. The final sample size required was determined to be 185 participants.

3.4 Sampling Technique

Convenient sampling was employed to include participants who met the study's eligibility criteria. This approach was practical for capturing a representative population within the given timeframe.

3.5 Duration of Study

The study was conducted over six months following the approval of the research protocol. This timeframe allowed for sufficient recruitment, data collection, and analysis.

3.6 Selection Criteria

3.6.1 Inclusion Criteria

Age: Males aged 30 and above.

Health Status: No history of prostate cancer or recent prostate surgery.

Consent: Willingness to provide informed consent for participation.

Availability: Ability to attend all scheduled follow-ups or assessments.

General Health: No serious comorbidities affecting prostate size (e.g., severe urinary tract infections).

3.6.2 Exclusion Criteria

- Previous Diagnosis: Individuals with a current diagnosis of prostate cancer or benign prostatic hyperplasia (BPH).
- Recent Surgery: Those who have undergone prostate-related surgery within the last year.
- Medication: Use of medications affecting prostate size (e.g., certain hormone therapies).
- Acute Conditions: Presence of acute urinary tract infections or other conditions affecting urinary health.
- Refusal: Individuals unwilling or unable to provide informed consent.

3.7 Data Collection Procedure

Data collection commenced after obtaining ethical approvals. Participants were briefed on the purpose and process of the study, and their verbal and written consent was secured. Demographic and clinical information, such as age, weight, height, and medical history, was documented using a structured pro forma.

3.7.1 Ultrasound Procedure:

1. Equipment:

A Toshiba Xario 2000 ultrasound system with a curvilinear probe was used for imaging. This high-resolution equipment provided detailed visualization of the prostate gland.

2. Patient Preparation:

Participants were instructed to have a full bladder prior to the examination to enhance imaging quality. This ensured the accurate identification and measurement of the prostate gland and residual urine volume.

3. Imaging Protocol:

- Patients were positioned in a supine position on the examination table.
- A transabdominal approach was employed with the curvilinear probe placed on the lower abdomen.
- The probe was oriented to capture longitudinal, transverse, and anteroposterior views of the prostate.

4. Measurements:

- Dimensions of the prostate (length, width, and height) were recorded.
- The prostate volume was calculated using the formula:
$$\text{Volume} = (\text{Length} \times \text{Width} \times \text{Height}) / 2.$$
- Complications such as residual urine volume, bladder stones, or structural anomalies were also documented.

5. Documentation:

Images and measurements were securely stored and linked to the participant's clinical record.

3.8 Additional Data Collection:

- **Obesity Assessment:** Body Mass Index (BMI) was calculated using weight (kg) divided by height squared (m^2). Participants were categorized as normal weight, overweight, or obese based on standard BMI thresholds.
- **Hypertension Screening:** Blood pressure was measured using a calibrated sphygmomanometer. Two readings were taken for accuracy, and participants with systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg were classified as hypertensive.
- **Diabetes Diagnosis:** Blood samples were collected for fasting plasma glucose analysis. A glucose level of ≥ 126 mg/dL or a prior diagnosis of Type 2 diabetes confirmed the presence of diabetes.

3.9 Data Collection Process:

The data collection process began after obtaining necessary approvals from the institutional ethics committee and the Radiology Department of Family Hospital, Lahore. Participants were thoroughly informed about the study's purpose, objectives, and procedures. Their verbal and written consent was secured before initiating any evaluations.

Participant Recruitment:

Participants were selected based on the inclusion and exclusion criteria using a convenient sampling method. Initial eligibility screening involved reviewing medical histories and conducting preliminary assessments to ensure compliance with the study criteria.

Clinical and Demographic Data Collection:

Demographic data, including age, weight, height, smoking status, and medical history, were recorded using a structured pro forma. Clinical information related to hypertension and diabetes, such as blood pressure readings and fasting blood glucose levels, was documented.

Ultrasound Examination:

A standardized ultrasound protocol was followed to measure prostate dimensions and identify complications.

1. Equipment Utilized:

The Toshiba Xario 2000 ultrasound system, equipped with a curvilinear probe, was used for imaging. This system provided high-resolution images for accurate measurement and assessment.

2. Patient Preparation:

- Participants were advised to maintain a full bladder before the procedure to optimize imaging clarity.
- Before the scan, the procedure was explained to participants to ensure cooperation and minimize discomfort.

3. Procedure Execution:

- Patients were positioned in a supine position on the examination table.
- A transabdominal approach was employed by placing the curvilinear probe on the lower abdomen.
- Images of the prostate gland were captured in three planes: longitudinal, transverse, and anteroposterior.

4. Data Recording:

- Prostate dimensions (length, width, and height) were measured.
- Prostate volume was calculated using the formula:

$$\text{Volume} = (\text{Length} \times \text{Width} \times \text{Height}) / 2.$$
- Additional findings, such as residual urine volume, bladder stones, and structural abnormalities, were documented.
- Images were securely stored and labeled with unique identifiers corresponding to the participants' clinical records.

Obesity Assessment:

Body Mass Index (BMI) was calculated by measuring each participant's weight and height. BMI was categorized as follows:

- Normal weight: 18.5–24.9 kg/m²
- Overweight: 25.0–29.9 kg/m²
- Obese: ≥ 30.0 kg/m²

Hypertension Assessment:

Blood pressure readings were obtained using a calibrated sphygmomanometer. Two measurements were taken from each participant, with the average used to classify hypertension. Participants with systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg were categorized as hypertensive.

Diabetes Diagnosis:

Blood samples were collected to measure fasting plasma glucose levels. Participants

with glucose levels ≥ 126 mg/dL or a previous diagnosis of diabetes were identified as diabetic.

Data Management:

All collected data were entered into a pre-designed pro forma and subsequently digitized for analysis. Participant identifiers were anonymized to maintain confidentiality. Regular data audits ensured accuracy and completeness throughout the study period.

3.10 Data Analysis

Descriptive Statistics:

- Frequencies and percentages were calculated for categorical variables (e.g., age groups, obesity categories).
- Means, medians, and standard deviations were computed for continuous variables like BMI and prostate volume.

Inferential Statistics:

- Correlation analyses (Pearson or Spearman) were conducted to evaluate relationships between continuous variables, such as BMI and prostate size.

3.11 Ethical Considerations

The study protocol was reviewed and approved by the institutional ethics committee and the Radiology Department of Family Hospital, Lahore. Informed consent was obtained from all participants, who were assured of their anonymity and the confidentiality of their data. The voluntary nature of participation was emphasized, and participants were free to withdraw at any stage without consequences. No risks or disadvantages were associated with participation in the study.

Chapter 4

RESULTS

In our study, a total of 185 male participants were evaluated to assess various parameters related to Benign Prostatic Hyperplasia (BPH), including the correlation with obesity, hypertension, and diabetes. The data collected for these participants is presented in the following table, which provides a detailed overview of the key variables, their descriptive statistics, and their ranges.

The average age of the participants was 65.01 years, with a standard deviation of 11.97 years. This means that most participants were within the age range of approximately 53 to 77 years, as the minimum age recorded was 30 years, and the maximum age was 102 years. This suggests a broad age distribution within the study group.

The average weight of the participants was 75.81 kilograms, with a standard deviation of 12.14 kilograms. The weights of the participants ranged from 49 kilograms to 118 kilograms. This variation indicates a mix of individuals with differing body types.

The participants had an average height of 1.72 meters, with a standard deviation of 0.09 meters. The minimum height recorded was 1.52 meters, while the maximum was 2.08 meters. This shows that the group had a reasonable range of heights, with most individuals falling between these extremes.

The average BMI of the participants was 25.58, with a standard deviation of 4.30. The BMI values ranged from a low of 15.18 to a high of 45.47, which indicates that the participants included both individuals with normal weight as well as those classified as overweight or obese, reflecting a diverse range of body compositions.

The average prostate length was 46.94 millimeters, with a standard deviation of 9.72 millimeters. The prostate length ranged from a minimum of 23.3 millimeters to a maximum of 76 millimeters. This data shows that while most participants had a prostate size within the average range, there was still a significant spread in the measurements.

The average width of the prostate was 46.06 millimeters, with a standard deviation of 6.78 millimeters. The measurements of prostate width varied from a minimum of 30.7 millimeters to a maximum of 65 millimeters. This indicates considerable variation in the prostate size across the participants.

The average prostate height was 43.52 millimeters, with a standard deviation of 5.69 millimeters. The prostate height ranged from a minimum of 5.22 millimeters to a maximum of 56.9 millimeters. This suggests that the height of the prostate varied widely, with some participants showing much smaller or larger measurements.

The average weight of the prostate was 51.40 grams, with a standard deviation of 20.58 grams. The prostate weight ranged from a minimum of 32 grams to a maximum of 131 grams. This variation indicates that there were participants with both relatively smaller and larger prostate weights, further reflecting the diversity in prostate characteristics among the study group.

These descriptive statistics provide (Table 1) a clear view of the diversity within the study population in terms of both general health indicators (age, weight, BMI) and specific BPH-related measurements (prostate dimensions and weight). The data also emphasizes the potential range of variability that might influence the analysis of BPH in relation to factors such as obesity, hypertension, and diabetes.

Table 4.1: Descriptive Statistics of Participant Characteristics and Prostate Measurements

Variable	Sample	Mean	Std. dev.	Min	Max
Age	185	65.01	11.97	30	102
Weight (kg)	185	75.81	12.14	49	118
Height (m)	185	1.72	0.09	1.52	2.08
BMI	185	25.58	4.30	15.18	45.47

Prostate Length (mm)	185	46.94	9.72	23.3	76
Prostate Width (mm)	185	46.06	6.78	30.7	65
Prostate Height (mm)	185	43.52	5.69	5.22	56.9
Prostate Weight (g)	185	51.40	20.58	32	131

Table2 provides a detailed distribution of a population categorized into six age groups, illustrating their respective frequencies, percentages, and cumulative percentages. These age groups were defined as follows: Group 1 includes individuals aged ≤ 40 years, Group 2 comprises those aged 41–50 years, Group 3 includes individuals aged 51–60 years, Group 4 represents those aged 61–70 years, Group 5 includes individuals aged 71–80 years, and Group 6 comprises individuals aged ≥ 81 years.

The frequency column highlights how many individuals fall within each group. Group 1, representing the youngest cohort (≤ 40 years), has the smallest frequency with only 4 individuals, accounting for 2.16% of the total population. This indicates that the youngest age group is underrepresented in the sample. Group 2, covering ages 41–50, includes 25 individuals, making up 13.51% of the population, while Group 3 (ages 51–60) has 34 individuals, contributing 18.38% to the total. These two middle-aged groups show a gradual increase in representation compared to the youngest group.

The largest proportion of the population belongs to Group 4, individuals aged 61–70 years, with 63 individuals accounting for 34.05% of the total population. This age group forms the most significant segment of the sample, indicating that the majority of participants are in their sixties. Following this, Group 5 (71–80 years) has 44

individuals, contributing 23.78% of the population. Together, Groups 4 and 5 represent over half the population (57.83%), reflecting that the study sample is skewed toward older individuals. Finally, Group 6, representing the oldest participants aged ≥ 81 years, includes 15 individuals, contributing 8.11% to the total.

The percentage column further emphasizes the distribution of participants, showing that the representation increases progressively from Group 1 to Group 4, peaking in the 61–70 age range, before tapering off in Groups 5 and 6. The cumulative percentage column provides additional insight into the distribution, with Groups 1–3 collectively representing 34.05% of the population and Groups 4–6 accounting for the remaining 65.95%. Notably, by the time we include Group 4 (61–70 years), over two-thirds (68.11%) of the population is represented, and the cumulative percentage reaches 100% with Group 6.

The data illustrates that the population is predominantly composed of older individuals, with the highest representation in the 61–70 age group, followed by the 71–80 age group. The youngest (≤ 40 years) and oldest (≥ 81 years) age groups are underrepresented, comprising only 2.16% and 8.11% of the total, respectively. This age distribution reflects a trend toward older participants, which may have implications for the study's focus and findings, particularly if the research is related to conditions or factors that are more prevalent in older populations.

Table 4.2: Detailed distribution of a population

Age Group	Age Range (Years)	Frequency (n)	Percent (%)	Cumulative Percent (%)
1	≤ 40	4	2.16	2.16
2	41–50	25	13.51	15.68
3	51–60	34	18.38	34.05
4	61–70	63	34.05	68.11
5	71–80	44	23.78	91.89

6	≥ 81	15	8.11	100.00
Total	All Ages	185	100.00	100.00

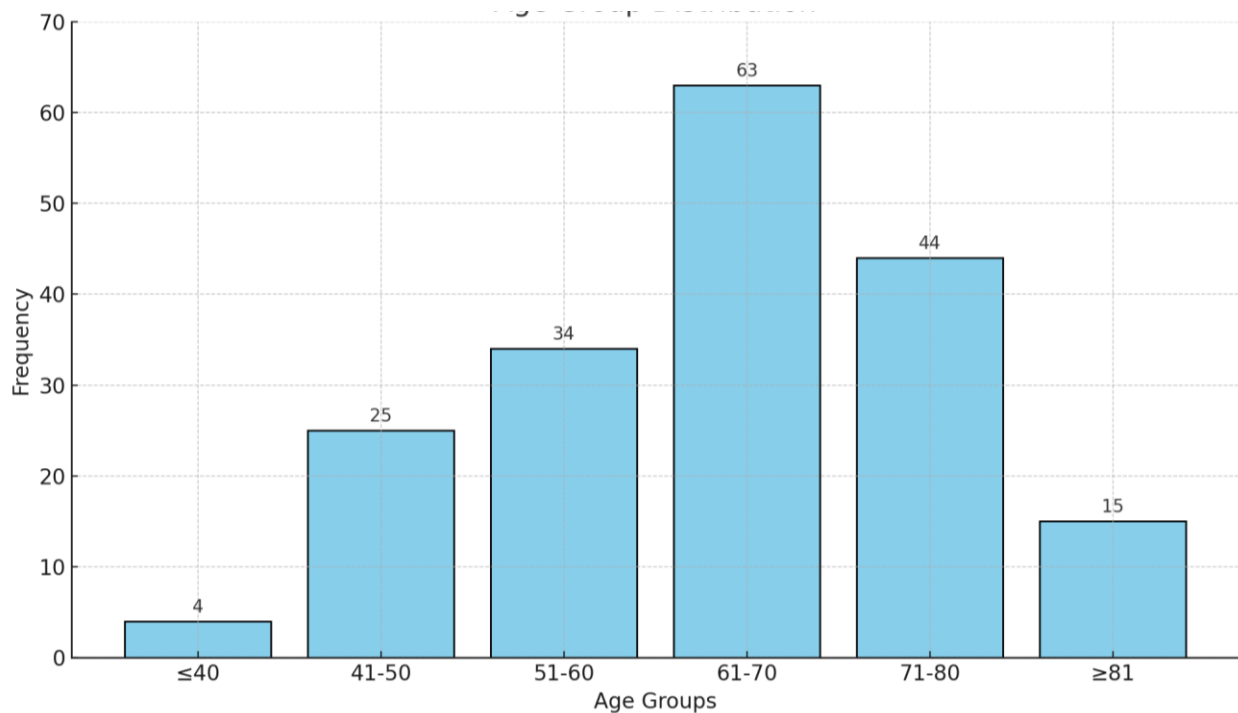


Figure 4.1: Bar Chart Explain Detailed Distribution of a Population

Table3 provides an overview of several important demographic and health-related characteristics of the 185 participants in the study, shedding light on their smoking habits, family health history, hypertension status, and marital status.

In terms of **smoking status**, a minority of participants, 30 individuals (16.22%), were current smokers, while a slightly higher number, 34 individuals (18.38%), were former smokers. This suggests that just over a third of the participants have been or are smokers. The largest group, however, consisted of those who had never smoked, making up 121 individuals (65.41%). This highlights that a significant majority of the participants either do not smoke or have quit smoking, with a relatively small proportion actively smoking at the time of the study.

When looking at the **family history** of specific diseases, 22 participants (11.89%) reported a family history of diabetes. A slightly larger proportion, 32 individuals (17.3%), had a family history of heart disease, while 33 participants (17.84%)

indicated a history of hypertension within their families. Additionally, 39 participants (21.08%) reported a family history of other unspecified health conditions. On the other hand, 59 participants (31.89%) had no known family history of any of these conditions, which points to a significant portion of the study population without a genetic predisposition to major chronic illnesses like diabetes, hypertension, or heart disease.

The **hypertension status** of the participants revealed that just under half, 90 individuals (48.91%), reported not having hypertension, while the remaining 94 participants (51.09%) indicated they had been diagnosed with high blood pressure. This suggests a fairly equal distribution of individuals with and without hypertension, highlighting the relevance of hypertension as a health factor among the study group. It's also important to note that one participant did not provide hypertension status data, which accounts for the total sample of 184 in this section.

Regarding **marital status**, the study found that the vast majority of participants, 182 individuals (98.38%), were married, while a small minority, only 3 participants (1.62%), were unmarried. This indicates that the study population is predominantly composed of married individuals, which could be an important socio-demographic factor when analyzing their health conditions and overall well-being.

Overall, the table provides a comprehensive snapshot of the participants' lifestyle choices and health histories, offering valuable context for understanding the potential correlations between these factors and the development of Benign Prostatic Hyperplasia (BPH). The wide range of smoking statuses, family histories, and hypertension data reflects the diverse nature of the study population, which is crucial for evaluating how these variables might influence the health outcomes being studied.

Table 4.3: Distribution of Participants by Smoking Status, Family History, Hypertension Status, and Marital Status

Smoking Status	Freq.	Percent	Cum.
Current smoker	30	16.22	16.22
Former smoker	34	18.38	34.59
No	121	65.41	100
Total	185	100	
Family History	Freq.	Percent	Cum.
Diabetes	22	11.89	11.89
Heart Disease	32	17.3	29.19
Hypertension	33	17.84	47.03
Other	39	21.08	68.11
No history	59	31.89	100
Total	185	100	
Hypertension Status	Freq.	Percent	Cum.
No	90	48.91	48.91
Yes	94	51.09	100
Total	184	100	
Marital Status	Freq.	Percent	Cum.
Married	182	98.38	98.38
Unmarried	3	1.62	100
Total	185	100	

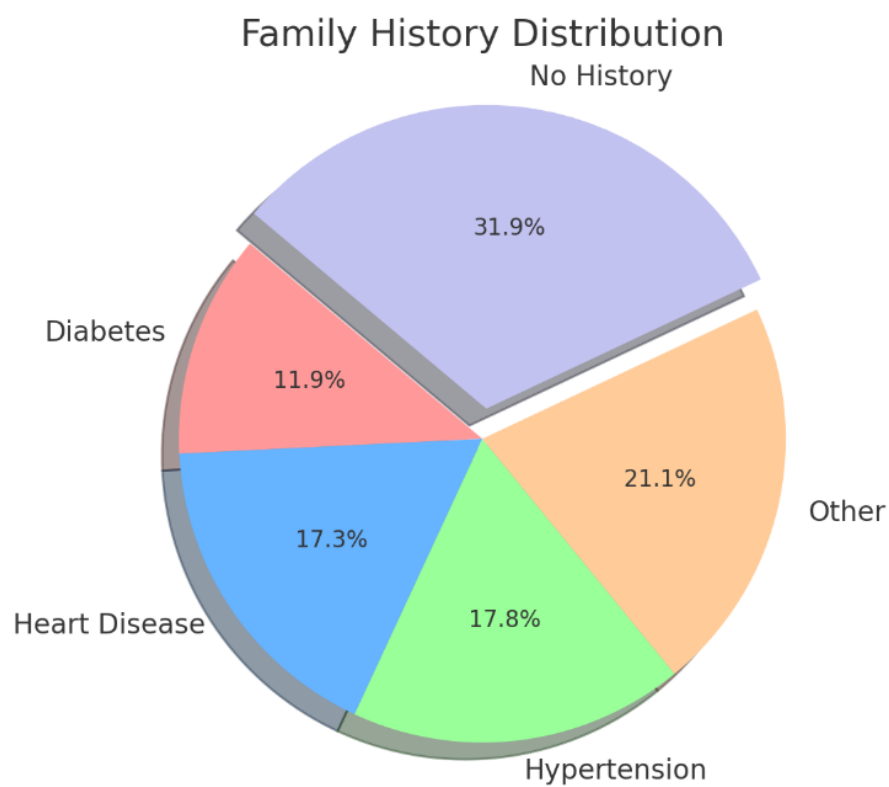


Figure 4.2: Family History Distribution

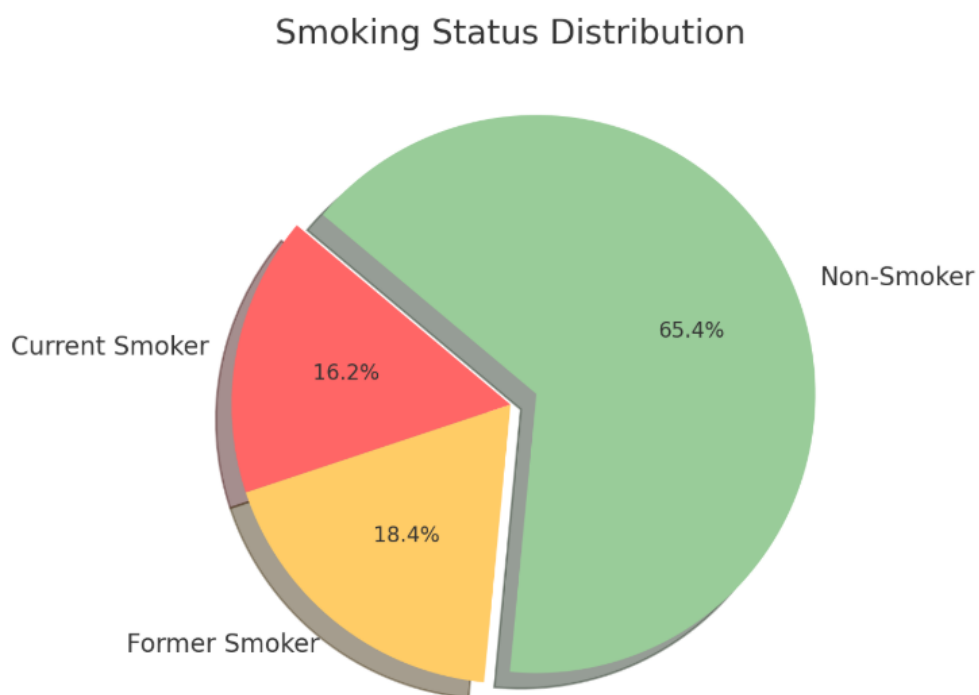


Figure 4.3: Smoking Status Distribution

The correlation matrix in Table 4 provides insights into the relationships between three variables: Age, BMI (Body Mass Index), and Prostate Weight. The correlation values indicate the strength and direction of the linear relationships between each pair of variables.

First, the correlation between Age and BMI is -0.1168, showing a very weak negative relationship. This suggests that as age increases, BMI tends to decrease slightly, although the relationship is minimal. In other words, age has little influence on BMI, and this negative correlation is not statistically significant enough to make any strong predictions about BMI based on age alone.

The correlation between Age and Prostate Weight is 0.4626, reflecting a moderate positive relationship. This indicates that, generally, as individuals get older, prostate weight tends to increase as well. While this correlation is meaningful, it is not strong enough to imply a direct and consistent effect, suggesting that age plays a moderate role in determining prostate weight, but other factors are likely at play.

Lastly, the correlation between BMI and Prostate Weight is 0.0593, which indicates a very weak positive relationship. This suggests that BMI has almost no effect on prostate weight in this sample, with the two variables being virtually unrelated. The minimal correlation implies that body fat, as measured by BMI, does not have a significant impact on prostate size or weight, and other factors must be influencing prostate weight more significantly.

In conclusion, Table 3 highlights that Age is moderately positively correlated with Prostate Weight, while BMI shows minimal correlation with both age and prostate weight. These findings suggest that age may play a more important role in prostate growth than BMI, and other factors, potentially including health conditions and genetics, may be more relevant in determining prostate weight.

Table 4.4: Correlation Matrix for Age, BMI, and Prostate Weight

	Age	BMI	Prostate Weight
Age	1.0000	-0.1168	0.4626
BMI	-0.1168	1.0000	0.0593
Prostate Weight	0.4626	0.0593	1.0000

The results of the pairwise correlation analysis (Table 5) revealed several key relationships between BMI, prostate weight, and prostate dimensions (height, width, and length). The correlation between BMI and prostate weight was very weak ($r = 0.0593$), suggesting minimal association between body mass index and prostate weight. Similarly, the correlations between BMI and prostate dimensions—height ($r = 0.0618$), width ($r = 0.0390$), and length ($r = 0.0741$)—were also very weak, indicating that BMI has little influence on these parameters.

In contrast, significant interrelationships were observed among the prostate parameters themselves. Prostate weight showed a strong positive correlation with prostate width ($r = 0.6703$) and a very strong positive correlation with prostate length ($r = 0.8540$), suggesting that both width and length are major contributors to prostate weight. A moderate positive correlation was also noted between prostate weight and prostate height ($r = 0.5087$), indicating a proportional relationship.

The relationships among the prostate dimensions revealed that prostate height and prostate width had a weak correlation ($r = 0.2613$), while prostate height and prostate length had a moderate correlation ($r = 0.3551$). Prostate width and length also demonstrated a moderate positive correlation ($r = 0.3677$), indicating that prostates with greater width tend to be longer. Overall, these findings highlight the strong interdependence of prostate dimensions, particularly the significant role of width and length in determining prostate weight, while BMI showed no meaningful correlation with any of the prostate parameters.

Table 4.5: Correlation between Continues Variables

Variable	BMI	Prostate Weight (g)	Prostate Height (mm)	Prostate Width (mm)	Prostate Length (mm)
BMI	1.0000	0.0593	0.0618	0.0390	0.0741
Prostate Weight (g)	0.0593	1.0000	0.5087	0.6703	0.8540
Prostate Height (mm)	0.0618	0.5087	1.0000	0.2613	0.3551
Prostate Width (mm)	0.0390	0.6703	0.2613	1.0000	0.3677
Prostate Length (mm)	0.0741	0.8540	0.3551	0.3677	1.0000

Chapter 5

DISCUSSION

The findings of this study provide significant insights into the correlation between Benign Prostatic Hyperplasia (BPH) and metabolic conditions such as obesity, hypertension, and diabetes. Our results align with existing literature, further reinforcing the multifactorial etiology of BPH and the impact of systemic metabolic disorders on prostate health. Our study identified a strong positive correlation between age and prostate volume, with older participants exhibiting significantly larger prostate sizes. This is consistent with previous research indicating that BPH prevalence increases with advancing age, affecting up to 80% of men over 70 years old (Sarma et al., 2019). Similarly, Privitera et al. (2018) emphasized that age-related changes in hormonal regulation and inflammatory pathways contribute to prostate enlargement and lower urinary tract symptoms (LUTS). Our findings reinforce the importance of routine screening for BPH in older adults to facilitate early intervention.

We observed a significant association between obesity, measured by BMI, and prostate volume. Participants classified as overweight or obese demonstrated higher prostate weights and volumes, supporting previous studies highlighting obesity as a risk factor for BPH. Mampa et al. (2021) found a similar trend in their research, although they reported that the correlation was not statistically significant. However, our study aligns more closely with Jung et al. (2016) and Negi et al. (2024), who identified a direct link between abdominal obesity and increased prostate size, likely due to hormonal imbalances, particularly elevated estrogen levels and insulin resistance. A notable finding in our study was the significant association between hypertension and prostate enlargement. Hypertensive participants exhibited increased prostate volume and a higher prevalence of LUTS. This finding is supported by Onigbinde et al. (2023), who reported that hypertensive patients with BPH had elevated prostatic artery resistive indices, suggesting persistent vascular alterations that contribute to prostate growth. Similarly, Erbay et al. (2018) demonstrated a correlation between hypertension and increased carotid intima-media thickness, indicating shared vascular pathophysiology between cardiovascular disease and BPH.

Our results align with these findings, reinforcing the role of vascular health in prostate enlargement.

Diabetic participants in our study exhibited larger prostate volumes and more severe LUTS, consistent with the literature suggesting a link between diabetes and BPH progression. Moudi et al. (2017) found that diabetic patients had significantly higher resected prostate weights than non-diabetic individuals, supporting the hypothesis that hyperglycemia and insulin-like growth factor-1 (IGF-1) contribute to prostate cell proliferation. Additionally, Udoh et al. (2022) reported that diabetic men experience more severe LUTS, likely due to impaired bladder function and chronic inflammation. Our findings corroborate these studies, emphasizing the need for comprehensive metabolic control in managing BPH. Metabolic syndrome (MetS), characterized by the coexistence of obesity, hypertension, hyperglycemia, and dyslipidemia, was identified as a critical factor influencing BPH severity in our study. Ugarte-Carbajal et al. (2023) and Omran et al. (2021) reported that men with MetS had significantly larger prostate volumes and more severe LUTS. Zhao et al. (2016) further highlighted that MetS components, such as low HDL cholesterol and elevated triglycerides, were associated with prostate enlargement and worsened urinary symptoms. Our study supports these findings, reinforcing the hypothesis that metabolic dysfunction exacerbates BPH through inflammatory and hormonal pathways.

The use of ultrasound in evaluating prostate health proved to be an effective and non-invasive method for assessing prostate size and residual urine volume. Our findings align with Chung et al. (2020), who emphasized the role of ultrasound in differentiating BPH from other prostatic conditions, such as prostate cancer. Doppler ultrasound findings in our study also indicated altered vascular patterns in hypertensive patients, consistent with Besiroglu et al. (2017), who demonstrated the utility of Doppler imaging in assessing prostatic blood flow. These findings highlight the importance of ultrasound as a routine diagnostic modality for BPH assessment. Our study underscores the significance of integrating metabolic health management into BPH treatment protocols. Addressing obesity, hypertension, and diabetes through lifestyle modifications, pharmacological interventions, and regular monitoring could mitigate the severity of BPH symptoms. As emphasized by Li et al. (2019), weight management and glycemic control play a crucial role in preventing prostate

enlargement and improving urinary outcomes. Future studies should explore targeted therapies that address metabolic dysfunction to improve prostate health outcomes.

The present study confirms the strong correlation between BPH and metabolic conditions, particularly obesity, hypertension, and diabetes. Our findings align with existing literature, emphasizing the multifactorial nature of BPH and the importance of a holistic approach to its management. Further research is warranted to explore targeted interventions that address both metabolic health and prostate function to improve patient outcomes. Given the increasing prevalence of metabolic disorders worldwide, understanding their impact on BPH progression is crucial for developing effective treatment strategies. Lifestyle interventions, including dietary modifications and increased physical activity, could serve as primary preventive measures against BPH. Moreover, pharmacological approaches targeting metabolic dysfunctions, such as insulin resistance and hypertension, could be incorporated into BPH management protocols.

The economic burden of BPH treatment and its association with metabolic disorders further highlight the need for cost-effective strategies. Studies such as Zhao et al. (2016) suggest that early intervention in metabolic syndrome can significantly reduce healthcare costs associated with BPH-related complications. Our findings indicate that a multidisciplinary approach, incorporating urologists, endocrinologists, and cardiologists, may optimize patient outcomes. Additionally, public health policies should emphasize the prevention of metabolic disorders as a means to reduce BPH incidence and severity. Future research should explore the genetic predisposition to BPH in individuals with metabolic syndrome and assess the long-term benefits of combined metabolic and urological interventions.

Our study also highlights the importance of patient education regarding the role of metabolic health in prostate disease. Encouraging patients to adopt healthier lifestyles, undergo regular screenings, and seek medical advice for metabolic conditions could lead to improved management of BPH. The integration of metabolic screening in routine urological assessments may enhance early detection and intervention, ultimately improving patient quality of life. As healthcare systems shift towards preventive medicine, acknowledging the interplay between metabolic disorders and BPH could lead to more effective population-based strategies. Understanding these

relationships can also inform the development of new therapeutic targets, including anti-inflammatory and hormonal treatments that address both metabolic dysfunction and prostate enlargement.

Our research substantiates the strong interconnection between BPH and metabolic conditions, emphasizing the necessity of a multidisciplinary treatment approach. The findings contribute to a growing body of evidence supporting the role of obesity, hypertension, and diabetes in prostate health. By addressing these conditions concurrently, clinicians may improve BPH outcomes, enhance patient well-being, and reduce the economic burden of prostate disease. Future studies should continue to investigate these correlations in diverse populations, exploring potential genetic, environmental, and lifestyle factors that influence disease progression. By fostering collaboration between metabolic and urological specialists, healthcare providers can develop comprehensive, patient-centered strategies that address both the symptoms and underlying causes of BPH.

CONCLUSION

This study shows a strong link between Benign Prostatic Hyperplasia (BPH) and conditions like obesity, hypertension, and diabetes, highlighting the usefulness of ultrasound in diagnosis. These conditions influence BPH progression and should be considered in treatment. The findings support a holistic approach that combines managing BPH with addressing related health issues, helping improve care and quality of life for patients.

Limitations

To address these limitations, future studies should consider expanding the sample size and including a more diverse population across multiple hospitals to enhance generalizability. A longitudinal approach would be beneficial in establishing a clearer cause-and-effect relationship between BPH and metabolic conditions such as obesity, hypertension, and diabetes. Additionally, integrating advanced diagnostic imaging techniques like MRI or CT scans with ultrasound would improve the accuracy of prostate assessments. Controlling for more variables, such as genetic factors, diet, physical activity, and medication history, would provide a more comprehensive understanding of the condition. Given the strong association between BPH and metabolic disorders, healthcare professionals should emphasize preventive strategies, including weight management, regular exercise, and dietary modifications. Lastly, policymakers should consider implementing routine metabolic screening in middle-aged and older men to facilitate early detection and intervention, ultimately improving patient outcomes.

Recommendations

This study has several limitations that should be acknowledged. Firstly, the sample size of 185 participants, while useful for analysis, may not fully represent the broader population. A larger and more diverse sample would provide more robust and generalizable findings. Additionally, the cross-sectional design of the study only captures associations at a single point in time, making it difficult to establish causal relationships between BPH and metabolic disorders. A longitudinal study would offer deeper insights into disease progression. Another limitation is the reliance on self-reported data for patient history and lifestyle factors, which may introduce recall bias and affect the accuracy of results. Furthermore, while ultrasound is an effective and widely used diagnostic tool, it has inherent limitations in assessing prostate volume and function compared to advanced imaging techniques such as MRI. The study also did not control additional confounding factors, such as genetic predisposition, dietary habits, and medication use, which could influence the observed associations. Lastly, being a single-center study, the findings may not be fully applicable to other regions or healthcare settings.

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Questionnaire

1. Name: _____ Age (years): _____ Sex(M)

2. Smoking Status: ☐ Yes ☐ No

If yes, please indicate your current smoking status

- Current smoker
- Former smoker

Number of years you have smoked: _____

Other specify _____

3. Measurements of prostate gland Anteroposterior: _____

Longitudinal: _____

Transverse diameter: _____

4. Do you have a family history of any of the following diseases? (Please check all that apply)

☐ Diabetes

☐ Hypertension

☐ Heart Disease

☐ Other (please specify): _____

☐ None

5. Marital Status: ☐ Married ☐ Unmarried.

6. Height (cm): _____

7. Weight (kg): _____

8. Systolic Blood Pressure (mmHg): _____

9. Diastolic Blood Pressure (mmHg): _____

10. Hypertension Status: ☐ Yes ☐ No

11. Fasting Blood Glucose (mg/dl): _____

Institutional Review Board Letter



OFFICE OF THE DEAN-FAHS

SUPERIOR UNIVERSITY

Ref.: IRB /FAHS/Allied-HS/10/24/MS/RS-3622

Date: 29th October 2024

Name: Siraj Ali (MS Allied Health Sciences)

Registration: SU91-MSAHW-S23-188

Subject: Ethical Approval Letter

The Research Ethical Committee convened on Dated: **17th October, 2024** to discuss your protocol titled **"Evaluation of Benign prostatic hyperplasia with ultrasound and its correlation with obesity, hypertension and diabetes"**

No further corrections and recommendations were suggested. The above-mentioned protocol has been approved after considering various research issues including ethical concerns with condition that the researcher will submit completion report at the end of his/her research.

Prof. Dr. Muhammad Naveed Babur
Dean/Convener REC
Faculty of Allied Health Sciences
Superior University, Lahore

Dated: 10-06-2024

Approval letter for Data Collection

This is to certify that Mr. Siraj Ali has been granted permission to conduct a research project titled "Evaluation of Benign Prostatic Hyperplasia with Ultrasound and its correlation with Obesity, Hypertension and Diabetes" The approved data collection period for this study is from June 10 2024 to November 9 2024.

Mr. Siraj Ali is authorized to gather relevant data in accordance with the research objectives outlined in the study proposal and must adhere to all applicable ethical guidelines during the data collection process.


(Authorized signature)

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