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Sonographic Determination of Urinary Bladder Wall Thickness in a Healthy Nigerian Population

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Abstract: The urinary bladder wall thickness (BWT) is an important parameter in assessing the patho-physiologic condition of the urinary bladder and/or other adjoining organs. Pre and post void urinary bladder wall thickness measurements, were made on 204 healthy asymptomatic adult Nigerian volunteers, with empirical evidence of absence of bladder pathologies, using ultrasound. Siemens Prima Ultrasound machine (Model 4900531-LH 300) with 3.5 MHz curvilinear transducer was used for the study. The study objectives were to determine sonographically the mean urinary bladder wall thickness in a healthy Nigerian population and correlate it with anthropometric parameters. The pre void bladder wall thickness was 2.3-5.0±0.45mm with mean of 3.15±0.45mm. The post void BWT was 3.0-7.3±0.73mm with mean of 5.24±0.73mm. Males have thicker bladder wall than females with mean and standard deviation of 3.27±1.24mm and 3.10±0.64mm respectively. BWT correlated positively with height but negatively with urinary bladder volume. No correlation was noted between BWT and age, weight and body mass index.

Key words: Urinary Bladder Wall Thickness · Sonographic Measurement · Adult Nigerians

INTRODUCTION

Urinary bladder wall thickness has been noted to increase in patients with pathophysiologic conditions of the urinary bladder and other adjoining organs such as benign prostatic hyperplasia (BPH), bladder outlet obstruction (BOO), lower urinary tract symptoms (LUTS), spinal cord injury, infection and carcinoma [1-5]. The increase in bladder wall thickness observed was attributed to mechanical processes of contractions against a closed sphincter, deposition of collagens in the muscle fibre or oedema [3, 6].

Several studies have shown significant differences in bladder wall thickness between obstructed and non-obstructed patients [2, 6].

Ultrasound with high frequency transducers is invaluable in precise measurement of bladder wall thickness [7]. It is not associated with pain, invasiveness, risk of infection, ionizing radiation and high cost. It is also adaptable for all age groups. Ultrasound mucosal bladder wall measurement is a non invasive, simple and reliable method for diagnosis of cystitis and has been shown to detect BOO better than uroflowmetry [8-11].

Studies suggest that there could be ethnic/racial differences in bladder wall thickness of normal healthy adults [1, 2, 12]. As promising as this emerging modality is, presently, it is challenged by a number of issues including the lack of data in healthy asymptomatic population [4]. This study sought to determine the bladder wall thickness in a healthy Nigerian population in order to aid diagnosis of related pathologies.

MATERIALS AND METHODS

The study was a prospective cross-sectional hospital-based survey carried out at the Radiology Department of Federal Teaching Hospital, Abakaliki (FETHA), Nigeria. A total of 204 volunteers who met the inclusion criteria were enlisted. This covered apparently healthy adult Nigerians, 18years and above with no history of urinary bladder pathologies. Medical laboratory analyses (Urinalysis and urine microscopy) were conducted for the volunteers to exclude participants with urinary tract infection. Ethical clearance was obtained from the FETHA Research and Ethics Committee. The procedure was explained to the participants and their

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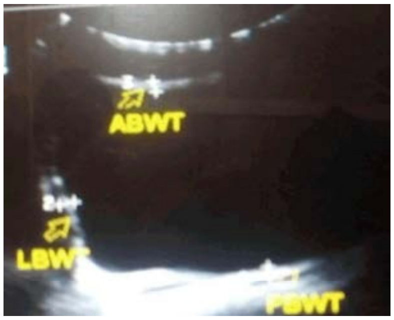

KEY

ACRONYM	MEANING
ABWT	Anterior Bladder Wall Thickness
LBWT	Lateral Bladder Wall Thickness
PBWT	Posterior Bladder Wall Thickness

Fig. 1: Ultrasound image of the urinary bladder showing sites of measurement of the bladder wall thickness

signed consents were obtained. Data were obtained with Siemens Prima Ultrasound machine (Model 4900531-LH 300) with 3.5 MHz curvilinear transducer.

Each participant with urge to void was scanned in a supine position. The probe was placed longitudinally above the symphysis pubis and below the umbilicus to get a longitudinal view of the bladder. A little angulation from the mid line was needed for different bladder shapes. A transverse view was obtained by rotating the transducer 90°. The images were frozen and the length (l), height (h) and width (w) of the bladder were obtained by measuring from the inner walls. With a correction factor of 0.521, the volume of the urinary bladder was calculated as a product of these values. This ensured that a minimum volume of 200 ml was obtained.

Urinary bladder wall thickness was obtained at the anterior wall, the posterior wall and the lateral aspect (Fig. 1). The mean value was taken as the bladder wall thickness (BWT) at full bladder. The patient was asked to void and the process repeated for an empty bladder. This method as was described by Blatt *et al.* [13] ensures repeatability.

The data were subjected to descriptive statistics and analyzed using Pearson's product moment correlation. Regression equation was generated for bladder wall thickness. Probability value less than 0.05 was considered statistically significant.

RESULTS

Table 1 shows the range, mean, standard deviation, standard error and skewness of the age, height, weight, body mass index, pre-void bladder volume, pre-void BWT and post-void BWT. The age of the participants ranges from l8 to 70 years (Mean, 31.87 ± 10.4 years). The body mass index (BMI) ranged from 16.0 to 39.6 (mean 24.36 ± 4.499). A mean bladder volume of 296 ml was noted. Pre-void BWT ranged from 2.3 mm to 5.0 mm (mean 3.l5mm ± 0.454). Mean post-void BWT was 5.24 ± 0.733 (range, 3.0 - 7.3mm).

Table 2 shows the distribution of the participants according to age, sex and bladder biometry. The modal age was 21-30years (46.57%).

Fig. 2 shows mean pre and post-void BWT for various grouped BMI. The normal weight group (18.5-25.9) had a mean pre-void BWT of 3.15mm and mean post void BWT of 5.24mm. The obese group (>30.00) also had a mean pre-void BWT of 3.15mm but a mean post-void BWT of 5.09mm.

Table 1: Descriptive statistics of variables measured showing range, mean, standard deviation, standard error and skewness

Parameter /variable	Sample size	Range	Mean	Standard deviation	Standard error	Skewness
Age (years)	204	18-70	31.87	10.4	0.733	1.152
Height (cm)	204	145-182	162.61	8.028	0.562	0.269
Weight (kg)	204	40-103	64.54	13.319	0.933	0.716
Body mass index	204	16.0-39.6	24-36	4.499	0.315	0.865
Pre-void bladder volume (ml)	204	200-801	296.37	120.759	8.455	1.308
Pre-void bladder wall thickness (mm)	204	2.3-5.0	3.15	0.452	0318	0.875
Post-void bladder wall thickness (mm)	204	3.0-7.3	5.24	0.733	0.513	0.290

Table 2: Frequency distribution of age and sex of volunteers with mean pre and post-void BWT at a mean bladder volume for each age group

S/N	Age Year	Male	Female	Total	Percentage (0%)	Mean Pre-void Bladder Vol. (ml)	Mean Pre-void BWT (mm)	Mean Post-void BWT (mm)
1	<20	1	20	21	10.29	330	2.88	5.19
2	21-30	33	62	95	46.57	280	3.14	5.21
3	31-40	11	42	53	25.98	297	3.28	5.27
4	41-50	9	14	23	11.28	320	3.11	5.40
5	51-60	6	2	8	3.92	278	3.03	5.28
6	61-70	1	3	4	1.96	331	3.68	4.91

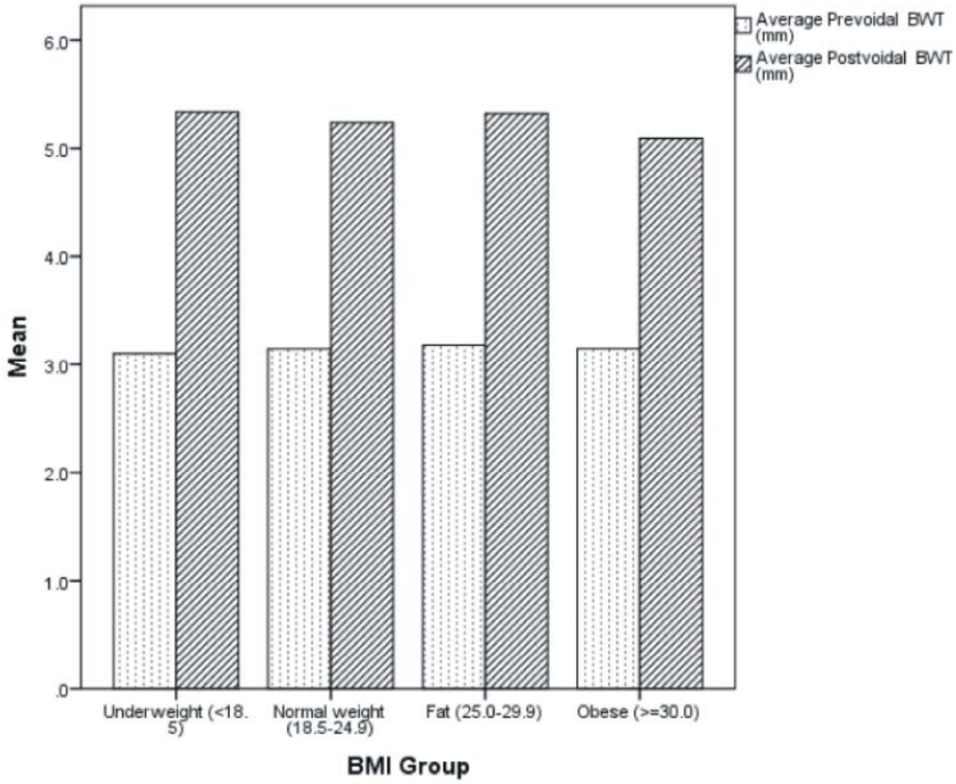

Fig. 2: Bar Chart showing mean pre void and mean post void BWT according to BMI of volunteers

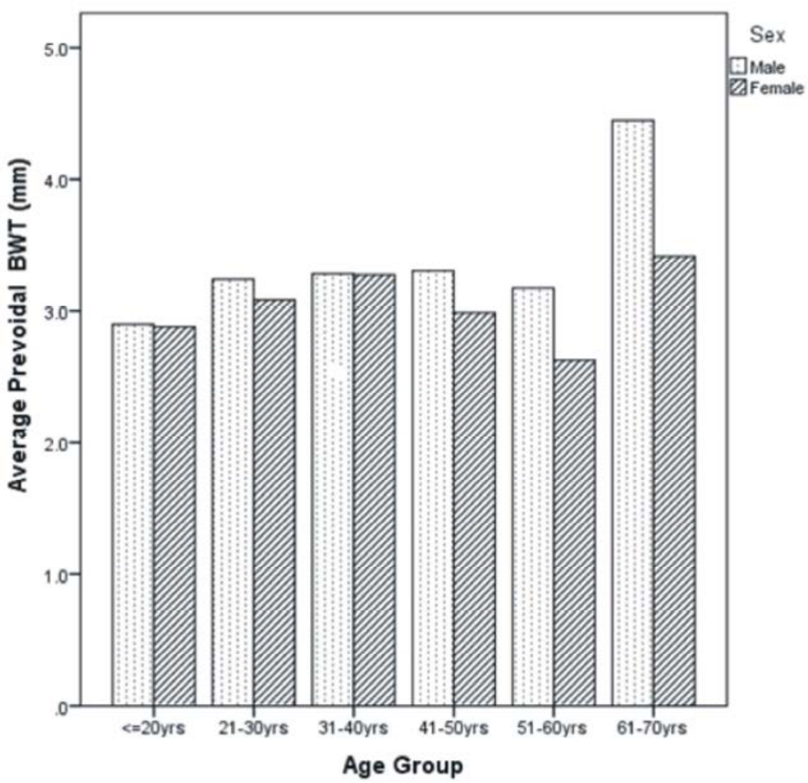

Fig. 3: Bar Chart showing mean pre void BWT of male and female volunteers according to the various age groups

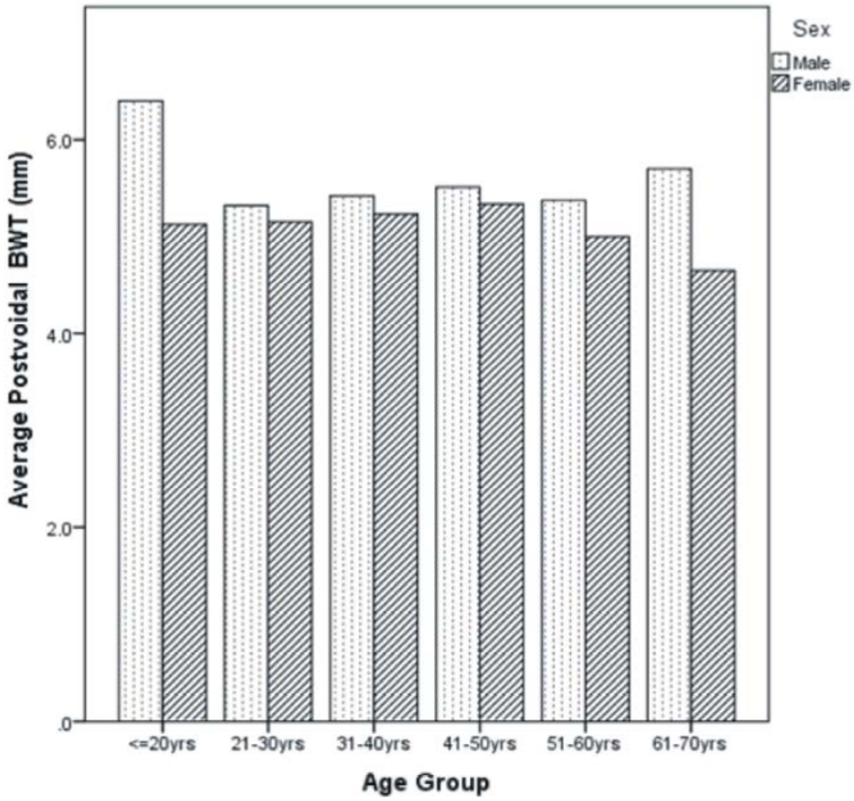

Fig. 4: Bar Chart shows mean post void BWT of male and female volunteers according to the various age groups

Table 3: Correlation of mean pre and post void BWT with age, height, weight, BMI and bladder volume

S/N	Correlation/ Variables	Pearson Correlation Co- Efficient	Probability (P<0.05)	Sample Size	Predictive Equation of Regression
1	MEAN PRE-VOID BWT WITH AGE	0.179	0.010	204	Y=2.903+0.008(X) (R^2=0.032)
2	MEAN POST-VOID BWT WITH AGE	0.040	0.574	204	Y=5.152+0.003(X) (R^2=0.002)
3	MEAN PRE-VOID BWT WITH HEIGHT	0.153	0.002	204	Y=1.143+0.012(X) (R^2=0.048)
4	MEAN POST-VOID BWT WITH HEIGHT	0.162	0.021	204	Y=5.152+0.015(X) (R^2=0.026)
5	MEAN PRE-VOID BWT WITH WEIGHT	0.153	0.029	204	Y=2.814+0.005(X) (R^2=0.023)
6	MEAN POST-VOID BWT WITH WEIGHT	0.025	0.720	204	Y=5.152+0.001(X) (R^2=6.359E-4)
3	MEAN PRE-VOID BWT WITH BMI	0.054	0.420	204	Y=3.137+0.04(X) (R2=0.134)
4	MEAN POST-VOID BWT WITH BMI	0.055	0.423	204	Y=5.568-0.09(X) (R2=0.023)
5	MEAN PRE-VOID BWT WITH PRE-VOID BLADDER VOLUME	0.373	0.000	204	Y=3.132-0.01(X) (R2=0.134)
6	MEAN POST-VOID BWT WITH BLADDER VOLUME	-0.132	0.059	204	Y=5.568-0.01(X) (R2=0.023)

Fig. 3 shows mean pre void BWT measurements according to sex of participants. The pre void BWT was higher in males for all the age groups.

Fig. 4 shows the mean post void BWT of male and female volunteers according to the various age groups. For all the age groups the post-void BWT was higher in males than in females

Table 3 shows the correlation of mean pre-void and mean post-void BWT with age, height, weight, BMI and bladder volume. The predictive equations of regression and co-efficient of determination are also included.

DISCUSSION

Our study revealed that bladder wall thickness (BWT) was generally higher in males than in females. A mean pre-void BWT of 3.10 mm was found in females while 3.27mm was found in males. Mean post-void BWT of 5.18mm was found in females and 5.39mm in males. Our study is in agreement with the findings of Hakenberg *et al*. [2] who reported mean pre-void bladder wall thickness of 3.04mm in healthy women and 3.3mm in healthy men. In general, males are more muscular than females and since urinary bladder is a muscular organ, its thickness was expected to be higher in males than in females. A thicker BWT in males was also attributed to the greater resistance of the male bladder outlet compared with that of the females [15]. There was very weak relationship between pre void BWT ($r = 0.042$, $p = 0.002$) and height. There was also very weak relationship between post void BWT ($r = 0.026$, $p = 0.021$) and height. Our finding is however contrary to that of Hadis *et al*. [7] who found moderate relationship ($r = 0.596$, $p<0.001$) among pediatric subjects. There was a very weak but significant relationship between pre void BWT ($r = 0.023$, $p = 0.029$) and weight. This agreed with findings of Bright *et al*. [4] who also observed weak but significant relationship between pre void BWT and weight ($r = 0.216$, $p = 0.014$) in men with presumably normal bladder function.

There was no relationship between pre void BWT ($r= 0.02$, $P= 0.876$) and post-void BWT ($r = -0.234$, $p = 0.07$) and body mass index (BMI). The findings of Hakenberg *et al*. [2] and Jang *et al*. [12] agree with this.

Our study found very weak relationship between BWT and age in pre and post void states, ($r= 0.04$, $p = 0.574$) and ($r= 0.179$, $P= 0.01$) respectively, in adult population. This finding is in agreement with previous studies [2, 12]. However, in children and young adult, Blatt [13] found strong relationship between BWT and age

A negative correlation was found between BWT and bladder volume ($r = -0.302$, $p = 0.000$) indicating that as the pre-void bladder volume increases, bladder wall thickness decreases. Our finding is in agreement with other studies in literature [2, 4, 11, 13, 14]

CONCLUSIONS

The mean pre-void and post-void BWT in this population were 3.15mm± 0.45mm and 5.24mm±0.73mm respectively. This compares closely with the result from a German group study but differs from a Korean population finding. Males have thicker bladder walls than females. Pre void bladder wall thickness were 3.27mm for males and 3.10mm females. Post void bladder wall thickness was 5.39mm and 5.18mm for males and females respectively.

BWT correlates positively with height and negatively with bladder volume. No correlation was noted with age, weight and body mass index.

This can be used as a reference baseline for evaluating changes in bladder wall thickness in relation to different urinary bladder disorders.

Highlights

- Bladder wall thickness can be objectively assessed both at pre-void and post-void states.
- The mean pre void bladder wall thickness (BWT) is 3.15±0.45mm.
- The mean post void bladder wall thickness is 5.24±0.73mm.
- Males have thicker bladder wall of 3.27±1.24mm than females with 3.10±0.64mmBWT.
- BWT correlated positively with height but negatively with urinary bladder volume.
- There was no correlation between BWT and age, weight and body mass index.
- Bladder wall thickness in our population compares significantly with the Caucasian population.

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