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Correlation of prostate volume with severity of lower urinary tract symptoms as measured by international prostate symptoms score and maximum urine flow rate among patients with benign prostatic hyperplasia

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Abstract

Background: The aim of the study is to find the correlation between the prostate volume and severity of lower urinary tract symptoms (LUTS) as measured by international prostate symptoms score and maximum urine flow rate among patients with benign prostatic hyperplasia (BPH).

Methods: The study was a prospective correlational study conducted between June 2016 and November 2017. A total of 290 patients who presented with LUTS suggestive of BPH and satisfied the inclusion criteria were consecutively recruited. Clinical evaluation including digital rectal examination of the prostate was done. Symptoms severity was assessed using the self-administered international prostate symptoms score (IPSS) questionnaire. Prostate volume was determined by transrectal ultrasound scan, and the urine flow rate was measured using uroflowmeter. Data were analyzed using SPSS version 20.0, and p value < 0.05 was taken to be statistically significant.

Results: The mean age of the patients was 64.22 ± 9.04 years with a range of 40 to 95 years. Most of the patients had moderate symptoms (55%) on IPSS with the mean IPSS value of 16.41 ± 7.43. The mean Qmax value was 16.55 ± 7.41 ml/s, and the median prostate volume (IQR) was 45.05 (35, 59). There was a positive significant correlation between prostate volume and IPSS ($r = 0.179$, $p = 0.002$) and a negative significant correlation between prostate volume and Qmax ($r = -0.176$, $p = 0.003$).

Conclusion: This study showed a significant correlation between the prostate volume and IPSS, and also between prostate volume and maximum flow rate (Qmax).

Keywords: Benign prostatic hyperplasia, Prostate volume, International prostate symptoms score, Uroflowmetry

1 Background

Benign prostatic hyperplasia (BPH) refers to the proliferation of smooth muscle and epithelial cells within the prostatic transition zone and clinically manifests as LUTS [1]. It is more common in men of African descent than Caucasians [2, 3]. The development of BPH and lower urinary tract symptoms (LUTS) is frequent events in aging males [4]. However, the relationship between BPH and LUTS is not a linear one, and some elderly patients with LUTS may not have BPH and vice versa. Clinically, BPH has been reported to occur in 8% of men at the age

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of 40 years rising to 50% and 90% by the ages of 60 and 80 years, respectively.

Most men who seek medical attention do so because of bothersome LUTS [5]. Many urologists use the symptoms as the basis for diagnosis of bladder outlet obstruction (BOO) and for assessment of treatment efficacy. The most widely used symptoms score is the International Prostate Symptoms Score (IPSS). It is a reliable and valid instrument to measure subjective severity of lower urinary tract symptoms and progression over time.

Urodynamic investigation with pressure flow analysis is the preferred standard to measure the degree and site of obstruction; however, they are invasive and time-consuming [6]. To document obstruction, most urologists still use non-invasive objective parameters such as urinary flow rate, residual urine and prostate volume [7]. Prostate volume estimation is an important parameter in the management of patients with BPH. Prostate volume can be estimated by digital rectal examination (DRE); however, ultrasound, particularly transrectal ultrasound (TRUS), is more accurate and currently is considered as the gold standard. The use of transrectal ultrasound to objectively measure the prostate volume has been popularized since it was first introduced by Watanabe [8]. Prostate volume measurement is useful in aiding the choice of treatment modalities and calculating prostate-specific antigen density (PSAD) [2–4]. Several studies were done to correlate the prostate volume with the severity of lower urinary tract symptoms (LUTS), but the results were conflicting. While some of the studies showed significant correlation [9, 10], others did not demonstrate significant relationship [11]. Studies done on this subject from the available literature are sparse in the African population. Furthermore, some of the studies employed subjective measures only for the assessment of severity of LUTS. This study was conducted considering its strength in terms of larger sample size and utilizing both subjective (IPSS) and objective (uroflowmetry) parameters when compared with the previous ones done in Africa. Knowledge of the true relationship between LUTS and BPH will facilitate easy decision making in terms of diagnosis and treatment planning. The purpose of this study is to evaluate the relationship between the prostate volume and severity of LUTS as measured by IPSS and maximum flow rate (Qmax) among patients with benign prostatic hyperplasia.

2 Methods

A total of 290 patients with LUTS suggestive of BPH and aged 40 years and above were prospectively recruited from June 2016 to November 2017. Approval was obtained from the Health Research Ethics committee (HREC) of the hospital. Patients with suspected or histologically confirmed prostate cancer, patients already on medical therapy or had surgical intervention for BPH, patients with benign prostatic hyperplasia coexisting with urethral stricture and those with LUTS due to other causes were excluded from the study. Informed consent was obtained from all the patients. All enrolled patients were evaluated at the time of initial visit using the International Prostate Symptom Score (IPSS) which is a self-administered questionnaire. The questionnaire has seven items, and each has a score of 0 to 5 with total score of 35. It also assesses the quality of life which has values from 0 (delighted) to 6 (terrible). Patients were categorized into three groups as mild (0–7), moderate (8–19) and severe (20–35) symptoms. Because it is a self-administered questionnaire and not translated in the local language, many patients who did not understand the questions or who could not read English required assistance. Digital rectal examination (DRE) was done on each patient to assess the prostate size and characteristics. Patients with suspected malignant prostate were excluded from the study and investigated appropriately. All the participants had transrectal ultrasound (TRUS) to measure the volume of the prostate. TRUS was done using Mindray Digital Ultrasonic Diagnostic Imaging System: Model DP—20. The procedure was performed with the patients in the left lateral position using a well-lubricated gloved rectal probe at a frequency of 6.5 MHz. Prostate volume was calculated using the prolate ellipsoid formula (length × height × width × $\prod/6$) in cm^3 ($\prod/6 = 0.5238$). Uroflowmetry was done using ARK Meditech System Uroflowmetry Machine: Urol 010 Model. All the patients voided while standing when they have strong urge to void. The maximum urine flow rate (Qmax) was obtained from the graph printed using EPSON LX-300-II Model printer.

3 Data analysis

The data obtained were recorded in a structured proforma and entered into statistical software. Analysis was subsequently done using Statistical Package for Social Sciences (SPSS) software version 20.0. Data were displayed in percentages, tables and charts, and the Pearson's correlation coefficient (r) was used to describe the association between IPSS score, Qmax and prostate volume, while Chi-square was used for categorical variables. p value < 0.05 was considered statistically significant.

4 Results

4.1 Socio-demographic parameters

A total of 290 patients met the inclusion criteria and were included in the study. The mean age of the patients was 64.22 ± 9.04 years with a range of 40 to 95 years. The peak age group was 60–69 years as shown in Table 1.

Table 1 Age distribution of patients in the study population

Age (years)	Frequency	Percent
40–49	19	6.6
50–59	46	15.9
60–69	138	47.6
70–79	75	25.9
80–89	10	3.4
90–99	2	0.7
Total	290	100.0

Ninety-four patients (32.4%) were civil servants followed by 66 patients (22.8%) who were retired. Majority of the patients had moderate symptoms on IPSS as shown in Fig. 1. One hundred and forty-five patients (50%) had tertiary level of education. The symptoms severity based on the level of education is shown in Fig. 2.

The most common presenting LUTS was nocturia (97.2%), followed by frequency (89.0%), poor stream (82.4%), straining (79.7%), feeling of incomplete emptying (63.4%), urgency (51.7%), terminal dribbling (49.3%) and hesitancy (18.3%). Overall, the mean IPSS score was 16.41 ± 7.43. The quality of life (QoL) assessments showed that majority of the patients were unhappy with their symptoms (51.7%) as shown in Fig. 3.

The mean Qmax value was 16.55 ± 7.41 ml/s. The median prostate volume was 45.05 cm^3 with IQR (35–59), and the mean prostate volume was 52.58 ± 30.53 cm^3 (range 24.60–319.00 cm^3). When the prostate volume and IPSS for the 290 patients were subjected to Pearson's correlation coefficient test, there was a positive significant correlation ($r = 0.179$, $p = 0.002$). The correlation between prostate volume and Qmax showed a negative significant correlation ($r = -0.176$, $p = 0.003$), as shown in Table 2, and the scatter diagrams in Figs. 4 and 5.

5 Discussion

Benign prostatic hyperplasia and lower urinary tract symptoms are quite prevalent in men with advancing age [4]. Clinical BPH may not be life threatening; however, its manifestation as LUTS interferes with QoL [12]. In this study, the mean age of participants was 64.2 ± 9.0 years with a range of 40 to 95 years. This is similar to 64.4 ± 8.9 years found in the study done by Badmus et al. [13] in Ife, South-Western Nigeria. Other similar findings were seen in [7, 14, 15]. The peak age group was 60–69 years consistent with the studies done by Movsas et al. [3] and Udeh et al. [15]. This findings further support the fact that BPH is a disease of men with advancing age [4]. Majority of the patients in this study were civil servants 94 (32.4%) with tertiary level of education. This was in contrast with the finding by Udeh et al. [15] in which majority of patients (61.0%) were farmers. This

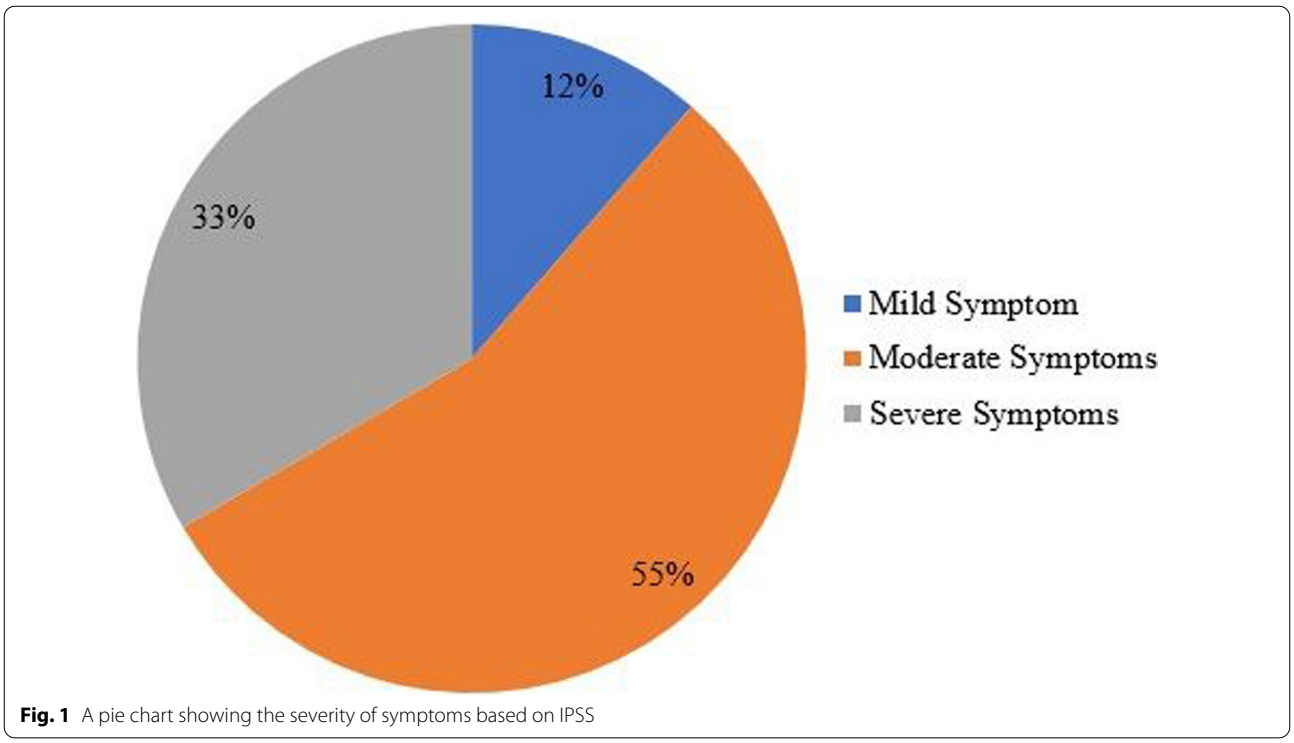

Fig. 1 A pie chart showing the severity of symptoms based on IPSS

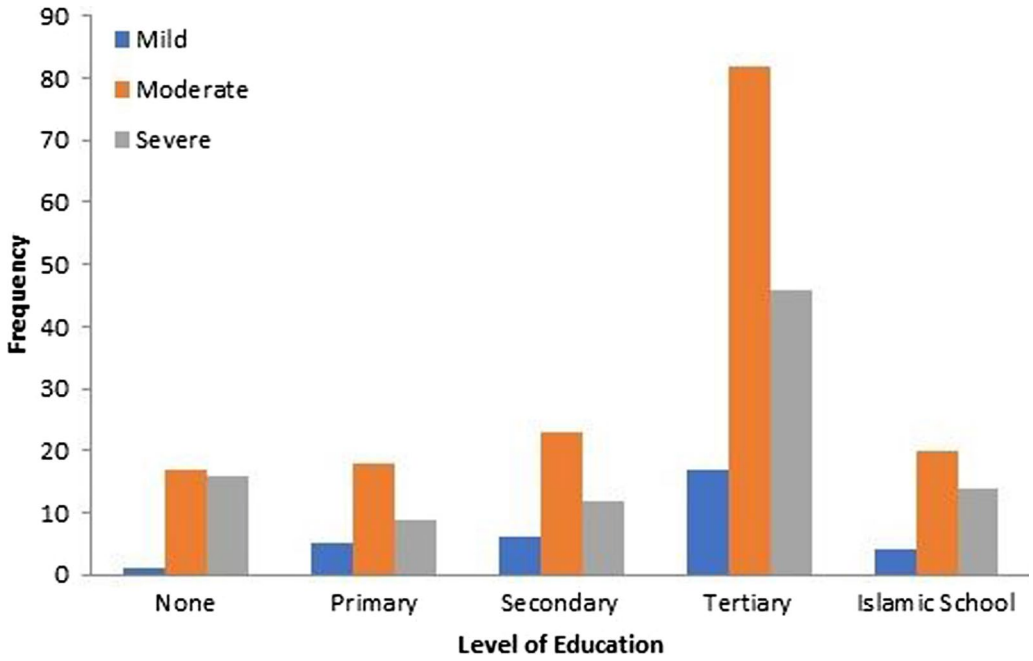

Fig. 2 Symptoms severity based on level of education ($n = 290$)

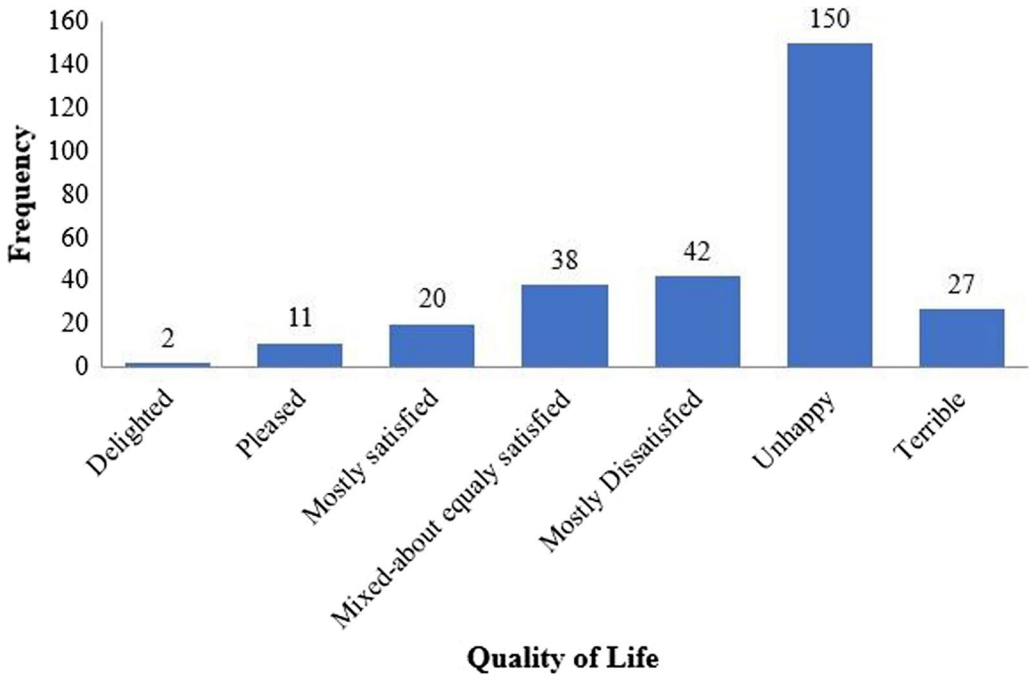

Fig. 3 The quality of life assessment of the patients ($n = 290$)

observation might be attributed to the fact that there are many higher institutions of learning in the study environment.

The mean IPSS value in this study was 16.3 ± 7.1 which was slightly different from the findings by Kenneth et al. [16] in Ghana and Ofoha et al. in Jos, Nigeria [17]. This difference may be due to a relatively larger sample size in

Table 2 Correlation of prostate volume with IPSS and Qmax in the study population

Test components	Correlation (*r*-value)	*p*-value
Prostate volume/IPSS	0.179	0.002
Prostate volume/Qmax	−0.176	0.003

IPSS International Prostate Symptoms Score, *Qmax* Maximum flow rate
p-value < 0.05 is statistically significant

this study when compared with their own studies with sample size of 225 and 103 patients, respectively. Another reason could be due to delay in seeking treatment in our environment as majority of the patients present with moderate and severe LUTS.

The mean prostate volume was found to be similar to those obtained by Mohammed et al. [18] in Zaria, North-Western Nigeria, and Badmus et al. [13] in Ife, South-Western Nigeria. A different value was obtained by Gnyawali et al. [19] in Kathmandu, Nepal, though they use transabdominal ultrasound scan to calculate the prostate volume in their study.

The correlation of prostate volume with the International Prostate Symptoms Score (IPSS) was found to be significant in this study ($p=0.002$). Several studies were done to determine relationship between the prostate volume and severity of LUTS as measured by the IPSS, with various outcomes. A study done by Ofoha et al. [17] in Jos, North-Central Nigeria, reported a positive insignificant correlation between the prostate volume and IPSS. Similar findings of insignificant correlation between prostate volume and IPSS were also seen in other studies [7, 20, 21]. Some studies showed no relationship between prostate volume and IPSS [11, 22, 23], while some showed strong correlation [9, 10]. When the Qmax was correlated with the prostate volume, there was a negative significant correlation ($p=0.003$). This showed an inverse relationship between the prostate volume and the maximum flow rate, i.e., as the prostate volume increases, the maximum flow rate decreases.

The most common LUTS was found to be nocturia in 282 patients (97.2%) followed by frequency in 258 patients (89.0%) which was consistent with the finding by Oranusi et al. [24] Majority of the patients in this study described nocturia as the most bothersome LUTS affecting their QoL. Like other studies, the storage (irritative) symptoms were more frequent among the patients than the voiding (obstructive) symptoms [4].

Quality of life assessment showed that 150 patients (51.7%) and 42 patients (14.5%) were unhappy (QoL = 5) and mostly dissatisfied (QoL = 4), respectively. This demonstrated that lower urinary tract symptoms in patients with benign prostatic hyperplasia

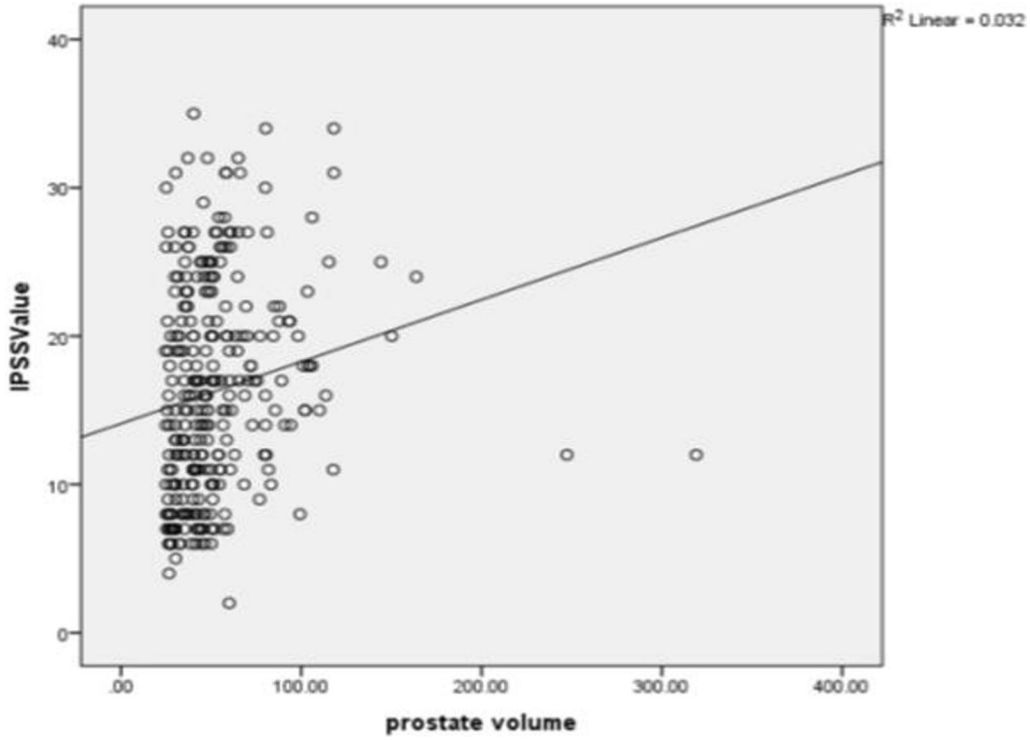

Fig. 4 Scatter diagram showing correlation between IPSS and prostate volume

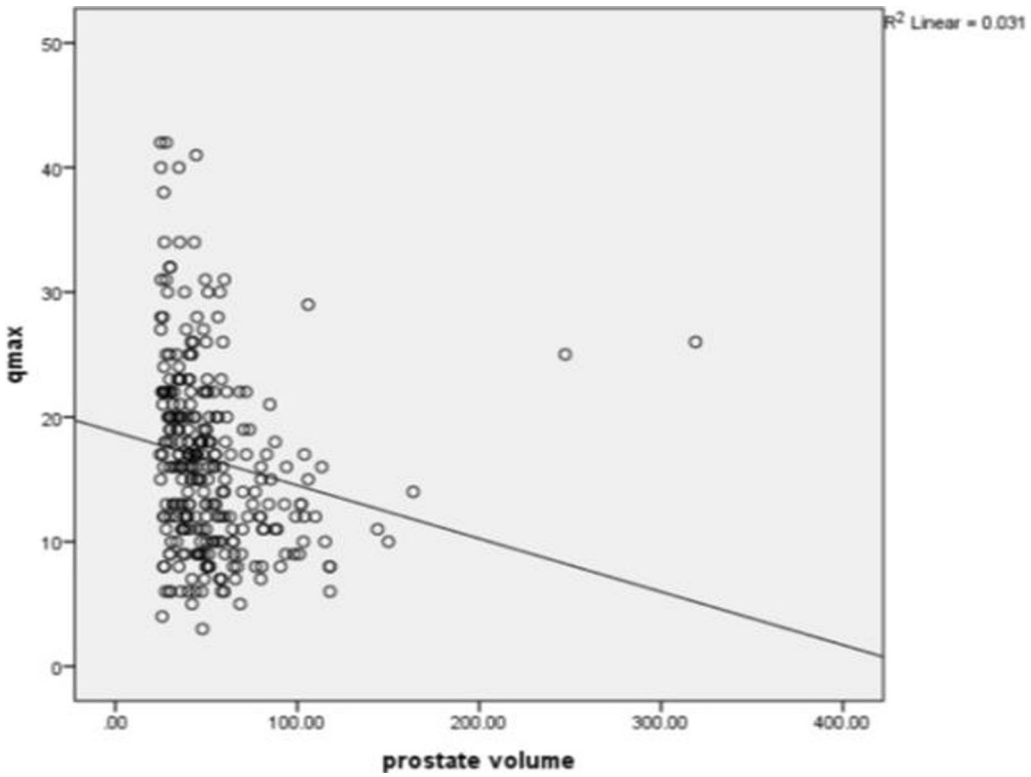

Fig. 5 Scatter diagram showing correlation between Qmax and prostate volume

significantly affect the quality of life. There was statistically significant relationship between the severity of LUTS assessed by IPSS and the QoL. This finding is consistent with the study by Patrick et al. [12] who concluded that it might be better to use the quality of life (QoL) as determinant of the choice of treatment, rather than the IPSS scores alone for prompt treatment of LUTS. Patients presented more with moderate IPSS symptoms (55.2%), mild symptoms (11.4%) and severe symptoms (33.4%), with the findings similar to that of Ofoha et al. [17]. Generally, our patients present late with moderate or severe LUTS probably because in many cases, mild symptoms are accepted as a natural occurrence with aging, and men learn to live with them. The level of education has no influence on presentation in this study, because majority still present with moderate and severe symptoms on IPSS despite having tertiary level of education. The limitation of the study includes problems with administration of International Prostate Symptoms Score questionnaire in those without formal education that require interpretation and or administration by the researcher, which may result in some level of bias in the ultimate IPSS score.

6 Conclusion

In conclusion, there was positive significant correlation between the prostate volume and International Prostate Symptoms Score (IPSS) and a negative significant correlation between prostate volume and maximum flow rate (Qmax). Therefore, in low resource settings where uroflowmetry is not readily available for the objective assessment of lower urinary tract symptoms, prostate volume could serve as a proxy parameter and complement subjective assessment with IPSS.

Abbreviations

BPH: benign prostatic hyperplasia; BOO: bladder outlet obstruction; LUTS: lower urinary tract symptoms; IPSS: international prostate symptoms score; QoL: quality of life; DRE: digital rectal examination; TRUS: transrectal ultrasound; Qmax: maximum flow rate; SPSS: statistical package for social sciences; IQR: inter-quartile range.

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Authors' contributions

MA contributed to protocol development, data collection and manuscript writing. MAh contributed to data analysis, manuscript editing and manuscript revision. ATL contributed to data analysis, manuscript editing and manuscript revision. AS contributed to data collection, manuscript writing and manuscript revision. MAT contributed to data collection, data analysis and manuscript

revision. NO contributed to data collection, manuscript editing and manuscript revision. MSM contributed to data collection and data analysis. AB contributed to manuscript writing, editing and revision. HYM contributed to manuscript editing and revision. All authors read and approved the final manuscript.

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Ethics approval and consent to participate
Our manuscript is an excerpt from the first author's dissertation for which ethical approval was obtained from the Health Research Ethics Committee of Ahmadu Bello University Teaching Hospital, Shika-Zaria, Nigeria (ABUTH/HREC/M17/2014), and written informed consent was obtained. Participation was voluntary, and confidentiality was maintained throughout the study.

Consent for publication
Not applicable.

Competing interests
The authors declare that they have no competing interests.

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