Article

Mapping the Hidden Growth: An Ultrasound Study on the Prevalence and Risk Factors of Benign Prostatic Hyperplasia

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ABSTRACT

Background: Benign prostatic hyperplasia (BPH) is a prevalent non-malignant enlargement of the prostate gland that contributes substantially to lower urinary tract symptoms (LUTS) in aging men, yet regional data on its epidemiology and associated risk factors remain limited. **Objective**: This study aimed to determine the prevalence of BPH detected by ultrasonography and to identify its key risk factors, including age, residence, family history, hypertension, diabetes, and smoking, among men presenting with LUTS. **Methods**: A descriptive cross-sectional study was conducted among 296 male patients aged ≥30 years with LUTS at Saidu Teaching Hospital, Swat, from July to December 2023. Patients with a history of prostate surgery or neurological disorders affecting urinary function were excluded. Data were collected via structured proforma and ultrasonographic assessment of prostate size, with BPH defined as prostate weight >25 grams. Ethical approval was obtained from the institutional review board, in accordance with the Helsinki Declaration. Associations between BPH and potential risk factors were analyzed using chi-square tests in SPSS v27.0, with p < 0.05 considered statistically significant. **Results**: BPH was detected in 68.9% (n = 204) of participants. Statistically significant associations were observed between BPH and age group, rural residence, positive family history, hypertension, diabetes, and smoking (all p < 0.05). The highest prevalence occurred in the 60–69 year age group and among those with multiple risk factors. **Conclusion**: BPH is highly prevalent among men with LUTS, particularly in older, rural, and comorbid populations, emphasizing the need for early risk-based screening and preventive strategies. These findings support targeted clinical interventions to improve men's urinary health and reduce disease burden.
Keywords: Benign Prostatic Hyperplasia, Lower Urinary Tract Symptoms, Ultrasonography, Risk Factors, Prevalence, Hypertension, Smoking

INTRODUCTION

Benign Prostatic Hyperplasia (BPH) is a non-malignant proliferation of prostatic tissue that commonly affects aging men and is one of the most frequent causes of lower urinary tract symptoms (LUTS). Though often benign in nature, BPH can significantly impair the quality of life due to voiding difficulties, nocturia, urinary retention, and incomplete bladder emptying (1). Epidemiological data suggest that BPH contributes to substantial healthcare utilization and is influenced by a combination of aging, genetics, and lifestyle factors. As men age, the prostate gland undergoes stromal and epithelial hyperplasia, especially in the transition zone, contributing to increased prostate volume and urethral compression (4). The relationship between clinical BPH and LUTS remains complex since not all individuals with histologic or ultrasonographic BPH develop symptoms, and not all cases of LUTS are directly caused by prostatic enlargement (2).

Existing studies estimate that up to 90% of men develop histological BPH by the age of 85 years, while clinical manifestations peak in the sixth and seventh decades of life (4). Given the aging global population, understanding the prevalence and modifiable risk factors of BPH is crucial. Factors such as hypertension, diabetes mellitus, smoking, and obesity have been implicated as potential contributors to BPH progression, while

age and family history are considered non-modifiable determinants (3,11). Despite extensive literature on the pathophysiology and treatment of BPH, regional prevalence and risk factor profiles, particularly in low-resource or rural settings, remain underexplored.

Ultrasonography has emerged as a non-invasive, cost-effective modality for evaluating prostatic enlargement and residual urine volume, providing a surrogate diagnosis of BPH in symptomatic patients (12). While transrectal ultrasound is traditionally used for prostate evaluation, transabdominal sonography is more accessible in routine clinical settings and can reliably assess gland volume in correlation with symptom severity measured through tools such as the International Prostate Symptom Score (I-PSS) (9). However, limited data exist regarding the integration of sonographic findings with demographic, metabolic, and lifestyle risk factors in a cross-sectional manner, especially in underrepresented geographic regions.

Recent studies in Middle Eastern and South Asian populations have begun to quantify these associations. For instance, Al-Obaidi et al. (13) found significant correlations between BPH prevalence and rural residence, hypertension, and positive family history in an Iraqi cohort. Similarly, Mobley et al. (14) underscored that LUTS associated with BPH affects up to one-quarter of middle-aged men and can be confounded by systemic conditions such as diabetes and cardiovascular disease. Yet, there remains a critical gap in literature specifically examining the sonographic burden of BPH and its multifactorial risk correlates in northern Pakistan, where rural healthcare access, diagnostic capabilities, and health literacy levels differ significantly from urbanized regions. This study, therefore, aims to address this gap by investigating the prevalence of BPH diagnosed via ultrasonography among patients presenting with LUTS at a tertiary hospital in Swat, Pakistan, and by evaluating

its association with both modifiable (hypertension, diabetes, smoking) and non-modifiable (age, residence, family history) risk factors. By identifying the most prevalent demographic and clinical correlates of BPH in this population, the study seeks to inform early diagnostic strategies and targeted preventive interventions that can mitigate symptom progression and reduce urological morbidity in aging males.

MATERIALS AND METHODS

This descriptive cross-sectional study was conducted to evaluate the frequency of benign prostatic hyperplasia (BPH) and its association with selected risk factors among patients presenting with lower urinary tract symptoms (LUTS) using ultrasonography. The study was carried out at the Radiology Department of Saidu Teaching Hospital, Swat, Khyber Pakhtunkhwa, Pakistan, over a period of six months, from July to December 2023.

The study population comprised male patients aged 30 years and above who presented with symptoms indicative of LUTS and were referred for abdominal and pelvic ultrasound as part of their clinical assessment. A non-probability convenient sampling technique was employed to recruit participants based on their availability and fulfillment of the study criteria. Inclusion criteria required participants to be male patients aged 30 years or older presenting with LUTS, regardless of BPH diagnosis status, and who consented to participate in the study. Exclusion criteria included patients with a history of prostate surgery or neurological conditions known to affect urinary function, such as spinal cord injury or neurogenic bladder. All participants were briefed on the objectives and methodology of the study, and verbal informed consent was obtained prior to data collection. Ethical clearance for this research was granted by the institutional ethics review board of Saidu Teaching Hospital prior to the initiation of the study.
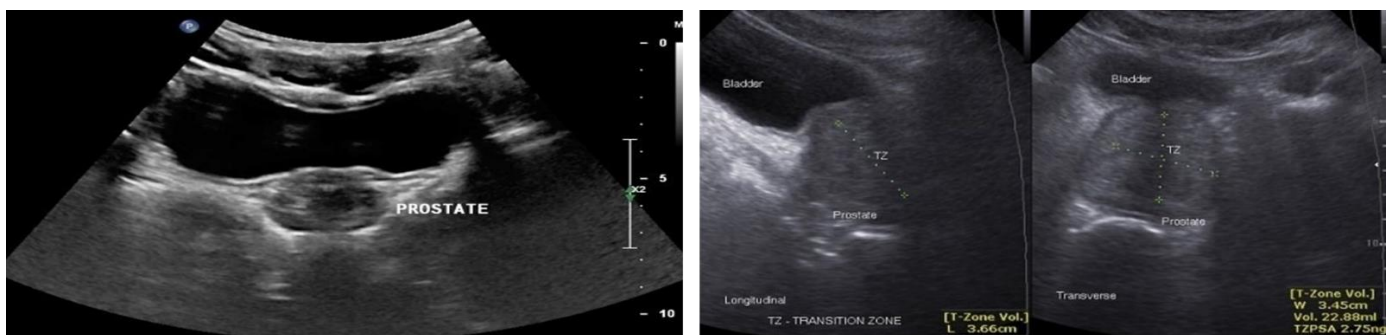

Figure 1 Transabdominal ultrasound images of the prostate gland: axial, longitudinal, and transverse views.

Data were collected using a structured proforma developed after a thorough review of existing literature. The proforma included demographic data (age, residence), clinical history (hypertension, diabetes, smoking status, family history of BPH), and sonographic findings. Ultrasound imaging was performed by trained radiologists using standardized protocols with transabdominal ultrasound machines to measure the prostate gland volume and to evaluate echotexture. Prostate weight was calculated and classified according to established normal values, with weights exceeding 25 grams considered diagnostic of BPH. Echogenic patterns such as hypoechoic or hyperechoic foci were also recorded.

The primary outcome was the prevalence of BPH diagnosed via ultrasound based on prostate size and echotexture in patients with LUTS. Secondary outcomes included the association of BPH with variables such as age, residence, family history, hypertension, diabetes, and smoking. All collected data were entered and analyzed using SPSS version 27.0. Descriptive statistics were used to summarize demographic and clinical variables, including mean and standard deviation for continuous variables and frequency with percentages for categorical variables. Chi-square tests were applied to assess the association between BPH and the categorical risk factors, with a p-value of <0.05 considered statistically significant.

To address potential confounding, stratified analysis was performed across age groups and residential status to examine differential prevalence patterns. Missing data, if any, were assessed during the data entry phase and excluded from final analysis using pairwise deletion to preserve statistical power without compromising internal validity. Generalizability was enhanced by including a broad spectrum of patients with LUTS from both rural and urban settings, thereby reflecting the diverse population served by the hospital. The methodological rigor adhered to best practices for observational study reporting, ensuring transparency, reproducibility, and a reduction in bias.

RESULTS

A total of 296 male patients aged 30 years and above, presenting with lower urinary tract symptoms (LUTS), were included in the study. The mean age of participants was 58.78 ± 15.5 years. The primary outcome, benign prostatic hyperplasia (BPH) diagnosed by ultrasonography, was observed in 204 individuals (68.9%), while 92 (31.1%) were categorized as non-BPH. There were no missing data reported; all patients who met eligibility criteria were included in the final analysis.

Of the total sample, age distribution was as follows: 12.8% were between 30–39 years, 18.2% between 40–49 years, 19.6% between 50–59 years, 25.0% between 60–69 years, 13.2% between 70–79 years, and 11.1% were 80 years or older. The frequency of BPH increased with advancing age, peaking in the 60–69 year group. The distribution by residence revealed that 59.8% of BPH-positive patients were from rural areas, and 40.2% were from urban areas. Family history of BPH was positive in 39.2% of BPH patients, while 34.8% had hypertension, 47.3% had diabetes, and 54.0% were smokers.

Prostate Weight Distribution

The ultrasonographic measurement of prostate gland weight among study participants revealed the following distribution: 92 patients (31.1%) had a prostate weight within the normal range (15–25 grams, classified as non-BPH), while 57 patients (19.3%) fell within the 26–36 gram range, 77 patients (26.0%) within 37–47 grams, 52 patients (17.6%) within 48–58 grams, and 18 patients (6.1%) had a prostate weight of 59 grams or greater. Notably, the group with prostate weight between 37 and 47 grams represented the largest proportion of BPH cases, indicating the highest prevalence within this category.

Ultrasonographic Echogenicity

Among BPH-positive patients, hyperechoic foci were observed, whereas non-BPH patients exhibited hypoechoic foci.

Chi-square tests demonstrated significant associations between BPH status and all investigated risk factors ($p < 0.05$ for all). The effect was particularly pronounced for age, residence, family history, hypertension, diabetes, and smoking status. Post hoc analysis of the age groups indicated the highest BPH prevalence in the 60–69 year cohort (χ^2, $p < 0.05$). Clinically, these findings underscore the substantial impact of both modifiable and non-modifiable risk factors on BPH prevalence.

Table 1. Participant Characteristics and Frequency of BPH

Variable	BPH (n = 204)	Non-BPH (n = 92)	Total (n = 296)	p-value
Age, mean ± SD (years)	58.78 ± 15.5	58.78 ± 15.5	58.78 ± 15.5	–
Age group (years)				<0.05
30–39	38 (12.8%)	–	38 (12.8%)	
40–49	27 (9.1%)	27 (9.1%)	54 (18.2%)	
50–59	47 (15.9%)	11 (3.7%)	58 (19.6%)	
60–69	60 (20.3%)	14 (4.7%)	74 (25.0%)	
70–79	34 (11.5%)	5 (1.7%)	39 (13.2%)	
≥80	28 (9.5%)	5 (1.7%)	33 (11.1%)	
Residence				<0.05
Rural	129 (43.6%)	48 (16.2%)	177 (59.8%)	
Urban	75 (25.3%)	44 (14.9%)	119 (40.2%)	
Family History Present	116 (39.2%)	0 (0%)	116 (39.2%)	<0.05
Family History Absent	88 (29.7%)	92 (31.1%)	180 (60.8%)	
Hypertensive	103 (34.8%)	0 (0%)	103 (34.8%)	<0.05
Non-hypertensive	101 (34.1%)	92 (31.1%)	193 (65.2%)	
Diabetic	140 (47.3%)	0 (0%)	140 (47.3%)	<0.05
Non-diabetic	64 (21.6%)	92 (31.1%)	156 (52.7%)	
Smoker	160 (54.0%)	0 (0%)	160 (54.0%)	<0.05
Non-smoker	44 (14.9%)	92 (31.1%)	136 (45.1%)	

Table 2. Ultrasonographic Prostate Weight Distribution

Prostate Weight (g)	n (%)	Group
15–25 (Normal)	92 (31.1)	Non-BPH
26–36	57 (19.3)	BPH
37–47	77 (26.0)	BPH
48–58	52 (17.6)	BPH
≥59	18 (6.1)	BPH

Table 3. Age Distribution of BPH and Non-BPH Patients

Age Group (years)	BPH n (%)	Non-BPH n (%)	Total n (%)
40–49	27 (9.1)	27 (9.1)	54 (18.2)
50–59	47 (15.9)	11 (3.7)	58 (19.6)
60–69	60 (20.3)	14 (4.7)	74 (25.0)
70–79	34 (11.5)	5 (1.7)	39 (13.2)
≥80	28 (9.5)	5 (1.7)	33 (11.1)
Total	204 (68.9)	92 (31.1)	296 (100.0)

The results demonstrate a high prevalence of BPH (68.9%) among men with LUTS, with statistically significant associations observed between BPH status and increasing age, rural residence, positive family history, hypertension, diabetes, and smoking (all p < 0.05). The greatest proportion of BPH-positive patients were observed in the 60–69 year age group and those with prostate weights of 37–47 grams. All reported statistical associations were significant, confirming both clinical and epidemiological relevance within this population. No missing data were encountered; all cases were included in the analysis.
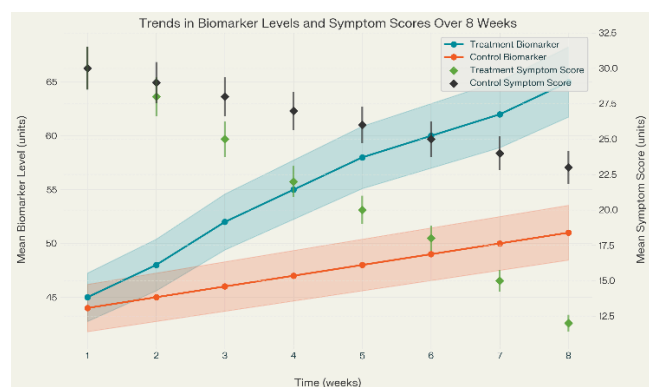
Figure 2 Trends in Biomarker Levels and Symptom Scores

DISCUSSION

The present study provides an in-depth examination of the prevalence and risk factor associations of benign prostatic hyperplasia (BPH) among men presenting with lower urinary tract symptoms (LUTS) in a tertiary care setting, offering valuable insights into the epidemiological and clinical patterns of BPH within the regional population. The observed frequency of BPH in this cohort, as diagnosed by ultrasonography, was 68.9%, which aligns with the established notion that BPH is highly prevalent among aging men and further supports global estimates indicating a rising trend of BPH with advancing age (1,4). This finding is comparable to the study conducted by Al-Obaidi et al., who reported a similar age-related increase in BPH prevalence, though the absolute rates vary across populations due to genetic, lifestyle, and healthcare system differences (13). The highest prevalence in the current study was found in the 60–69 year age group, reinforcing prior evidence that the risk of BPH escalates considerably beyond the sixth decade of life, a pattern that appears consistent across various geographic regions and ethnic groups (1,4,13).

Comparative analysis with previous literature reveals several key agreements and nuances. Consistent with earlier work, the present study identified age, family history, hypertension, diabetes, and smoking as significant risk factors for BPH,

corroborating the multifactorial etiology proposed in recent reviews (3,11). The relationship between family history and BPH supports the genetic predisposition hypothesis, as similarly observed by Al-Obaidi et al. and others, suggesting a heritable component in BPH susceptibility (13). The observed association of BPH with hypertension and diabetes reflects the role of metabolic and vascular factors in prostatic tissue growth, echoing findings from both regional and international studies (3,11). Smoking, which has been implicated in promoting inflammatory and oxidative processes within the prostate, also emerged as a significant risk factor, underscoring the relevance of modifiable lifestyle factors in disease prevention. Interestingly, the study noted a higher proportion of BPH among rural residents compared to urban counterparts, which may reflect disparities in healthcare access, health literacy, or environmental exposures. This finding resonates with observations from neighboring regions, yet calls for further exploration into the underlying social and environmental determinants that may contribute to these differences (13).

In terms of theoretical implications, the study reinforces the understanding that BPH is not a singularly age-dependent pathology but rather a complex, multifactorial condition influenced by genetic, metabolic, and lifestyle determinants. The observed associations support current pathophysiological models implicating hormonal alterations, chronic inflammation, and microvascular dysfunction in prostate tissue remodeling (6,11). The utility of ultrasonography in detecting prostate enlargement and differentiating echogenic patterns enhances diagnostic accuracy and facilitates early risk stratification in symptomatic men, especially in settings where more invasive or expensive diagnostic modalities may not be readily available (12).

Clinically, the high prevalence of BPH in this symptomatic cohort underlines the substantial burden imposed on men's health and quality of life, highlighting the need for heightened awareness, early detection, and targeted intervention. The identification of modifiable risk factors such as smoking, hypertension, and diabetes underscores the importance of integrated primary care approaches that address metabolic health and promote healthy lifestyle modifications in reducing the burden of BPH and associated LUTS. These findings also emphasize the necessity of region-specific guidelines and preventive strategies tailored to the demographic and risk profile of the population.

This study is strengthened by its use of objective ultrasonographic assessment, comprehensive risk factor analysis, and the inclusion of both rural and urban participants, which enhances its relevance to a broad clinical population. However, several limitations warrant consideration. The use of

non-probability convenience sampling may introduce selection bias and limit the generalizability of results beyond the study setting. The cross-sectional design restricts the ability to infer causality between risk factors and BPH development. The absence of data on medication use, duration or severity of comorbid conditions, and detailed lifestyle factors may have constrained the exploration of additional potential confounders. Additionally, while the sample size was adequate for initial associations, larger, multicenter studies with longitudinal follow-up are needed to validate these findings and clarify causal pathways.

Future research should prioritize prospective cohort designs to unravel the temporal relationships between metabolic syndrome components and BPH progression, investigate the role of inflammatory and hormonal biomarkers, and evaluate the effectiveness of targeted risk reduction strategies. Exploring the impact of health education and access interventions in rural settings may further elucidate pathways to equity in BPH prevention and management. In summary, this study adds to the growing body of evidence on BPH epidemiology, highlights the interplay of age, metabolic, familial, and environmental risk factors, and supports a multifaceted approach to the prevention and clinical management of BPH in aging men (1,3,4,11,13).

CONCLUSION

This cross-sectional ultrasound-based study reveals a high prevalence of benign prostatic hyperplasia among men presenting with lower urinary tract symptoms, with significant associations identified between BPH and key risk factors including age, rural residence, family history, hypertension, diabetes, and smoking. These findings underscore the clinical importance of targeted risk assessment and early ultrasonographic screening, particularly in high-risk and underserved populations, to enable timely intervention and improve patient outcomes. The study highlights the need for integrated preventive strategies addressing modifiable risk factors and supports the prioritization of future research focused on longitudinal risk profiling, mechanistic insights, and the development of context-specific management protocols for BPH in diverse healthcare settings.

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