Research Article

Stretched Penile Length and Penile Circumference in Pediatric Population of Pakistan: A Cross-Sectional Single-Center Study

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Abstract: Background: Evaluation of pediatric male external genitalia in Pakistan often relies on reference standards of foreign populations due to lack of standard local reference data, which may not accurately represent the local population. This study aims to establish the first standard nomogram of male external genitalia of pre-pubertal males in Pakistan.

Materials and Methods: A single-center cross-sectional study was conducted from 1st April 2025 to 1st December 2025 at pediatric surgery department, Mayo hospital Lahore affiliated with King Edward Medical University, Lahore. The study included 403 healthy boys aged 0–13 years to establish age-specific normative values for stretched penile length, penile circumference, glans diameter, and testicular volume in a Pakistani pediatric population. Standardized clinical measurement techniques were applied, and data were analyzed descriptively with results expressed as mean and standard deviation across predefined age groups.

Result: Stretched penile length increased from 2.85 ± 0.51 cm in infants aged 0–1 year to 7.28 ± 0.63 cm in those aged 11–13 years, while testicular volume increased from 1.78 ± 0.63 cm^3 to 7.47 ± 1.86 cm^3 across the same age range. Penile circumference and glans diameter demonstrated consistent age-related increases, with greater variability observed in older children.

Conclusion: The proposed age-specific nomogram provides locally relevant reference standards that may support more accurate clinical assessment of Pakistani pediatric male external genital development and reduce dependence on foreign datasets.

Keywords: Pediatric anthropometry, Stretched penile length, Testicular volume, Glans width, Normative reference values, Hypogonadism, Micropenis.

INTRODUCTION

Examination of the male external genitalia is a routine practice in assessment of pediatric patients in pediatric surgery, urology, and endocrine clinics to diagnose underlying endocrine disorders especially in neonates [1, 2]. This examination includes the evaluation of some standard measurements, such as stretched penile length, penile circumference, and testicular volume. Therefore, appropriate evaluation requires the standard reference data which can be used to diagnose the abnormalities which may indicate the disorders or differences of sexual development [3-5]. These abnormalities include micropenis, hypogonadism, buried penis, endocrine disorders, etc. If standard reference data is not used, the evaluation can lead to misinterpretation, misdiagnosis and unnecessary workup [6].

For this purpose, many authors across the world have generated the standard nomograms for their local pediatric male population to aid in the evaluation of their male external genitalia [7-11]. These regional studies established that their datasets varied across different racial and ethnical groups [12, 13]. Meanwhile, because of the sparsity of the standard reference data, Pediatricians in Pakistan, must rely on the foreign standards that may not accurately represent the Pakistani population and eventually lead to misdiagnosis [7, 14]. Pakistan lacks the sufficient reference data for this purpose, while on the other hand, in neighboring India, which shares close ethnic proximity, many studies have been conducted only for this sole purpose, some of which represent the state-wise population highlighting the importance of locally derived nomograms [8, 15-19].

Recently, Tahir R, *et al.* published a nomogram for stretched penile length in neonates according to their gestational age in Pakistan in 2025 [14]. After a thorough literature search, no such study can be found to be con-

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ducted in Pakistan previously. Therefore, it is essential to establish the nomogram for external male genitalia in Pakistani pediatric population. For this purpose, the aim of this study was to establish the first dataset of the normal reference values of the stretched penile length (SPL), Penile circumference (PC), Glans Diameter (GD), and Testicular Volume (TV) in the Pakistani prepubertal male population. This dataset will not only help in the diagnosis of underlying endocrine disorders accurately but will also assist the pediatric surgeons in planning and management to correct the congenital genital abnormalities e.g. hypospadias, buried penis, etc.

MATERIALS AND METHODS

A single-center cross-sectional study was conducted from 1st April 2025 to 1st December 2025 at pediatric surgery department, Mayo hospital Lahore affiliated with King Edward Medical University, Lahore. A total sample of 403 participants was required based on a confidence interval of 95 percent, a standard deviation of 0.55 and a margin of error of 0.05 using the standard formula $n = (Z\sigma/E)^2$ where Z was taken as 1.96 [8].

Prior to recruitment, study was ethically approved by the ethics committee of our institution (IRB No: 183/RC/KEMU, dated: 25/02/2025). Consent from the parents or legal guardians and assent from the children aged 7 and above were obtained for participation in the study.

All recruited participants were apparently healthy prepubertal boys with age from birth till 13 years who presented in outpatient department for minor ailments such as ankyloglossia, dermoid cyst, ritual circumcision etc. All boys who had any endocrine, nutritional, genital or chronic disorders such as hypospadias, cryptorchidism, etc. were excluded from participation. For the age group 11 to 13, no stratification was done for Tanner stage 1 and 2. Tanner stage 3 and above with visible and more pronounced secondary sexual characteristics were also excluded.

Stretched penile length (SPL) was measured along the dorsal surface of the penis from the pubic symphysis to the tip of the glans while compressing the suprapubic fat using a rigid ruler as previously described [4, 7, 20]. The penis was gently stretched to the point of comfortable resistance, and the foreskin was not included. Vernier caliper was also used to measure the glans diameter (GD) at the widest transverse level of Glans. Penile circumference (PC) was measured at the mid-shaft of the penis using a flexible measuring tape [6, 21]. Testicular volume (TV) of both testes was measured using the Prader's orchidometer and a mean value was recorded. Anthropometric measurements including height and weight were also recorded. All measurements were taken in a clinical environment at normal or warm room temperatures, ensuring the privacy of the participants. To reduce inter-observer bias, all measurements were obtained by trained clinicians using uniform techniques. Each parameter was recorded carefully on a structured data collection form. Where necessary, measurements were repeated to ensure consistency.

Participants were categorized into predefined age groups for analysis. Boys till 1 year of age were in first group; 0-1 years. Boys aged above 1 year till 3 years were in second group; 1-3 years and so on in further groups (3-5years, 5-7years, 7-9years, 9-11years and 11-13years).

STATISTICAL ANALYSIS

Data was summarized using SPSS 26.0 descriptive statistics, and results were expressed as mean values with corresponding standard deviations for each age group. To statistically evaluate the trend of linear growth, categorical age groups were converted to a continuous numeric variable by assigning the midpoint value to each respective age range (e.g., 0.5 years for the 0–1 year cohort). The third percentile (P3) and -2 standard deviation (-2SD) were used as lower limits of normal labelled as micropenis. Pearson correlation analysis was then utilized to assess the relationship between advancing age and anatomical measurements, with a p-value of < 0.05 considered statistically significant.

RESULT

In total of 403 participants, 260 (64.5%) belonged to urban areas and 143 (35.5%) participants were rural. Ethnically, majority of the participants were Punjabi at 74.2% (n=299) and Pashtuns being the second most common at 15.6% (n=63), followed by Saraiki (n=21), Sindhi (n=8), Kashmiri (n=6), and Baloch (n=6) (Fig. **1**). There was a variation also noted in the distribution of participants in each predetermined age group; 0-1y n=74, 1-3y n=45, 3-5y n=36, 5-7y n=64, 7-9y n=60, 9-11y n=56, and 11-13y n=68. With Infants group having the largest population (18.4%) and 3 to 5 years old group having the lowest number of participants (8.9%).

Mean height in centimeters and mean weight in kilograms with standard deviation for each age group was also measured and shown in Table **1**.

Table 1. Mean Height (cm) and Mean Weight (kg) for each Age Group with Standard Deviation (SD).

Age Group	Number of Participants	Mean Height (cm) ± SD	Mean Weight (kg) ± SD
0-1y	n=74	56.51 ± 13.65	6.15 ± 2.50
1-3y	n=45	74.50 ± 9.64	10.49 ± 2.44
3-5y	n=36	95.78 ± 7.10	15.03 ± 2.52
5-7y	n=64	101.25 ± 12.97	16.60 ± 3.49
7-9y	n=60	118.88 ± 10.11	20.07 ± 4.17
9-11y	n=56	129.16 ± 6.73	26.23 ± 3.07
11-13y	n=68	136.50 ± 5.74	28.90 ± 4.55

Across the seven age cohorts, ranging from infancy (0–1 year) to early adolescence (11–13 years), there is a progressive linear growth pattern observed in Stretched Penile Length (SPL), Glans Diameter (GD), Testicular Volume (TV), and Penile Circumference (PC) (Table **2**).

Table 2. Normative Pediatric Anthropometric Measurements with Mean, SD, 3rd Percentile (P3) Cutoff.

Stretched Penile Length (cm)									
Age Group	**n**	**Mean**	**SD**	**95% CI Lower**	**95% CI Upper**	**Min**	**Max**	**−2 SD Cutoff**	**P3 Cutoff**
0-1y	74	2.85	0.51	2.73	2.96	1.5	3.8	1.83	2
1-3y	45	3.78	0.71	3.57	3.99	2.5	5	2.37	2.53
3-5y	36	4.12	0.57	3.93	4.31	3.5	5.5	2.98	3.5
5-7y	64	5.32	0.91	5.1	5.54	4	7	3.49	4
7-9y	60	5.48	0.41	5.38	5.59	4.5	6.1	4.66	4.6
9-11y	56	6.52	0.92	6.28	6.76	4.9	8.2	4.67	4.9
11-13y	68	7.28	0.63	7.13	7.43	6.2	8.4	6.01	6.2
Glans Diameter (cm)									
0-1y	74	1.14	0.26	1.08	1.2	0.14	1.51	0.62	0.8
1-3y	45	1.22	0.21	1.16	1.28	0.79	1.8	0.8	0.86
3-5y	36	1.33	0.2	1.27	1.4	1.1	1.7	0.94	1.1
5-7y	64	1.4	0.12	1.37	1.43	1.1	1.6	1.16	1.2
7-9y	60	1.42	0.08	1.4	1.44	1.2	1.5	1.26	1.28
9-11y	56	1.56	0.19	1.51	1.61	1.3	1.9	1.18	1.3
11-13y	67	1.61	0.2	1.57	1.66	1.2	1.9	1.22	1.2
Testicular Volume (cm^3)									
0-1y	74	1.78	0.63	1.64	1.93	1	3	0.53	1
1-3y	45	2.64	0.83	2.4	2.89	1	4	0.98	1.32
3-5y	36	2.67	0.68	2.45	2.89	2	4	1.31	2
5-7y	64	3.61	0.85	3.4	3.82	2	5	1.91	2
7-9y	60	3.73	1.07	3.46	4	2	6	1.59	2
9-11y	56	4.5	0.91	4.26	4.74	3	6	2.67	3
11-13y	68	7.47	1.86	7.03	7.91	4	10	3.74	4
Penile Circumference (cm)									
0-1y	74	1.55	0.49	1.44	1.66	0.77	2.3	0.57	0.85
1-3y	45	2.54	0.48	2.4	2.68	1.5	3.4	1.57	1.66
3-5y	36	2.83	0.49	2.67	2.99	2.2	3.5	1.85	2.2

Continue

Continue

5-7y	64	3.6	0.47	3.49	3.72	3	4.5	2.66	3
7-9y	60	4.15	0.31	4.07	4.22	3.5	5	3.53	3.5
9-11y	56	4.3	0.61	4.14	4.46	2.6	5	3.09	3.06
11-13y	68	5.03	0.98	4.79	5.26	2.2	6.5	3.08	3.5

Detailed percentile values for all four parameters according to age are given in Table **3**, with lower and upper limit as 3rd and 97th percentile respectively.

Table 3. Age-Specific Percentile Values for All Four Parameters.

Stretched Penile Length (cm)									
Age Group	**P3**	**P5**	**P10**	**P25**	**P50**	**P75**	**P90**	**P95**	**P97**
0-1y	2	2	2.03	2.7	3	3.2	3.37	3.5	3.7
1-3y	2.53	2.6	2.8	3.3	3.8	4.4	4.6	4.6	4.87
3-5y	3.5	3.5	3.5	4	4	4.1	5	5.5	5.5
5-7y	4	4	4.3	4.8	5	6	7	7	7
7-9y	4.6	4.79	5	5.2	5.5	5.8	5.9	6.1	6.1
9-11y	4.9	4.9	5.3	6	6.55	7.4	7.5	8.2	8.2
11-13y	6.2	6.3	6.5	6.8	7.4	7.5	8.3	8.36	8.4
Glans Diameter (cm)									
0-1y	0.8	0.85	0.89	0.97	1.2	1.3	1.45	1.5	1.5
1-3y	0.86	1	1	1.1	1.2	1.3	1.4	1.7	1.77
3-5y	1.1	1.1	1.1	1.1	1.4	1.4	1.6	1.7	1.7
5-7y	1.2	1.2	1.23	1.3	1.4	1.5	1.5	1.6	1.6
7-9y	1.28	1.3	1.3	1.4	1.4	1.5	1.5	1.5	1.5
9-11y	1.3	1.3	1.32	1.4	1.6	1.7	1.8	1.9	1.9
11-13y	1.2	1.26	1.4	1.4	1.7	1.8	1.8	1.87	1.9
Testicular Volume (cm^3)									
0-1y	1	1	1	1	2	2	2.7	3	3
1-3y	1.32	2	2	2	3	3	4	4	4
3-5y	2	2	2	2	3	3	3.5	4	4
5-7y	2	2	3	3	4	4	5	5	5
7-9y	2	2	3	3	3	5	5	6	6
9-11y	3	3	3	4	4.5	5	6	6	6
11-13y	4	4.35	5	6	7	9	10	10	10
Penile Circumference (cm)									
0-1y	0.85	0.86	0.89	1.11	1.5	2	2.1	2.2	2.2
1-3y	1.66	1.8	1.94	2.1	2.6	2.9	3.1	3.18	3.27
3-5y	2.2	2.2	2.3	2.4	2.8	3.4	3.5	3.5	3.5
5-7y	3	3	3	3.3	3.5	4	4.2	4.5	4.5
7-9y	3.5	3.5	3.87	4	4.2	4.3	4.5	4.6	4.6
9-11y	3.06	3.5	3.6	3.95	4.35	5	5	5	5
11-13y	3.5	3.5	4	4.2	5	5.5	6.5	6.5	6.5

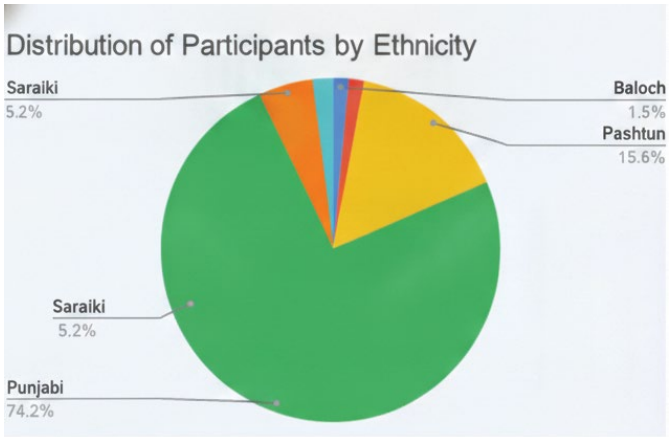

Fig. (1). Ethnic Distribution of the Participants.

Fig. (2). Mean Stretched Penile Length in cm by Age Group with Standard Deviation.

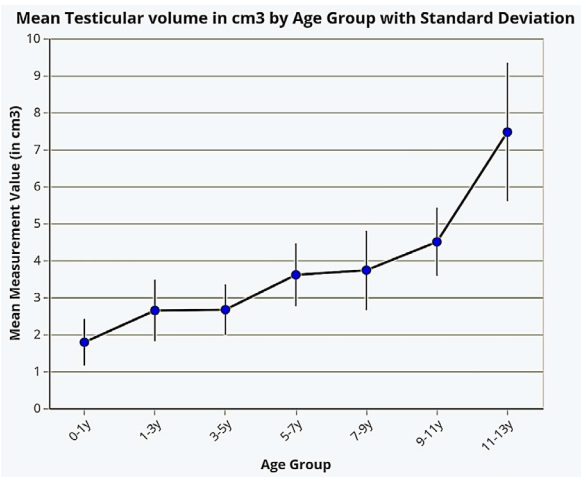

Fig. (3). Mean Testicular Volume in cm^3 by Age Group with Standard Deviation

Regarding SPL, the data established a baseline mean SPL of 2.85 cm (SD ±0.51) in the 0–1 year age group and demonstrated a steady increasing trend in the subsequent toddler and preschool years, rising to 3.78 cm (SD ±0.71) in the 1–3 year group and 4.12 cm (SD ±0.57) by 3–5 years. A notable progression was noticed as the cohorts advanced into school age; the mean SPL exceeds 5 cm in the 5–7 years group (5.32 cm, SD ±0.91) and continued an upward trajectory, ultimately reaching a mean of 7.28 cm (SD ±0.63) in the oldest cohort of 11–13 years (Fig. **2**). The standard deviations across these groups indicate a moderate degree of biological variability within each age bracket, yet the overall trend remains distinct and upward.

Penile Circumference increased more than threefold from infancy to the oldest age group. Starting at a mean of 1.65 cm (SD ±0.49) in infants, it increased in the 1–3 years group to 2.54 cm (SD ±0.48) and continues to widen steadily, recording 3.60 cm (SD ±0.47) at 5–7 years and closing at 5.03 cm (SD ±0.98) in the 11–13 years group. Similarly, Glans Diameter shows a gradual but consistent increase, starting at 0.64 cm (SD ±0.26) and slowly expanding to 1.61 cm (SD ±0.20) in the final age bracket.

Testicular Volume (TV) exhibits a particularly interesting growing trend as shown in the graph (Fig. **3**). In the earlier years, the increase is relatively gradual, moving from 1.78 cm^3 (SD ±0.63) in infants to 3.61 cm^3 (SD ±0.85) by age 5–7. However, the data highlights a marked acceleration in testicular growth in the final age cohort. While the 9–11 years group records a mean volume of 4.50 cm^3 (SD ±0.91), the 11–13 years group shows a substantial leap to a mean of 7.47 cm^3 (SD ±1.86). This sharp increase in the mean value and the wider standard deviation in the oldest group likely reflects the onset of physiological changes associated with early pubertal development in this demographic.

Descriptive analysis of penile and testicular measurements stratified by age groups revealed a consistent correlation with increasing pediatric age. A Pearson correlation analysis was performed, demonstrating a highly significant, strong positive linear relationship between advancing age and Stretched Penile Length ($r = 0.905$, $p < 0.001$). Table **4** shows the computed results of correlation. This confirms a progressive and proportional linear growth pattern of external male genitalia from infancy through early adolescence.

Table 4. Pearson Correlation Coefficients with 95% Confidence Intervals.

Correlation of Each Parameter with Age					
Parameter	**n**	**Pearson r**	**95% CI Lower**	**95% CI Upper**	**p-value**
Stretched Penile Length (cm)	403	0.905	0.885	0.921	<0.001
Glans Diameter (cm)	403	0.66	0.601	0.712	<0.001
Testicular Volume (cm^3)	403	0.79	0.75	0.824	<0.001
Penile Circumference (cm)	403	0.88	0.856	0.9	<0.001

DISCUSSION

This cross-sectional study provides the first age-specific normative reference values for stretched penile length, penile circumference, glans diameter, and testicular volume in pediatric population, aged from birth to 13 years of Pakistan. The findings address an important clinical gap, as local reference data for male external genital anthropometry in Pakistan have been very limited [14]. These locally derived age-wise mean values and variability can be used as a standard tool for clinical assessment in routine pediatrics practice [4, 5].

As revealed in the results, a progressive increase in all measured parameters was observed across advancing age groups. Stretched penile length and penile circumference demonstrated gradual progression from infancy through late childhood supporting the similar finding in other studies [15, 22]. On the other hand, testicular volume showed a gradual increase in early age groups and more marked rise in older age groups. This pattern aligns with previously reported pediatric growth trends and reflects the influence of advancing age on testicular development [22, 23]. These findings depict the coordinated growth of external genital structures during childhood and early adolescence, also supporting the similar studies conducted in other regions [15, 16, 18, 22, 24, 25]. The age-stratified presentation of values would help in direct application in clinical settings when evaluating children with suspected growth abnormalities.

Penis is a cylindrical shaped organ and, therefore, SPL only would not be enough for its anthropometry. That's why measurement of penile circumference should also be included when describing penile growth, hence, included in this study as well. This study showed that penile circumference increased in parallel with stretched penile length across all age groups. The coordinated increase of both parameters supports the concept that penile growth occurs in a proportional manner [26-28]. Inclusion of penile circumference alongside length measurement may therefore improve clinical assessment [6].

The growth patterns illustrated in Fig. (**2**) and (**3**) further demonstrate these findings by visually depicting age-related trends in stretched penile length and testicular volume. The figures demonstrate gradual growth during early childhood, followed by a more pronounced increase in later age groups. Such growth pattern supports recognition of developmental phases where growth acceleration becomes more evident, which is particularly relevant during preadolescence [18, 23, 29].

Comparison with published reference values from other populations highlights interpopulation variation in penile measurements. Differences in absolute values have been attributed to ethnicity age distribution and measurement techniques [7, 8, 19, 20]. These findings support the importance of using population-specific reference standards to avoid inappropriate or inaccurate diagnosis

LIMITATIONS

This study has certain limitations that should be considered when interpreting the findings. The cross-sectional design provides age-specific reference values but does not allow assessment of individual longitudinal growth patterns. From the ages above 10, the values are not stratified based on tanner staging, though stage 3 and above were excluded. When compared to other similar studies, this study also has a relatively smaller sample size. Additionally, the study was conducted at a single tertiary care center and lacks the equal ethnic distribution of Pakistani population, which may limit generalizability to all regions of the country despite inclusion of children from diverse ethnic backgrounds.

Participants were recruited using convenience sampling, which may introduce selection bias. Furthermore, pubertal staging was not formally assessed, and age was used as the primary stratification variable, which may not fully capture individual variations in pubertal onset and progression. Despite these limitations, the study offers valuable baseline normative data derived from a relatively large pediatric sample.

CONCLUSION

This study established first age-specific normative reference values for penile and testicular anthropometry in pediatric population of Pakistan. The findings demonstrated progressive growth of external genital parameters across childhood, with greater increases and variability observed in later age groups. Further multicenter studies across Pakistan should be conducted to generate a stronger dataset.

LIST OF ABBREVIATIONS

GD: Glans Diameter.

PC: Penile Circumference.

SPL: Stretched Penile Length.

TV: Testicular Volume.

P3: 3rd Percentile.

-2SD: -2 Standard Deviation.

AUTHORS' CONTRIBUTION

Babar Shahzad: Conceptualization, Study Design, Methodology, Data analysis and interpretation, Writing draft, Critical review and revision the manuscript and Final approval, final proof to be published.

Batool Fatima: Study Design, Writing draft, Critical review and revision the manuscript and Final approval, final proof to be published.

Muhammad Kashif Bashir: Study Design, Critical review and revision the manuscript and Final approval, final proof to be published.

Muhammad Rehman Waheed and **Zuha Zafar**: Methodology, Data analysis and interpretation and Writing draft.

Syed Salman Hussain Zaidi: Conceptualization and Methodology, Data analysis and interpretation.

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ETHICAL DECLARATIONS

Data Availability

Collected data are available and shall be provided on demand.

Ethical Approval

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Ethics Committee of University King Edward Medical University (IRB no: 183/RC/KEMU, Dated: 25/02/2025)

Consent to Participate

Informed written consent taken from the participants of the study.

Consent for Publication

All authors give consent for the publication of this work.

Conflict of Interest

Declared none.

Competing Interest/Funding

Declared none.

Use of AI-Assisted Technologies

Claude AI was used in this manuscript for the purpose of improving and correcting English grammar.

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