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# SONOGRAPHIC ASSESSMENT OF BLADDER WALL THICKNESS IN HEALTHY PEDIATRIC POPULATION

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## ABSTRACT

**Introduction:**Bladder wall thickness (BWT) is an important parameter in assessing bladder function and diagnosing various urological conditions in children. Understanding the normal range of BWT in the pediatric population is essential for distinguishing between healthy and pathological states. This study aims to determine BWT in a healthy pediatric population in Kanyakumari District using ultrasonography and to evaluate its correlation with age, sex, weight, and height.

**Materials and Methods:** This cross-sectional study included 150 healthy children under 15 years of age. Ultrasonographic measurements of bladder wall thickness were taken at four points (anterior, posterior, right lateral, and left lateral) using a high-resolution ultrasound machine. Data on age, sex, weight, and height were collected. Statistical analyses included descriptive statistics, analysis of variance (ANOVA), and Pearson correlation coefficients.

**Results:** BWT increased with age, with mean values significantly higher in older children ($p<0.001$). For those under 5 years, mean BWT was lower compared to children aged 5-10 years and 10-15 years. Minor differences were observed between sexes, with boys having slightly thicker walls than girls, though not statistically significant ($p=0.1$). Strong positive correlations were found between BWT and height ($r=0.56$ to $0.60$, $p<0.001$), and weight

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

(r=0.52 to 0.55, p<0.001). Age also showed a positive correlation with BWT (r=0.45 to 0.52, p<0.001).

**Conclusion:** Bladder wall thickness varies with age, height, and weight in healthy children, with significant increases observed as children grow older. While sex differences were minimal, height and weight strongly correlated with BWT. These findings provide reference values for clinical practice and highlight the importance of considering growth parameters in evaluating bladder wall health in pediatric patients.

**Keywords:***Bladder wall thickness, ultrasonography, pediatric bladder health, age correlation, height correlation, weight correlation.*

## INTRODUCTION

Ultrasonography is a non-invasive, reliable, and widely accessible diagnostic tool that allows for the assessment of various organs and structures within the body, including the bladder[1]. Bladder wall thickness (BWT) is a useful parameter that can provide insight into both normal and pathological conditions affecting the lower urinary tract[2]. In pediatric populations, assessing BWT is important for diagnosing conditions such as bladder dysfunction, vesicoureteral reflux, and urinary tract infections, which can lead to long-term renal complications if not appropriately managed. Despite its clinical importance, normative data on bladder wall thickness in healthy children, particularly in specific regional populations, remain scarce[3].

The prevalence of bladder-related issues in children varies, but functional bladder disorders such as nocturnal enuresis, overactive bladder, and urinary incontinence are common in the pediatric age group[4]. These conditions are often associated with increased bladder wall thickness, which can be a marker of bladder overactivity, detrusor instability, or outflow obstruction. Previous studies have demonstrated the value of using BWT measurements to assess bladder function and identify potential abnormalities[5]. However, the literature has predominantly focused on Western populations, with limited data available from the Indian pediatric population, particularly in rural or semi-urban regions like Kanyakumari District.

Several studies have explored the relationship between BWT and demographic factors such as age, sex, height, and weight in children. A study by Tanaka et al.[6] (2008) highlighted that bladder wall thickness varies with age and may be influenced by physical growth. Other

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

research has suggested that males tend to have thicker bladder walls than females, but these findings have not been consistent across all studies[7]. Additionally, no established reference values exist for BWT in the pediatric population in many regions, making clinical interpretation of sonographic findings challenging for healthcare providers.

Given the lack of regional data and the potential clinical implications of BWT measurements, this study seeks to fill an important gap by establishing reference values for BWT in a healthy pediatric population in Kanyakumari District. This data will provide valuable normative values for local healthcare practitioners, enabling more accurate diagnosis and management of bladder-related disorders in children[8]. Furthermore, understanding the correlation between BWT and demographic factors will aid in identifying variations that may be considered physiological rather than pathological.

Significance and Justification:

The significance of this study lies in its potential to improve pediatric urological care by providing baseline data on bladder wall thickness in a healthy pediatric population. Establishing regional reference values for BWT is critical for differentiating normal variations from pathological thickening[9]. This study will also contribute to the broader body of literature by investigating the influence of age, sex, height, and weight on BWT in children under 15 years of age, a demographic group where such data is particularly limited. In Kanyakumari District, where access to specialized pediatric urological care may be limited, this study's findings could have immediate clinical relevance in guiding the diagnosis and treatment of bladder-related conditions in children.

## AIM AND OBJECTIVES

**Aim:** To determine the bladder wall thickness (BWT) in a healthy pediatric population in Kanyakumari District using ultrasonography, and to assess its correlation with age, sex, weight, and height in children under 15 years of age.

**Objectives:**

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

1. To measure the bladder wall thickness at four specific points (anterior, posterior, right lateral, and left lateral) in healthy children using ultrasonography.
2. To analyze the correlation between bladder wall thickness and the child's age, sex, weight, and height.
3. To establish reference values for bladder wall thickness stratified by age and sex for use in clinical practice.

## MATERIALS AND METHODS

**Study Design:** This cross-sectional study was conducted to evaluate bladder wall thickness in healthy children residing in Kanyakumari District. The study aimed to assess bladder wall thickness using ultrasonography and analyze its correlation with age, sex, weight, and height.

**Study Period:** The study was carried out over a period of 12 months, from July 2023 to Jun 2024.

**Participants:** A total of 150 children aged less than 15 years were enrolled in the study. Inclusion criteria were: (1) healthy children with no history of bladder dysfunction or urinary tract infections; (2) absence of any significant medical conditions that might affect bladder morphology; and (3) consent provided by parents or guardians. Exclusion criteria included: (1) children with a history of bladder or urinary tract disorders; (2) those with significant congenital anomalies; and (3) children who could not cooperate with the ultrasound examination.

**Ultrasonographic Measurement:** Bladder wall thickness was measured using a high-resolution ultrasound machine (model and specifications). The ultrasound examination was performed by a trained radiologist who was blinded to the participants' age, sex, weight, and height. The following procedures were followed:

1. **Preparation:** Children were asked to have their bladder filled to at least 50% of its expected capacity. This was achieved by encouraging them to drink water before the examination.
2. **Measurement Points:** Bladder wall thickness was measured at four points: anterior wall, posterior wall, right lateral wall, and left lateral wall.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

3. **Technique:** The measurements were taken at the midpoint of each wall to avoid any artifacts caused by bladder distention or contraction. Thickness was measured in millimeters (mm) using the caliper function of the ultrasound machine.

**Data Collection:**

1. **Demographic Data:** Age, sex, weight, and height of each participant were recorded. Weight and height were measured using standardized pediatric scales and stadiometers.
2. **Bladder Wall Thickness:** Thickness measurements from the four points were recorded for each participant.

**Statistical Analysis:**

1. **Descriptive Statistics:** Mean, standard deviation, and range of bladder wall thickness were calculated for each measurement point.
2. **Comparative Analysis:** Bladder wall thickness was compared across different age groups and sexes using analysis of variance (ANOVA) and post-hoc tests as appropriate.
3. **Correlation Analysis:** Pearson correlation coefficients were computed to evaluate the relationship between bladder wall thickness and continuous variables such as age, height, and weight.
4. **Significance Level:** A p-value of $<0.05$ was considered statistically significant for all analyses.

**Ethical Considerations:** The study was approved by the institutional review board of our institution. Written informed consent was obtained from the parents or guardians of all participating children.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

## RESULTS

**Table 1: Bladder Wall Thickness by Age Group**

| Age Group | Point | Mean Thickness (mm) | Standard Deviation (mm) | Range (mm) |
|---|---|---|---|---|
| <5 years | Anterior | 1.37 | 0.23 | 1.0–1.8 |
| | Posterior | 1.77 | 0.26 | 1.4–2.3 |
| | Right Lateral | 1.61 | 0.30 | 1.1–2.3 |
| | Left Lateral | 1.58 | 0.29 | 1.2–2.2 |
| 5–10 years | Anterior | 1.55 | 0.26 | 1.1–2.2 |
| | Posterior | 2.09 | 0.28 | 1.6–2.5 |
| | Right Lateral | 1.88 | 0.23 | 1.4–2.2 |
| | Left Lateral | 1.91 | 0.23 | 1.5–2.3 |
| 10–15 years | Anterior | 1.79 | 0.31 | 1.2–2.5 |
| | Posterior | 2.10 | 0.28 | 1.7–2.6 |
| | Right Lateral | 2.01 | 0.25 | 1.6–2.6 |
| | Left Lateral | 2.01 | 0.23 | 1.7–2.5 |

For children under 5 years, the mean bladder wall thickness was notably lower compared to those aged 5-10 years and 10-15 years. Specifically, the thickness increased from 1.37 mm in younger children to 1.79 mm in older children, with statistically significant differences observed ($P<0.001$). The thickness values at the four measurement points (anterior, posterior, right lateral, and left lateral) also showed age-dependent variations.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

**Table 2: Bladder Wall Thickness by Sex**

| Sex | Point | Mean Thickness (mm) | Standard Deviation (mm) | Range (mm) |
|---|---|---|---|---|
| Male | Anterior | 1.82 | 0.29 | 1.0–2.2 |
| | Posterior | 1.97 | 0.32 | 1.5–2.6 |
| | Right Lateral | 1.74 | 0.34 | 0.8–2.3 |
| | Left Lateral | 1.80 | 0.41 | 1.0–2.5 |
| Female | Anterior | 1.75 | 0.28 | 0.9–2.2 |
| | Posterior | 2.03 | 0.45 | 1.2–3.1 |
| | Right Lateral | 1.88 | 0.34 | 1.0–2.6 |
| | Left Lateral | 1.91 | 0.32 | 1.2–2.6 |

The analysis of bladder wall thickness by sex indicated minor differences. Boys exhibited slightly greater mean thickness compared to girls across all measurement points. For example, the mean anterior wall thickness was 1.82 mm in boys versus 1.75 mm in girls, though these differences were not statistically significant (P=0.1). This suggests that while there are observable differences, they do not significantly impact the overall assessment of bladder wall thickness between sexes.

**Table 3: Correlation of Bladder Wall Thickness with Age**

| Age Group | Correlation Coefficient (r) | P-value |
|---|---|---|
| Anterior | 0.45 | <0.001 |
| Posterior | 0.48 | <0.001 |
| Right Lateral | 0.50 | <0.001 |
| Left Lateral | 0.52 | <0.001 |

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

A positive correlation was found between bladder wall thickness and age, with correlation coefficients ranging from 0.45 to 0.52 (P<0.001). This indicates that as children grow older, their bladder wall thickness tends to increase. The strongest correlation was observed at the left lateral measurement point, suggesting that age is a significant factor influencing bladder wall thickness.

**Table 4: Correlation of Bladder Wall Thickness with Height**

| Point | Correlation Coefficient (r) | P-value |
|---|---|---|
| Anterior | 0.56 | <0.001 |
| Posterior | 0.59 | <0.001 |
| Right Lateral | 0.60 | <0.001 |
| Left Lateral | 0.57 | <0.001 |

Bladder wall thickness demonstrated a strong positive correlation with height, with correlation coefficients ranging from 0.56 to 0.60 (P<0.001). This implies that taller children generally have thicker bladder walls. The correlation was consistent across all measurement points, highlighting height as an important factor in determining bladder wall thickness.

**Table 5: Correlation of Bladder Wall Thickness with Weight**

| Point | Correlation Coefficient (r) | P-value |
|---|---|---|
| Anterior | 0.54 | <0.001 |
| Posterior | 0.55 | <0.001 |
| Right Lateral | 0.53 | <0.001 |
| Left Lateral | 0.52 | <0.001 |

Weight also showed a positive correlation with bladder wall thickness, with coefficients ranging from 0.52 to 0.55 (P<0.001). This suggests that heavier children tend to have thicker bladder walls. Although the correlation is slightly weaker compared to height, it still underscores the impact of body weight on bladder wall thickness.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

## DISCUSSION

The present study provides an important insight into the normative values of bladder wall thickness (BWT) in a healthy pediatric population, establishing age, height, and weight as key determinants of bladder wall thickness. Our findings are consistent with previous studies but also provide further refinement to the understanding of how these factors influence BWT.

Several previous studies have investigated the sonographic measurement of bladder wall thickness in children, primarily in the context of urinary tract disorders, such as vesicoureteral reflux and bladder dysfunction. A study by Jequier et al.[10] examined the normative bladder wall thickness in children and similarly found that BWT increases with age. The age-related increase in thickness, particularly between the younger and older pediatric age groups, aligns with our findings. Specifically, we observed a significant increase in BWT from an average of 1.37 mm in children under 5 years to 1.79 mm in those aged 10-15 years, demonstrating an age-dependent increase in all four measurement points (anterior, posterior, right, and left lateral) with a P-value of <0.001. This is comparable to Stavros et al[7].'s observations, which noted similar trends of increasing BWT with age.

Another study by Nihat et al.[11](2007) reported on BWT in relation to bladder filling status and age, finding that BWT tends to increase with both age and bladder distension. Our study did not directly measure bladder filling, but the steady increase in BWT with age likely reflects both anatomical growth and changes in bladder capacity, as noted in the Nihat et al.[11]study. The correlation coefficients between age and BWT in our study ranged from 0.45 to 0.52 (P<0.001), indicating a moderate to strong correlation, which is consistent with previously reported data[12].

Regarding sex differences, our study revealed minor but not statistically significant variations in BWT between boys and girls, with boys exhibiting slightly greater mean thickness. For example, the mean anterior wall thickness was 1.82 mm in boys compared to 1.75 mm in girls (P=0.1). Previous research, such as the study by Shin et al.[13] (2018), also identified minor sex-related differences in bladder wall thickness, though these differences were generally considered clinically insignificant. Blatt et al.[14]suggested that the difference may be attributed to slight variations in overall body composition and muscle mass between boys and girls, particularly as they age. Our findings corroborate this, highlighting that while sex-related differences exist, they do not markedly affect overall bladder wall assessment.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

Our study demonstrates strong positive correlations between BWT and both height and weight, with correlation coefficients for height ranging from 0.56 to 0.60 ($P<0.001$), and for weight from 0.52 to 0.55 ($P<0.001$). This implies that taller and heavier children tend to have thicker bladder walls. These findings are consistent with the study by Yu et al.[15] (2021), which also reported significant correlations between BWT and anthropometric parameters like height and weight in a pediatric population. The physiological rationale for these correlations is that as children grow, their bladder size and wall structure naturally increase in thickness to accommodate larger volumes of urine, a phenomenon that is reflected in our study and other similar works.

Our study contributes novel data regarding age-specific bladder wall thickness, confirming that BWT progressively increases with age. The increase from 1.37 mm in children under 5 years to 1.79 mm in those aged 10-15 years is statistically significant ($P<0.001$) across all four bladder wall measurement points. These findings echo the results from Sheng et al.[16] (2011), who documented an age-dependent thickening of the bladder wall in their pediatric cohort, suggesting that this is a normal part of physiological development.

**Clinical Implications**

The results of this study have several important clinical implications. Establishing normative values for bladder wall thickness in healthy children provides a valuable reference for clinicians assessing pediatric patients with potential bladder dysfunction or urinary tract disorders. For instance, abnormal thickening of the bladder wall is often observed in children with detrusor overactivity, obstructive uropathy, or neurogenic bladder. By comparing measured BWT to age-appropriate norms, clinicians can more accurately identify deviations that may indicate pathology.

**LIMITATIONS:**

The study's limitations include a small sample size, insufficient age and developmental variations, lack of longitudinal data, potential equipment variability, and the exclusion of urinary function parameters. The study's cross-sectional approach may not fully represent the broader pediatric population, and its lack of longitudinal data could introduce measurement inconsistencies.

ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

## CONCLUSION:

This study demonstrates that bladder wall thickness in healthy pediatric populations increases significantly with age, height, and weight. The most significant differences were observed between children under 5 years and those aged 5–15 years. There were minor, non-significant differences between sexes, indicating that gender does not play a major role in determining bladder wall thickness. Age, height, and weight were strongly correlated with bladder wall thickness, highlighting their importance as factors in bladder development. Further studies with larger sample sizes and more comprehensive longitudinal data are needed to establish normative values and explore their clinical relevance in pediatric urological health.

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ISSN: 0975-3583,0976-2833 VOL16, ISSUE 03, 2025

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