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A Cross-Sectional Growth Reference and Chart of Stretched Penile Length for Egyptian Prepubertal Boys Aged 5-9 Years: A Single Center Study

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ABSTRACT

Introduction: Penile length is very important for evaluation of the normal external genitalia and detection of genital anomalies such as macro- and micro-penis. Establishing a normal population, age specific reference range for penile length helps in both accurate evaluation of penile size and early detection of any penile abnormalities

Objective: To assess normal values of stretched penile length of the prepubertal normal Egyptian boys aged 5 to 9 years and to establish a penile growth chart & percentiles concerning penile length for those boys.

Patients and Methods: A cross sectional study is conducted in Egypt included 1500 boys aged 5 to 9 years in Cairo University Children's Hospital, Faculty of Medicine. Boys are divided into 5 groups each group 300 boys. All boys were subjected to measurement of stretched penile length, height, weight, and BMI.

Results: The mean penile length ± SD by age grouping were at 5 years = 5.31 ± 0.92 cm, at 6 years = 5.51 ±1 cm, at 7 years = 5.87 ± 0.85 S cm, at 8 years = 6.19 ± 0.93 cm and at 9 years = 6.1 ± 0.92 cm.

Conclusion: In order to aid in the diagnosis of genital abnormalities, this study introduced new reference values, percentiles and chart for stretched penile length in prepubertal normal Egyptian boys aged 5 to 9 years.

Key words: Stretched penile length, Percentiles, Chart, Prepubertal Egyptian boys.

INTRODUCTION

Stretched penile length (SPL)gradually increases during growing up. In order to assess the gonadal axis in children, it is crucial to measure the stretched penile length. Early detection of abnormal penile size is significant from a medical and psychological aspects [(1)].

Mechanical anomalies are frequently suspected in a child with isolated unilateral undescended testis, simple hypospadias diagnosis indicates that the remainder of the external genitalia are intact. In contrast, patients with disorders of sex development also exhibit micropenis and other genital malformations. Identification of the child with micropenis by the urologist will enable prompt referral to the endocrinologist, leading to early investigations and medical treatment before trying surgical repair of the child's undescended testis or hypospadias [(2)].

There are different methods to measure penile size. Ruler or calipers could be used to measure SPL, the pubic fat is depressed and a disposable spatula or ruler is fixed alongside the penis to its attachment to the symphysis pubis then the penis is fully stretched and the distance between the symphysis pubis and the tip of the glans penis is measured [(3)].

Establishing an age-appropriate reference range for the normal population is the first step in properly assessing penises with abnormal sizes. This reference explains how the population's healthiest children are developing at that period [(4)]. As a result of racial, geographic, genetic, and nutritional factors, there may be variations in penile anthropometry among different populations [(5)].

Historical normal penile length standards were derived from three well-known studies [(6, 7, 8)]. Children's penile lengths of various ethnicities were compared to commonly accepted norms of penile sizes and found to be significantly different [(9)].

This could potentially lead to the overdiagnosis of the abnormalities in healthy children, therefore, because of these significant differences between different ethnic groups, it is mandatory to establish norms for penile lengths in healthy children for each country. Therefore, this study aimed to assess SPL values for prepubertal Egyptian boys from the age of 5 to 9 years and establishment of a novel penile growth curves and percentiles for SPL at this age group. Our study is a complementary study to another Egyptian study was held at the same time also in Cairo University Hospital, included boys from the age of 1 month to 5 years and was published in 2021 [(2)].

PATIENTS AND METHODS

This descriptive cross-sectional study was held at Cairo University Children's Hospital, Faculty of

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Medicine, Egypt. Data are collected from children attending to the hospital outpatient clinics seeking medical care for acute conditions not influencing external genitalia. We randomly selected boys attending the Pediatric Out-patient Clinic during the period from October 2016 to September 2018, the study included the age groups from five to nine years.

Reviewing other studies that had been published on the same subject helped us to determine the sample size. Sample size were stratified by age groups, each group were of one year interval; five age groups were recruited (5-6 years, 6-7 years, 7-8 years, 8-9 years and 9-10 years). A sample of 300 children from each group were collected. Accordingly, a total sample size of 1500 children were included.

Inclusion criteria: Prepubertal boys born to Egyptian parents between the ages of 5 and 9 years.

Exclusion criteria: Children with abnormal growth (short stature under-or over-weight), suffering from any chronic illness, skeletal, chromosomal, endocrinal or genital abnormalities (bifid scrotum, hypo-or epispadias, under-virilization, phimosis, cryptorchidism), uncircumcised boys or boys having any family history of sexual differentiation disorders.

To produce a homogenous group, we removed uncircumcised children from our study, because at least 94.7% of Egyptian male children are circumcised, and 93.7% of Egyptian doctors prefer to conduct circumcision at the age of 3 months [10].

All measurements (anthropometry and SPL) were done by single well-trained pediatric physician. Age of all boys was calculated in decimals. A thorough physical examination including weight and height. Seca electronic scales with pre-measurement calibration were used to measure weight (nearest 100 grams). Harpenden Stadiometer (wall mounted) was used to measure height. BMI=weight (kg)/height (m^2), is the formula used to calculate the body mass index (BMI).

SPL was measured in the attendance of the parents while the child was lying supine in a warm, comfortable environment at room temperature on a flat surface [10, 11]. The observer held the glans between the left thumb and index finger and gradually stretched the penis to the point of increased resistance. The pubic fat was depressed and SPL is measured by a disposable spatula fixed alongside the penis to its attachment to the symphysis pubis. Then the spatula is marked at the level of the glans penis' tip and the measurement is taken in centimeters using a measuring tape. The mean of the three readings for each SPL was obtained after each measurement was made three times by the same observer.

Ethical Approval:

This study was reviewed and approved by The Ethical Committee Institutional Review Board of Kasr Alainy Faculty of Medicine, Cairo University prior to patients' enrollment. Patients were treated according to the principles of the Declaration of Helsinki. An informed written consent form was obtained from the parents following proper orientation. Throughout and after the study, participant privacy and anonymity were maintained.

Statistical Analysis

Analysis of data was performed using SPSS 21 for Windows. Description of numerical variables was in the form of mean, standard deviation (SD), median, 25th and 75th percentiles. Description of categorical variables was in the form of numbers (No.) and percent (%). Binary correlation was carried out by Pearson correlation test. Results were expressed in the form of correlation coefficient (R) and P-values. Numerical data was not normally distributed. Accordingly, nonparametric tests were used for comparison.

This was carried out by Mann–Whitney U test when comparing between two groups of independent variables and Kruskal Wallis test when comparing between more than 2 groups of independent variables. A comparison of SPL (mean ± SD) was done between data from the current study and other studies; one recent study held in Egypt [12] and other studies done in different parts of the world (Korea [13], India [14], China [15], and Bulgaria [16]). Results were expressed in the form of P-values. A p-value ≤ 0.05 was regarded as significant. Data were converted into percentile curves.

RESULTS

We enrolled 1500 healthy prepubertal Egyptian children. The mean age of a total of 1500 patients was 7.42 ± 1.46 years. Mean height, weight, and BMI were 123.3 ± 11.16 cm, 26.49 ± 7.33 kg and 17.09 ± 2.27 kg/m^2, respectively.

Mean SPL was 5.79 ± 0.98 (Table 1). The mean penile length by age grouping were at five years = 5.31 ± 0.92 cm, at six years = 5.51 ± 1 cm, at seven years = 5.87 ± 0.85 cm, at eight years = 6.19 ± 0.93 cm and at nine years = 6.1 ± 0.92 cm (Table 4). Figure (1) and table (2) demonstrated SPL percentiles and chart for children aged from 5 to 9 years, which showed SPL gradual increase in relation to age.

Table (1): Descriptive data of all study age groups

		Age decimal (years)	SPL (cm)	Weight (kg)	Height (cm)	BMI (kg/m^2)
Mean		**7.42**	**5.79**	**26.49**	**123.3**	**17.09**
Std. Error of Mean		**0.03**	**0.02**	**0.19**	**0.28**	**0.05**
SD		**1.46**	**0.98**	**7.33**	**11.16**	**2.27**
Percentiles	**3**	**5.05**	**3.95**	**16.9**	**105**	**14.08**
	5	**5.16**	**4.2**	**17**	**106**	**14.14**
	10	**5.34**	**4.6**	**18**	**109**	**14.48**
	25	**6.19**	**5**	**21**	**115**	**15.31**
	50	**7.42**	**5.8**	**25**	**124**	**16.6**
	75	**8.67**	**6.5**	**31**	**131**	**18.37**
	85	**9.18**	**6.9**	**35**	**136**	**19.5**
	90	**9.42**	**7.15**	**37**	**139**	**20.33**
	95	**9.67**	**7.4**	**41**	**142**	**21.52**
	97	**9.83**	**7.59**	**43**	**145**	**22.25**

SD = Standard Deviation, SPL = stretched penile length, BMI = body mass index

Table (2): SPL percentiles in all age groups

	Age (years)				
Percentiles	**5-6 years**	**6-7 years**	**7-8 years**	**8-9 years**	**9-10 years**
3rd	**3.7**	**3.75**	**4.5**	**4.7**	**4.6**
5th	**3.8**	**3.85**	**4.6**	**4.75**	**4.65**
10th	**4**	**4.2**	**4.7**	**4.9**	**4.8**
25th	**4.6**	**4.8**	**5.13**	**5.46**	**5.35**
50th	**5.3**	**5.5**	**6**	**6.2**	**6**
75th	**6.1**	**6.3**	**6.5**	**7**	**6.8**
85th	**6.35**	**6.6**	**6.79**	**7.29**	**7.2**
90th	**6.6**	**7**	**7**	**7.5**	**7.4**
95th	**6.75**	**7.2**	**7.4**	**7.7**	**7.6**
97th	**6.99**	**7.3**	**7.5**	**7.8**	**7.8**

SPL = stretched penile length

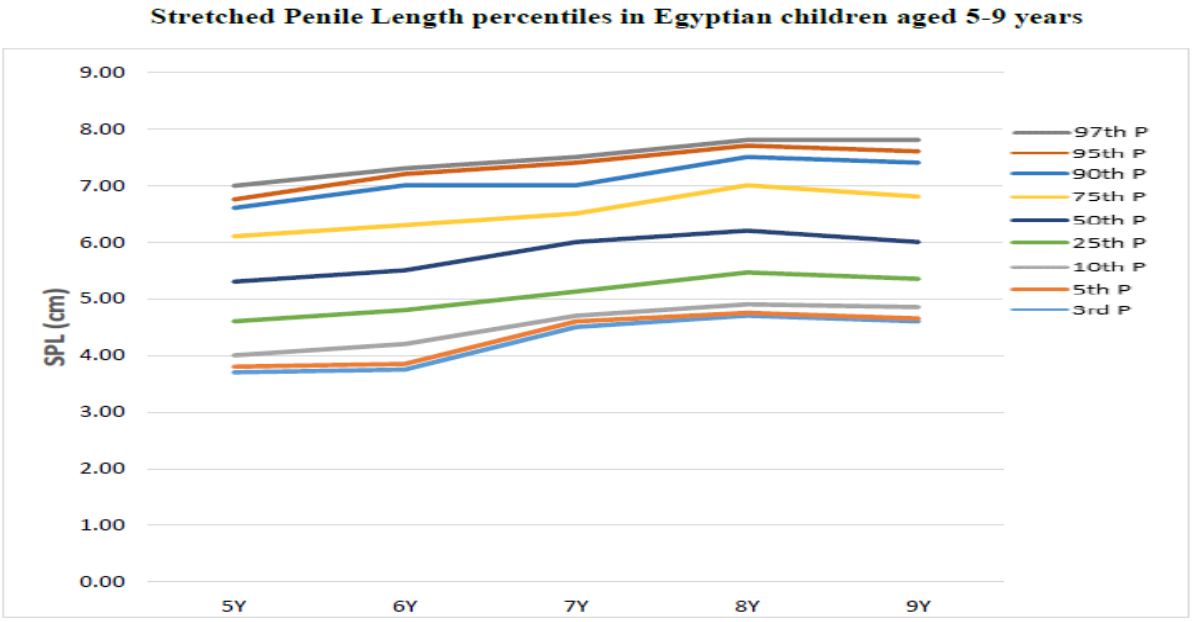

Figure (1): Stretched penile length percentiles in Egyptian children aged 5-9 years

There was significant correlation between SPL, weight & height in 5-, 7-, 8- and 9-years categories. Regarding BMI there was significant correlation in 7-, 8- and 9-years categories as shown in table (3).

Table (3): Coefficient correlation and p value between SPL and age decimal, weight, height, BMI in different age groups

SPL (cm)		Age decimal (years)	Weight (kg)	Height (cm)	BMI (kg/m2)
5y	r*	0.517	0.28	0.309	0.069
	P value	<0.001	<0.001	<0.001	0.235
6y	r*	0.26	0.104	0.047	0.106
	P value	<0.001	0.071	0.416	0.067
7y	r*	0.095	0.151	0.121	0.132
	P value	0.1	0.009	0.036	0.022
8y	r*	0.234	0.205	0.144	0.192
	P value	<0.001	<0.001	0.012	0.001
9y	r*	0.342	0.283	0.348	0.126
	P value	<0.001	<0.001	<0.001	0.03

P-value < 0.05 is considered significant, r*= Pearson's correlation coefficient, SPL= stretched penile length, BMI = body mass index.

We statistically compared our data to those from cross-sectional studies that were conducted similarly in Egypt [12] and in other parts of the world [13, 14, 15, 16] (Table 4).

Table (4): Age-related changes in SPL in comparison with data from previous studies conducted in Korea (group 2) [13], India (group 3) [14], Bulgaria (group 4) [16], China (group 5) [15] and Egypt (group 6) [12].

Age in years	Current study	Park *et al.* 2021 [13]	Teckchanddani and Bajpai 2013 [14]	Tomova *et al.*, 2010 [16]	Wang *et al.* 2018 [15]	El_ammawi *et al.* 2018 [12]	P-VALUE
5-6 years Mean ± SD	5.31 ±0.92	4.5±0.7	6.11±0.61	4.39±0.62	4.45±0.2	5.6±0.8	1 VS 2 (< 0.0001) 1VS 3 (< 0.0002) 1 VS 4 (< 0.0001) 1 VS 5 (< 0.0001) 1 VS 5 (< 0.0001) 1 VS 6 (< 0.01)
6-7 years Mean ± SD	5.51±1.00	4.4±0.5	6.31±0.66	4.53±0.6	4.55±0.27	5.6±0.9	1 VS 2 (< 0.0001) 1VS 3 (0.0005) 1 VS 4 (< 0.0001) 1 VS 5 (< 0.0001) 1 VS 6 (< 0.46)
7-8 years Mean ± SD	5.87±0.85	4.6±0.5	6.5±0.68	4.66±0.68	4.67±0.23	5.8±0.7	1 VS 2(< 0.0001) 1VS 3(< 0.001) 1 VS 4(< 0.0001) 1 VS 5(< 0.0001) 1 VS 6 (< 0.59)
8-9 years Mean ± SD	6.19±0.93	4.7±0.6	6.6±0.75	4.71±0.67	4.81±0.26	5.8±0.8	1 VS 2(< 0.0001) 1VS 3(< 0.05) 1 VS 4(< 0.0001) 1 VS 5(< 0.0001) 1 VS 6 (< 0.002)
9-10 years Mean ± SD	6.10±0.92	4.6±0.9	6.71±0.75	4.66±0.67	4.94±0.26	5.9±0.9	1 VS 2(< 0.0001) 1VS 3(< 0.004) 1 VS 4(< 0.0001) 1 VS 5(< 0.0001) 1 VS 6 (< 0.1)

SD = standard deviation, P-value < 0.05 is considered significant.

DISCUSSION

For diagnosing penile abnormalities, SPL is usually used as a well-defined parameter. Precise measurement of penile length is crucial when a child has genital development problems such as micropenis and concealed penis. Micropenis is defined as 2.5 standard deviations below the mean SPL [17]. On the contrary, by concealed penis we meant an "inconspicuous penis" with normal length [18]. Therefore, SPL is important to differentiate between various penile abnormalities, hence, accurate references for age-related SPL is mandatory.

In this study, the SPL percentile chart and the relationship between the weight, height and BMI of children and SPL of 5-9 years old children are introduced. This might provide a guide for pediatricians in our country to identify penile length abnormalities. Therefore, the target of this study was to develop an Egyptian SPL percentile curve that will be needed for the follow-up of healthy children between the ages of 5 and 9.

A number of variables, including the penile erection, body temperature, ambient temperature, and individual measurement variabilities, might alter SPL values [5]. For that reason, all measurements were obtained by the same well-trained observer and with the same physical circumstances, however, the fact that the data we collected showed differences from the data collected from the other studies may be due to the area where we conducted the study (being a single center, although this center covers a large population variability coming from different regions of our country). Different data were reported in different areas, even though within Egypt [12].

The pattern of penile growth is not well-identified. A previous historical study showed that penile growth is slow up to the age of 5 years this is followed by a steady phase which ends by the start of puberty during which penile growth increases rapidly [6]. This pattern of growth was demonstrated later thereafter in several studies [1, 16]. For this reason, we selected this age group from 5 to 9 years (the steady phase of penile growth) to be explored through our study. It is important to mention that the data obtained in our study are complementary to data obtained from another study held in Egypt at the same timing but done by another research group [2]. Interestingly, our study showed that the mean SPL was significantly lower in age group from 5-6 years and significantly higher in age groups from 8-9 years with P-values of 0.01 and 0.002 respectively when compared to data obtained from the Egyptian study [12]. No detected statistically significant difference between the SPL measurements in the other different age groups (6-7years, 7-8 years, 9-10 years).

On the other hand, when comparing our data to the results of the Korean study mean SPL in all age groups was significantly longer in our study than the Korean cohort with P-value < 0.0001 in each age group [13]. Similarly, our SPLs were significantly longer than the Chinese SPL in all age groups with P-value < 0,0001 in each age group [15]. The same results were obtained when comparing the Egyptian SPL to the Bulgarian subjects; mean SPLs were significantly longer in our Egyptian age groups with P-value <0.0001 in each age group [16].

On the contrary, comparing data derived from Asian Indian boys to our data, the mean SPL in all age groups of the Indian study was significantly longer than mean SPL in our study with P-values of < 0.0002, < 0.0005, < 0.001, < 0.05 and <0.004, respectively [14].

Comparing SPL percentiles values at five-year age group in our study are 3.7, 3.8, 4.6, 5.3, 6.75, 6.99 at 3rd, 5th, 25th, 50th, 95th and 97th percentiles. Respectively in Bulgarian study values were 3.46, 4.5, 5.5 at 5th, 50th and 95th percentiles [16]**.** In Japanese boys at the same age values were 3.4, 4, 4.3, 5.4 at 3rd, 25th, 50th and 97th percentiles [19]. The current study showed that SPL percentiles values at six-years age group were 3.75, 3.85, 4.8, 5.5, 7.2, 7.3 at 3rd, 5th, 25th, 5oth, 95th & 97th percentiles, respectively in another study in Bulgaria values were 3.5, 4.5, 5.5 at 5th, 50th & 95th percentiles [16]**.** In Japanese boys at the same age values were 3.4, 4.1, 4.5, 5.6 at 3rd, 25th, 50th & 97th percentiles **[19]**. Our study also showed that SPL percentiles values at seven-year age group were 4.5, 4.6, 5.13, 6, 7.4, 7.5 at 3rd, 5th, 25th, 50th, 95th and 97th percentiles, while in another study in Bulgaria values were 3.56, 4.6, 6.0 at 5th, 50th and 95th percentiles [16]**.** In Japanese boys at the same age values were 3.5, 4.2, 4.6, 5.7 at 3rd, 25th, 50th and 97th percentiles [19]. At eight years age category SPL percentiles values in our study were 4.75, 6.2, 7.8 at 5th, 50th and 95th percentiles, while in the Bulgarian study values were 3.7, 4.6, 6 at 5th, 50th and 95th percentiles [16]**.** Our SPL percentiles values for nine-year age group were 4.65, 6, 7.8 at 5th, 50th and 95th percentiles, but in Bulgarian boys' values were 3.61, 4.6, 5.89 at 5th, 50th and 95th percentiles [16]**.** SPL was increased directly proportional to age, weight, height & BMI (p<0.001) for overall studied boys. The correlation coefficient values in our study did not follow a regular trend for either weight, height, or BMI. Some age groups showed statistically significant positive relation with SPL, some showed positive but not statistically significant correlation. The inconsistent pattern in the correlation coefficient values in the various age groups could be attributed to the different residential areas of patients. Among all the age groups, the highest correlations were found for SPL with height (0.42), weight (0.28), and BMI (0.19) among the study groups. A North Indian study showed similar correlation and the highest correlation values for SPL in relation to height, weight, and BMI (R-values 0.65, 0.67 and 0.29 [5]. In two Turkish studies, SPL showed direct proportional increase with age, height and body weight [11, 20]. Another study conducted in Indonesia showed that SPL was proportionally increased in relation to height, body weight but not with BMI [21]**.** SPL in the Korean [13], Bulgarian [16] and Chinese [15] studies is significantly lower in all age groups than our data. While the Indian study [10] has reported significantly higher SPL

in all age groups than our corresponding study. In comparison with the Egyptian study was conducted recently [12], SPL in our study in (5-6y) age group was significantly lower but, SPL in (8-9y) age group was significantly higher than the corresponding data in the other Egyptian study and no significant difference was detected in the other age groups.

STUDY STRENGTHS & LIMITATIONS

Our study included many strengths. It included a large sample size around 300 children for each group, a total of 1500 children were enrolled, while other studies included smaller sample size in various age groups. The studied patients' ages were evenly distributed. Another point of strength is the presence of a single observer for SPL measurement thus minimizing interpersonal variabilities. Moreover, in our study we considered the potential impact of well-recognized determinants; weight, height or BMI on the percentile values presented. Finally, the age-specific centiles created by this study can be used easily as useful reference source in clinical practice in Egypt.

One of the limitations of our study included the fact that it was held in one (single center), but it is considered the largest children hospital in Cairo as it receives children from different regions, but it would be better to include more than one hospital in different regions in Egypt. Moreover, the study didn't include uncircumcised healthy children although the same SPL measurement technique could be used after foreskin retraction. The findings provided from our cross-sectional study needs to be confirmed through longitudinal study.

CONCLUSION

We established here SPL reference values and percentiles for our prepubertal Egyptian boys aged 5 to 9 years. The means of SPL were 5.31, 5.51, 5.87, 6.19, 6.1 at five, six, seven, eight and nine years respectively. SPL measurements increased proportionally with age. A statistically significant correlation was found between the weight, height and BMI of the children and SPL measurements at the age of 7, 8 and 9 age groups therefore these anthropometric data (weight, height and BMI) should be taken in consideration while evaluating penile lengths in these age groups. The data we introduced might be crucial in the monitoring of healthy Egyptian boys. We also pointed to the importance of SPL measurement during the routine examination of young male children. Moreover, SPLs of our children were found to be nearly the same as the Korean population. In Indonesia, Japan, Bulgaria & North India, SPLs were found to be smaller than our results, while in Turkey & Asian Indian boys SPL were found to be larger than our results.

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