Original Article

Correlation between Transabdominal Sonographic Prostate Volume and Anthropometric Parameters

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Abstract

Background: Prostate diseases commonly present with lower urinary tract symptoms (LUTS) resulting from prostatic enlargement. Prostate volume (PV) can be evaluated using transabdominal ultrasonography. Focus is currently on relative factors of prostatic enlargement which includes obesity and central adiposity. The aim of this study is to correlate transabdominal sonographic PV and anthropometric parameters in patients with LUTS in Port Harcourt. **Methods:** This was a prospective cross-sectional study carried out at the Radiology Department, Rivers State University Teaching Hospital, Port Harcourt, between September 2020 and January 2021. One hundred and twenty (120) males from 40 years and above who presented with LUTS were recruited. Transabdominal PV estimation was done and body mass index (BMI) as well as WC was assessed. Data were analyzed using a Statistical Package for Social Sciences; appropriate statistical tests were applied and $P < 0.05$ was considered significant. **Results:** The mean PV was 69.8 ± 63.5 cm^3, 79.2% of the subjects had enlarged prostate with volume ≥ 30 cm^3. PV was found to increase with age. The correlation between PV and anthropometric measures of obesity (BMI and WC) was statistically not significant. **Conclusion:** The work established that there is no correlation between PV and anthropometric measures of obesity – BMI and WC in negro population as opposed to nonblack population where there is correlation. Obesity may not be a considerable risk factor of prostatic enlargement in the studied population. Thus, anthropometrics may not be useful in predicting prostate size.

Keywords: Body mass index, International Prostate Symptom Score, obesity, prostate volume, waist circumference

Introduction

Pathologies of the prostate gland which are mainly hyperplastic (benign prostatic hyperplasia), malignant (carcinoma of the prostate), and less commonly inflammatory (prostatitis) frequently give rise to increase in the organ size. Prostatic enlargement (prostatomegaly) leads to bladder outlet obstruction as a result of static compression as well as dynamic obstruction owing to the contraction of prostatic smooth muscles.[1] This could be asymptomatic in some cases; however, it commonly manifests as lower urinary tract symptoms (LUTS). PV assessment has become increasingly important because of its connections to disease progression, treatment response prediction, and therapeutic options.[2] Therefore, determinants of prostate volumes (PVs) will invariably influence management options, prognosis as well as preventive measures.

Radiologic evaluation of prostatic disease is commonly by ultrasonography, particularly in Nigeria as a developing country where availability of imaging equipment and cost of services are limiting factors.[3,4] Magnetic resonance imaging could be done, especially when malignant disease is suspected. Other modalities such as plain radiography, fluoroscopy, computed tomography as well as radionuclear studies can also image the gland. However, ultrasound remains the first-line modality which is safe, noninvasive, fast, cost-effective, and readily available imaging tool for the prostate gland. Transabdominal, transperineal, transurethral, and transrectal approaches are the common routes employed.[5]

Anthropometric measurements include body mass index (BMI), body circumferences, among others. The

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most common anthropometric measure of central obesity is waist circumference (WC), and hip circumference. The ethnic-specific definition of central obesity for African men by the International Diabetes Federation is WC ≥94 cm.[6,7] Central adiposity is a function of subcutaneous and visceral fats which are important components of metabolic syndrome; it may be considered "at-risk obesity."[8]

Ultrasonography is the mainstay of PV assessment. Transabdominal and transrectal approaches are the common routes employed in imaging the prostate. The later, although it gives more accurate volumetric assessment, however, studies have shown no statistically significant difference between the transabdominal and transrectal sonographic PVs for clinical purposes.[9,10] In addition, patient's discomfort, the need for rectal emptying, relatively more time consuming, and less cost-effectiveness relative to the former are the considerations in the choice of transabdominal approach for the study.

Currently, with emphasis on preventive than therapeutic medicine, more attention is given to determinants and risk factors of prostate enlargement with a view to identifying modifiable factors associated with prostate diseases.

Although studies have been carried out among Caucasians on the relationship between PV and obesity, limited data are available on researches done in sub-Sahara Africa. Particularly in Nigeria, few studies have been done in the area of the subject matter.[11,12] Thus, the purpose of this research project is to determine the association between PV and anthropometric measurements (particularly BMI and WC) and its relationship with symptom severity among men in South–South Nigeria.

Materials and Methods

This research was a prospective cross-sectional study, carried out at Rivers State University Teaching Hospital (RSUTH), Port Harcourt, from September 2020 to January 2021, among men above 40 years of age with complaints of LUTS, referred from the Urology Clinic to Radiology Department of RSUTH.

All the patients who presented for prostate ultrasound in the radiology department within the study period, who met the eligibility criteria, were recruited once they gave informed.

Informed consent was obtained. Then, the subject's age and demographic and anthropometric parameters (height, weight, and WC) were taken. Transabdominal ultrasonography of the prostate gland was done and PV was measured. The information was appropriately recorded on the study data sheet. Participants were scanned with a moderately filled urinary bladder in a supine position using an ultrasound scanner fitted with an 3.5-MHz curvilinear transducer (Logiq F6, General Electric, USA, 2017). The patient was asked to lie supine in the ultrasound couch and his pelvic region was adequately exposed, then the area draped and cleaned. Coupling gel was applied to bridge acoustic impedance between the skin and probe surface.

PV was calculated from the dimensions obtained (in cm) using the default computer algorithm in the ultrasound machine based on the prostate ellipsoid formula[13] – PV (in cm^3) = length x height x width x 0.52, where the length, height, and width were the maximum cephalocaudal, anteroposterior, and transverse diameters, respectively, as shown in Figure 1.

Anthropometric measurements

The subjects' height, weight, and WC were obtained using standard anthropometric techniques as follows.

Height: With the subjects standing straight on the stadiometer base with barefoot, heels put together, while the buttocks and back make contact with the vertical rod, the heights were read. The measurements were taken in meters using a Z-16 Stadiometer (Wincom Company Limited, China, 2017).

Weight: Was also measured with the same Stadiometer, with the patient in the same position as above, having removed foot wares and heavy clothing. Readings were taken in kilometers.

BMI was calculated using the subjects' height and weight measurements as BMI = weight/height^2 (kg/m^2).

WC: The subject in a standing position with the abdomen exposed, the lower rib margin and iliac crest were felt from behind, and measurements were taken in centimeters at the midpoint of the two bony landmarks at the end of expiration.

Ethical consideration

Ethical approval was granted by the Ethical Committee of RSUTH (approval number: RSHMB/RSHREC/11.19/VOL 7/039).

Results

The mean age (±standard deviation [SD]) was 65.1 ± 9.6 years, with an age range of 48–94 years [Table 1]. The lowest and highest age ranges of the participants were observed as 40–49 years (*n* = 6; 5%) and 60–69 years (*n* = 50;

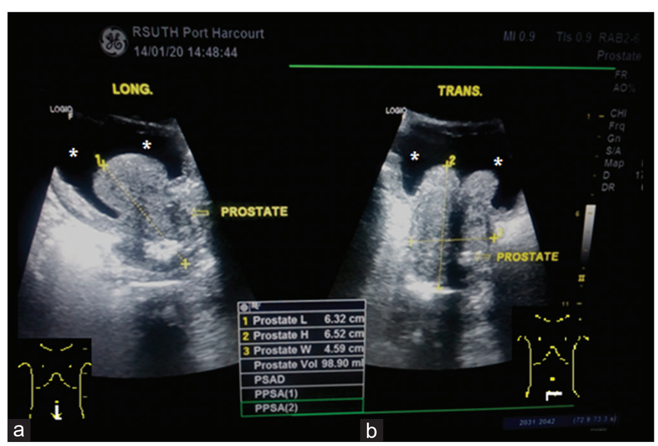

Figure 1: Transabdominal sonograms of a participant showing grey-scale static images of the prostate gland – Longitudinal (a) and Transverse (b) sections with a prostatic volume of 98.90cm^3 NB: LONG: Longitudinal section, TRANS: Transverse section; *: Urinary bladder

41.7%), respectively, as shown in Figure 2. The mean BMI was 26.7 ± 4.1 kg/m^2, while the mean WC was 90.72 ± 12.7 cm (±SD). The mean PV measured among the participants was 69.8 ± 63.5 cm^3 (±SD) [Table 1].

Table 2 shows that 41 (34.2%), 54 (45.0%), and 25 (28.8%) are of normal BMI, overweight, and obsessed, respectively, whereas 64 (53.3%) subjects are of normal group (WC <94 cm) and 56 (46.7%) in the central obesity group (WC ≥94 cm).

As shown in Table 3, a total of 95 subjects (79.2%) had enlarged prostate of volume ≥30 cm^3, while the higher proportion (66.7%) of the younger age group (40–49 years) had PV <30 cm^3. PV was seen to vary among the various BMI (kg/m^2) categories, with the mean volumes of 78.1 and 64.9 recorded in the normal and overweight (BMI 18.5–24.9 and 25.0–29.9), while 65.0 was noted in the obese (BMI ≥30) categories, respectively, as shown in Table 4. Table 3 also demonstrates that Fisher's test between PV and BMI categories shows no significant association (P = 0.560); the same also applies to the t-test between PV and WC categories (P = 0.064).

The Pearson correlation of PV with BMI shows a very weak negative relationship which is not statistically significant (r = −0.120, P = 0.192), as illustrated in Table 5. So also, is PV with WC (r = −0.137, P = 0.137) which showed a very weak negative relationship that was not statistically significant [Table 5].

Discussion

In this cross-sectional study involving 120 men aged 40 years and above, the average age was 65.1 years. Majority of the patients were in the age range of 60–69 years (41.7%). The above findings are similar to the mean ages of 66.25 and 62.50 years reported locally by Udeh *et al*.[14] (Enugu) and Mohammed *et al*.[15] (Zaria), respectively, and 64.10 years by Rupam *et al*.[16] in India, with the highest frequencies (46%, 34.5%, and 42%, respectively) recorded within 60–69 years age range.

The mean transabdominal sonographic PV was 69.84 ± 63.5 cm^3. In a related study on transrectal PV correlation with prostate-specific antigen level in the same study setting,

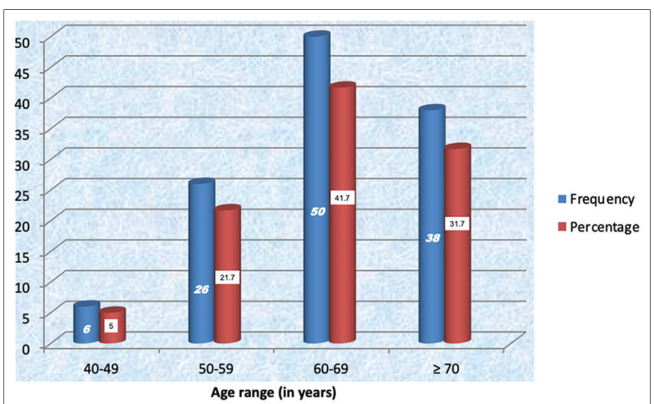

Figure 2: Age distribution of participants

Robinson[17] reported a mean volume of 66.13 ± 30.43 cm^3 among 143 symptomatic patients. The value is however lower than the mean 83.8 ± 37.7 cm^3 and 72.79 ± 44.4 cm^3 reported

Table 1: Demographic characteristics of the participants

Variables participants (n=120)	Mean±SD	Median
Age (years)	65.1±9.6	64.0
Height (m)	1.7±0.05	1.7
Weight (kg)	72.7±12.9	70.0
BMI (kg/m^2)	26.7±4.1	26.0
WC (cm)	90.7±12.7	92.0
Prostate volume (cm^3)	69.8±63.5	51.6

BMI: Body mass index, WC: Waist circumference, SD: Standard deviation, IPSS: International Prostate Symptom Score

Table 2: Distribution of body mass index and waist circumference categories of the participants

Variables	Frequency (n=120) n (%)
BMI category (kg/m^2)	
18.5-24.9	41 (34.2)
25.0-29.9	54 (45.0)
≥30.0	25 (28.8)
WC category (cm)	
<94	64 (53.3)
≥94	56 (46.7)

BMI: Body mass index, WC: Waist circumference

Table 3: Distribution of prostate volume with age group

Age (years)	Prostate volume cm^3		Total, n (%)
	<30, n (%)	≥30, n (%)	
40-49	4 (66.7)	2 (33.3)	6 (100.0)
50-59	4 (15.4)	22 (84.6)	26 (100.0)
60-69	8 (16.0)	42 (84.0)	50 (100.0)
≥70	9 (23.7)	29 (76.3)	38 (100.0)
Total	25 (20.8)	95 (79.2)	120 (100.0)

Table 4: Distribution of prostate volume and anthropometric (body mass index and waist circumference)

Variable	Frequency	Mean (cm^3)±SD	F-test	P
BMI category (kg/m^2)				
18.5-24.9	41	78.1±83.5	0.582	0.560
25.0-29.9	54	64.9±52.0		
≥30	25	65.0±44.7		
Total	120	69.8±63.5		
Variable	**Frequency**	**Mean (cm^3)±SD**	**t-test**	**P**
Waist circumference category (cm)				
<94	64	79.5±79.1	1.875	0.064
≥94	56	58.8±36.3		
Total	120	69.8 ± 63.5		

SD: Standard deviation

Table 5: Prostate volume correlation with body mass index and waist circumference

Variables	Correlation coefficient	*P*
Prostate volume versus BMI	−0.120	0.192
Prostate volume versus WC	−0.137	0.137

BMI: Body mass index, WC: Waist circumference

by Badmus *et al*.[11] in Ile-Ife and Udeh *et al*.[18] in Jos among 105 (mean age of 64.4 years) and 100 (mean age of 65.6 years) subjects, respectively. It is however higher than 56.2 ± 42.7 cm^3 recorded by Mohammed *et al*.[15] among 602 patients in Zaria with the age of 64.1 years. The differences may be attributed to numerical bias – more patients were recruited in this index study than was done in the work by Badmus *et al*. and that of Udeh *et al*., while Mohammed *et al*. enrolled larger subjects in his study. The use of transrectal approach by Mohammed *et al*. compared to transabdominal volume estimation by the two studies as well as the index work may also account for the discrepancy.

The mean BMI recorded in this study is 26.7 ± 4.1 kg/m^2. This is similar to the mean BMI of 25.00 ± 5.10 reported by Robinson[17] among adult men aged 45–84 in the same facility, while Ejike[12] and Mubenga[19] recorded 24.0 ± 3.03 and 25.1 ± 3.3 in Eastern Nigeria and Congo Republic, respectively. The mean WC reported in this study was 90.72 ± 12.69 cm, and it is similar to 88.4 cm accounted by Badmus *et al*.[11] in Ile-Ife in 2019, while 94.6 ± 10.3 cm was recorded among Congolese.[20]

The association between prostate size and anthropometric measures of obesity has shown a wide range of variance from studies done both locally and in foreign settings. Different studies have shown significant correlation, either positive or negative, while others recorded no statistically significant association. This study found no significant correlation between PV and BMI ($P = 0.192$) and also between PV and WC ($P = 0.137$) respectively. The findings are in agreement with the two local studies done in Ife in 2013 and 2019 where PV was correlated with anthropometric in men presenting with LUTS. In the former, Badmus *et al*.[11] found no correlation between transabdominal PV and BMI among 105 men aged 40 and above who were managed for BPH ($P = 0.840$). The latter study by Asaleye *et al*.[21] among 90 men of similar age, correlation of transabdominal and transrectal PV with BMI ($r = 0.156$, $P = 0.144$) and PV with WC ($r = −0.068$, $P = 0.525$) was not significant in both cases. However, a positive but weak correlation was demonstrated between BMI and transrectal transitional zone volume ($r = −0.230$, $P = 0.029$).

Burke *et al*.[22] in an age-stratified random sample of 105 Caucasian males aged 43–88 years in Minnesota established that association between PV and anthropometric measures (BMI, $P = 0.49$, WC, $P = 0.07$) was not significant. Similarly, the work done by Kim *et al*.[23] in South Korea found no correlation between PV and BMI ($r = 0.164$, $P < 0.001$) but positive linear correlation between PV and WC ($r = 0.217$, $P < 0.01$). Conversely, a control study in Italy showed a moderate inverse relationship between BMI and BPH.[24] In the study, Zucchetto *et al*.[24] compared previous BMI of 1 year prior to histological diagnosis of BPH which was assessed by self-reported weight and height, with current PV in this case–control study. Thus, methodology may have accounted for the difference in findings.

On the other hand, most studies among nonblack men have shown a significant positive correlation between PV and anthropometric measures of obesity. In Pakistan, Raza *et al*.[25] found that transabdominal PV correlated positively with BMI and WC ($P = 0.046$, $P = 0.003$, respectively). Jung *et al*.[26] and Fowke *et al*.[27] made similar findings in South Korea and the United States, respectively. In the same vein, Monowara *et al*.[28] reported a significant positive PV correlation coefficient of $r = 0.352$ ($P < 0.001$) with BMI. Furthermore, Li *et al*.[29] and Sokhal *et al*.[30] established similar relationship between PV and BMI among Chinese and Indian men (odds ratio = 1.772, $P = 0.005$; $r = 0.132$, $P < 0.001$), respectively.

Most studies reported among the blacks, including this index study, however, demonstrate no significant relationship between obesity and prostate gland enlargement. This therefore suggests a strong influence of ethnoracial factor in the determination of prostate size among adult males. Another possible explanation for the findings is the hypothesis of reduced testosterone levels in obese individuals as proposed by Zucchetto *et al*.[24] and La Vignera *et al*.[31]

Conclusion

The work established that there is no correlation between PV and anthropometric measures of obesity – BMI and WC in black population as opposed to nonblack population where there is correlation. Obesity may not be a considerable risk factor of prostatic enlargement in the studied population. Thus, anthropometrics may not be useful in predicting prostate size, other risk factors aside obesity should be considered in the evaluation, prevention, and management of prostatic enlargement.

Furthermore, a longitudinal study design is recommended for further studies to address the limitations of this cross-sectional study in making an objective comparison of the variables over time. Finally, further studies on the scopes of this work are recommended in other geopolitical regions of Nigeria and beyond, including community-based surveys, to add to the existing body of knowledge.

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Conflicts of interest

There are no conflicts of interest.

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